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Economic Analysis for the National Emission Standards for Hazardous Air Pollutants for Source Category; Pulp and Paper Production; Effluent Limitations Guidelines, Pretreatment Standards, and New Source Performance Standards: Pulp, Paper, and Paperboard Category - Phase 1

Economic Analysis for the National Emission Standards for Hazardous Air Pollutants for Source Category: Pulp and Paper Production; Effluent Limitations Guidelines, Pretreatment Standards, and New Source Performance Standards: Pulp, Paper, and Paperboard Category—Phase 1

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CHAPTER 1

INTRODUCTION

1.1 SCOPE AND PURPOSE

The U.S. Environmental Protection Agency (EPA) promulgates water effluent discharge limits (effluent limitations guidelines and standards or “effluent guidelines”) and air emissions standards for industrial sectors. This Economic Analysis (EA) evaluates the costs and economic impacts of technologies that form the bases for setting these limits and standards for the pulp, paper, and paperboard industry. The report also examines and estimates the qualitative, quantitative, and monetized benefits from reduced pollution, and compares the benefits and costs of the promulgated rules. The report also describes the relative cost-effectiveness of the pollution control technologies and evaluates the costs and impacts of the regulations that significantly impact a substantial number of small businesses. Because EPA considered the air and water requirements jointly, they are known as the "Cluster or Integrated Rules."

The Federal Water Pollution Control Act (commonly known as the Clean Water Act [CWA, 33 U.S.C. §1251 et seq.]) establishes a comprehensive program to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (section 101(a)). EPA is authorized under sections 301, 304, 306, and 307 of the CWA to establish effluent limitations guidelines and standards of performance for industrial dischargers. In part, EPA establishes:

- Best Available Technology Economically Achievable (BAT). Required under section 304(b)(2), these rules control the discharge of toxic and non-conventional pollutants and apply to existing industrial direct dischargers.

- Pretreatment Standards for Existing Sources (PSES). Analogous to BAT controls, these rules apply to existing indirect dischargers (whose discharges flow to publicly owned treatment works, or POTWs).

- New Source Performance Standards (NSPS). Required under section 306(b), these rules control the discharge of toxic and non-conventional pollutants and apply to new source industrial direct dischargers.

- Pretreatment Standards for New Sources (PSNS). Analogous to NSPS controls, these rules apply to new source indirect dischargers (whose discharges flow to publicly owned treatment works, or POTWs).

The Clean Air Act's (CAA, 42 U.S.C. §§7401 to 7671q) purpose is "to protect and enhance the quality of the Nation's air resources" (Section 101(b)). Section 112 of the CAA as amended in 1990 establishes EPA's authority to set national emission standards for 189 hazardous air pollutants (NESHAP). NESHAPs are industry-specific. For air pollutants, EPA establishes:

- Maximum Achievable Control Technology (MACT). MACT standards are set by the NESHAP. The term "MACT floor" refers to minimum control technology on which MACT can be based. For existing sources, the MACT floor is the average emissions limits achieved by the best performing 12 percent of sources (if there are 30 or more sources in the category or subcategory), or best performing 5 sources (if there are fewer than 30 sources in the category or subcategory). MACT can be more stringent than the floor considering costs, non-air-quality health and environmental impacts, and energy requirements.

1.2 REPORT ORGANIZATION

This EA encompasses economic information formerly presented in three separate documents at proposal,[1] presents analyses for final effluent guidelines and air pollution control requirements for noncombustion sources, and includes analyses for proposed air pollution controls on combustion sources. To clarify the roles served by the different analyses, the report is organized as follows:

- Chapter 2—Industry Profile

  Provides background information on the facilities and companies affected by this regulation. The information is presented for two sets of mills: (1) the 158 mills to which final MACT I and proposed MACT II apply[2] and (2) the subset of 96 mills to which final effluent

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[1]Economic impact analysis, cost-effectiveness analysis, and regulatory impact analysis; EPA 1993a, EPA 1993b, and EPA 1993c.

[2]EPA, 1993b identifies 158 mills with kraft, soda, sulfite, or semichemical pulping processes. Of these, 155 mills are anticipated to bear costs under final MACT I and/or proposed MACT II. The counts are caveated because mills may change processes or close operations over time.

limitations guidelines and standards apply. The chapter examines recent industry financial trends, foreign trade, and related industries.

- Chapter 3—Economic Methodology

  Summarizes the economic methodology by which EPA examines incremental pollution control costs and their associated impacts on the industry.

- Chapter 4—Benefits Methodology

  Summarizes the methodology by which EPA identifies, qualifies, quantifies, and—where possible—monetizes the benefits associated with reduced pollution.

- Chapter 5—Regulatory Alternatives: Description, Costs, Pollutant Removals and Cost-effectiveness

  Presents short descriptions of the regulatory alternatives considered by EPA[3]. EPA presents annualized costs reflecting the capital and annual operating and maintenance costs that are associated with more stringent pollution control. EPA summarizes the pollutant reductions associated with the regulatory alternatives. EPA also calculates and presents cost-effectiveness of the regulatory alternatives.

- Chapter 6—Economic Impact Results

  Using the methodology described in Chapter 3, EPA presents the economic impacts associated with the regulatory alternative costs on companies, facilities, regions, and nationwide direct and indirect impacts on employment and output. For example, EPA examines company failures; facility closures; losses in direct employment, production, and exports; increased regional unemployment rates; and total impacts on employment and output. EPA examines these impacts for the two sets of mills described in Chapter 2. In other words, this section presents the findings on which EPA made its determination of economic achievability under the CWA. EPA also examines and presents the findings for the combined costs for promulgated and proposed requirements and various sensitivity analyses.

- Chapter 7—Regulatory Flexibility Analysis and Unfunded Mandates Reform Act

  Pursuant to the Regulatory Flexibility Act as amended by the Small Business Regulatory Enforcement Fairness Act, EPA examines whether the regulatory options have a significant

[3]More detail is given in the Office of Water Development Document (EPA, 1997a) and the Office of Air Background Information Document (EPA, 1997b).

adverse impact on a substantial number of small entities. Chapter 7 also addresses the Unfunded Mandates Reform Act of 1995 (UMRA) requirements. EPA considers the reduction in property tax collection from projected mill closures and the impacts of potential revenue losses at the city/town and county levels.

- Chapter 8—Nationwide Benefits Analysis Results

  Using the methodology described in Chapter 4, EPA prepares an assessment of the nationwide benefits of the regulation pursuant to Executive Order 12866 and UMRA. EPA also presents its environmental justice analysis in Chapter 8 and Appendix F.

- Chapter 9—Benefit-Cost Case Studies

  Using the methodology described in Chapter 4, EPA prepares an assessment of the benefits of increased pollution control for specific regions and mills as part of the cost-benefit analysis of the regulation pursuant to Executive Order 12866 and UMRA.

- Chapter 10—Comparison of Benefits and Costs

  EPA summarizes the costs and benefits of the regulation based on the information in Chapters 5, 8, and 9.

1.3 RULEMAKING HISTORY

1.3.1 Integrated Rulemaking Effort by the Office of Air and the Office of Water

The rulemaking for the pulp, paper, and paperboard industry is an integrated effort coordinated by the Office of Air and Radiation and the Office of Water. The EPA Administrator is authorized by law to set pollution control requirements for this industry. A lawsuit filed by the Environmental Defense Fund and the National Wildlife Federation required the EPA to propose water regulations by 1993, which it did. The CAA Amendments of 1990 require EPA to set MACT standards for the pulp, paper, and paperboard industry by 1997. EPA decided to integrate or cluster the rulemaking efforts, because with the comprehensive perspective afforded by considering both CAA and CWA requirements:

- EPA can encourage pollution prevention approaches that reduce the formation of pollutants, consistent with the Pollution Prevention Act of 1990.

- EPA can reduce the possibility of cross-media pollutant transfers.
- EPA can select controls that optimize pollutant reduction.
- EPA can fully assess the combined economic impact of separate EPA regulations on an industry, more clearly representing real-world conditions.

Industry benefits from the integrated rulemaking through compliance savings by knowing the requirements for all rules in advance of investment. Industry can select the best combination of controls to meet all rules, thus potentially reducing capital equipment costs.

This rulemaking emphasizes pollution prevention. The control technologies considered by EPA include process changes that avoid or minimize the formation of pollutants, as well as "end-of-pipe" control technologies that remove pollutants before their release to air or water. For example, a process change that prevents chloroform formation might also prevent or minimize the formation of dioxin and chlorinated organics. The same process change, however, could affect the amount and type of volatile contaminants sent to the air pollution control equipment. The engineering analysis evaluates the interactions among process changes, the amount and type of contaminants sent to water and air pollution control treatment, and the final releases. This systems-analysis approach evaluates the many interactions of pulping and papermaking operations.

1.3.2 December 1993 Proposal

EPA proposed regulations for the pulp, paper, and paperboard industry on 17 December 1993. Five documents supporting the proposed regulations provide detailed information regarding the proposed rule:

- Economic Impact Analysis (EPA, 1993a).
- Office of Water Development Document (EPA, 1993d).
- Office of Air Quality Planning and Standards Background Information Document (EPA, 1993e).
- Regulatory Impact Analysis (EPA, 1993c).
- Cost-effectiveness Analysis (EPA, 1993b).

1.3.3 Changes From Proposal

EPA published two Notices of Data Availability (NOA, FR, 1996a and FR, 1996b) describing changes from the proposal considered for the rule. These changes include updating mill-specific data to reflect the technology in place as of mid-1995, particularly technology installed after proposal. The updated technology in place has a direct effect on the costs and pollutant removals (both emissions and effluent) that form the basis for the economic, cost-effectiveness, and benefits analyses, see the Development Document for more details (EPA, 1997a). At this time, the following requirements are being promulgated:

- MACT I (non-combustion sources) for the kraft, sulfite, soda, and semichemical subcategories.
- MACT III for mechanical pulping, secondary fiber pulping, and non-wood pulping mills.
- effluent limitations guidelines, new source performance standards, and pretreatment standards for two subcategories—papergrade sulfite and bleached papergrade kraft and soda ("effluent guidelines").

EPA is also proposing MACT II (combustion sources) for the kraft, sulfite, soda, and semichemical subcategories at this time. EPA analyzed the costs and impacts of each separate requirement, the combined promulgated requirements, and the combined promulgated and proposed requirements.

1.3.3.1 Mills and Subcategories Considered

At proposal, the Cluster Rule addressed the entire pulp and paper manufacturing industry. At that time, EPA did not propose subcategories for mills falling under CAA MACT I requirements while—for facilities regulated under the CWA—EPA proposed 12 subcategories to replace the existing subcategorization scheme.

Since proposal, EPA published a notice stating it planned to subcategorize the pulping and associated wastewater components in order to develop different MACT requirements (FR, 1996a). The industry subcategories under MACT I and MACT II are kraft, sulfite, soda, and semichemical. MACT III applies to facilities with mechanical, secondary fiber, and non-wood pulping processes. At this time, MACT I (non-combustion) and MACT III requirements are being promulgated, while MACT II (combustion) requirements are being proposed.

Also since proposal, the EPA published a notice announcing the Agency's intent to develop final effluent guidelines for the bleached papergrade kraft and soda and papergrade sulfite subcategories, and to defer final rules on the other 10 subcategories for up to two years (FR, 1996b). The CAA kraft subcategory is a broader subcategory that includes all mills that use a kraft pulping process. The CWA subcategories make distinctions within the group of mills that use a kraft pulping process; that is, mills in the CWA bleached papergrade kraft, unbleached kraft and dissolving kraft subcategories are all subsumed under the CAA kraft subcategory. The CAA soda subcategory is distinct from the MACT kraft subcategory, but is part of the CWA bleached papergrade kraft and soda subcategory. The CAA sulfite subcategory is a broader category that includes mills that are included in the CWA dissolving sulfite and papergrade sulfite subcategories. In other words, the set of mills covered by today's final effluent guidelines is a subset of the mills covered by the final MACT I and proposed MACT II limitations, see Figure 1-1.

1.3.3.2 Options

MACT

Only one MACT I option is considered in the economic analysis. MACT II air standards are being proposed for the pulp and paper mills previously noted. The control options for pulp and paper combustion sources include: (1) two control options for particulate matter (PM) hazardous air pollutant (HAP) emissions from kraft and soda recovery furnaces, lime kilns, and smelt dissolving tanks (SDTs); (2) one control option for total gaseous organic HAP (TGOHAP) emissions from kraft and soda non-direct contact evaporator (NDCE) recovery furnaces; and (3) two control options for TGOHAP emissions from kraft and soda direct contact evaporator (DCE) recovery furnace systems (i.e., control of black liquor oxidation [BLO] vent emissions [kraft only] and conversion to an NDCE recovery furnace).

The control options also include two PM control options for sulfite combustion sources and two TGOHAP control options for semichemical combustion sources. Option one for semichemical combustion

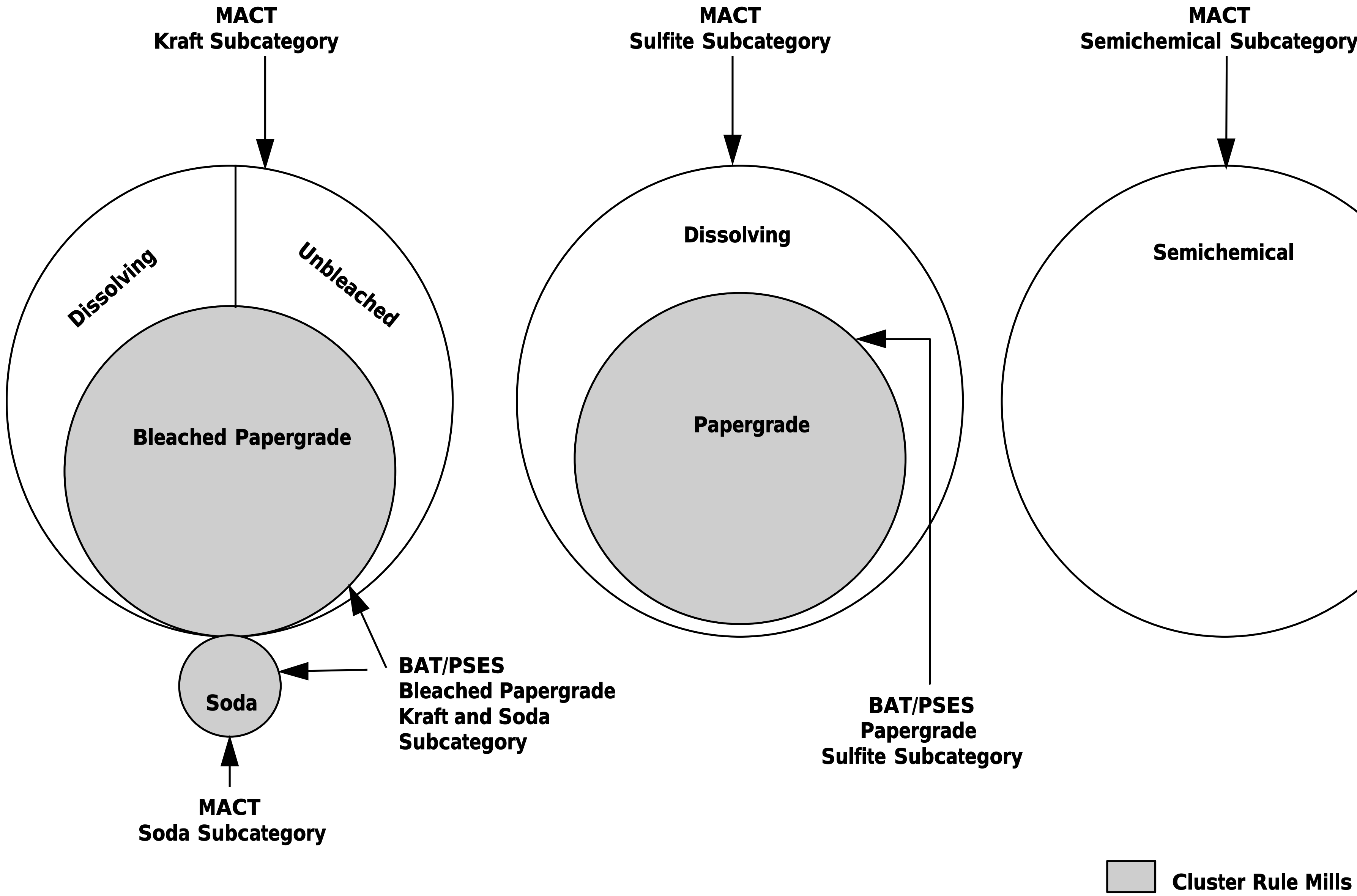

Figure 1-1. Relationship between MACT- and BAT/PSES-Regulated Subcategories

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sources is the floor control option that involves no add-on controls or control costs. Only MACT II option two for semichemical combustion sources, an above the floor option, is considered in the EA analyses.

The operations addressed in the MACT III standard also have been noted previously. A Presumptive MACT was completed in September 1995 for MACT III. There was very little data available on HAP emissions from MACT III mills and the available data indicated that there are no air pollution control devices in place on MACT III sources except for possibly chlorine bleaching. Based on the Presumptive MACT, MACT III was proposed with the MACT I announcement of availability of supplemental information on March 8, 1996. The final MACT for MACT III sources is no add-on control.

Effluent Guidelines

For the final rule, as discussed in the July 15, 1996, NOA, EPA has examined an additional option for BAT/PSES and NSPS/PSNS for the bleached papergrade kraft and soda subcategory (Option A) - 100 percent substitution of chlorine dioxide for elemental chlorine. The second option (Option B) described in this economic assessment is the technology basis from proposal, which includes 100 percent substitution of chlorine dioxide for chlorine plus oxygen delignification or extended cooking. EPA also examined totally chlorine free (TCF) technology as a basis for BAT/PSES and NSPS/PSNS for the bleached papergrade kraft and soda subcategory.

For three segments of the papergrade sulfite subcategory, EPA examined TCF and elemental chlorine free (ECF) technologies as bases for BAT/PSES and NSPS/PSNS. The promulgated requirements differ by subcategory segment.

1.3.3.3 Methodology

EPA revised components of the economic methodology to account for recent changes that have occurred in the pulp and paper industry, including: (1) a revised discount rate, (2) integration of market effects (such as the ability to pass on pollution control costs through price increases) to the financial closure model, (3) incorporating new industry cycle data into the forecasting methodology, (4) moving the starting year for the analysis to 1996, (5) incorporating updated mill ownership data in the Altman's Z model (bankruptcy analysis based on a weighted average of financial ratios), and (6) revising the calculation of annual costs.

EPA uses a 7-percent real discount rate in the analysis to reflect the drop in interest rates that has occurred since 1989; the Office of Management and Budget also recommends this discount rate to evaluate the social costs of federal regulations (OMB, 1992). EPA investigates the effects of a different cost of capital to provide a sensitivity analysis (see Chapter 6). EPA used both a financial model and a comprehensive market model to assess economic effects at proposal. Much of the information used in the market model was derived from the 1989 Section 308 survey. A number of substantial changes have occurred in pulp and paper markets since 1989 that this model does not reflect. EPA decided not to update the market model because an update would have required a new survey of all mills and product lines. This would have been unnecessarily costly and burdensome to mill operators and not likely to produce analytical results significantly different from the financial model. Instead, EPA modified the financial model to incorporate product supply and demand elasticities, which are estimates of changes in supply or demand in response to price changes.

Between 1988 and 1995, the pulp and paper industry completed a full industry revenue cycle with revenues peaking in 1988, falling through 1992, and reaching new heights in 1995. This information was incorporated into the forecasting methods within the facility closure model. EPA obtained updated financial facility information for publicly held companies for the Altman's Z (financial ratio, also called the company failure or bankruptcy analysis) analysis. The inability to update facility-level financial information for all facilities, including privately held firms, without a new survey led to EPA discontinuing the facility financial ratio analysis. While the facility financial analysis provided some useful information, it did not provide the basis for making determinations of economic achievability at proposal.

EPA considers general and variable annual costs in the cost annualization calculation. At proposal, the economic impact analysis calculated general annual costs (GAC) as 4 percent of capital costs plus 60 percent of variable annual costs. Subsequent analysis indicated that the cost estimates for effluent control provided in the Development Document already included the 60 percent of variable annual costs. To remove this double-counting, GAC is now calculated as 4 percent of capital costs for effluent control (CIRT, 1994) GAC is added in the economic impact analysis after the engineering estimates and prior to cost annualization;

this explains any differences between engineering and economic estimates of operating and maintenance costs.

In sum, EPA has made a number of changes in response to:

- comments;
- new options;
- changes in the industry; and
- new financial and economic information.

As a result of these changes, both analytical methods and results have changed from proposal. More details on these changes are found in Chapter 2— Industry Profile and Chapter 3—Economic Impact and Regulatory Flexibility Analysis Methodology.

1.4 REFERENCES

Reference material supporting Chapter 1 is located in the Pulp and Paper Water Docket.

CIRT. 1994. Pulp & Paper Cost Issues Review Team (CIRT). Telephone summary of conference call. 30 March 1994. Water Docket, DCN 14,086.

FR. 1996a. National emission standards for hazardous air pollutants for source category: pulp and paper. Environmental Protection Agency. Notice of Availability. *Federal Register* 61(47):9383-9399. March 8. Water Docket, DCN 13,212.

FR. 1996b. Effluent limitations guidelines, pretreatment standards, and new source performance standards: pulp, paper, and paperboard category; national emission standards for hazardous air pollutants for source category: pulp and paper production. Environmental Protection Agency. Notice of Availability. *Federal Register* 61(136):36835-36858. July 15. Water Docket, DCN 13,471.

OMB. 1992. Guideline and discount rates for benefit-cost analysis of Federal programs. Washington, DC: Office of Management and Budget. Revised circular No. A-94. Water Docket, DCN 14,301.

U.S. EPA. 1993a. Economic impact and regulatory flexibility analysis of proposed effluent guidelines and NESHAP for the pulp, paper, and paperboard industry. EPA/821/R-93/021. Washington, DC: Office of Water. Water Docket, DCN 8,590.

U.S. EPA. 1993b. Cost-effectiveness analysis of proposed effluent limitations guidelines for the pulp, paper, and paperboard industry. EPA/821/R-93/018. Washington, DC: Office of Water. Water Docket, DCN 33,595.

U.S. EPA. 1993c. Regulatory impact assessment of proposed effluent limitations guidelines and NESHAP for the pulp, paper, and paperboard industry. EPA/821/R-93/020. Washington, DC: Office of Water. Water Docket, DCN 8,587.

U.S. EPA. 1993d. Development document for proposed effluent limitations guidelines for the pulp, paper, and paperboard point source category. EPA/821/R-93/019. Washington, DC: Office of Water. Water Docket, DCN 8,517.

U.S. EPA. 1993e. Pulp, paper, and paperboard industry background information for proposed air emission standards. EPA/453/R-93/050a. Washington, DC: Office of Air Quality Planning and Standards. Water Docket, DCN 8,586.

U.S. EPA. 1997a. Supplemental development document for effluent limitations guidelines and standards for the for the pulp, paper, and paperboard category subpart B (bleached papergrade kraft and soda) and subpart E (papergrade sulfite). Washington, DC: Office of Water. Water Docket, DCN 14,487.

U.S. EPA. 1997b. Pulp, paper, and paperboard industry—background information for promulgated air emission standards, manufacturing processes at kraft, sulfite, soda, semi-chemical, mechanical and secondary and non-wood fiber mills, final EIS. EPA-453/R-93-050b. Washington, DC: Office of Air Quality Planning and Standards. Water Docket, DCN 14,319.

CHAPTER 2

INDUSTRY PROFILE

The U.S. pulp, paper, paperboard and allied products industry is the eleventh largest contributor of all U.S. manufacturing industries to the U.S. gross domestic product (GDP), with aggregate shipments totaling $169 billion in 1995. In addition, the U.S. industry currently enjoys a dominant position in the international pulp, paper, and paperboard market because of its low per-unit labor costs, high-quality production, and favorable exchange rates. Historically, the pulp and paper industry has represented one of the nation's most heavily capitalized economic sectors. Capital expenditures by the industry in 1993 totaled approximately $8.24 billion (Stanley, 1996).

The industry profile for the proposed Cluster Rule (FR, 1993) encompassed the entire industry. The data used in the profile were based on over 500 mills in all subcategories, including 325 mills potentially affected by both the proposed air and water regulations. The industry profile associated with this report describes two interrelated sets of mills:

- the 158[1] mills covered by the final MACT I (non-combustion) and proposed MACT II (combustion) requirements. These mills are called MACT-regulated mills throughout the rest of the chapter.

- the 96 mills covered by final effluent guidelines. These 96 mills are a subset of the of the 158 mills covered by the MACT requirements and are called BAT/PSES-regulated mills throughout the rest of the chapter. Because these mills are covered by both BAT/PSES and MACT requirements, they are also called Cluster Rule mills.

The industry profile has two foci:

- To describe the mills affected by the final Cluster Rule (final effluent guidelines and MACT I) and proposed MACT II.

- To describe industry-wide changes and trends since the rule's proposal, which EPA discussed in the Notice of Availability 61 FR 36835-36858 (July 15, 1996).

[1]EPA, 1993b identifies 158 mills with kraft, soda, sulfite, or semichemical pulping processes. Of these, 155 mills are anticipated to bear costs under final MACT I and/or proposed MACT II. The counts are caveated because mills may change processes or close operations over time.

As such, the profile describes the baseline against which economic impacts are measured. The reader is directed to three documents supporting the proposed regulations for more detailed information:

- Economic Impact Analysis (EPA, 1993a).
- Office of Water Development Document (EPA, 1993b).
- Office of Air Quality Planning and Standards Background Information Document (EPA, 1993c).

These documents present information on the raw materials, industry processes, alternative technologies, emissions, effluents, other environmental issues (i.e., recycling, chlorine-free products, and pollution prevention), and environmental regulations affecting foreign competitors.

This chapter describes factors that affect the economic impact analysis. Section 2.1 identifies the subcategories being regulated under this rule and briefly explains how the Clean Air Act (CAA) and Clean Water Act (CWA) subcategories relate to each other. Sections 2.2 and 2.3 present information regarding these groups of facilities on an aggregated basis. Company information is presented in Section 2.4, while business patterns for the industry are described in Section 2.5. Section 2.6 discusses issues on international competitiveness and Section 2.7 describes related industries potentially affected by the proposed MACT II and the final Cluster Rule.

2.1 SUBCATEGORIES REGULATED UNDER THIS RULE

As mentioned above, the proposed Cluster Rule addressed the entire industry (FR, 1993). At that time, the CAA proposal did not differentiate MACT I requirements by subcategory while the CWA proposal contained 12 subcategories to replace the existing subcategorization scheme.

Since proposal, EPA published a notice stating it planned to subcategorize the pulping and associated wastewater components to develop different MACT requirements. The subcategories being considered are kraft, sulfite, soda, and semichemical. More details are given in FR 1996a and the preamble supported by this study. At this time, EPA is promulgating MACT I (non-combustion) and MACT III requirements and proposing MACT II (combustion) requirements. The MACT III rule contains National

Emission Standards for Hazardous Air Pollutants (NESHAP) for mechanical pulping, secondary fiber pulping, and non-wood pulping mills. No emission reductions or control costs, however, are associated with the MACT III rule and mills to which only MACT III applies are not discussed further in the industry profile.

At this time, the economic analysis presents results for several sets of analyses:

- 96 mills subject to BAT/PSES
- combined costs for the clustered regulations (also called the Cluster Rule) for the group of 96 mills covered by the promulgated effluent guidelines and promulgated MACT I.
- combined costs for the 96 mills for effluent guidelines, MACT I, and MACT II alternatives.
- costs for the 155 mills covered by MACT I and MACT II. Three sets of costs are presented: MACT I only, MACT II only, and combined MACT I and MACT II.
- combined costs for the 155 mills: BAT/PSES, MACT I, and MACT II.

The industry profile presented in support of the 1993 Proposal reflected all mills in operation as of February 1993. Facility-specific data from EPA's industry survey (EPA, 1991), also called the 308 survey because the data were collected under the authority of Section 308 of the CWA, are presented here for both sets of mills to provide the basis for evaluating the economic impacts. The most recent year for the survey data is 1989, but it is still the only source of facility-specific data available without repeating the survey. The profile of mills has been updated to reflect ownership and type of production as of the end of 1995. There are 96 and 158 mills affected by the final effluent guidelines and MACT requirements, respectively. Data for 94 and 156 mills (effluent guideline and MACT requirements, respectively) are available from the survey.[2] The data in Sections 2.2 and 2.3 are presented twice, once for each set of mills. For simplicity, mills affected by the final effluent guidelines are called "BAT/PSES-regulated" mills in the following sections while those regulated under MACT are called "MACT-regulated" mills. Figure and table numbers ending in "W" and "A" present data for the BAT/PSES- and MACT-regulated mills, respectively.

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[2]Two mills went into operation after the survey (1989 data). They are included in the mill counts, cost estimates, and all other facets of the industry profile and economic analysis with the exception of the survey data.

2.2 PRODUCTS AND MARKETS

If clarification is needed, the reader is referred to the EIA for Proposal where Tables 2-2, 2-8, and 2-14 cross-reference the codes used in the EPA survey with the American Forest and Paper Association's (AF&PA's) statistical categories (EPA, 1993a).

2.2.1 Pulp, Paper, and Paperboard Shipments

Table 2-1 lists pulp, paper, and paperboard shipments in tons. Two sources are shown for 1989 data. The first is EPA data collected via the 308 survey. Facility-specific information is aggregated over all facilities to obtain the industry totals shown in the first column of Table 2-1. The second column contains the 1989 industry totals as published by the American Forest & Paper Association (AF&PA; AF&PA 1996a). The AF&PA data are available only on an industry-wide basis. As such, they are useful for examining industry trends but not for facility-specific analyses. A comparison of the first and second columns, shown in the third column, illustrates the relationship between the EPA subset of mills and AF&PA industry-wide data for the same year. Some variations between the two sets of data should be expected because the EPA data are from a census while industry data are based on a sample.[3] Industry shipment data for 1995, shown in the fourth column, are taken from AF&PA 1996a. A comparison of AF&PA industry data for 1989 and 1995 (i.e., columns 2 and 4) is shown in the fifth column which indicates the industry-wide changes since 1989.

Table 2-1W lists the shipments for the BAT/PSES-regulated mills while Table 2-1A lists the shipments for the larger group of MACT-regulated mills. An examination of Table 2-1W highlights several features of the BAT/PSES-regulated mills. As expected, they account for all of the U.S. market bleached kraft (sulfate) pulp production reported in the AF&PA statistics.[4] The mills account for a substantial portion of the market unbleached kraft pulp and some nonchemical pulps as well. The reported market bleached sulfite pulp, however, is only about 10 percent of that reported in AF&PA, indicating substantial sulfite pulp

[3]The relationship between the product codes used in the EPA survey and AF&PA's statistical categories is summarized in Tables 2-2, 2-8, and 2-14 in the EIA for proposal (EPA, 1993a).

[4]The EPA data show a larger tonnage than the AF&PA data. Some variations between the two data sources should be expected because one is based on a census while the other is based on a sample.

TABLE 2-1W

PULP, PAPER, AND PAPERBOARD SHIPMENT TONNAGE STATISTICS FROM EPA SURVEY AND AF&PA STATISTICS BAT/PSES-REGULATED MILLS

	Shipments (tons)				
Product Name	EPA Survey BAT/PSES-Regulated Mills 1989	Industry Totals AF&PA Statistics 1989	Percent*	Industry Totals AF&PA Statistics 1995	Percent Change From 1989 to 1995 AF&PA Statistics
Pulp					
Sulfate-bleached	8,905,844	6,842,000	130%	8,534,000	25%
Sulfate-unbleached	94,085	161,000	58%	254,000	58%
Sulfite-bleached	21,103	237,000	9%	213,000	-10%
Groundwood	166,932	n/a	n/a	n/a	n/a
Thermomechanical	ND	n/a	n/a	n/a	n/a
Defibrated	53,045	n/a	n/a	n/a	n/a
Total Pulp	9,241,009	7,240,000	128%	9,001,000	24%
Paper					
Newsprint	2,993,712	6,088,000	49%	7,001,800	15%
Uncoated groundwood	496,621	1,742,700	28%	2,129,600	22%
Clay coated printing and converted	4,652,437	7,215,400	64%	8,795,400	22%
Uncoated free sheet	8,337,376	11,080,700	75%	12,996,500	17%
Bleached bristols	1,080,538	1,163,100	93%	1,360,700	17%
Cotton fiber writing	245,705	160,800	153%	123,000	-24%
Unbleached kraft packaging	1,302,851	2,682,100	49%	2,006,800	-25%
Special industrial and packaging	90,645	1,767,200	5%	1,870,000	6%
Tissue	1,927,663	5,636,500	34%	6,210,300	10%
Wrapping	59,360	28,200	210%	26,500	-6%
Shipping sack	333,875	102,000	327%	115,100	13%
Bag and sack	70,896	256,000	28%	170,400	-33%
Other bag and sack paper for conversion	77,860	81,800	95%	74,600	-9%
Total Paper	21,669,539	38,004,500	57%	42,880,700	13%
Paperboard					
Unbleached kraft packaging and industrial	2,925,138	19,490,100	15%	22,697,600	16%
Semichemical, including corrugated medium	564,901	5,656,000	10%	5,661,900	0%
Recycled paperboard	ND	8,851,900	0%	12,976,700	47%
Linerboard	362,620	177,700	204%	151,600	-15%
Folding carton	2,099,734	1,965,800	107%	2,067,700	5%
Milk carton	1,120,306	565,600	198%	626,900	11%
Heavyweight cup and round nested food container	425,541	452,400	94%	724,800	60%
Plate, dish, and tray stock	216,543	362,100	60%	458,800	27%
Bleached paperboard for miscellaneous packaging	54,853	930,000	6%	1,207,300	30%
Other bleached, incl. board for moist, oily, & liquid food	531,817	n/a	n/a	n/a	n/a
Total Paperboard	8,301,453	38,451,600	22%	46,573,300	21%

*Column measures percentage of 1989 BPK and PS mill production from the EPA survey with respect to total industry production from AF&PA statistics.
ND: Data not disclosed due to confidentiality.
Totals for pulp and paperboard exclude nondisclosed figures.
n/a: not available.

Sources: AF&PA. 1996a. 1996 Statistics; Paper, Paperboard, and Wood Pulp. American Forest and Paper Association, Washington, DC.; U.S. EPA. 1991. 1990 National Census of Pulp, Paper, and Paperboard Manufacturing Facilities. Washington, DC. October, 1991.

TABLE 2-1A

PULP, PAPER, AND PAPERBOARD SHIPMENT TONNAGE STATISTICS FROM EPA SURVEY AND AF&PA STATISTICS MACT-REGULATED MILLS

	Shipments (tons)				
Product Name	EPA Survey MACT-Regulated Mills 1989	Industry Totals AF&PA Statistics 1989	Percent*	Industry Totals AF&PA Statistics 1995	Percent Change From 1989 to 1995 AF&PA Statistics
Pulp					
Special alpha and dissolving woodpulp	1,413,751	1,423,000	99%	n/a	n/a
Sulfate-bleached	9,438,949	6,842,000	138%	8,534,000	25%
Sulfate-unbleached	109,825	161,000	68%	254,000	58%
Sulfite-bleached	218,538	237,000	92%	213,000	-10%
Groundwood	ND	n/a	n/a	n/a	n/a
Thermomechanical	ND	n/a	n/a	n/a	n/a
Defibrated	ND	n/a	n/a	n/a	n/a
Total Pulp	11,234,438	7,240,000	155%	9,001,000	24%
Paper					
Newsprint	3,277,154	6,088,000	54%	7,001,800	15%
Uncoated groundwood	496,621	1,742,700	28%	2,129,600	22%
Clay coated printing and converted	4,652,437	7,215,400	64%	8,795,400	22%
Uncoated free sheet	8,494,061	11,080,700	77%	12,996,500	17%
Bleached bristols	1,080,538	1,163,100	93%	1,360,700	17%
Cotton fiber writing	278,211	160,800	173%	123,000	-24%
Unbleached kraft packaging	2,876,155	2,682,100	107%	2,006,800	-25%
Special industrial and packaging	345,651	1,767,200	20%	1,870,000	6%
Tissue	2,030,063	5,636,400	36%	6,210,300	10%
Wrapping	59,360	28,200	210%	26,500	-6%
Shipping sack	333,875	102,000	327%	115,100	13%
Other shipping sack, incl. rope and kraft/rope	ND	n/a	n/a	n/a	n/a
Bag and sack	70,896	256,000	28%	170,400	-33%
Other bag and sack paper for conversion	10,548	81,800	13%	74,600	-9%
Total Paper	24,005,570	38,004,400	63%	42,880,700	13%
Paperboard					
Unbleached kraft packaging and industrial	18,688,142	19,490,100	96%	22,697,600	16%
Semichemical, including corrugated medium	5,542,883	5,656,000	98%	5,661,900	0%
Recycled paperboard	ND	8,851,900	0%	12,976,700	47%
Linerboard	362,833	177,700	204%	151,600	-15%
Folding carton	2,099,734	1,965,800	107%	2,067,700	5%
Milk carton	1,120,306	565,600	198%	626,900	11%
Heavyweight cup and round nested food container	425,541	452,400	94%	724,800	60%
Plate, dish, and tray stock	216,543	362,100	60%	458,800	27%
Bleached paperboard for miscellaneous packaging	54,853	930,000	6%	1,207,300	30%
Other bleached, incl. board for moist, oily, & liquid food	531,817	n/a	n/a	n/a	n/a
Total Paperboard	29,042,652	38,451,600	76%	46,573,300	21%

*Column measures percentage of 1989 BPK and PS mill production from EPA survey with respect to total industry production from AF&PA statistics.
ND: Data not disclosed due to confidentiality.
Total for pulp includes nondisclosed figures. Totals for paper and paperboard exclude nondisclosed figures.
n/a: not available.

Sources: AF&PA. 1996a. 1996 Statistics; Paper, Paperboard, and Wood Pulp. American Forest and Paper Association, Washington, DC.; U.S. EPA. 1991. 1990 National Census of Pulp, Paper, and Paperboard Manufacturing Facilities. Washington, DC. October, 1991.

production from mills not being regulated in this rulemaking. The same set of BAT/PSES-regulated mills accounts for nearly 60 percent of the paper products (in tons), indicating a high level of integration at mills with these chemical pulping and bleaching operations.

Table 2-1A highlights the more extensive nature of the MACT-regulated mill population. The group accounts for all dissolving pulp and over 90 percent of the bleached sulfite pulp reported by AF&PA. The variation among the pulp types reported in the EPA survey and estimated by AF&PA may reflect small differences in categorization of particular pulps between the two sources. The MACT-regulated mills also show a high level of integration, accounting for nearly all of the unbleached and semichemical paperboard production. In general, the MACT-regulated mills represent nearly two-thirds of paper production and three-quarters of paperboard production tonnage.

From 1989 to 1995, the industry showed an 25 percent increase in bleached kraft pulp shipments but a 10 percent decrease in bleached sulfite pulp shipments. During the same period, paper shipments increased by 4.9 million tons (13 percent) while paperboard shipments increased by 8.1 million tons (21 percent).

2.2.2 Value of Pulp, Paper, and Paperboard Shipments

Table 2-2 lists the value of product shipments in thousands of current dollars. The BAT/PSES-regulated mills (top half of the table) account for 71, 54, and 31 percent of the 1989 pulp, paper, and paperboard shipments, respectively. Although the BAT/PSES-regulated mills are less than 20 percent of the mill population, they account for about half of the industry pulp, paper, and paperboard production. The MACT-regulated mills (bottom half of the table) account for 90, 59, and 80 percent of the 1989 industry shipments for pulp, paper, and paperboard, respectively,[5] or nearly 70 percent of all industry production.

During 1989, the industry entered a cyclical slump. Table 2-1 indicates how shipments increased from 1989 to 1995 while Table 2-2 indicates how the values of those shipments decreased from 1989 to 1994 (the most recent year available in AF&PA, 1996a) due to falling pulp prices. Shipments for SICs 261,

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[5]The BAT/PSES-regulated mills are a subset of the MACT-regulated mills; the percentages are not additive.

TABLE 2-2

VALUE OF PULP, PAPER, AND PAPERBOARD SHIPMENTS

Product Category	Shipments (thousands of current dollars)				
	EPA Survey 1989	Industry Totals AF&PA Statistics 1989	Percentage*	Industry Totals AF&PA Statistics 1994	Percent Change From 1989 to 1994 AF&PA Statistics
BAT/PSES-REGULATED MILLS					
Pulp	$5,468,222	$7,719,000	70.84%	$5,941,000	-23.03%
Paper	$18,027,340	$33,293,000	54.15%	$32,440,000	-2.56%
Paperboard	$5,120,793	$16,352,000	31.32%	$18,444,000	12.79%
Total	$28,616,355	$57,364,000	49.89%	$56,825,000	-0.94%
MACT-REGULATED MILLS					
Pulp	$6,959,710	$7,719,000	90.16%	$5,941,000	-23.03%
Paper	$19,513,018	$33,293,000	58.61%	$32,440,000	-2.56%
Paperboard	$13,119,784	$16,352,000	80.23%	$18,444,000	12.79%
Total	$39,592,512	$57,364,000	69.02%	$56,825,000	-0.94%

*Column measures percentage of 1989 BAT/PSES-regulated or MACT-regulated mill shipment value from the EPA survey with respect to total industry shipment value from AF&PA statistics.

Sources: AF&PA. 1996a. 1996 Statistics; Paper, Paperboard, and Wood Pulp. American Forest and Paper Association, Washington, DC.; U.S. EPA. 1991. 1990 National Census of Pulp, Paper, and Paperboard Manufacturing Facilities. Washington, DC. October, 1991.

262, and 263 totalled $57 million in 1989, $52 million in 1993, $57 million in 1994, and $75 million in 1995 (AFPA, 1996a and Stanley, 1996).

Table 2-3 presents statistics relevant to the value of 1989 shipments by facility. The range is from $0 to $367 million in pulp shipments for both BAT/PSES and MACT-regulated mills.[6] A typical BAT/PSES-regulated mill ships $58 million while a typical MACT-regulated mill ships $44 million in pulp. Loss in shipments is a direct impact of either the BAT/PSES or MACT regulations, which is calculated by examining the value of shipments from facilities that are projected to close under increased pollution control costs. Facility-specific information on shipments, exports, and employment is available only from the 308 survey. Impacts, therefore, are calculated based on 1989 data from the survey.

2.2.3 Exports

Table 2-4 summarizes the value of pulp, paper, and paperboard exports for BAT/PSES-regulated and MACT-regulated mills. Table 2-4 follows the same 5-column pattern described for Table 2-1; 1989 data from EPA and AF&PA in the first and second columns, a comparison of the 1989 data in the third column, AF&PA 1995 data in the fourth column, and a 1989 to 1995 comparison of AF&PA data in the fifth column. Table 2-4 indicates that the BAT/PSES-regulated mills represented approximately two-thirds of the industry's 1989 pulp exports and about one-third of the paper and paperboard exports. The MACT-regulated mills accounted for over 90 percent of the pulp exports and 77 percent of the paperboard exports. Loss in exports is a direct impact of the rule calculated by examining the tonnage exported from facilities projected to close under increased pollution control costs (see Chapter Six). For reasons given in Section 2.2.2, data from 1989 are used to assess impacts in Chapter Six.

While pulp, paper, and paperboard exports, in general, increased by $4.6 billion from 1989 to 1995 in current dollars, the mix of products changed. Annual pulp, paper, and paperboard exports all increased in value. Annual pulp exports increased by 30 percent from $3.5 billion to $4.5 billion. Annual paper exports more than doubled from $1.2 billion in 1989 to $3.1 billion in 1995. Paperboard exports also more than doubled from $1.7 billion in 1989 to $3.5 billion in 1995. It should be noted that exports increased during a

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[6] A mill with $0 shipments reflects data not held at the facility level.

TABLE 2-3

VALUE OF PULP, PAPER, AND PAPERBOARD SHIPMENTS
1989 DATA

Statistic	Facility Value of Shipments (thousands of 1989 dollars)		
	Pulp	Paper	Paperboard
BAT/PSES-REGULATED MILLS			
Observations	94	94	94
Minimum	$0	$0	$0
Maximum	$364,738	$718,702	$497,031
Median	$10,647	$171,605	$0
Average	$58,173	$191,780	$54,477
Total	$5,468,222	$18,027,340	$5,120,793
MACT-REGULATED MILLS			
Observations	158	158	158
Minimum	$0	$0	$0
Maximum	$366,918	$718,702	$497,031
Median	$0	$69,710	$47
Average	$44,049	$123,500	$83,037
Total	$6,959,710	$19,513,018	$13,119,784

Source: U.S. EPA. 1991. 1990 National Census of Pulp, Paper, and Paperboard Manufacturing Facilities. Washington, DC. October, 1991.

TABLE 2-4

VALUE OF PULP, PAPER, AND PAPERBOARD EXPORTS

	Exports (thousands of current dollars)				
Product Category	EPA Survey 1989	Industry Totals AF&PA Statistics 1989	Percent*	Industry Totals AF&PA Statistics 1995	Percent Change From 1989 to 1995 AF&PA Statistics
BAT/PSES-REGULATED MILLS					
Pulp	$2,321,690	$3,512,604	66.10%	$4,536,523	29.15%
Paper	$375,437	$1,233,526	30.44%	$3,112,293	152.31%
Paperboard	$638,088	$1,734,402	36.79%	$3,456,711	99.30%
Total	$3,335,215	$6,480,532	51.47%	$11,105,527	71.37%
MACT-REGULATED MILLS					
Pulp	$3,185,916	$3,512,604	90.70%	$4,536,523	29.15%
Paper	$438,846	$1,233,526	35.58%	$3,112,293	152.31%
Paperboard	$1,332,836	$1,734,402	76.85%	$3,456,711	99.30%
Total	$4,957,598	$6,480,532	76.50%	$11,105,527	71.37%

*Column measures percentage of 1989 BAT/PSES-regulated or MACT-regulated mill export value from the EPA survey with respect to total industry export value from AF&PA statistics.

Sources: AF&PA. 1996a. 1996 Statistics; Paper, Paperboard, and Wood Pulp. American Forest and Paper Association. Washington, DC.; U.S. EPA. 1991. 1990 National Census of Pulp, Paper, and Paperboard Manufacturing Facilities. Washington, DC. October, 1991.

period when industry was not only combating an industry downturn but increasing investments in environmental controls as well.

2.3 FACILITY-LEVEL INFORMATION

2.3.1 Geographic Distribution of Facilities

Figures 2-1 and 2-2 illustrate the geographic distribution of facilities. Figure 2-1 illustrates the predominance of facilities along the eastern portion of the country. Figures 2-2W and 2-2A are histograms where the states are rank-ordered by the number of facilities. Twenty-seven states are home to facilities affected by the effluent guidelines. Alabama has the most mills (11 BAT/PSES and 15 MACT-regulated mills); Maine, Washington, and Wisconsin each have seven to eight BAT/PSES-regulated mills. Georgia, Wisconsin, Washington, and Louisiana each have 10 to 12 MACT-regulated mills. As of 1995, no additional mills have opened in the regulated subcategories since 1993. Of the mills to be affected by the final rule, one mill has closed and one has changed subcategory since 1993.[7]

2.3.2 Facility Size

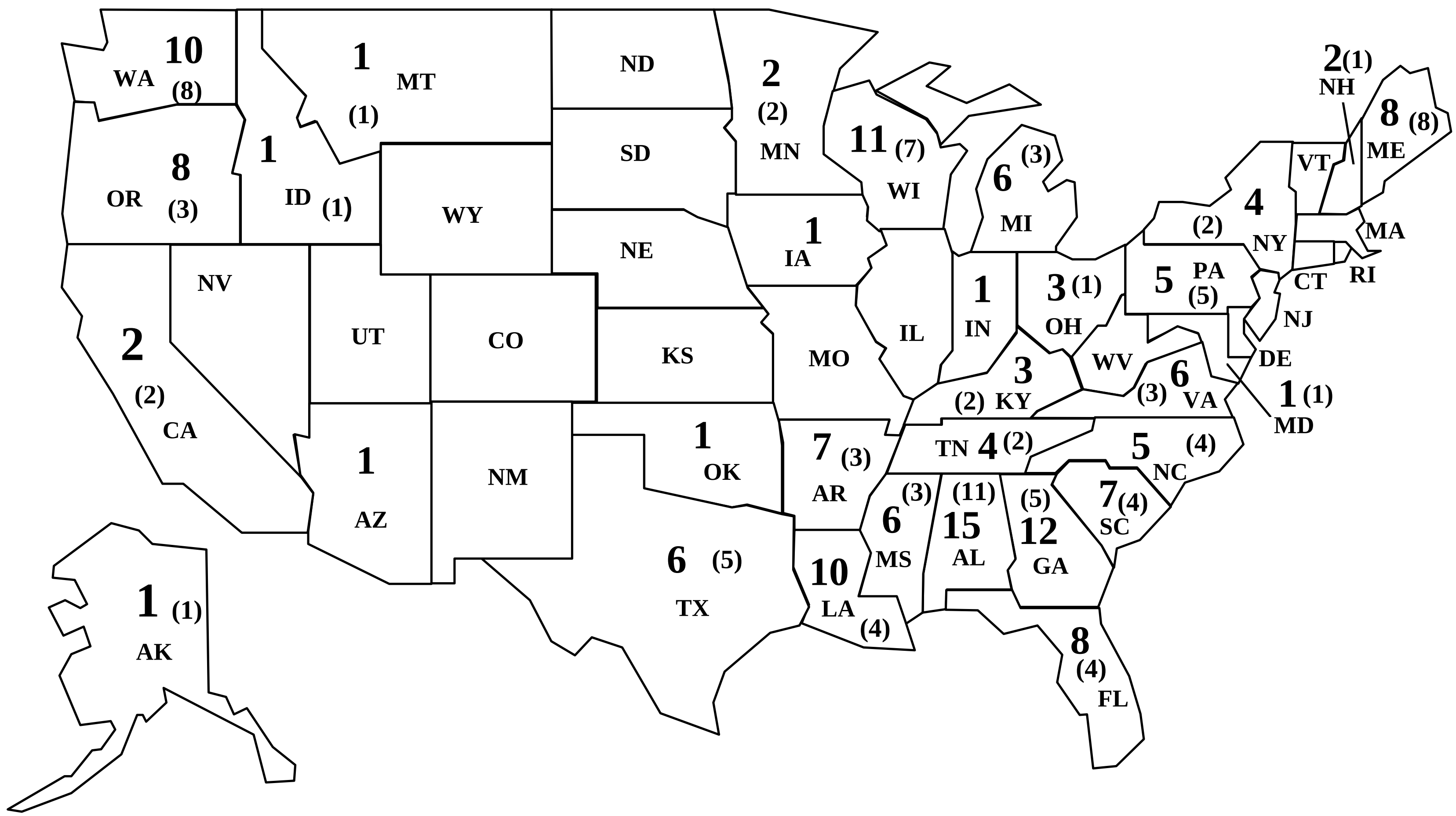
2.3.2.1 Assets

Facility-level asset value information is an integral part of the closure analysis (Chapter 6) because asset value determines salvage value and closure is determined when salvage value exceeds the present value of forecasted earnings. The EPA survey is the only source of such data; there are no publicly available sources with which to update it. The asset determination for a mill, therefore, does not reflect additions after 1989, while the costing database for the engineering estimates incorporates the technology installed as of 1995. The lack of additional assets has two counterbalancing effects for calculating salvage value for the closure model—equipment installed after 1989 is not considered but neither is the additional cumulative

[7] An additional mill closed in 1997.

FIGURE 2-1

PULP, PAPER, AND PAPERBOARD MILLS BY STATE, 1995
MACT-Regulated Mills and BAT/PSES-Regulated Mills

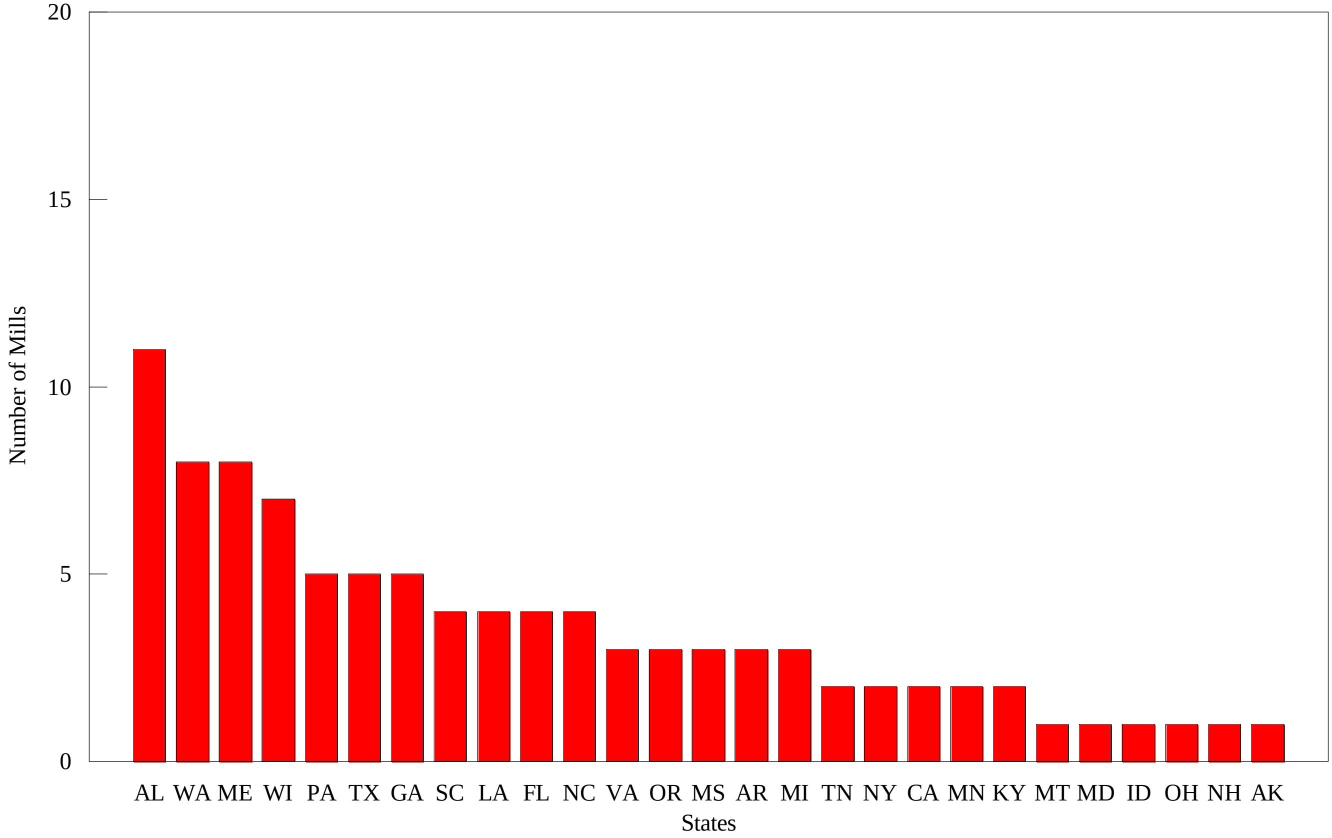


Numbers in large font show the number of MACT-regulated mills in the state.
Numbers in parenthesis show number of mills that are both BAT/PSES- and MACT- regulated.

o/s/g/n/8297/map2.ppt

FIGURE 2-2W

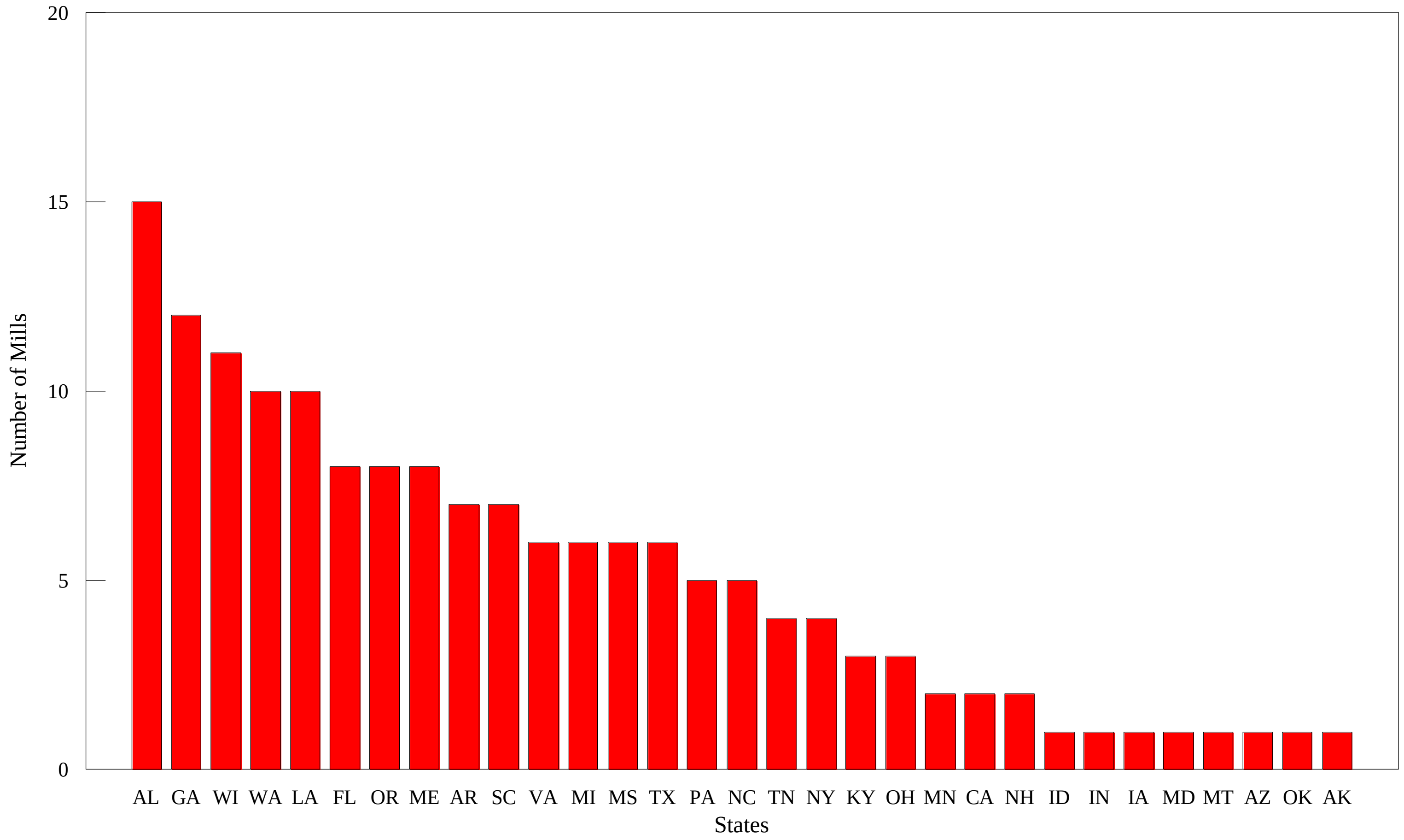
DISTRIBUTION OF PULP, PAPER, AND PAPERBOARD MILLS BY STATE
BAT/PSES-Regulated Mills



Source: U.S. EPA. 1991. 1990 National Census of Pulp, Paper, and Paperboard Manufacturing Facilities. Washington, DC. October, 1991.

FIGURE 2-2A

DISTRIBUTION OF PULP, PAPER, AND PAPERBOARD MILLS BY STATE
MACT-Regulated Mills



Source: U.S. EPA. 1991. 1990 National Census of Pulp, Paper, and Paperboard Manufacturing Facilities. Washington, DC. October, 1991.

depreciation. EPA assumes these effects offset each other with the incremental closure analysis remaining relatively unaffected.

As mentioned in Section 2.1, the EPA database contains information on 94 mills affected by the final effluent guidelines and 156 mills affected by MACT requirements. 1989 facility-level asset data are available for 82 and 138 of these mills, respectively. A mill may not have facility-level asset information for several reasons, including: the company does not record assets at the facility level, the company keeps records for some facilities on combined basis, or the mill changed ownership between 1989 to 1990 (when the survey was performed). The continuity of the asset data is an indication of the fluidity of mill ownership during 1985 to 1990 (when the survey was performed). In most cases, if a mill was sold to a new owner, the new owner had technical but not financial information for earlier years. Data from 1989 were not available for slightly over 5 percent of the 1989 BAT/PSES-regulated mill population. Since 1989, two new bleached papergrade kraft facilities have opened, and approximately 10 existing facilities have changed ownership. In other words, there is a fair amount of fluidity in mill ownership; a mill may have been operating for decades but may have had several owners during that time.[8]

Table 2-5 summarizes the minimum, maximum, mean, and total facility-level assets for 1985, 1988, and 1989. These assets are the total of current and noncurrent assets and are listed in thousands of current dollars (i.e., data for 1985 are in terms of 1985 dollars, while data for 1989 are in terms of 1989 dollars).[9] The average BAT/PSES-regulated mill had assets of $249 million in 1985, $307 million in 1988, and $352 million in 1989. Assets for the BAT/PSES-regulated mill population totaled $19 billion in 1985, $25 billion in 1988, and $29 billion in 1989. The average MACT-regulated mill had assets of $194 million in 1985, $239 million in 1988, and $268 million in 1989. Assets for the MACT-regulated mill population totaled $25

[8]No 1989 data were available for mills that changed ownership after 1989, began operations after 1989, or combined their financial information with that of another facility. When a mill is purchased, the purchase price reflects the mill's value plus goodwill (the excess cost paid over liquidation value). Old financial records on asset value are generally not transferred to the new owners because they are not relevant to the new financial basis for the facility.

[9]According to survey data, facilities that are part of a multifacility organization frequently keep an intercompany account as a current asset. This intercompany account can have a negative value if, for example, the books close after the payroll has been written but the check from corporate headquarters to cover the payroll has not been received. In other words, negative current assets are a legitimate survey response at the facility level.

TABLE 2-5

FACILITY ASSETS

Year	Facilities with Asset Information	Facility Assets* (thousands of current dollars) Minimum	Maximum	Median	Mean	Total
BAT/PSES-REGULATED MILLS						
1985	77	$28,108	$987,764	$181,070	$248,750	$19,153,754
1988	82	$31,392	$852,194	$240,944	$307,284	$25,197,326
1989	82	$41,432	$995,129	$273,728	$352,445	$28,900,507
MACT-REGULATED MILLS						
1985	131	$9,594	$987,764	$147,864	$193,526	$25,351,847
1988	138	$1,950	$852,194	$175,996	$238,541	$32,918,655
1989	138	$16,119	$995,129	$201,001	$267,537	$36,920,065

* Total of current and noncurrent (e.g., land, buildings, equipment) assets.

Notes: For BAT/PSES-regulated mills, 82 kept asset information at the facility level and five changed ownership or opened between 1985 and 1988.

For MACT-regulated mills, 138 kept asset information at the facility level and seven changed ownership or opened between 1985 and 1988.

Source: U.S. EPA. 1991. 1990 National Census of Pulp, Paper, and Paperboard Manufacturing Facilities. Washington, DC. October, 1991.

billion in 1985, $33 billion in 1988, and $37 billion in 1989. In comparison, the total assets reported for all facilities in the industry survey totaled $55 billion in 1989. AF&PA reports data for SIC 26, paper and allied products, a larger scope than considered in the rulemaking because SIC 26 includes converting operations, such as boxmaking plants, as well as building paper and paperboard operations. For comparison, AF&PA lists 1989 industry assets at $109 billion and 1994 assets at $150 billion.

2.3.2.2 Employees

The census requested the average number of employees engaged in:

- Pulp, paper, or paperboard operations
- Other production operations
- Nonproduction operations

Data were provided for 1989 and are summarized in Table 2-6. In one independent facility, whose workers are all "contract labor," the facility's books show zero employees.[10] A typical BAT/PSES-regulated mill has approximately 900 to 1,000 employees, with 20 percent engaged in nonproduction activities. Some mills also have a small number of employees engaged in production of non-pulp, -paper, and -paperboard products. Total employment for the BAT/PSES-regulated mills is about 97,000. A typical MACT-regulated mill is slightly smaller with approximately 800 to 850 employees. Some mills also have a small number of employees engaged in production of nonpulp, -paper, and -paperboard products. Total employment is about 129,000 for MACT-regulated mills.

When the economic methodology projects a mill to close due to increased costs for pollution control, all employment at the mill is considered lost. The total population figures are a measure against which to compare the magnitude of the direct impacts of the regulation. The data also indicate that a typical **mill** exceeds the 750-employee criterion for a large **business** for this set of SIC codes.

[10]Zero employees for a nonindependent mill can occur when the mill 1) started operations after 1989, or 2) has information combined with that of another mill. In the last case, both mills are kept in the count, but the number of employees for one mill is set to zero.

TABLE 2-6

NUMBER OF EMPLOYEES BY FACILITY, 1989

Type of Employee	Minimum	Maximum	Mean	Median	Total
BAT/PSES-REGULATED MILLS					
Production	0	2,583	806	698	75,737
Non-production	0	715	206	165	19,320
Other	0	265	20	0	1,909
Total Employment	0	3,050	1,032	928	96,966
MACT-REGULATED MILLS					
Production	0	2,583	638	511	99,591
Non-production	0	715	165	126	25,809
Other	0	473	23	0	3,639
Total Employment	0	3,050	827	635	129,039

Note: Zero employees may result when a facility 1) uses contract labor, 2) started operations after 1989, or 3) has information combined with that of another mill. In the last case, both mills are included, but the number of employees for one mill is set to zero.

Source: U.S. EPA. 1991. 1990 National Census of Pulp, Paper, and Paperboard Manufacturing Facilities. Washington, DC. October, 1991.

2.3.3 Facility Age

Figures 2-3W and 2-3A show the age of the pulp and paper operations for the BAT/PSES- and MACT-regulated mills, respectively. (In some cases, a facility built for one purpose was later transformed into a pulp and paper operation.) The paper industry has a long history in this country; several operations date back to the Colonial period. The kraft pulping process was developed about 100 years ago, immediately followed by a large increase in the number of facilities. The number of BPK and papergrade sulfite facilities declined during World War II, and a new influx of facilities came in the postwar phase.

The histograms (Figures 2-3W and 2-3A) do not tell the industry's whole story, however. After establishing pulp and paper operations, the majority of mills continue to update, upgrade, and expand their operations. The EPA census asked for the date of the most recent renovation or expansion for the facility, defined as the renovation or expansion of at least 10 percent of the value of the plant's accumulated gross investment. The renovation and expansion dates are shown in Figures 2-4W and 2-4A. While a portion of the population functions with decades-old equipment, more than half the mills renovated or expanded between 1985 and 1990.

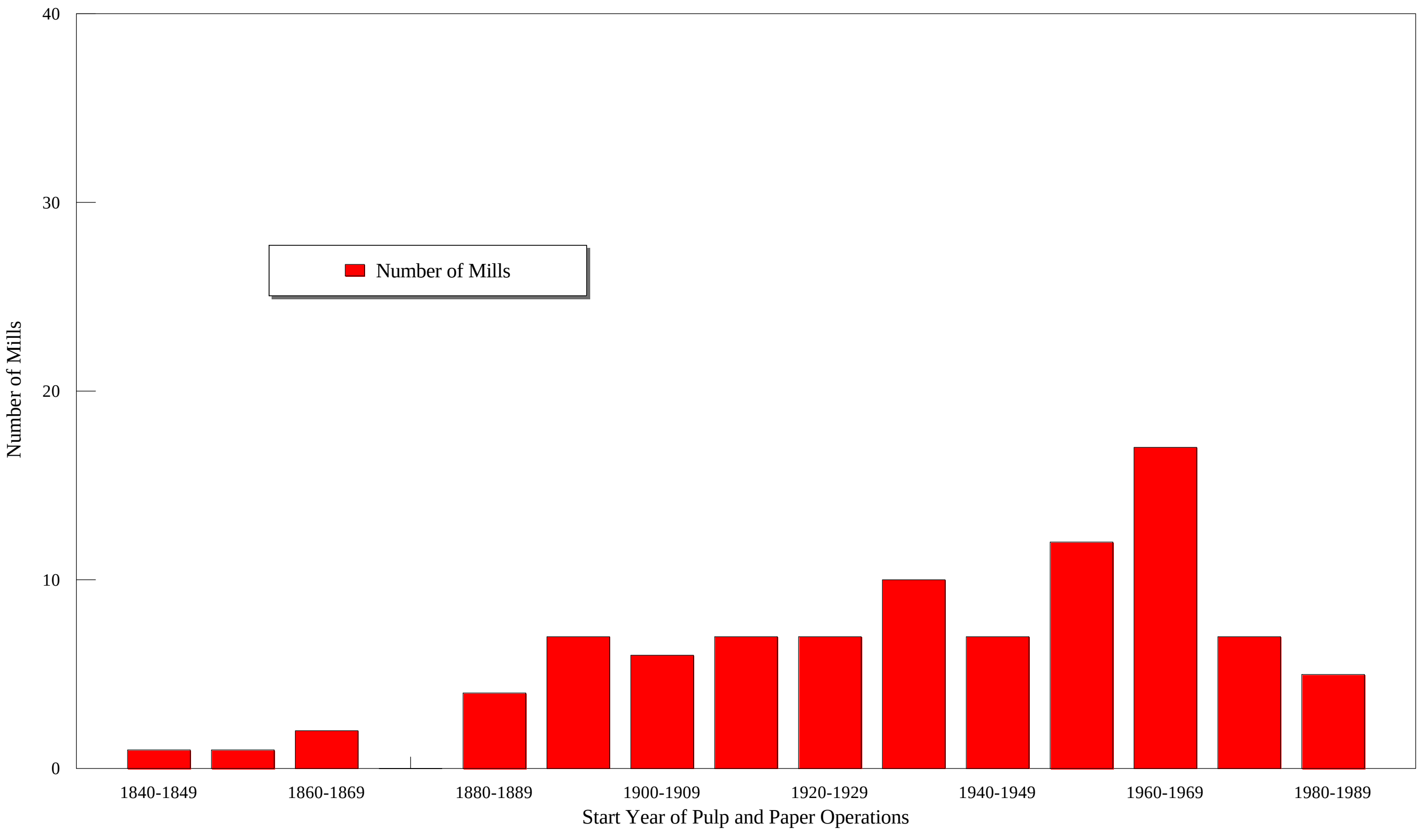
2.3.4 Capital Investment

At the end of 1989, BAT/PSES- and MACT-regulated mills showed original investments of $39 billion and $51 billion, respectively, in land, timberlands, buildings, equipment, and other assets (Table 2-7). Even after depreciation, these investments totaled $25 billion and $32 billion. In 1989, there were approximately 76,000 pulp, paper, and paperboard production workers in BAT/PSES-regulated mills, and 129,000 production workers in MACT-regulated mills (Table 2-6). The original investment per employee, then, was approximately $400,000 to $510,000, indicating the capital-intensive nature of the industry.

Capital investment is a continuing process in this industry. Table 2-8 lists the expenditures on new plants and equipment from 1980 to 1994 (AF&PA, 1996a). Investments range from $3.5 to $8.3 billion, including a dramatic increase in 1988 which began to decline in 1991. In 1989, the industry invested about $47,000 per employee in new plants and equipment. Table 2-8 also lists the expenditures for environmental protection. Pollution control accounted for between 6 and 20 percent of new investment during this period.

FIGURE 2-3W

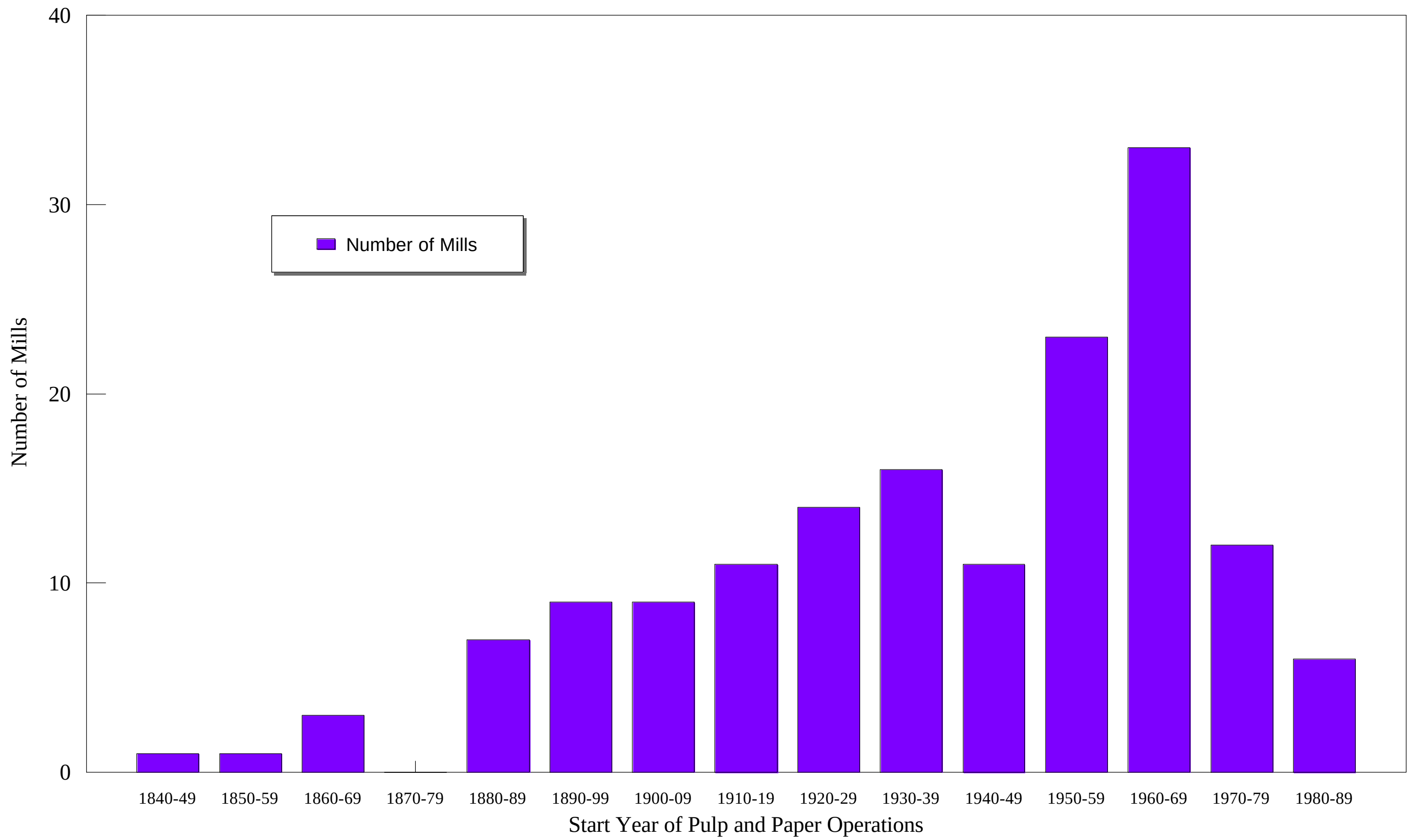
AGE OF PULP AND PAPER OPERATIONS HISTOGRAM
BAT/PSES-Regulated Mills



Source: U.S. EPA. 1991. 1990 National Census of Pulp, Paper, and Paperboard Manufacturing Facilities. Washington, DC. October, 1991.

FIGURE 2-3A

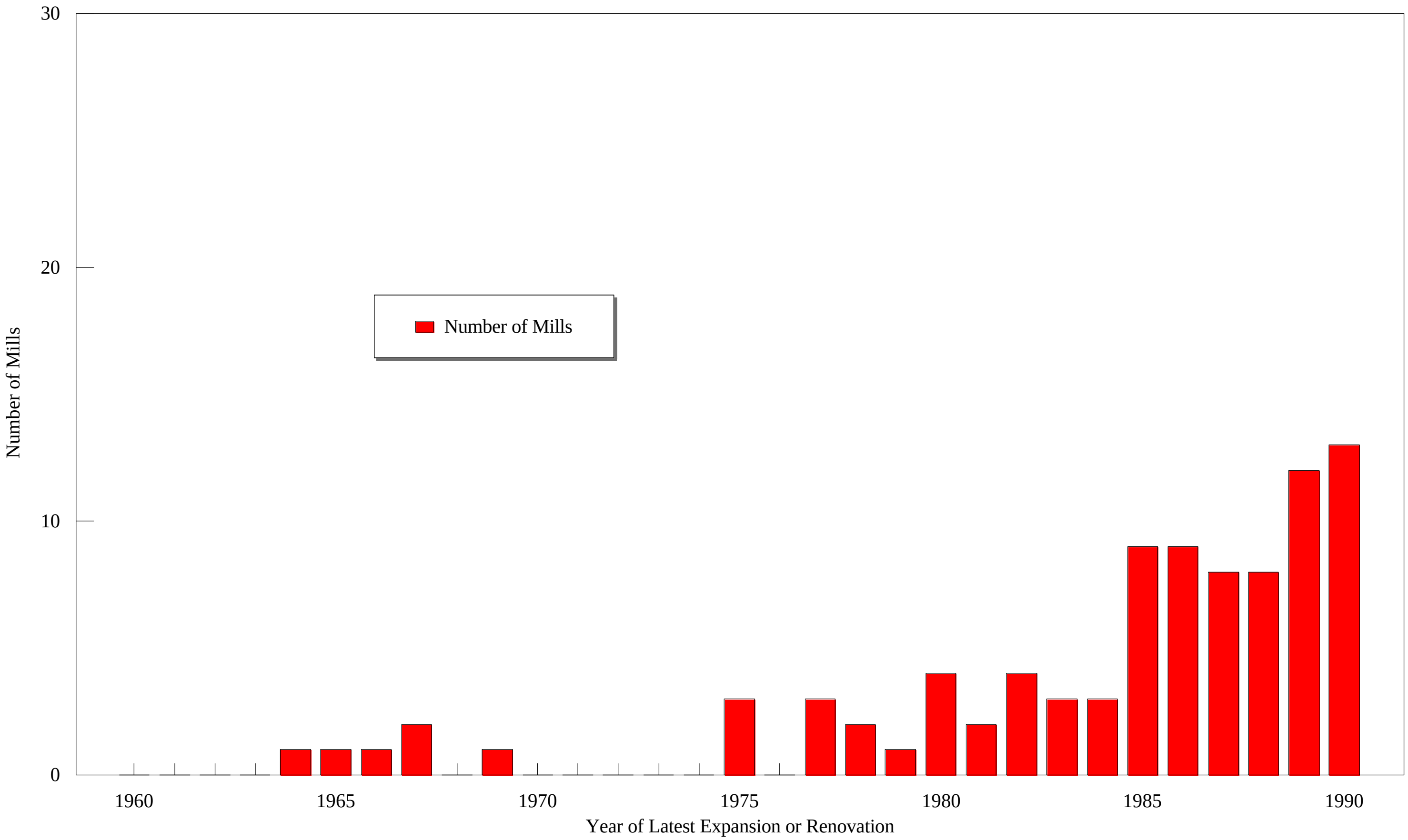
AGE OF PULP AND PAPER OPERATIONS HISTOGRAM
MACT-Regulated Mills



Source: U.S. EPA. 1991. 1990 National Census of Pulp, Paper, and Paperboard Manufacturing Facilities. Washington, DC. October, 1991.

FIGURE 2-4W

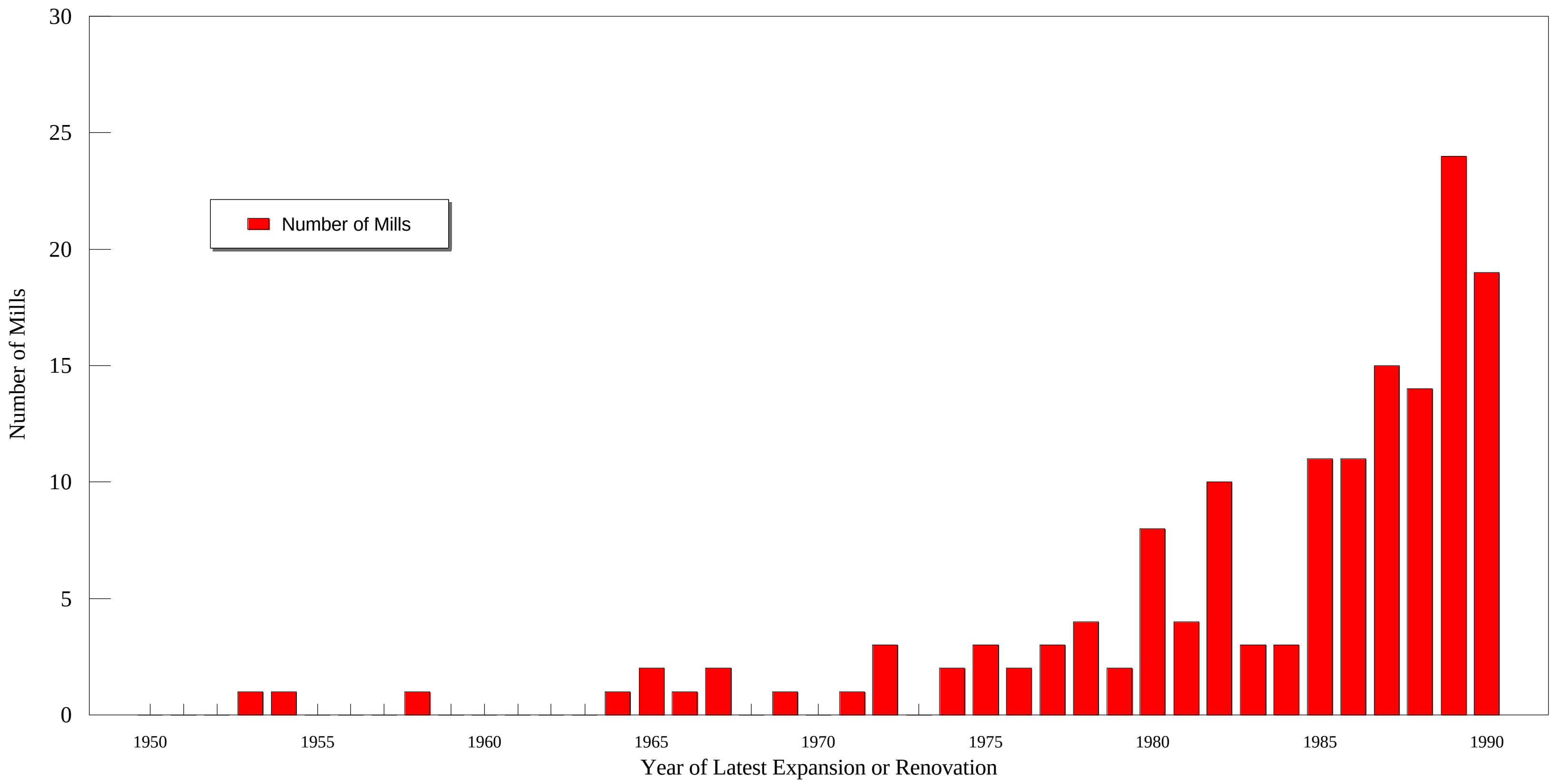
HISTOGRAM OF EXPANSION AND RENOVATION YEARS
BAT/PSES-Regulated Mills



Source: U.S. EPA. 1991. 1990 National Census of Pulp, Paper, and Paperboard Manufacturing Facilities. Washington, DC. October, 1991.

FIGURE 2-4A

HISTOGRAM OF EXPANSION AND RENOVATION YEARS
MACT-Regulated Mills



Source: U.S. EPA. 1991. 1990 National Census of Pulp, Paper, and Paperboard Manufacturing Facilities. Washington, DC. October, 1991.

TABLE 2-7

1989 CAPITAL INVESTMENTS BEFORE AND AFTER DEPRECIATION

Type of Investment	Capital Investment (thousands of dollars)
BAT/PSES-REGULATED MILLS	
Land	$399,440
Timberlands	$626,279
Buildings	$2,474,849
Equipment and machinery	$33,626,587
Other assets	$1,903,942
Total capital	$39,031,097
Value after depletion and depreciation	$25,069,696
MACT-REGULATED MILLS	
Land	$502,425
Timberlands	$963,600
Buildings	$3,270,099
Equipment and machinery	$43,841,755
Other assets	$2,227,985
Total capital	$50,805,864
Value after depletion and depreciation	$31,947,329

Source: U.S. EPA. 1991. 1990 National Census of Pulp, Paper, and Paperboard Manufacturing Facilities. Washington, DC. October, 1991.

TABLE 2-8

EXPENDITURES ON NEW ENVIRONMENTAL PROTECTION PLANT AND EQUIPMENT
Industry Totals

Year	Expenditures on New Plants and Equipment (thousands of dollars)	Expenditures on Environmental Protection (thousands of dollars)	Environmental Expenditures Investment Percent of Total
1980	$3,726,000	$368,000	9.88%
1981	$3,957,000	$260,000	6.57%
1982	$3,820,000	$318,000	8.32%
1983	$3,497,000	$327,000	9.35%
1984	$3,713,000	$226,000	6.09%
1985	$4,290,000	$342,000	7.97%
1986	$4,038,000	$237,000	5.87%
1987	$3,764,000	$403,000	10.71%
1988	$5,126,000	$572,000	11.16%
1989	$7,587,000	$1,039,000	13.69%
1990	$8,307,000	$1,292,000	15.55%
1991	$6,781,000	$1,343,000	19.81%
1992	$5,725,000	$1,048,000	18.31%
1993	$4,933,000	$737,000	14.94%
1994	$4,829,000	$721,000	14.93%

Source: AF&PA. 1996a. 1996 Statistics; Paper, Paperboard, and Wood Pulp. American Forest and Paper Association, Washington, DC.

However, the AF&PA data on environmental expenditures do not specify whether these expenditures are for SIC 26 (paper and allied products, e.g., converting mills) or SICs 2611, 2621, and 2631 (pulp, paper, and paperboard mills).

2.3.5 Level of Integration

A facility that both produces pulp and uses it to manufacture paper and/or paperboard products is considered an integrated mill. The technical and financial sections of the census categorize mills differently; only products that are sold appear in the census's financial portion. If a facility manufactures pulp but consumes it all in the manufacture of paper, that facility will appear as a integrated facility in the technical portion but not in the financial portion of the survey. If that facility sells some of its pulp in addition to its paper products, it would appear as an integrated facility in both the technical and financial portions of the census.

Table 2-9 presents data on the number of mills by type of production derived from the financial portion of the census. In 1989, eight BAT/PSES-regulated mills sold only pulp, 15 sold only paper, and three sold just paperboard. The remainder of the mills sold a mixture of products. Some of these facilities might be integrated, but data from the survey's financial portion do not identify them. The MACT-regulated mills show a similar level of integration.

Mills that exist to serve other facilities under the same ownership also can be considered integrated with respect to company operations. During 1985 to 1989, 72 of 94 BAT/PSES-regulated mills indicated that they transferred pulp, paper, and/or paperboard to other facilities under the same ownership. Depending on the year, between one and 10 of the BAT/PSES-regulated mills indicated that 90 percent or more of their revenues from a single product (pulp, paper, or paperboard) came from such transfers. Between five and six mills reported that over 90 percent of *all* pulp, paper, and paperboard revenues were from transfers to other facilities under the same ownership. For MACT-regulated mills, between seven and nine mills reported that over 90 percent of all pulp, paper, and paperboard revenues were from transfers to other facilities under the same ownership. These mills are considered captive (i.e., they exist to serve other parts of the organization). The majority of transfers for both BAT/PSES- and MACT-regulated mills were completed using the market price as the transfer price.

TABLE 2-9

LEVEL OF PRODUCTION INTEGRATION AT U.S. PULP AND PAPER MILLS

Type of Production	Number of Mills
BAT/PSES-REGULATED MILLS	
Pulp, paper, and paperboard	19
Pulp and paper	38
Pulp and paperboard	5
Paper and paperboard	6
Pulp	8
Paper	15
Paperboard	3
Total	94
MACT-REGULATED MILLS	
Pulp, paper, and paperboard	20
Pulp and paper	38
Pulp and paperboard	6
Paper and paperboard	16
Pulp	14
Paper	20
Paperboard	42
Total	156

Source: U.S. EPA. 1991. 1990 National Census of Pulp, Paper, and Paperboard Manufacturing Facilities. Washington, DC. October, 1991.

This information affects the baseline closure analysis. Those captive mills that make transfers at cost will appear to earn little or no revenues in the census's financial portion. If captive mills have any salvage value, they could be deemed as closures in the economic analysis (i.e., the salvage value exceeds the expected stream of earnings; EPA 1993a, Section 3) even before the addition of incremental pollution control costs. Because of this phenomenon, the closure analysis removes this type of baseline closure from consideration as an incremental closure when evaluating the facility-level impacts of the regulatory options. Instead, EPA considers the economic impact on such facilities by including them in the estimation of company-level impacts.

2.4 COMPANY-LEVEL INFORMATION

2.4.1 Number of Facilities and Ownership

The number of companies in the pulp and paper industry remains in flux as new companies enter the market and others go out of business or merge with other entities. Table 2-10W lists 37 companies with BAT/PSES-regulated mills in 1995; Table 2-10A lists 52 companies with MACT-regulated mills. Since the proposal, Sappi acquired the S.D. Warren mills from Scott Paper, while Kimberly-Clark acquired the remaining parts of the Scott Paper company. ITT spun off Rayonier, which it had acquired in 1968. Proctor and Gamble spun off Buckeye Cellulose and James River spun off Crown Paper. In 1997, James River merged with Fort Howard to form Fort James.

The companies listed in Table 2-10W own the 96 mills in the BPK and PS subcategories. Seventeen companies own only one BPK or PS facility, while the largest number of facilities owned by a single company is 12. The average number of facilities owned by the companies is 2.6 mills. Table 2-10A lists companies with mills in the MACT-regulated subcategories. Two companies account for 37 mills while 26 companies have one mill each.

Approximately 79 percent of the companies owning BAT/PSES-regulated mills are publicly held, with the remaining 21 percent privately held. For the entire industry, ownership is closer to 28 percent public, and 64 percent private; the remaining 8 percent includes partnerships, wholly-owned subsidiaries, joint ownership, and foreign ownership with no stock holdings. Thus the 308 survey data are important for

TABLE 2-10W

BUSINESS ENTITIES WITH MILLS IN THE BLEACHED PAPERGRADE KRAFT AND PAPERGRADE SULFITE BAT/PSES-REGULATED SUBCATEGORIES

APPLETON PAPERS, INC.
BADGER PAPER MILLS, INC.
BOISE CASCADE CORPORATION
BOWATER INCORPORATED
CHAMPION INTERNATIONAL CORP.
CHESAPEAKE PAPER PRODUCTS CO.
CONSOLIDATED PAPERS, INC.
CROWN PAPER CO.
FINCH PRUYN & CO., INC.
GEORGIA-PACIFIC CORPORATION
GILMAN PAPER COMPANY
GULF STATES PAPER CORPORATION
INTERNATIONAL PAPER COMPANY
JAMES RIVER CORPORATION
JEFFERSON SMURFIT CORPORATION
KIMBERLY-CLARK CORPORATION
LINCOLN PULP & PAPER CO., INC.
LONGVIEW FIBRE CO.
LOUISIANA-PACIFIC CORPORATION
MEAD CORPORATION
NORANDA FOREST
P. H. GLATFELTER COMPANY
PARSONS & WHITTEMORE
POPE & TALBOT, INC.
PORT TOWNSEND PAPER CORPORATION
POTLATCH CORPORATION
PROCTER & GAMBLE
SAPPI (S.D. WARREN CO.)
SIMPSON PAPER COMPANY
ST. JOE FOREST PRODUCTS COMPANY
STONE CONTAINER CORPORATION
TEMPLE-INLAND, INC.
UNION CAMP CORPORATION
WAUSAU PAPER MILLS, INC.
WESTVACO CORPORATION
WEYERHAEUSER COMPANY
WILLAMETTE INDUSTRIES, INC.

TABLE 2-10A

BUSINESS ENTITIES WITH MILLS IN THE KRAFT, SULFITE, AND SEMICHEMICAL MACT-REGULATED SUBCATEGORIES

APPLETON PAPERS, INC.
BADGER PAPER MILLS, INC.
BOISE CASCADE CORPORATION
BOWATER INCORPORATED
BUCKEYE FLORIDA, L.P.
CHAMPION INTERNATIONAL CORP.
CHESAPEAKE PAPER PRODUCTS CO.
CONSOLIDATED PAPERS, INC.
CROWN PAPER CO.
FINCH PRUYN & CO., INC.
FOUR M PAPER CORPORATION
GAYLORD CONTAINER CORPORATION
GEORGIA-PACIFIC CORPORATION
GILMAN PAPER COMPANY
GREEN BAY PACKAGING INC.
GULF STATES PAPER CORPORATION
INTERNATIONAL PAPER COMPANY
INTERSTATE PAPER CORPORATION
JAMES RIVER CORPORATION
JEFFERSON SMURFIT CORPORATION
KIMBERLY-CLARK CORPORATION
LINCOLN PULP & PAPER CO., INC.
LONGVIEW FIBRE CO.
LOUISIANA-PACIFIC CORPORATION
LYONS FALLS PULP AND PAPER, INC.
MACMILLAN BLOEDEL LTD.
MEAD CORPORATION
MENASHA CORPORATION
MOSINEE PAPER CORPORATION
NORANDA FOREST
P. H. GLATFELTER COMPANY
PARSONS & WHITTEMORE
POPE & TALBOT, INC.
PORT TOWNSEND PAPER CORPORATION
POTLATCH CORPORATION
PROCTER & GAMBLE
RAYONIER, INC.
RIVERWOOD INTERNATIONAL CORP.
SAPPI (S.D. WARREN CO.)
SIMPSON PAPER COMPANY
SONOCO PRODUCTS COMPANY
ST. JOE FOREST PRODUCTS COMPANY
STONE CONTAINER CORPORATION
TEMPLE-INLAND, INC.
TENNECO, INC.
UNION CAMP CORPORATION
VIRGINIA FIBRE CORPORATION
WAUSAU PAPER MILLS, INC.
THE WESTON PAPER AND MANUFACTURING COMPANY
WESTVACO CORPORATION
WEYERHAEUSER COMPANY
WILLAMETTE INDUSTRIES, INC.

Note: Ownership based on 1995 Lockwood-Post's Directory of the Pulp, Paper, and Allied Trades.

examining privately-held mills. Of the 17 companies that own only one BPK or PS mill, two are independent facilities that have no other facilities under the same ownership and no other components in the corporate hierarchy, eight own mills in other subcategories, and seven either own other facilities outside of the pulp and paper industry or are owned by another entity. S corporations can be identified only if the financial information submitted with the census includes this information. The income from an S corporation would be taxed at the rate for the individuals to whom the income is distributed. None of the corporations owning BPK or PS mills were identified as S corporations.

2.4.2 Small Business Entities

Companies in the paper industry span a wide range in sizes. The Small Business Administration (SBA) specifies definitions of "small businesses" in 13 CFR Part 121. The SBA defines small business in terms of the number of persons employed and, in some cases, by annual revenues. For pulp, paper, and paperboard companies (SIC 2611, 2621, and 2631, respectively), the size cutoff for defining small business is 750 employees. The Regulatory Flexibility Act (RFA) came into effect on January 1, 1981 (5 U.S.C. 601 et seq.). A goal of the act is to provide policymakers with information about how regulatory options affect small entities, including small businesses. The purpose of the RFA is to ensure, if possible, that agencies identify and consider ways of tailoring regulations to the size of the regulated entities to minimize any rule’s significant economic impact on a substantial number of small entities (see Chapter 7). The Small Business Regulatory Enforcement Fairness Act of 1996 (SBREFA; P.L. 104-121, March 29, 1996) amended RFA. Four of the companies listed in Table 2-10W and 11 of the companies listed in Table 2-10A are small businesses.

2.4.3 Concentration Ratios

The concentration of ownership in an industry influences how costs are passed through to the consumers (e.g., price increases) and therefore whether firms or customers bear the burden of cost-increasing regulation. One method of examining the extent to which an industry is concentrated in a few companies is to examine the ratio of production for the top five or 10 firms to industrywide production. To reflect ownership changes, capacity expansions of individual mills, and other changes since the 1989 census data, concentration ratio information is taken from industry data for North America.

Table 2-11 examines the market share distribution for market pulp. The data reflect bleached and unbleached sulfate (kraft) and sulfite pulps in North America. With this inclusive definition, the concentration ratios are not high. The top five producers account for slightly over 38 percent of the capacity, while the next five producers account for only an additional 20 percent of capacity (Pulp and Paper, 1995a).

Much pulp is consumed on site in integrated mills or shipped to other mills under the same ownership. Looking at bleached paperboard (Table 2-12), the top five companies account for nearly 70 percent of capacity, while the top 10 companies account for nearly 90 percent of capacity (Pulp and Paper, 1995b). For coated free sheet, the concentration ratios are 63 and 90 percent for the top five and 10 companies, respectively (Table 2-13) (Pulp and Paper, 1995c). Uncoated free sheet is less concentrated. Market share for the top five and top 10 companies is 37.8 percent and 61.2 percent, respectively (Table 2-14) (Pulp and Paper, 1995d).

2.5 FINANCIAL PATTERNS FOR THE INDUSTRY 1985-1995

The pulp and paper industry is highly cyclical in nature. Table 2-15 presents industry net profits from 1985 to 1995. A full cycle is seen, with peak years in 1988 and 1995. Earnings actually peaked in the third quarter of 1989, but the fourth quarter downturn was strong enough to pull the entire year's financial performance below that of 1988. The most recent cycle peaked in 1995. Data from the first three quarters of 1996 indicate that paper and paperboard production was down 1.8 percent compared to the first 9 months in 1995. However, when comparing third-quarters, 1996 shows a 3.8 percent production increase over 1995 (AF&PA, 1996b). By April 1996, pulp prices were down 40 percent from 1995's peak and some paper grades prices had dropped over 30 percent, but newsprint held steady due to negligible capacity growth (Pulp and Paper, 1995e, 1996a, 1996b).

Figure 2-5 illustrates the U.S. capacity to produce paper and paperboard and actual U.S. production of paper and paperboard. Figure 2-6 presents U.S. utilization (percentage of production capacity in production) rates for paper and paperboard production. Dips in 1985 and again in 1991 coincide with low

TABLE 2-11

1995 CONCENTRATION RATIOS FOR MARKET PULP

Company	Annual Capacity (000 tons)	Market Share (%)
Weyerhaeuser[1,2,4,5]	2,100	12.3
Georgia-Pacific[1,2,4,5]	1,685	9.9
Parsons & Whittemore[1,2]	1,055	6.2
Stone Container[1,2]	905[a]	5.3
Champion International[1,2,3,5]	785[b]	4.6
Avenor[1,2]	775	4.5
International Paper	750	4.4
Fletcher Challenge[1,3]	660	3.9
Daishowa-Marubeni[1,2]	610[c]	3.6
Canfor[1,3]	590[d]	3.5
Market share of top five companies:	38.3%	
Market share of top ten companies:	58.1%	
Total North American capacity (1995):	17,069 million metric tons	

[1]Bleached softwood kraft.
[2]Bleached hardwood kraft.
[3]Unbleached kraft.
[4]Bleached sulfite.
[5]Fluff.

Capacity shown on equity ownership basis.
[a]Includes 45% of Celgar Pulp and 100% of Stone Savannah River.
[b]Includes 84.6% of Weldwood, which owns 50% of Cariboo Pulp.
[c]Includes 100% of Peace River and 50% of Cariboo Pulp.
[d]Includes 50% of Howe Sound.

Source: *Pulp & Paper*. 1995a. Grade profile. August, 1995, p. 13.

TABLE 2-12

1995 CONCENTRATION RATIOS FOR BLEACHED PAPERBOARD

Company	Annual Capacity[1] (000 tons)	Market Share (%)
International Paper Co.	1,450	21.2
Federal Paper Board Co.	1,030	15.1
Westvaco Corp.	925	13.5
Temple-Inland, Inc.	750	11.0
Potlatch Corp.	554	8.1
Georgia-Pacific Corp.	370	5.4
Champion International	284	4.2
James River Corp.	270	3.9
Gulf States Paper Corp.	250	3.7
Weyerhaeuser Co.	230	3.4
Gilman Paper Co.	200	2.9
Jefferson-Smurfit/CCA	185	2.7
Union Camp Corp.	140	2.0
Capacity share of top five companies:	68.9%	
Capacity share of top ten companies:	89.5%	
Total U.S. capacity, 1995:	6.841 million tons	

[1]Capacity includes bleached packaging board and bleached bristols.

Source: *Pulp & Paper*. 1995b. Grade profile. July, 1995, p. 13.

TABLE 2-13

1995 CONCENTRATION RATIOS FOR COATED FREE SHEET

Company	Annual Capacity[1] (000 tons)	Market Share (%)
S.D. Warren	1,045	20.8
Westvaco	680	13.6
Champion International	574	11.4
Simpson	495	9.9
Consolidated Papers	450	9.0
Repap	405	8.1
Mead	375	7.5
Potlatch	333	6.6
Boise Cascade	140	2.8
Appleton Papers	130	2.6
Capacity share of top five companies:	63.0%	
Capacity share of top ten companies:	90.0%	
North American capacity:	5,166,000 tons (U.S.: 4,826,000 tons; Canada: 340,000 tons)	

[1]As of 1995.

Source: *Pulp & Paper*. 1995c. Grade profile. March, 1995, p. 13.

TABLE 2-14

1995 CONCENTRATION RATIOS FOR UNCOATED FREE SHEET

Company	Annual Capacity (tpy)*	Market Share (%)
Georgia-Pacific Corp.	2,100	13.4
International Paper Co.	2,040	13.1
Champion International[1]	1,495	9.6
Boise Cascade Corp.	1,265	8.1
Union Camp Corp.	1,100	7.0
Willamette, Inc.	818	5.2
James River Corp.[2]	800	5.1
Weyerhaeuser Co.[3]	790	5.1
Domtar, Inc.	665	4.3
Appleton Papers, Inc.[4]	575	3.7
Market share of top five companies:	37.8%	
Market share of top ten companies:	61.2%	
Total North American capacity/yr:	15.614 million (U.S.: 14.030 million; Canada: 1.584 million)	

*All tons are short tons.

[1]Company data. Also has 373,000 tons per year capacity in Brazil.
[2]Company data.
[3]Includes Prince Albert, Saskatchewan.
[4]Includes carbonless basestock.

Source: *Pulp & Paper*. 1995d. Grade profile. April, 1995, p. 13.

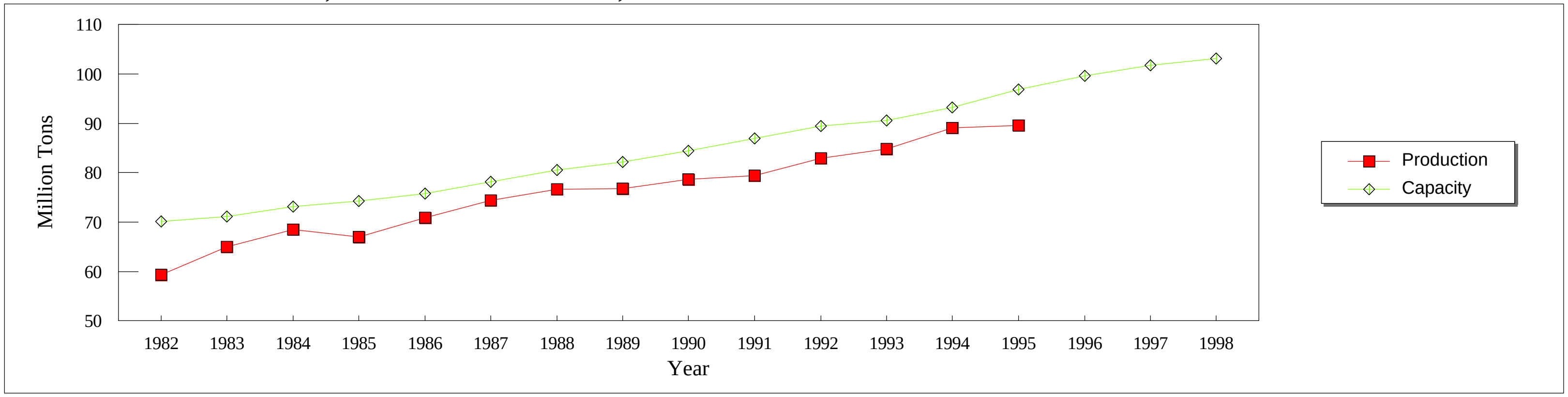
TABLE 2-15
PULP AND PAPER INDUSTRY DATA, 1985-1995
(MILLIONS OF DOLLARS)

Year	Net Profit After Tax (Current Dollars)	CPI	Net Profit After Tax (1989 Dollars)
1985	$2,880	107.6	$3,319
1986	$3,280	109.6	$3,711
1987	$5,522	113.6	$6,028
1988	$8,081	118.3	$8,470
1989	$7,047	124.0	$7,047
1990	$4,883	130.7	$4,633
1991	$2,164	136.2	$1,970
1992	$1,197	140.3	$1,058
1993*	$1,778	144.5	$1,526
1994	$5,264	148.2	$4,404
1995	$11,982	152.4	$9,749

* 1993 data are adjusted for Fort Howard write-down of goodwill. In acquisition accounting, goodwill is the difference between purchase prices and what the asset would yield in a liquidation. Goodwill is generally amortized over a period of years, but in this case, Fort Howard subtracted the entire value of remaining goodwill from 1993 operating income.

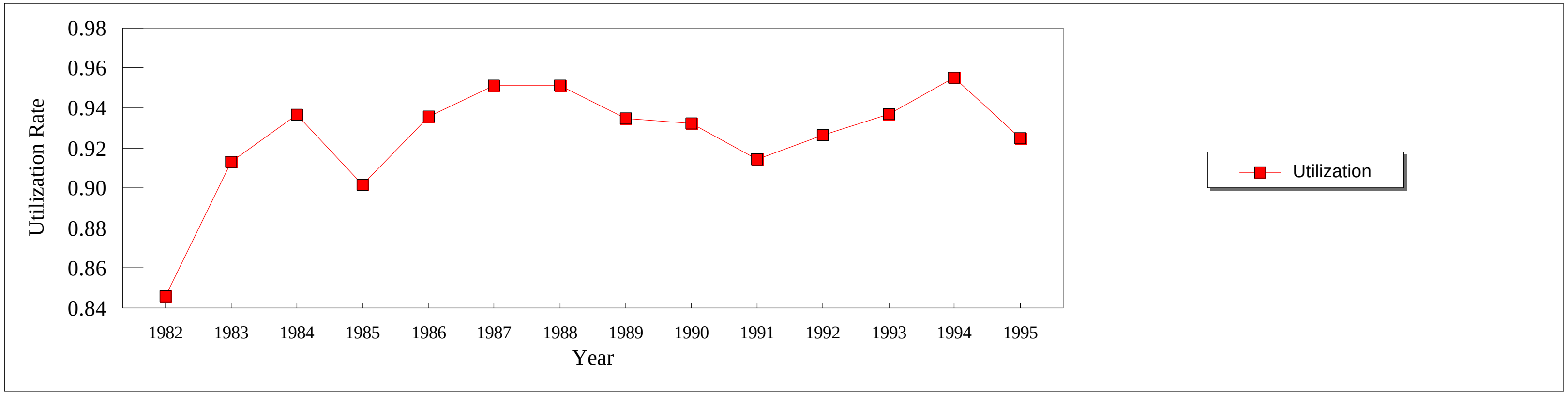
Sources: AF&PA. 1996a. 1996 Statistics; Paper, Paperboard, and Wood Pulp. American Forest and Paper Association, Washington, DC.; CEA. 1996. Economic report of the president. Council of Economic Advisors, Washington, DC.; DOC. 1995. Quarterly Financial Report for Manufacturing, Mining, and Trade Corporation, Fourth Quarter 1995. Washington, DC: Economics and Statistics Administration, Bureau of the Census.

FIGURE 2-5
CAPACITY AND PRODUCTION, PAPER AND PAPERBOARD, 1982-1998



Source: AF&PA. 1996a. 1996 Statistics; Paper, Paperboard, and Wood Pulp. American Forest and Paper Association, Washington, DC.

FIGURE 2-6
UTILIZATION RATE, PAPER AND PAPERBOARD, 1982-1995



Source: AF&PA. 1996a. 1996 Statistics; Paper, Paperboard, and Wood Pulp. American Forest and Paper Association, Washington, DC.

points in the business cycle. During the last cycle's peak in 1988, utilization rates were up to 95 percent (Figure 2-6). Utilization rates averaged 96 percent in 1994 and 1995 (Rooks, 1995). An AF&PA survey predicts only 2 percent per year growth in capacity for the next 3 years (Stanley, 1996). At the same time, consumption is expected to grow 2.5 to 3 percent yearly (Rooks, 1995). Limited growth in capacity with increased consumption should help to keep prices stable and avoid a slump like that of the early 1990s.

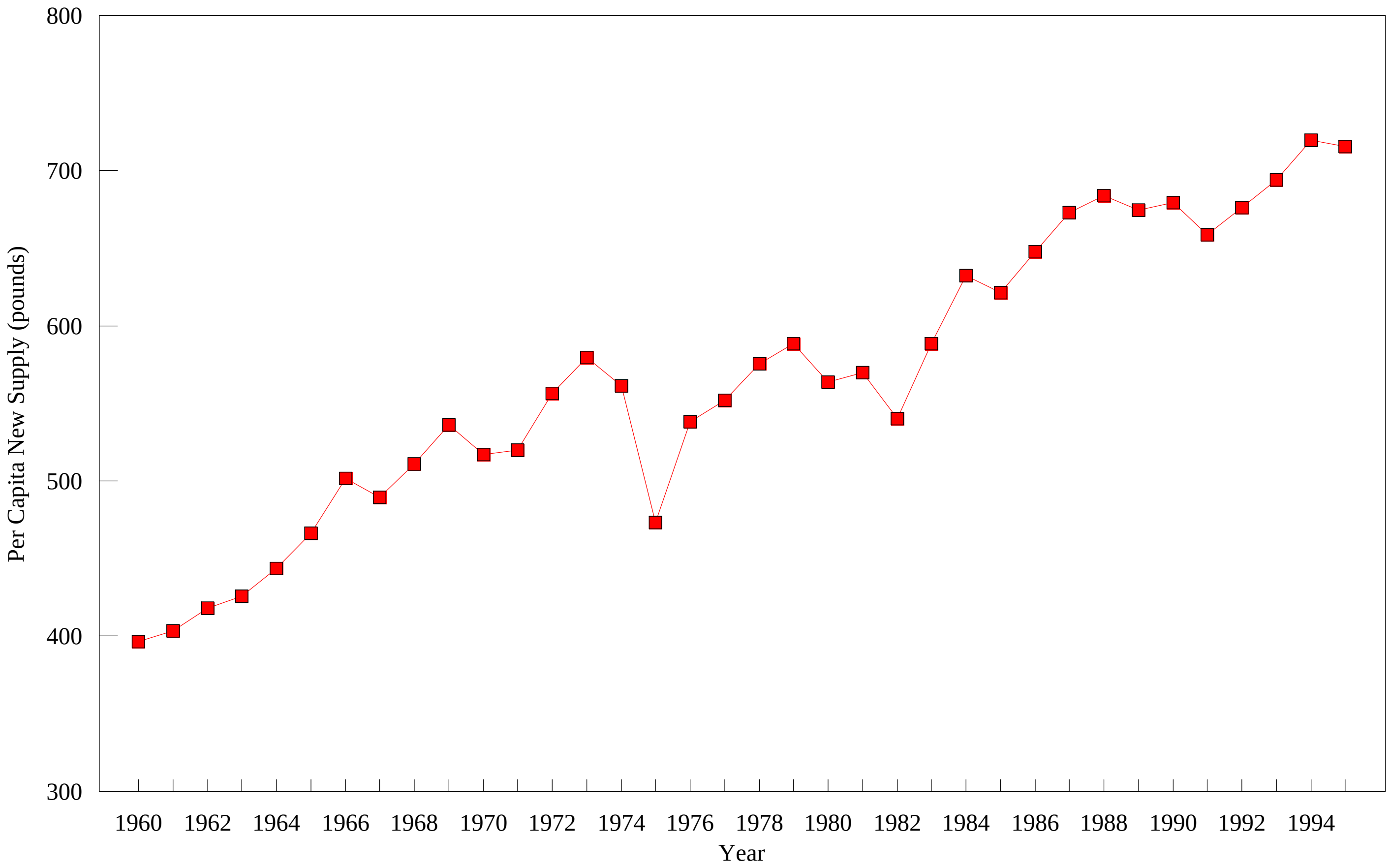
Another factor influencing industry financial patterns is consumer consumption. Figure 2-7 is a graph of the per capita consumption from 1960 through 1995. New supply is defined as production plus imports minus exports. The per capita supply may be interpreted as the per person apparent consumption of paper and paperboard. It appears that paper usage leveled out from the mid- to late-1980s, averaging 680 pounds per year, but since 1991 usage has steadily increased to reach new highs of over 700 pounds per year in 1995.

Capital spending is expected to remain high throughout 1997. Unlike capital spending in the late 1980s and early 1990s, which focused primarily on restructuring and expansion, spending will focus on improving recycling and environmental protection operations (Stanley, 1996). Although capital expenditures for the industry are expected to reach $13.5 billion in 1996, this figure is still 20 percent less than the 1989 and 1990 spending levels of $16 billion per year. With such high profits, the industry is decreasing its debt and in some cases increasing shareholder dividends. In an interview with *TAPPI Journal*, Bruce Kirk, an investment consultant with SBC Capital Markets, Inc., said he did not expect the Cluster Rule to have a "marked effect" on capital spending (Rooks, 1995).

2.6 INTERNATIONAL COMPETITIVENESS OF THE PULP AND PAPER INDUSTRY

While the global dominance the U.S. industrial sector enjoyed in the 1980s eroded in the face of increased international competition from Europe and Asia, the U.S. pulp and paper industry succeeded in maintaining and enhancing its international performance level. The industry's continued dominance is a result of both of the general capital and labor structure of U.S. pulp and paper mills, and of favorable economic conditions. This section reviews the pulp and paper industry's present position and predicted future in the global market.

FIGURE 2-7
APPARENT PER PERSON CONSUMPTION, PAPER AND PAPERBOARD, 1960-1995



Source: AF&PA. 1996a. 1996 Statistics; Paper, Paperboard, and Wood Pulp. American Forest and Paper Association, Washington, DC.

2.6.1 Foreign Trade Statistics

According to the *U.S. Industrial Outlook: 1994*, published by the U.S. Department of Commerce International Trade Administration, the trade deficit for the pulp and paper industry declined for 4 years, from 1988 to 1992, to $302 million. In 1993, however, the deficit jumped to $1.5 billion. These figures do not include U.S. exports of recovered paper, which far exceed imports of recovered paper. By adding exports of recovered paper to 1992's trade balance, the figure changes to a $260 million surplus. 1993's trade deficit declines from $1.5 to $1 billion when trade of recovered paper is added into the equation (ITA, 1994). In 1995, total exports, including $110 million in recovered paper, were valued at approximately $15.9 billion. Import value is approximated at $16.2 billion, which includes $12 million in recovered paper, leaving a trade deficit of $300 million.

Table 2-16 presents the value of exports for pulp, paper, and paperboard products from 1990 to 1995. Each year the U.S. shows a net surplus of exports in pulp and paperboard but a trade deficit in paper. Table 2-16 does not include many of the products contained in industry figures, such as wastepaper, which explains the difference in the net deficits seen in the table and the statistics quoted above.

Exports accounted for nearly 8 percent of U.S. paper shipments in 1993, compared to 7 percent in 1990 (ITA, 1994). Since 1990, exports have accounted for about one-third of paper and paperboard production growth (AF&PA, 1995). As seen in Figure 2-8, exports of pulp, paper, and paperboard, in tons, have increased steadily except for a slight decline in 1993.

In 1993, Canada purchased the largest amount of U.S. exports, buying 21 percent of the total. The European Community purchased 19 percent, Mexico 15 percent, and Japan 12 percent of U.S. pulp, paper, and paperboard (ITA, 1994). In that same year, over three-quarters of the paper imported to the United States came from Canada, which ships a significant but diminishing amount of newsprint to this country. Finland, Germany, Japan, the United Kingdom, and Brazil were the other main suppliers (ITA, 1994).

TABLE 2-16
PULP, PAPER, AND PAPERBOARD IMPORTS AND EXPORTS, 1990-1995
(THOUSANDS OF CURRENT DOLLARS)

Year	Product	Exports	Imports	Net Trade Balance
1990				
	Pulp	$3,155,671	$2,831,327	$324,344
	Paper	$1,455,104	$7,077,036	($5,621,932)
	Paperboard	$1,988,145	$307,261	$1,680,884
	Total	$6,598,920	$10,215,624	($3,616,704)
1991				
	Pulp	$2,799,620	$2,131,711	$667,909
	Paper	$1,809,482	$6,587,222	($4,777,740)
	Paperboard	$2,246,552	$335,367	$1,911,185
	Total	$6,855,654	$9,054,300	($2,198,646)
1992				
	Pulp	$3,114,419	$2,094,235	$1,020,184
	Paper	$2,061,389	$6,296,038	($4,234,649)
	Paperboard	$2,231,226	$414,388	$1,816,838
	Total	$7,407,034	$8,804,661	($1,397,627)
1993				
	Pulp	$2,369,414	$1,860,163	$509,251
	Paper	$2,066,657	$6,753,642	($4,686,985)
	Paperboard	$2,157,308	$448,268	$1,709,040
	Total	$6,593,379	$9,062,073	($2,468,694)
1994				
	Pulp	$2,833,433	$2,271,544	$561,889
	Paper	$2,429,696	$6,825,677	($4,395,981)
	Paperboard	$2,454,477	$544,440	$1,910,037
	Total	$7,717,606	$9,641,661	($1,924,055)
1995				
	Pulp	$4,536,523	$3,727,941	$808,582
	Paper	$3,112,293	$9,543,974	($6,431,681)
	Paperboard	$3,456,771	$810,268	$2,646,503
	Total	$11,105,587	$14,082,183	($2,976,596)

Note: Wastepaper is not included in these figures.

Source: AF&PA. 1996a. 1996 Statistics; Paper, Paperboard, and Wood Pulp. American Forest and Paper Association, Washington, DC.

FIGURE 2-8
PULP, PAPER, AND PAPERBOARD IMPORT/EXPORT TONNAGE, 1989-1995

Note: Figures do not include tons of recovered paper traded.

Sources: AF&PA. 1996a. 1996 Statistics; Paper, Paperboard, and Wood Pulp. American Forest and Paper Association, Washington, DC.; AF&PA. 1995. 1995 Statistics; Paper, Paperboard, and Wood Pulp. American Forest and Paper Association, Washington, DC.

2.6.2 Global Competitiveness of U.S. Paper Industry

According to *Fortune* magazine, a leading U.S. business journal, the pulp and paper industry is a domestic industry capable of competing well in an international market (Kupfer, 1992). *Fortune* supports its argument with statistics released by the Organization for Economic Cooperation and Development, which indicate that U.S. forest products manufacturers' share of total production among facilities in Japan, Europe, and the United States rose from 46 percent in 1980 to 49.3 percent in 1989 (Kupfer, 1992; OECD, 1992). The U.S. share of total world pulp and paper production points to similar dominance: in 1995, the United States produced 28.5 percent of the world's paper and paperboard and 31.3 percent of the world's wood pulp (Stanley, 1996). U.S. production levels exceed the total pulp and paper output of the next four largest pulp- and paper-producing nations combined—Japan, Canada, Germany, and China (Storat, 1992).

The continuing success of U.S. pulp and paper manufacturers in the global marketplace can be attributed to a series of industry and market factors. First, the United States possesses vast natural reserves of trees and highly developed tree farming practices, resulting in steady and relatively inexpensive fiber sources. More importantly, however, the pulp and paper industry has managed to maintain a well-trained workforce by investing billions of dollars since 1980 to boost productivity (Kupfer, 1992). This high productivity, along with an industry operating rate that exceeds 90 percent, has resulted in low unit labor costs. In addition, by generating over 50 percent of its own energy through incineration of manufacturing byproducts, the pulp and paper industry has relatively low energy costs.

On the market side, a favorable foreign currency exchange rate has buoyed U.S. exports of pulp and paper in recent years (Stanley, 1996). In addition, trade agreements (e.g., NAFTA, US-Canada, GATT, and Japan-US) have improved the export market for U.S. pulp, paper, and paperboard. As a result, U.S. exports have increased nearly 130 percent from 1989. U.S. imports have also increased. With an increased focus on global markets among U.S. producers and continued economic growth in developing nations, U.S. pulp and paper exports should continue to increase throughout the 1990s (Stanley, 1996).

2.7 RELATED CHEMICAL SUPPLIER INDUSTRIES

The pulp and paper industry has historically consumed large amounts of chlorine for bleaching operations. Chlorine is produced by the chloralkali process that generates chlorine (CL_2) and NaOH in a fixed ratio from table salt (NaCl) and water. The pulp and paper industry is a major consumer of both chloralkali products (The Chlorine Institute, 1996).

Facing regulations and demand for dioxin-free products, pulp and paper manufacturers have been shifting away from chlorine in their bleaching sequences since the mid-to-late 1980s. For example, chlorine use was 1.6 million short tons in 1987 and dropped to 1.1 million short tons in 1992 (AF&PA, 1992; AF&PA, 1995). The chlorine industry has adjusted to these changes without severe dislocations. Other chemicals that use chlorine include glycerine and glycols (in manufacture, not the final products), vinyl chloride, chlorinated solvents, refrigerants, and antiknock compounds. Decreases in chlorine use by the pulp and paper industry are offset by the growth in other uses of chlorine.

At present, *Pulp & Paper* estimates that approximately 50 percent of bleached chemical pulp mills have converted to elemental chlorine free (ECF) bleaching practices (Finchem, 1996). Chemical industry experts note that long-term growth is on track for key paper chemicals. Ed Michalowski, chlorine marketing manager at Occidental Chemical notes that, "From a chlorine perspective, the volume will be much steadier over the next five years than we thought." Price increases instituted in the peak year of 1995 are holding in 1996 (Thurston, 1996). EPA considers it likely that the remainder of the transition to ECF practices will be managed by the chemical industry as smoothly as the first part.

Second, the chlorine industry is part of a larger chemical industry serving the pulp and paper industry. Suppliers that see reduced chlorine demand are predominantly those that see increased demand in other chemicals. As noted above, these companies have managed the first part of the transition to ECF without major dislocation. This has not had a major effect on the chloralkali industry. In 1994, the price of NaOH increased tenfold from 1993 prices ($30 to $300 per short ton) while the price of chlorine held steady at $170 to $220 per short ton. Operating rates remained close to 94 percent (Young, 1994).

The increased use of alternative bleaching chemicals and processes is leading to the increased use of other chemicals by the pulp, paper, and paperboard industry. These chemicals include:

- Chlorine dioxide—usually produced from sodium chlorate at the mill.
- Oxygen—used in oxygen delignification and bleaching extraction stages. Traditionally supplied in liquid form, some mills are installing onsite oxygen production units.
- Ozone—still relatively new to full-scale operations, it has the potential to eliminate the need for chlorine compounds in the bleaching sequence.
- Hydrogen peroxide—used as a brightener for mechanical and sulfite pulps for many years, it is now used in the alkaline extraction stage for kraft pulps

Demand for these chemicals shows long-term growth even with the brief industry downturn seen in early 1996 (Ducey, 1989; Thurston, 1996; Young, 1991; Young, 1994).

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CHAPTER 3

ECONOMIC IMPACT AND REGULATORY FLEXIBILITY ANALYSIS METHODOLOGY

EPA is promulgating effluent limitations guidelines for the bleached papergrade kraft and papergrade sulfite subcategories of the pulp, paper, and paperboard industry, and maximum achievable control technology (MACT) standards for mills that chemically pulp wood fiber (using kraft, soda, sulfite, and semi-chemical methods) and for the following operations located at any mill: mechanical pulping, (e.g., groundwood, thermomechanical, pressurized); pulping of secondary fibers (deinked and nondeinked); and nonwood pulping. EPA is also proposing NESHAP for recovery area combustion sources. Since the economic impact and regulatory flexibility analysis methodology was explained in detail for the proposed regulations in *Economic Impact and Regulatory Flexibility Analysis of Proposed Effluent Guidelines and NESHAP for the Pulp, Paper, and Paperboard Industry* (EPA, 1993), this chapter focuses on the revisions and updates in the compliance cost model data and methodology since proposal, including:

- Updated and revised data
- Revised calculation of annual costs
- Adjustment to discount rate
- Discontinued use of the market model
- Revision of the financial closure model
    - forecasting methods
    - industry cycle
    - start year is 1996
    - price change parameter
- Discontinued use of the facility financial ratio analysis
- Update of mill ownership in Altman's Z model

These changes were discussed or referenced in EPA's Notice of Availability (NOA), 61 FR 36835 (July 15, 1996). Data updates include the mill population and options considered. The set of mills to which the final Cluster Rule will apply is a subset of the population for which EPA proposed regulations, see

Chapter 2, Industry Profile, for a more detailed explanation. As discussed in EPA's NOA, EPA is promulgating a different BAT/PSES option for the effluent guidelines than was initially proposed while MACT I requirements now differ by subcategory. Chapter Five summarizes the compliance options and regulatory alternatives evaluated by EPA. These changes, however, affect the model inputs rather than the methodology.

3.1 COMPLIANCE COST MODEL

The compliance cost model, also called the cost annualization model, estimates the cost incurred by each facility to upgrade its pollution controls. Compliance costs include both capital costs (such as equipment) and annual operating costs (such as labor and chemicals). Capital costs are one-time expenditures while incremental operating costs are incurred each year. Both types of costs generally increase the cost of production. Two revisions since proposal affect the compliance cost model: the calculation of one annual cost component (general and administrative cost, GAC), and the discount rate used in the model.

EPA has revised its estimate of annual GAC—which captures annual non-capital indirect costs associated with carrying additional capital equipment at the plant. These indirect costs are incurred regardless of how much the additional equipment is used and include overhead, property taxes, insurance, and administrative costs. In the EIA for proposal, EPA calculated GAC as 4 percent of capital costs plus 60 percent of operating expenses, supervisory and maintenance labor, and maintenance materials (EPA, 1993). Upon further examination, and as discussed in EPA's NOA, EPA determined that EPA had already included the 60-percent component in engineering estimates for the annual cost for the effluent guideline requirements (Docket Item 14,086) and thus the GAC calculated in the EIA at proposal had "double-counted" 60 percent of operating expenses in determining annual GAC. Therefore, for the EA for the final rule, EPA no longer added 60 percent of operating expenses (already taken into account in the engineering cost estimates) in estimating annual GAC. EPA did, however, add 4 percent of capital costs in estimating annual GAC. GAC is added to the engineering annual costs after the engineering estimates and prior to running the cost annualization model. The annual costs presented in the Development Document and Background Information Document are the engineering costs. They do not include GAC and are therefore lower than the annual costs presented in this report.

For proposal, the discount rate (also called the cost of money) used in the cost annualization model was taken from the facility-specific data supplied in the 1990 survey;[1] it averaged about 9 percent in real terms (EPA, 1991). The Office of Management and Budget (OMB) released guidance on the use of discount rates to estimate the social cost of regulations (OMB, 1992). For final analyses, EPA used the OMB-recommended real discount rate of 7 percent in all cost annualizations as a lower bound of real interest rates. To provide a sensitivity analysis, EPA has scaled facility-specific borrowing costs by the change in prime lending rates and corporate bond rates from 1989 to 1995 to reflect the reductions in interest rates that have occurred since 1989. The prime rate has dropped from 10.87 percent in 1989 to 8.83 percent in 1995, while inflation dropped from 4.8 percent in 1989 to approximately 2.8 percent in 1995 (CEA, 1996). The real cost of capital, as measured by the prime rate, hovered around 6 percent from 1989 to 1995. Industry's cost of capital, however, will reflect its borrowing ability and its debt/equity mix. The after-tax costs (also called industry compliance costs) are used to evaluate impacts and cost effectiveness (i.e., closure). The pre-tax annualized costs are considered the social costs of the regulation and are also used to compare costs and benefits as another cost-effectiveness measure.

3.2 MARKET IMPACT ANALYSIS METHODOLOGY

Due to the changes in the industry, a new survey would be required for all mills and product lines in order to update the partial equilibrium market model used at proposal. This is because the market model depends for its validity on having a complete set of data on each facility as an input to the model. Because doing this would be an extremely burdensome task for industry, and not likely to provide substantially different analytical results than the financial model alone, EPA did not repeat the industry survey to estimate market model results. Instead, EPA revised the financial model and incorporated relevant features of the market model (e.g., elasticities to estimate market price increases) into the financial and economic analysis presented in Chapter Six.

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[1]The EPA survey, performed under the authority of the Clean Water Act, was run during 1990 in order to collect complete 1985, 1988, and 1989 data. Hence, the text may list the 1990 survey but 1989 survey data.

3.3 FINANCIAL IMPACT ANALYSIS METHODOLOGY

The financial model methodology provides analysis of two major economic impacts that result from the final rule:

- Analysis of facility closure through the comparison of estimated salvage value, projected earnings, and regulatory costs using both a 0 percent price increase and a product-specific price increase (Section 3.3.1).
- Identification of employment and output impacts resulting from potential closures.

The closure analysis is based, in part, on facility-specific information gathered in the *1990 National Census of Pulp, Paper, and Paperboard Manufacturing Facilities, Part B: Financial Information* (EPA, 1991).

3.3.1 Closure Model

As discussed in the NOA, EPA has made three revisions to the financial closure model since proposal:

- EPA revised the forecasting model to incorporate the entire industry cycle based on 1989-1995 data.
- EPA moved the initial year for projections to 1996.
- EPA incorporated a price increase parameter reflecting product supply and demand elasticities.

3.3.1.1 Present Value of Forecasted Earnings

As for proposal, EPA uses three methods to forecast future earnings. The details, however, have been revised to reflect new information. Facility-specific 1989 census data, industry data, and the same general set of assumptions and procedures as used at proposal form the basis for all three methods:

- No growth. EPA assumes the mill to be running at or near capacity and significant growth is considered unlikely without a major capacity addition. This is conservative because it does not assume a facility can increase its earnings via increased production (and therefore lessen impacts) without incurring costs of expansion (which may not be the case).

- Constant 1989 dollars. Data are deflated using the change in the Consumer Price Index (see Table 3-1).

- After-tax earnings. EPA applied corporate tax rates, if necessary, to obtain after-tax earnings. For facilities that are part of multiple-facility companies, EPA estimates earnings as revenues minus costs. These amounts are adjusted to after-tax earnings using tax rates for corporate income shown in Section Two of the questionnaire for the business entity. For independent facilities, net income is taken from the income statement and does not need to be adjusted.[2]

Earnings data for 1990-1995 used in the closure model are developed using 1989 data from the EPA survey modified by 1990-1995 industry earnings data. 1988 and 1995 are peaks in the industry's earnings cycle with downturns beginning in the last quarter of 1989 and 1995, respectively (see Section 2.5). Earnings data for facilities from 1990 to 1995 are based on the industry earnings cycle from 1990-1995. Table 3-2 shows industry earnings as a percent of 1989 industry earnings. Earnings data are estimated by multiplying the 1989 earnings[3] for each facility by the percentage of industry earnings with respect to 1989 earnings for 1990 through 1995, shown on Table 3-2. The earnings developed for 1990 through 1995 are then used in the forecasting methods to predict data from 1996 to 2011. Table 3-3 presents an example of the developed and forecasted earnings for a hypothetical mill for the years 1990 through 2011.

The three forecasting methods used can be summarized as follows:

- Simple Cycle
  - Data from 1989 to 1995 are repeated to provide a 7-year cycle.
  - Advantage: retains cyclical nature of industry.

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[2] A facility's operating losses, like all costs, are reduced by the tax shield. The owner may use the operating loss to offset income from another facility or carry the loss forward to offset income generated in the future. For mills owned by multi-facility companies, the closure model selects a federal tax rate based on the parent company's marginal income tax rate. The closure model uses a marginal federal tax rate of 34 percent for mills whose parent company shows a net loss. The 34 percent bracket was the most representative for companies in the closure analysis.

[3] 1989 is the most recent year for which facility-specific data are available from the survey.

TABLE 3-1
INFLATION RATE 1981-1995

Year	Consumer Price Index	Percent Change
1981	90.9	
1982	96.5	6.2%
1983	99.6	3.2%
1984	103.9	4.3%
1985	107.6	3.6%
1986	109.6	1.9%
1987	113.6	3.6%
1988	118.3	4.1%
1989	124.0	4.8%
1990	130.7	5.4%
1991	136.2	4.2%
1992	140.3	3.0%
1993	144.5	3.0%
1994	148.2	2.6%
1995	152.4	2.8%
Average Inflation Rate		3.8%

Source: CEA. 1996. Economic report of the president. Council of Economic Advisers, Washington, DC. Table B-56.

TABLE 3-2
PULP AND PAPER INDUSTRY DATA, 1985-1995
(MILLIONS OF DOLLARS)

Year	Net Profit After Tax (Current Dollars)	CPI	Net Profit After Tax (1989 Dollars)	Percent of Industry Earnings 1989 Base Year
1985	$2,880	107.6	$3,319	47%
1986	$3,280	109.6	$3,711	53%
1987	$5,522	113.6	$6,028	86%
1988	$8,081	118.3	$8,470	120%
1989	$7,047	124.0	$7,047	100%
1990	$4,883	130.7	$4,633	66%
1991	$2,164	136.2	$1,970	28%
1992	$1,197	140.3	$1,058	15%
1993	$1,778	144.5	$1,526	22%
1994	$5,264	148.2	$4,404	63%
1995	$11,982	152.4	$9,749	138%

* 1993 data are adjusted for Fort Howard write-down of goodwill. In acquisition accounting, goodwill is the difference between purchase prices and what the asset would yield in a liquidation. Goodwill is generally amortized over a period of years, but in this case, Fort Howard subtracted the entire value of remaining goodwill from 1993 operating income.

Sources: AF&PA. 1995. 1995 Statistics; Paper, Paperboard, and Wood Pulp. American Forest and Paper Association, Washington, DC.; CEA. 1996. Economic report of the president. Council of Economic Advisers, Washington, DC.; DOC. 1995. Quarterly Financial Report for Manufacturing, Mining, and Trade Corporation, Fourth Quarter 1995. Washington, DC: Economics and Statistics Administration, Bureau of the Census.

TABLE 3-3
DEVELOPED AND FORECASTED EARNINGS, 1990-2011
Example based on hypothetical mill using three forecasting methods

Year		Percent of Industry Earnings 1989 Base Year	Revenues Thousands 1989 Dollars	
Survey Data				
	Survey ID		99999	
	1989 Earnings		$100,000	
Developed Data				
	1990	66%	$66,000	
	1991	28%	$28,000	
	1992	15%	$15,000	
	1993	22%	$22,000	
	1994	63%	$63,000	
	1995	138%	$138,000	
Forecasted Data		Simple Cycle	Modified Cycle	Moving Average
	1996	$100,000	$138,000	$61,714
	1997	$66,000	$100,000	$56,245
	1998	$28,000	$66,000	$54,851
	1999	$15,000	$28,000	$58,687
	2000	$22,000	$15,000	$64,928
	2001	$63,000	$22,000	$71,061
	2002	$138,000	$63,000	$72,212
	2003	$100,000	$138,000	$62,814
	2004	$66,000	$100,000	$62,971
	2005	$28,000	$66,000	$63,932
	2006	$15,000	$28,000	$65,229
	2007	$22,000	$15,000	$66,164
	2008	$63,000	$22,000	$66,341
	2009	$138,000	$63,000	$65,666
	2010	$100,000	$138,000	$64,731
	2011	$66,000	$100,000	$65,005
Present Value 1996-2011 7% real discount rate		$633,976	$708,145	$638,918

- Modified Cycle

  - Data are offset 1 year from the simple cycle with the developed data for 1995 being repeated in 1996. This method is based on a forecast in *Pulp & Paper* (DeKing et al., 1996) that papermakers will try to hold prices stable in 1996.

  - Advantage: retains cyclical nature of industry.

- Moving Average

  - Data for 1996 to 2011 are generated as a 7-year moving average.

  - Advantage: traditional forecasting method

  - Disadvantage: moving average dampens industry cycle.

These forecasting methods reflect alternative approaches to modeling the cyclical nature of the paper and pulp industry.[4] Table 3-3 and Figure 3-1 illustrate the developed data and the three forecasting methods. The survey datum is the point shown for 1989. The data for 1990 through 1995 are obtained by the process described above of scaling the survey data to industry earnings.

For the simple cycle, the value for 1989 is repeated for 1996, 2003, and 2010. The forecasted sequence has two peaks, 2002 and 2009, and two low points, 1999 and 2006. The modified cycle has a 1-year timing difference from the simplified cycle—there are three peaks, 1996, 2003, and 2010, and two low points, 2000 and 2007. The moving average approach rapidly smooths the fluctuations of the business cycle to a near-horizontal line (see Proposal EIA Chapter 3 for derivation). While Figure 3-1 illustrates a typical pattern seen in the survey data, a wide range of possible patterns exist. Because of the potential range in estimated earnings resulting from three different forecasting methodologies, the same scoring methodology developed for proposal was used in the final analyses (described in Section 3.3.1.3).

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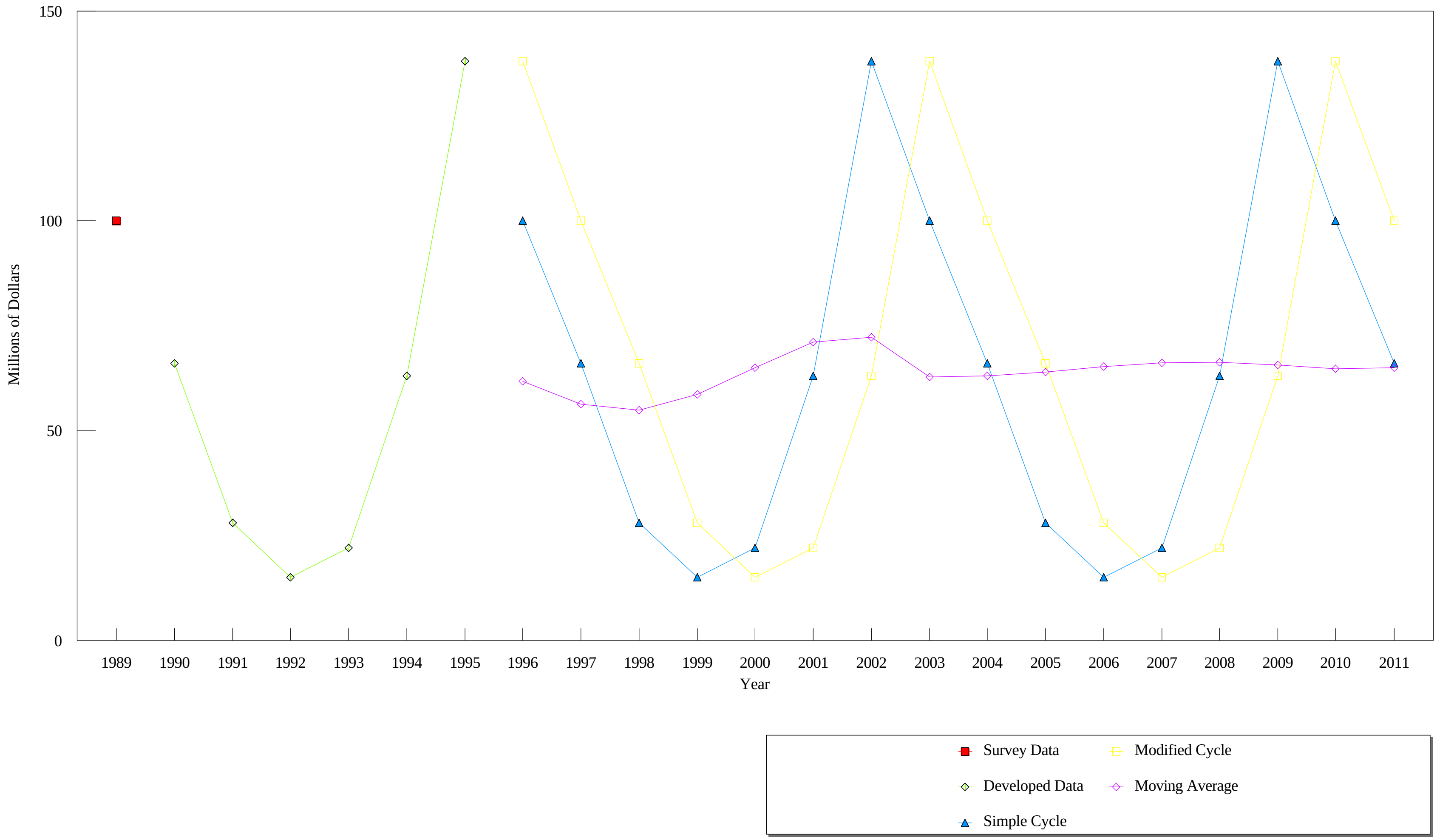
[4]Other parameters, such as gross domestic product and population, are not included in the forecasting model because they are measured on a national basis, while the forecasts are done on a facility basis. For example, a population increase may lead to increased paper demand, but the mill cannot increase its output beyond its capacity.

FIGURE 3-1
FORECASTING METHODS



The Agency estimated the present value of forecasted future earnings for 94 mills for which 1989 census data were collected (EPA, 1991).[5] Table 3-4 summarizes the results. The moving average method results in the highest average present value and, in 98 percent of the cases, the highest present value for an individual mill. The modified cycle and simple cycle each result in the highest present value for only one mill. The simple cycle method has the lowest average present value.

The three forecasting methods produce average present values of future industry earnings that are within 15 percent of each other. For specific facilities, however, the estimates can show a wider variation. Since the determination of whether a facility is likely to close results from a comparison of the salvage value[6] and value of future earnings, the choice of a forecasting method may affect whether or not a facility is projected to close, particularly where there is very little difference between the salvage value and post-regulatory future earnings. For these reasons, the closure analysis incorporates all three forecasting methods in the evaluation of facility closure.

3.3.1.2 Market Price Increase

As mentioned above, EPA is examining the closure analysis in two ways—first, by assuming a 0 percent price increase from pulp producers to pulp consumers and, second, by incorporating a price increase. The first method is consistent with an assumption that producers cannot increase prices in response to cost increases because foreign competition would flood the market with lower priced goods. The second method assumes manufacturers will be able to pass on a percentage of the compliance costs to their customers by increasing product prices. The exact amount of the price increase is dependent upon both the demand and supply elasticities of the product being sold.[7]

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[5]Ninety-six mills are estimated to bear BAT/PSES regulatory costs but two of these mills started operations after the 1990 census was taken (although prior to 1993).

[6]Salvage value is the value of the mill if the owner decides to liquidate it. EPA estimates salvage value as 100 percent cash, 40 percent of inventories, and 20 percent of fixed assets. EPA uses two methods for estimating fixed assets based on the book value or the tax assessment value of the assets (EPA, 1993). Section 3.2.1.1 provides a more detailed description of how EPA estimates salvage value.

[7]A mill that would incur no incremental costs to meet pollution control requirements would benefit from higher consumer prices. This effect is described as a "price increase" rather than a "cost pass-through."

TABLE 3-4
SUMMARY OF FORECASTED EARNINGS

Parameter	Present Value of Forecasted Earnings (Thousands, 1989 Dollars) Mill Average	Mill Total	Percent of Time Forecasting Method Produced Highest Estimate
Simple Cycle:	$211,141	$20,058,417	1.06%
Moving Average:	$229,173	$21,771,403	1.06%
Modified Cycle:	$247,679	$23,529,523	97.87%

Note: Based upon 94 BPK and PS mills.
Sources: U.S. EPA. 1991. 1990 National Census of Pulp, Paper, and Paperboard Manufacturing Facilities. Washington, DC. October.; U.S. EPA. 1993. Economic impact and regulatory flexibility analysis of proposed effluent guidelines and NESHAP for the pulp, paper, and paperboard industry. EPA/821/R-93/021. Washington, DC: Office of Water.

Supply elasticity is calculated as the percentage change in quantity supplied divided by the percentage change in price. An upward sloping supply curve has a positive elasticity since price and quantity move in the same direction. If the supply curve has an elasticity greater than one (i.e. the percentage change in quantity supplied that results from a price increase is greater than the percentage change in price, see Table 3-5), then supply is considered elastic; a small price increase will lead to a relatively large increase in quantity supplied. A supply curve with elasticity less than one is considered inelastic (i.e. the percentage change in quantity supplied is less than the percentage change in price); an increase in price will cause little change in quantity supplied. In the long-run, when producers have sufficient time to completely adjust their production to a change in price, the price elasticity of supply is usually greater than one. The difference between a relatively elastic and a relatively inelastic supply curve is illustrated in Figures 3-2a and 3-2b. The elastic supply curve in Figure 3-2a is much flatter than the inelastic supply curve in Figure 3-2b. This represents a much greater responsiveness on the part of suppliers to changes in price.

Demand elasticity is calculated as the percentage change in the quantity of a product demanded divided by the percentage change in price. An increase in price causes a decrease in the quantity demanded, hence the negative values seen in Table 3-5.[8] Figures 3-2c and 3-2d illustrate the difference between elastic and inelastic demand. In Figure 3-2c, the relatively flat demand curve means that a small price increase will cause a large decrease in quantity demanded while in Figure 3-2d, the steep demand curve means that a large increase in price has very little effect on the quantity demanded. Demand is considered elastic if demand elasticity exceeds 1.0 in absolute value (i.e., the percentage change in quantity exceeds the percentage change in price). The quantity demanded, then, is very sensitive to price increases. Demand is considered inelastic if demand elasticity is less than 1.0 in absolute value (i.e., the percentage change in quantity is less than the percentage change in price). Inelastic demand implies that the quantity demanded changes very little in response to price changes.

The significance of these elasticities is that they determine the percentage of pollution control costs that producers can pass on to consumers in the form of higher prices, as illustrated in Figure 3-2. The imposition of pollution control costs on mills causes an upward shift in the supply curve (an increase in product costs) measured by λ; for the purposes of this illustration, the upward shift in the supply curve is

[8] Economists frequently drop the minus sign on the price elasticity of demand with the understanding that price and quantity always move in different directions.

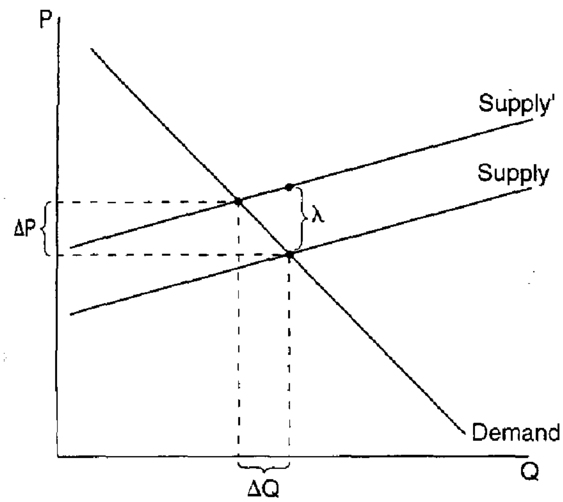
TABLE 3-5
PRICE PERCENTAGE INCREASE COMPONENTS

Variable	Bleached Papergrade Kraft Pulp	Papergrade Sulfite Pulp	Dissolving Pulps	Unbleached Kraft Pulp	Semichemical
Supply Elasticity (ε)	0.186	0.232	0.201	0.267	0.276
Demand Elasticity (δ)	-0.413	-1.051	-0.750	-0.913	-0.353
Equilibrium Price ($/ton)	$646.49	$556.77	$735.33	$384.37	$361.50
Equilibrium Quantity (off-machine tons)	9,207,000	359,000	1,470,000	320,000	5,927,000
Total Annualized Pre-tax Compliance Costs ($)	depends on specific option	depends on specific option	depends on specific option	depends on specific option	depends on specific option

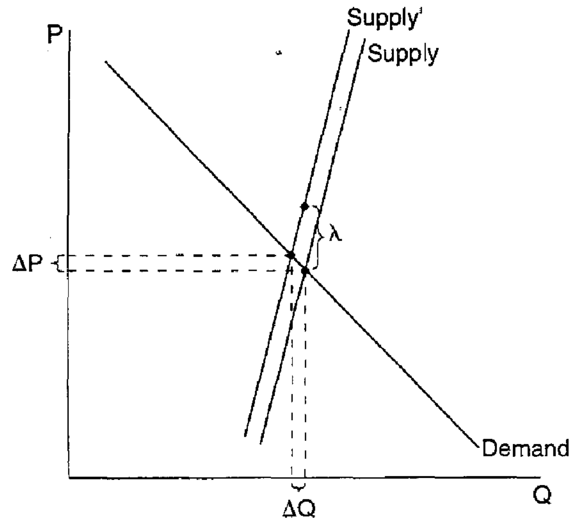
Source: U.S. EPA. 1993. Economic impact and regulatory flexibility analysis of proposed effluent guidelines and NESHAP for the pulp, paper, and paperboard industry. EPA/821/R-93/021. Washington, DC: Office of Water.

Figure 3-2

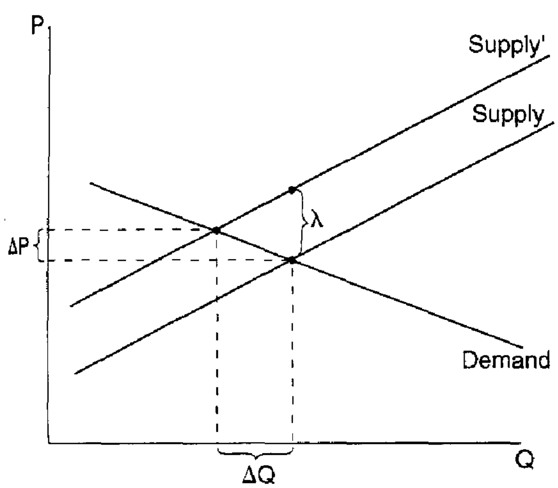
The Effect of Differences in Supply and Demand Elasticities on Changes in Output and Prices



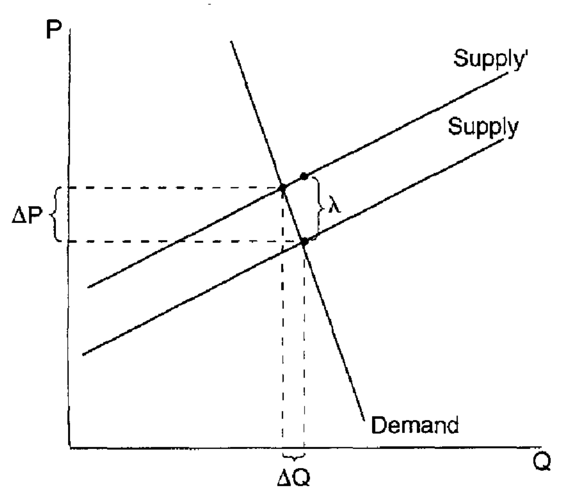
(a) Relatively Elastic Supply



(b) Relatively Inelastic Supply



(c) Relatively Elastic Demand



(d) Relatively Inelastic Demand

identical in all four figures. In Figures 3-2a and 3-2b, a relatively elastic supply curve and a relatively inelastic supply curve are shifted upward against the same demand curve. In Figure 3-2a the portion of the cost increase that can be passed on to the consumer in the form of higher prices, ΔP, is much larger than that which can be passed on if supply is inelastic (compare Figure 3-2b).

Figures 3-2c and 3-2d illustrate the same point for demand curves with different elasticities; in this case the supply curve is identical in both graphs. The demand curve in Figure 3-2d is much less elastic than the demand curve in Figure 3-2c. Because consumers decrease purchases of a good very little when demand is inelastic, producers are able to pass on much more of the pollution control costs as higher prices. The increase in price, ΔP, is much larger in Figure 3-2d than Figure 3-2c. In the end, the ability of mills to pass on costs depends on both the elasticity of supply and demand; the effects of these elasticities may either offset or reinforce each other in determining the net effect on price. The details of this calculation are found in Appendix A: Price Increase Methodology.

Table 3-5 displays the components used to calculate the percentage price increase for various subcategories. At this time, clustered air and water pollution rules are being promulgated only for the bleached papergrade kraft and papergrade sulfite subcategories. Table 3-5 contains data for dissolving pulps, unbleached kraft pulp, and semichemical products to address the larger number of mills covered by the promulgated MACT I and proposed MACT II requirements. Supply and demand elasticities were taken from EPA, 1993, Table A-14. Equilibrium price ($1989) and equilibrium quantity—calculated as 1989 domestic production— were taken from EPA, 1993, Table A-16.

The values shown in Table 3-5 indicate that the supply for these pulp products is very inelastic. This implies that even significant price increases result in very little additional supply. This is consistent with mills running near capacity, when only a very substantial increase in supply would warrant expansion at existing facilities or new mills, because both are capital-intensive options. The values in Table 3-5 indicate inelastic demands for most products listed. The conditions described in Table 3-5 indicate that the percentage price increases will tend to be small with unbleached kraft showing the largest percentage price increase for a given cost.

The overall percentage increase in earnings due to a price increase will be less at integrated mills than at mills that produce and sell only pulp. Given that the percentage price increase is generally small, and obtaining up-to-date information on all of the variables in Equation 3.4 for all mills is difficult, the price increase calculated for each mill's primary product (Equation 3.1 and Table 3-5) is used in the initial closure analysis. The zero percent price increase and the pulp-specific price increase provide an upper and lower bound of the percentage of compliance costs that mills can pass onto their consumers. If a particular mill showed sensitivity to a price increase, EPA re-examined the production mix at the mill to determine whether a more precise estimate would affect the results. Price increases will vary by the cost of the selected option and are reported in Chapter Six.

3.3.1.3 Sample Closure Analysis

Figures 3-3a and 3-3b show an annotated printout of the closure model based on hypothetical data. Actual closure model output contains facility-specific confidential information. The inputs and summary outputs from the closure model are contained in the Confidential Business Information (CBI) record for the rule. A non-confidential version of the closure model is included in the record for the rule.

In Figure 3-3a, the section labeled "A" contains input variables for the mill closure calculation. EPA's analysis used both the OMB-recommended real discount rate of 7 percent (OMB, 1992) and a mill-specific cost of capital adjusted to 1995. The top two lines in the model (inflation and nominal discount rate) have been retained for the sensitivity analysis on facility-specific discount rates. Recovery factors (i.e., the fraction of assets value recovered in the liquidation process) for inventories and fixed assets are given as 40 and 20 percent, respectively.[9] The company tax structure is used to identify which set of tax rates should be used to calculate after-tax income. In the example, the facility's tax rate is based on the income level of the company that owns the mill. For an independent facility, the net income does not need to be adjusted for taxes. For an S Corporation, personal income tax rates are used (CCH, 1991). The average state tax rate is added to federal tax rate to provide the combined effective tax rate for the mill.

Figure 3-3a, Section B, lists the calculation of the two salvage value estimates—the value of a mill if liquidated—used in the closure decision. In this analysis, salvage value has three components:

[9]EPA based this on conservative financial judgement. No commenters on the proposed rule suggested an alternative approach for this estimate.

FIGURE 3-3a
CLOSURE ANALYSIS MODEL--INPUTS AND SALVAGE VALUE USING HYPOTHETICAL DATA

C O N F I D E N T I A L   B U S I N E S S   I N F O R M A T I O N

CLOSURE MODEL   Survey ID#: 12345   Class: BAT   run date: 27-Jun-96

ALL FIGURES IN THOUSANDS OF DOLLARS

A INPUT VARIABLES:

Inflation Rate (1990-2011):	4.0%
Nominal Discount Rate:	11.0%
Real Discount Rate:	7.0%
Inventory Recovery Factor:	40.0%
Fixed Asset Recovery Factor:	20.0%
Company Tax Structure:	1
Taxable Income (Corp. Parent):	520,000
Federal Income Tax Rate:	34.0%
Avg. State Income Tax Rate:	7.0%
Combined Eff. Income Tax Rate:	41.0%

Federal Corp.Tax Table:		Federal Personal Tax Table:	
Taxable Income ($000)	Average Effective Tax Rate	Taxable Income ($000)	Average Effective Tax Rate
$0	15.0%	$0	15.0%
$50	16.7%	$20	21.5%
$75	20.4%	$47	30.5%
$100	28.3%	$98	31.0%
$335	34.0%		

(1=Multi; 2=Independent; 3=S-Corp.)

B SALVAGE VALUE:

CURRENT ASSETS:

1989 Cash:	20,000
1989 Inventories:	25,000
Total:	$30,000

FIXED ASSETS:

Tax Assessed Value:

	Assessed Value	Assessment Rate	Market Value	Recoverable Value
Total (b077D):	135,000	50%	$270,000	$54,000

Book Value:

1989 Land:	8,000
1989 Buildings:	35,000
1989 Equipment:	410,000
Less Cum. Deprec.:	100,000
Total:	$353,000
Recoverable Value:	$70,600

TOTAL SALVAGE VALUE OF MILL:

Using Tax Assessments:	$84,000
Using Book Value:	$100,600

Need to examine notes sections to see if assessment rates vary for real assets vs. fixed assets.

FIGURE 3-3b
FORECASTED EARNINGS AND CLOSURE SCORE USING HYPOTHETICAL DATA

C PRESENT VALUE:

PAST EARNINGS ($1989):
Corporate Tax Structure: Multi-Facility Co.

		Pre-Tax	Post-Tax
Earnings	1989	55,000	$32,450

FORECASTED EARNINGS:

Year	Cycle	ModCycle	MovAvg
1990	$21,417		
1991	$9,086		
1992	$4,868		
1993	$7,139		
1994	$20,444		
1995	$44,781		
1996	$21,417	$44,781	$20,026
1997	$9,086	$21,417	$18,251
1998	$4,868	$9,086	$17,799
1999	$7,139	$4,868	$19,044
2000	$20,444	$7,139	$21,069
2001	$44,781	$20,444	$23,059
2002	$21,417	$44,781	$23,433
2003	$9,086	$21,417	$20,383
2004	$4,868	$9,086	$20,434
2005	$7,139	$4,868	$20,746
2006	$20,444	$7,139	$21,167
2007	$44,781	$20,444	$21,470
2008	$21,417	$44,781	$21,528
2009	$9,086	$21,417	$21,309
2010	$4,868	$9,086	$21,005
2011	$7,139	$4,868	$21,094
BASELINE PRESENT VALUE:	$163,580	$195,241	$207,329

Bleached Papergrade Kraft Regulatory Percentage Price Increase (PI)

OPTION1	2.58%
OPTION2	2.59%
OPTION3	2.57%
OPTION4	2.62%
OPTION5	2.68%

D SUMMARY:

Salvage Value:
Assessment: $84,000 Book: $100,600

Regulatory Option	PV of Incremental Reg. Costs	Present Value: Cycle $163,580	Mod Cycle $195,241	Mov. Avg. $207,329	Cycle $163,580	Mod Cycle $195,241	Mov. Avg. $207,329	Closures
Baseline	$0	0	0	0	0	0	0	0
Option 1	$25,000	0	0	0	0	0	0	0
Option 2	$40,000	0	0	0	0	0	0	0
Option 3	$85,000	1	0	0	1	0	0	2
Option 4	$110,000	1	0	0	1	1	1	4
Option 5	$120,000	1	1	0	1	1	1	5
Option 1 with PI	$25,000	0	0	0	0	0	0	0
Option 2 with PI	$40,000	0	0	0	0	0	0	0
Option 3 with PI	$85,000	1	0	0	1	0	0	2
Option 4 with PI	$110,000	1	0	0	1	1	0	3
Option 5 with PI	$120,000	1	1	0	1	1	1	5

- Cash (salvage value is 100 percent of book value)
- Inventories (salvage value is 40 percent of book value)
- Fixed assets (e.g., land, buildings, and equipment; salvage value is 20 percent of book or tax assessment value)

Book value refers to the value of the assets as recorded on the facility's books or financial records. For fixed assets, the book value is the original purchase price of the asset minus the accumulated depreciation. The industry profile indicates that several facilities started pulp and papermaking operations as long as 50 to 100 years ago. Under these circumstances, some fixed assets, such as buildings, may have been completely depreciated (i.e., a book value of zero) but still have value to the facility. For this reason, EPA developed a second method to estimate the value of fixed assets, calculated as the tax assessment value of the fixed assets divided by the percentage of market value on which the tax assessment value is based. Because there are two methods of estimating the value of fixed assets, there are two estimates for the total salvage value of a mill. The total salvage value for a mill is the sum of the salvage values for cash, inventory, and fixed assets. For brevity, the two estimates are named after the method of calculating the value of fixed assets, i.e., book or tax assessment.

Salvage values for the example mill are calculated in Figure 3-3a, Section B. (Note that all values are expressed in thousands of dollars.) In this example, the salvage value of cash is $20,000 while the salvage value of inventories is $10,000 ($25,000 x 40 percent recovery factor). The salvage value of current assets is $30,000 (i.e., cash plus the salvage value of inventories). The value of fixed assets is either:

- $270,000 (based on a tax assessment of $135,000 and an assessment rate or market value rate of 50 percent), or
- $353,000 (based on book value for the individual components minus the cumulative depreciation, i.e., $8,000 + $35,000 + $410,000 - $100,000 = $353,000)

Salvage value for fixed assets is estimated as 20 percent of the book or tax assessment value. In this example, the salvage value for fixed assets is $54,000 (tax assessment, 20 percent * $270,000) or $70,600 (book value, 20 percent * $353,000). The total salvage value for the mill is:

- Tax assessment = $54,000 + $30,000 = $84,000
- Book value = $70,600 + $30,000 = $100,600

Forecasted earnings are shown in Section C of Figure 3-3b. The first part reports the earnings for 1989 as taken from the survey. This value along with industry data (Table 3-2) is used to estimate 1990-1995 data as described in Section 3.3.1.2 above. The data are then used in the three forecasting methods to predict earnings through 2011. Because the example mill is part of a multifacility company, the earnings (revenues minus costs) must be adjusted to post-tax earnings. The present value of earnings from each method is calculated as 1996 earnings plus the stream of earnings from 1997 to 2011 discounted at 7 percent/year.

The percentage price increase for each specific option is also calculated in Section C. The method of calculating the percentage of compliance cost that can be passed onto the consumer is described in Appendix A. The sample closure analysis considers five options with price increases ranging from 2.57 percent to 2.68 percent.

Section D of Figure 3-3b summarizes the results of the closure analysis. Each row, beginning with the one entitled "Baseline," represents a regulatory alternative or option. The present value of the incremental regulatory cost for each option is calculated with the cost annualization model. Five options are considered in the sample closure analysis. Figure 3-3b, Section D lists 11 comparisons—a baseline analysis, five options with no price increase, and five options with a price increase. Because Figure 3-3 is an illustrative example, the five options and their associated costs and price increases bear no relationship to any of the options under consideration for promulgation. The costs were chosen to illustrate a range of costs and an increasing severity of the impact of those costs. The price increases were selected to illustrate how the ability of a facility to raise prices could mitigate the cost impacts. Note that the costs do not change for options with price increases, but the number of closures may change depending on the price increase.

A facility is projected to close if the salvage value exceeds the present value of future earnings after increased pollution control costs. The present value of future earnings for the options that incorporate the price increase are calculated as: present value of expected earnings multiplied by (1 + option X's percentage price increase). The post-regulatory earnings are calculated by subtracting the present value of incremental regulatory costs from the present value of projected earnings.

With two methods of estimating salvage value (book and tax assessment) and three methods of estimating the present value of future earnings (simple cycle, moving average, and modified cycle), there are six ways to evaluate facility closure. A mill that is determined not to close under a particular earnings/salvage value combination is given a score of 0 for that combination. A mill that is determined to close under a particular combination is given a score of 1 for that combination. The scores are then totaled for all combinations, creating a range from 0 (no closure under any combination) to 6 (closures under all combinations).

The last step in the closure analysis is to evaluate when a mill would be considered a closure. Closure is the most severe impact that can occur at the facility level and represents a final, irreversible decision in the analysis. The decision to close a mill is not made lightly; the business is aware of and concerned with the turmoil introduced into its worker's lives, community impacts, and how the action might be interpreted by stockholders. The business will likely investigate several business forecasts and several methods of valuing their assets. Not only all data, assumptions, and projections of future market behavior would be weighed in the corporate decision to close a mill, but the uncertainties associated with the projections would be evaluated. When examining the results of several analyses, the results are likely to be mixed. Some indicators may be negative while others indicate that the facility can weather the current difficult situation. A decision to close a facility is likely to be made only when the weight of evidence indicates that this is the appropriate path for the company to take.

EPA emulated corporate decisionmaking patterns when determining when a facility would close. A score of 3 means that half of the comparisons indicate a financially viable concern.[10] A business is unlikely to close a facility when the uncertainty in the data means there is a 50-50 chance of it being viable. EPA selected a score of 4 or higher to indicate closure because it meant that the majority of the comparisons (i.e., at least 4 of 6) now indicate poor financial health. EPA believes that this scoring approach represents a reasonable and conservative method for determining closure.

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[10]For mills with no tax assessment salvage value, however, a score of 3 predicts closure. A mill with a score of 3 would have scored 1 for every combination of forecasting method and book value for salvage value estimate, and EPA reasoned that, if a tax assessment were available, the mill would be likely to close under at least one forecasting method/tax assessment for salvage value combination.

Returning to the sample closure analysis in Figure 3-3b, the present value of earnings under Option 1 with the price increase using the simple cycle forecasting method would be: $163,580 (1 + 0.0258) = $167,800 (in thousands of dollars). Post-regulatory earnings would then be: $167,800 - $25,000 = $142,800. This figure is larger than either of the salvage estimates, therefore a score of 0 is given for both. The same regulatory options are being evaluated when the price increase is incorporated, therefore the present value of incremental regulatory costs remain the same whether the option has a price increase or not. Only the present value of forecasted earnings change—each increasing by the specific option's percentage price increase.

Under Option 4, the present value of the post-regulatory earning is $195,241 - $110,000 = $85,241 for the modified cycle method of projecting earnings. This value is greater than the salvage value as calculated by the tax assessment method ($84,000) but lower than the salvage value as calculated by book value ($100,600). Under Option 4, the modified cycle/tax assessment combination has a score of 0, while the modified cycle/book value combination has a score of 1. The right-hand column sums the entries for all six earnings projections/salvage value combinations to provide a closure score.

In the example, the mill experiences adverse financial impacts beginning with Option 3. Whether it is projected to be a closure in Option 4 depends on whether a price increase is incorporated. Under Option 5, however, the mill is projected to close even with the estimated price increase.

3.3.1.4 Baseline Closures

A baseline closure is a mill that fails the salvage value test before the addition of incremental pollution control costs. The industry profile identified a category of mills that is likely to appear as baseline closures. These are "captive" mills—mills that exist to serve other facilities under the same ownership. Over 75 percent of the bleached papergrade kraft (BPK) and papergrade sulfite (PS) mills indicated they transferred **some** product to other facilities under the same ownership during the survey period. Between 5 and 6 mills indicated that 90 percent or more of their revenues from **one** product (pulp, paper, or paperboard) were from transfers to other facilities under the same ownership. Finally, between 1 and 10 mills reported that over 90 percent of **all** pulp, paper, and paperboard revenues were from transfers to other facilities under the same ownership (captive mills).

If the transfers are done at cost, these captive and near-captive mills would show little, if any, profit. If the captive mills have any salvage value, they could be deemed closures before the addition of incremental pollution control costs. In actuality, these mills would not necessarily close but could raise the transfer prices for their products to meet the incremental costs of pollution control; they should not be considered as incremental closures.

Of the 96 mills estimated to bear incremental costs in this rulemaking, data were available to perform the closure analysis on 94. About 9 of these 94 mills are considered baseline closures. Fifty-five percent of the baseline closures (5 mills) show anywhere from 1 to 3 years of losses. One mill shows only minimal profits. (The earnings for this mill might be more favorable if cash flow rather than net income were the basis for the analysis.) Two mills are considered "captive" mills. One mill had high salvage values because of its large amounts of cash. (Current assets, other than inventory, are valued at 100 percent while all other components in the salvage value are reduced by a recovery factor.) This mill is unlikely to close even though the salvage value exceeds the present value of future earnings because the owner already has access to the cash and would not have to liquidate a profitable business to gain access to it.

Given the widespread practice of transferring product to other mills under the same ownership, low earnings may be a frequent phenomenon in the census data. The methodological choice of analyzing net income rather than cash flow for projected earnings also results in low earnings projections. In summary, a mill could be a baseline closure for a wide range of reasons. The objective of the closure analysis, however, is to examine the impacts of additional pollution control costs on the pulp and paper industry. To examine impacts, only the incremental closures (i.e., beyond baseline) are counted because only these closures can be attributed to the incremental costs of compliance. For mills that are determined to be baseline closures, the economic analysis defaults to the company-level analysis to evaluate the impacts of incremental costs.

3.3.2 Associated Impacts

There are no changes to the methodology used to calculate associated impacts. Direct impacts (such as employment, production, and export losses) are calculated by aggregating the facility-specific data from mills projected to close. Secondary impacts are calculated by multiplying the direct losses by the U.S. Department of Commerce's Regional Input-Output Modeling System (RIMS II); see Table 3-6 (DOC, 1992,

TABLE 3-6
RIMS II MULTIPLIERS FOR THE PULP, PAPER, AND PAPERBOARD INDUSTRIES

Industrial Category	Final-demand multipliers	
	Output (dollars per dollar)	Employment (Full-time equivalents [FTEs] per $1,000,000 in output, $1992)
Pulp Mills	2.9711	23.2
Paper Mills	2.9017	22.9
Paperboard Mills	2.9017	22.9

Source: DOC. 1996. U.S. Department of Commerce. Bureau of Economic Analysis. *Regional Input-Output Modeling System (RIMS II)*. Total Multipliers by Industry aggregation for output, earnings, and employment. Washington, DC: Bureau of Economic Analysis, U.S. DOC. Table A-2.4.

and DOC, 1996). Impacts on the pulp and paper industry are known as direct effects, impacts that continue to resonate through the economy are known as indirect effects (effects on input industries), and effects on consumer demand are known as induced effects. These effects are tracked both nationally and regionally in massive "input-output" (I-O) tables prepared by the U.S. Department of Commerce's Bureau of Economic Analysis (BEA). For every dollar spent in a "spending industry," these tables identify the portion spent in contributing or vendor industries.

For example, as a result of this rule, a pulp and paper company might purchase equipment to meet BAT standards. One piece of this equipment could be a tank to hold chlorine dioxide. To make the tank, the manufacturer might purchase stainless steel. The steel manufacturer would purchase iron ore, coke, energy sources, and other commodities, etc. Thus a portion of a dollar spent by the pulp and paper industry becomes a smaller portion of a dollar spent by the tank manufacturer, and a smaller portion of a dollar spent by the steel manufacturer, and so on. These iterations are captured in the BEA's I-O tables and summarized as regional and national multipliers for output (revenues). BEA also has determined average wages and the proportion of output in each industry that goes to employee earnings and, as a result, the number of employees or full-time equivalents (FTEs)[11] associated with each $1 million change in output. I-O analysis provides a straightforward framework as long as the direct effects to the industry are small and certain limiting assumptions about technology are valid (e.g., constant returns to scale, fixed input ratios).

3.3.3 Facility-Level Ratio Analysis

A facility-level ratio analysis was not performed for several reasons. First, the facility-level financial ratio analysis performed for the EIA for proposal (EPA, 1993) provided only limited information because certain items, such as long-term debt, are frequently not held on a facility's books. These items are held at the company-level only. As a result, the resultant financial ratios were frequently incomplete and difficult to interpret because the values differed so much from those generated with company-level data. Second, a number of facilities have changed ownership since 1989. When mill ownership changes, the assets and liabilities for a mill are changed to reflect the purchase price and debt acquisition for the new owner. Because updating the information would have required another survey effort, which would have been burdensome to

[11]One FTE = 2,080 labor hours = 1 person-year of employment.

both EPA and industry, and the information gathered would have limited usefulness for this part of the analysis because only some items necessary for a ratio analysis are carried at the facility-level, EPA decided not to perform a facility-level financial ratio analysis. At proposal the facility-level ratio analysis was not a determinant of findings of economic achievability.

3.3.4 Company-Level Bankruptcy/Financial Ratio Analysis

There is no change to the methodology presented in the EIA for Proposal, EPA, 1993, Section 3.5.4.2. Impacts at the company level, e.g. bankruptcy, are based upon a composite of financial ratios termed Altman's Z score (Altman, 1993).

Public financial information for fiscal 1995 was gathered for the 29 public companies that own BPK and/or PS mills. The remaining eight companies (11 percent) that own BPK and PS mills are privately held and were therefore not included in the bankruptcy analysis. EPA chose not to use the 1989 survey information because it is no longer current enough for purposes of the Altman’s Z score analysis.

The results of a baseline Altman’s Z analysis are compared to an Altman’s Z analysis that incorporates costs incurred by each company due to the final pollution control regulations. EPA also examined changes in the Altman’s Z score due to the costs of final and proposed pollution control regulations. The changes made for calculation of the post-regulation analysis are:

- Total Assets = Total Assets + Compliance Capital Costs
- Total Liabilities = Total Liabilities + Compliance Capital Costs
- Earnings Before Interest and Taxes (EBIT) = EBIT - Pre-tax Annualized Compliance Cost

The results of the Altman's Z analysis are presented in Chapter Six.

3.4 REGULATORY FLEXIBILITY ANALYSIS METHODOLOGY

The Regulatory Flexibility Act (RFA) (5 U.S.C. 601 et seq.) as amended by the Small Business Regulatory Enforcement Fairness Act of 1996 (SBREFA) (Public Law 104-121) requires agencies to analyze how a regulation will affect small entities. The purpose of this legislation is to ensure, if possible, that agencies identify and consider ways of tailoring regulations to the size of regulated entities to minimize any rule's significant economic impact on a substantial number of small entities. The U.S. Small Business Administration issues definitions of "small businesses" in the 13 CFR 121. For the pulp, paper, and paperboard industry (SIC codes 2611, 2621, and 2631, respectively), the standard is 750 employees. The definition used in this analysis will therefore be any business entity (e.g., company) with less than 750 employees. The ancillary categories used in the proposed rule EIA, 1993 (e.g., very small entities with less than 126 employees and very small/small/large facilities) have been dropped to focus the analysis on meeting the requirements of the RFA.

A set of analyses, identical to those run for the entire BPK and PS subcategory population, is run on only small companies. Summary statistics, facility closure analysis results, and Altman's Z analysis results (using small publicly-owned businesses) are presented in Chapter Seven.

3.5 REFERENCES

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CHAPTER 4

BENEFITS AND ENVIRONMENTAL JUSTICE METHODOLOGY

This chapter presents revisions and updates to the benefits methodology implemented since proposal. The Regulatory Impact Analysis from proposal (EPA, 1993) provides additional detail regarding benefits estimation methodologies. The methodology presented below supports the evaluation of potential air benefits associated with the final MACT I rule and each of the regulatory alternatives under consideration for MACT II (both separately and combined) at 155 affected mills, as well as the evaluation of potential water benefits associated with the BAT/PSES requirements at 96 mills covered by the final effluent guidelines. As with costs, the baseline for estimating benefits has been revised since proposal to reflect emissions and discharges resulting from technology in place as of mid-1995. Sections 4.1 and 4.2 present revisions to the methods for estimating quantitative and monetized benefits for air and water benefits, respectively (EPA did not revise the methodology for qualitatively assessing benefits). Section 4.3 presents the methodology to evaluate benefits through case studies. Section 4.4 presents an alternative way to evaluate total benefits through the use of present value of the stream of benefits over a 30-year period. Lastly, Section 4.5 discusses the methodology for an Environmental Justice analysis.

4.1 AIR BENEFITS

Changes in the methodology used to quantify and monetize the potential health and welfare impacts of reduced air pollution emissions resulting from the integrated regulation are discussed below. The methodology described in this section and the analysis that follows in Chapter 8 represent the combined analysis of the final rule for MACT I, and the proposed rule for MACT II, along with their interactions with BAT/PSES requirements.

4.1.1 Hazardous Air Pollutants

The regulatory impact analysis (RIA) for the proposed MACT I standard evaluated the effect of reduced hazardous air pollutant (HAP) emissions (EPA, 1993). The findings of that analysis showed a nationwide reduction in the annual cancer incidence rate that is less than half of a statistical life, which resulted in an average monetized value that is less than $3 million. Although the final MACT I standard achieves slightly greater HAP emission reductions, it is not expected that these changes will influence the outcome of the benefit analysis conducted for the proposed standard by a significant amount. Likewise, the HAP emission reductions associated with MACT II are an order of magnitude lower than MACT I and are unlikely to reduce the annual cancer incidence by a measurable amount. In addition, other air-related benefits (i.e., from volatile organic compound [VOC] emission reductions) that are quantified in the RIA to the proposed rule range in total value from $88 million to $552 million (1992 dollars), as compared to the $3 million associated with HAP reductions. Due to this difference in magnitude, this analysis quantifies HAP emission reductions, but does not present a monetized value for these benefits.

4.1.2 Volatile Organic Compounds

VOC emissions are known precursors to the formation of ozone. Due to the inaccessibility of an air quality model, the analysis for the proposed rule in 1993 assumed a linear relationship for the transformation of total nationwide VOC emissions into ambient ozone. The analysis was based on data obtained for health and welfare effects by a study conducted by the Office of Technology Assessment (OTA, 1989), which examined the benefits of reducing ambient ozone concentrations. VOC benefits were derived based on average dollar per megagram (Mg) values from the OTA study. While the basic premise that a relationship exists between the transformation of nationwide VOC emissions into ambient ozone is unchanged, the present analysis alters two factors to monetize the VOC benefits (see Chapter 8 of this EA). First, we replace the average dollar per Mg values from the OTA report with monetary values obtained from the recently promulgated ozone National Ambient Air Quality Standard (NAAQS). The revised ozone NAAQS (0.08 parts per million, 8-hour, 4th highest concentration) provides recent scientific evidence of the health and welfare effects of acute and long term exposure to ozone concentrations below the current ozone standard (0.12 parts per million, 1-hour, 1 expected exceedance). The RIA for the revised ozone NAAQS (EPA, 1997a) presents monetized benefit estimates associated with the promulgated ozone standard, from which the

EPA obtains an updated range of average dollar per Mg values for a combination of health and welfare effects that are included in the analysis. Secondly, this analysis uses two approaches for monetizing VOC emission reductions: (1) apply the dollar per Mg value only to VOC emission reductions that would occur in areas with ozone concentrations exceeding either the current or the promulgated ozone NAAQS, and (2) apply the dollar per Mg benefit value to all VOC emission reductions expected to be achieved.

In addition, due to several limitations of the "cost avoidance approach" to value VOC benefits (as is discussed in the RIA for the proposed rule), EPA does not employ this method in the present analysis. Below is a summary of information from the ozone NAAQS RIA and the resulting range of values to be used in Chapter 8 to monetize VOC benefits.

The value of reducing VOC emissions is based on the health and welfare effects attributed to lowering ambient ozone concentrations. Adverse health effects include: transient changes in pulmonary function, transient respiratory symptoms and effects on exercise performance, increased airway responsiveness, transient pulmonary inflammation, increased susceptibility to respiratory infection, increased hospital admissions and emergency room visits, and possibly, premature mortality. The ozone RIA states that all of these effects have been attributed to short-term (1 to 3 hours), prolonged (6 to 8 hours), and long-term (months to years) exposures to ozone (EPA, 1997a). However, the ozone analysis was not able to quantify and monetize all of the health effects listed above. The benefit categories included in the estimated range of monetized values for health effects include: hospital admissions for all respiratory illnesses (e.g., pneumonia or chronic obstructive pulmonary disease), the presence of any of 19 acute respiratory symptoms, and—for the upper-end of the range—mortality (EPA, 1997a). .

Reductions in ambient ozone also produce welfare (non-human health) benefits. The effects of ozone on crops, ornamentals, tree seedlings, mature trees, and forested ecosystems have been studied extensively. Elevated ozone levels can inhibit growth and yield, create leaf damage, increase susceptibility to pests and disease, and affect long term survival (EPA, 1997a). Monetized benefits are valued in the ozone RIA for increased yields in commodity crops (e.g., wheat, corn), fruits and vegetables (e.g., citrus, tomatoes), and commercial forests. Additionally, the welfare benefits analysis includes monetized benefits associated with increased worker productivity.

There are two considerations given when selecting a benefit transfer value from the NAAQS RIA. First, the RIA presents analyses of full- and partial-attainment of the regulatory alternatives considered in that document. The VOC benefit transfer is derived from the most representative scenario presented in the RIA. The full-attainment scenario analyzes total air quality changes from VOC and NO_x reductions that are needed to achieve the regulatory alternatives, regardless of control technology available. The analysis of the partial attainment scenario estimates achieved emission reductions based on known control technology. The full attainment scenario incorporates achieved emission reductions with an estimate of "residual" emission reductions (i.e., those that remain after known control technology is applied) based on several assumptions of future control technology. Because the partial attainment scenario provides a more certain estimate of emission reductions and related benefits for each of the ozone regulatory alternatives, this scenario is used to calculate a transfer value for VOC to be applied in the pulp and paper analysis.

Secondly, this analysis utilizes the benefits results associated with the promulgated ozone NAAQS although other regulatory alternatives are examined in the RIA. The promulgated ozone NAAQS appears to be an appropriate scenario because all areas in the U.S. must now strive to meet this new air quality standard.

Additionally, the VOC benefits estimates presented in this analysis are calculated by including all effects categories reasonably believed to be associated with ozone exposure. The health benefits categories included in the estimated range of monetized VOC benefit calculations consist of: reduced premature mortality (for the upper-end of the range), reduced cancer risk from hazardous air pollutants in the VOC stream, reduced numbers of hospital admissions for all respiratory illnesses, and reduced incidences of acute respiratory symptoms. These benefits categories were included in the benefits analysis for the promulgated NAAQS for ozone, which serves as the basis of the monetized values used in this pulp and paper analysis.

A review of the ozone health effects literature in the 1995 Air Quality Criteria Document for Ozone and Related Photochemical Oxidants concluded that although an association between high ozone levels and mortality has been suggested, the strength of any such association remained unclear (EPA, 1996a).   Since that Criteria Document review, a significant number of new studies have been published that provides more support (i.e., statistically significant) for an association between ozone exposure and premature mortality (although there are also some new studies that fail to find a statistically significant relationship). The ozone NAAQS benefits analysis (and this pulp and paper benefits analysis) uses data from the new scientific studies to quantify the association between ozone exposure and premature mortality. In an effort to respond to concerns regarding the range of results and limited review of the new ozone literature thus far, the VOC benefits estimates provided in the ozone NAAQS RIA and for this pulp and paper analysis reflects a range of VOC benefits estimates that includes a lower-range estimate (assuming zero mortality effects associated with ozone exposure) and an upper-range estimate (based on a meta-analysis of existing studies). The Agency will continue to evaluate the new data on ozone-related premature mortality.

The resulting values obtained from the NAAQS RIA reflect benefits of achieving the promulgated ozone NAAQS incremental from the 2010 baseline established in the RIA. VOC emission reductions that are expected to be achieved for the promulgated ozone NAAQS are 369,296 tons (EPA, 1997b). The total value of the ozone (health and welfare) benefits is estimated to range from approximately $270 million to $1,200 million[1] (1990 dollars).

To determine the transfer values for VOC reductions, it is necessary to apportion the ozone benefits to the VOC emission reductions. Ozone is created from the interaction of two gases, VOCs and nitrogen oxides (NO_x). The benefits value presented above represents the value associated with reducing ozone through controlling both VOC and NO_x emissions. Dividing the total monetized ozone benefits by only the VOC emission reductions would inappropriately ignore the contributions of NO_x emission reductions to reducing ozone. Without additional air quality modeling, this analysis assumes that the monetized ozone benefits are proportionally related to the VOC and NO_x emissions. To apportion the monetized benefits to only to the VOC emission reductions, a ratio of VOC to the total emission reductions (VOC and NO_X) is calculated from the ozone NAAQS data. This calculation yields a ratio of 61%. This ratio is applied to the range of national monetized ozone benefits to arrive at the total value attributed to VOCs. The adjusted monetized values are then divided by the VOC emission reductions to yield a range of benefit per ton values from $444 to $2007 (in 1990 dollars).

Before the VOC benefit per ton value can be applied to the VOC emission reductions estimated for the pulp and paper rulemaking, the issue of geographical correlation must be considered. The ozone NAAQS control strategy analysis (the portion of the RIA that generates emission reduction estimates) was prepared for a specific set of geographical areas; areas that would potentially violate the new ozone air quality standard

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[1] These values exclude monetized benefits attributed primarily to NO_x emission reductions (e.g., ancillary PM benefits).

in the year 2010. The ozone NAAQS benefits analysis reflects ozone air quality changes based on projected emission reductions in these areas. Area-specific factors such as population and air quality distributions can significantly influence the benefits results. Although the ozone NAAQS benefits analysis attempted to estimate "transport" effects (the effect that reducing emission reductions within the boundaries of a potentially violating area would have on ozone air quality outside of those boundaries), it is recognized that the majority of the national monetized benefits are estimated for counties within the violating area boundaries.

Given the dependence of the benefits estimates on specific geographical factors, the issue of geographical correlation should be considered when these transfer values are applied to VOC emission reductions estimated for the pulp and paper rules. Two methods are employed to apply the benefit transfer values to pulp and paper reductions. The first method considers only VOC emission reductions estimated for pulp and paper mills located in areas that violate either the current or promulgated ozone NAAQS. This method ignores pulp and paper emission reductions estimated for mills that are not located in these areas and, in effect, would not assign a value to these VOC emission reductions. This method is only possible when VOC emission reduction estimates are available on a mill-by-mill basis. For this analysis, this method provides a lower-bound estimate of the potential monetized benefits associated with the VOC emission reductions. The second method for valuing VOC emission reductions is to apply the benefit transfer values to all VOC emission reductions estimated for all pulp and paper mills, regardless of location. Although this method ignores the issue of geographic location, it accounts for reduced ozone concentrations (even below the promulgated ozone standard) that yield reduced adverse health and welfare effects. For this analysis, this method provides an upper-bound estimate of the potential monetized benefits associated with VOC emission reductions. The actual value placed on VOC emission reductions is likely to be between this range.

To transfer these NAAQS RIA results to the pulp and paper rule, EPA converts the benefit per ton values to benefit per Mg values and escalate the values to 1995 dollars using the Consumer Price Index for all urban areas (BLS, 1997). The resulting value from this conversion is a range from $571 to $2580 (in 1995 dollars).

4.1.3 Total Reduced Sulfur

EPA did not revise the methodology used to assess the benefit of reductions in total reduced sulfur (TRS). No new information is available to monetize the effects of reducing the odor associated with paper mills.

4.1.4 Other Criteria Air Pollutants

For the proposed rule, EPA estimated that there would be an increase in emissions (i.e., negative benefits) of PM, sulfur dioxide (SO_2), nitrous oxides (NO_x), and carbon monoxide (CO) with the implementation of the MACT I standard. For the proposal analysis, data were not available to monetize the effects of these increased emissions. Although the final MACT I standard will still have negative benefits for these criteria air pollutants, MACT II produces positive benefits for PM and SO_2. The net effect of these combined MACT standards on PM, and CO are to reduce emissions, while NO_x and SO_2 continues to show an increase in emissions. While the analysis for the proposed rule was unable to monetize any of the benefits associated with criteria air pollutants, below is a discussion of the health and welfare effects as are discussed in the recently promulgated PM NAAQS (EPA, 1997a).

A variety of activities contribute significantly to PM concentrations. Course particles of PM (i.e., those greater than 10 micrograms in diameter) typically come from sources such as: construction and demolition activities, industrial operations, wind blown dust, and road dust. Fine particles (i.e., those smaller than 2.5 micrograms in diameter) are created by fuel combustion, residential fireplaces, agricultural and silvicultural burning, and atmospheric formation from gaseous precursors such as sulfur, nitrogen oxides and volatile organic chemicals.

The difference in chemical and physical composition between the two fractions of PM have significant implications for the relative health risk. The key health effects categories associated with PM include: premature mortality; increased hospital admissions and emergency room visits; increased respiratory symptoms such as shortness of breath; diseases such as asthma or chronic bronchitis; decreased lung function; and alterations in lung tissue and in respiratory tract defense mechanisms (EPA, 1997a). Welfare effects from elevated PM concentrations include changes in visibility and household soiling.

Several studies have evaluated the benefits associated with reduced PM concentrations in the ambient air, including a 1985 study of New Source Performance Standards (NSPS) for PM (EPA, 1985), a report to Congress of the benefits and costs under section 812 of the Clean Air Act (EPA, 1996b), and National Ambient Air Quality Standards for PM (EPA, 1997a). The report to Congress and the recently promulgated PM NAAQS provide the latest scientific evidence of the magnitude of benefits associated with particulate matter. However, the report to Congress provides data in a format that makes it difficult to derive a benefit transfer value ($/Mg).

The NAAQS RIA includes analyses of a number of PM regulatory alternatives. In addition to providing an analysis of the promulgated $PM_{2.5}$ standard, the RIA includes an analysis of the current PM_{10} standard. Given that the PM emission reductions measured for these pulp and paper MACT standards are primary particles, it may be more appropriate to use the benefits results associated with the current PM_{10} standard (an annual standard set at 50 µg/m^3 and a 24-hour standard set at 150 µg/m^3). As with the VOC benefits transfer analysis, the PM benefits transfer analysis uses the NAAQS data associated with the PM_{10} partial attainment scenario (see Appendix C of the NAAQS RIA).

The national monetized benefits (health and welfare) estimated for the PM_{10} NAAQS is approximately $5.4 billion (EPA, 1997b). The annual PM_{10} emission reduction estimated for this scenario is approximately 374,000 tons. However, as with the VOC valuation, PM_{10} is not the only pollutant reduced in order to achieve estimated benefits. The air quality model used in the PM NAAQS analysis identifies four major pollutants -- VOC, NO_x , sulfur dioxide (SO_2) and PM_{10} -- that are reduced through controls adopted to attain the PM_{10} standard. Once again, an assumption of proportionality must be used to apportion the benefits to the PM_{10}, SO_2, NO_x, and VOC is calculated. This calculation yields a ratio of 68%. This ratio is applied to the national monetized PM_{10} NAAQS benefits range. The adjusted monetized benefit estimate is then divided by the PM_{10} emission reduction estimate to yield a PM benefit per ton value (in 1990 dollars) of $9,818.

To transfer these PM_{10} NAAQS results to the pulp and paper rules, the benefit per ton value is converted to a benefit per Mg value and escalated to 1995 dollars using the same method as described for the VOC analysis. The final conversion yields a PM_{10} benefit value of $12,619/Mg (1995 dollars). This value is applied to all PM emission changes estimated for the pulp and paper rules.

The PM analysis in the NAAQS RIA also includes data that makes it possible to estimate SO_2 benefits. The RIA includes an analysis of a national SO_2 strategy for utilities and examines the benefits associated with reducing ambient PM concentrations through this SO_2 control strategy. As mentioned in the PM benefits transfer analysis, SO_2 is one of the major pollutants contributing to PM formation. Therefore, this SO_2 benefits transfer analysis examines the PM-related benefits associated with changing SO_2 emissions, but does not consider additional health and welfare effects directly associated with SO_2.

An examination of the national SO_2 strategy reveals that SO_2 emission reductions in the eastern half of the continental United States have a much larger effect in reducing ambient concentrations when compared to the western U.S.[2] Therefore, this benefits transfer analysis calculates an eastern SO_2 benefit value and a western SO_2 benefit value. The monetized benefits estimated for SO_2 reductions in the East ranges from approximately \$21 billion to \$46 billion. The monetized benefits estimated for SO_2 reductions in the West ranges from approximately \$1.2 billion to \$1.5 billion. SO_2 emission reductions estimated for the East is approximately 4.433 million tons, while SO_2 emission reductions estimated for the West is approximately 77,000 tons.

As with the VOC and PM analysis, the issue of apportionment applies. Even with a control strategy aimed at reducing SO_2 emissions, reductions of the other pollutants are also achieved. Once again, an assumption of proportionality is used to apportion the benefits to the SO_2 emission reductions. A ratio of SO_2 emission reductions to the sum of SO_2, NO_x, VOC, PM_{10} emission reductions, yielding a ratio of 94% in the East and 20% in the West. This ratio is applied to the appropriate monetized benefits for each region. The adjusted monetized benefit estimates are then divided by the appropriate regional SO_2 emission reductions to yield a range of SO_2 benefits per ton (in 1990 dollars) in the East from \$4,409 to \$9,764, and in the West the values are from \$3,190 to \$3,805.

To transfer these SO_2 NAAQS results to the pulp and paper rules, the benefit per ton value is converted to a benefit per Mg value in 1995 dollars, using the same method as described for the VOC and PM analysis. The final conversion yields an SO_2 benefit value ranging from \$5,667/Mg to \$12,550/Mg for the East and a range of \$4,100/Mg to \$4,891/Mg for the West.

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[2]Figure 6.2 of the NAAQS RIA presents a map of 6 regions that are considered in the PM analysis. For this analysis, the "East" is defined as the Midwest/Northeast, Southeast, and South Central regions, while the "West" is defined as the Rocky Mountain, Northwest, and West regions.

Before the benefit per Mg values can be applied to the SO_2 emission increases, an issue of certainty in estimating emissions must be addressed. The estimation of SO_2 emission increases is less certain than the estimation of VOC and PM emission changes. The estimation of SO_2 emission increases is based on the assumptions that mills will not be able to prevent or mitigate all potential SO_2 increases when complying with MACT I, when in fact, it is likely that some mitigation will occur through the proper selection of control technologies or pollution prevention activities. EPA also recognizes that the adoption of alternate control measures and pollution prevention activities may entail additional costs that have not been included in the cost estimates for the rule.

Therefore, this analysis uses two approaches for valuing the SO_2 emission increases: (1) apply the regional SO_2 benefit per Mg values to the appropriate regional SO_2 emission increases to derive a lower-bound (negative) monetized benefit estimate, and (2) assume a zero SO_2 emission increase to derive an upper-bound (zero) monetized benefit estimate.

4.1.5 Limitations

The use of benefit transfer values is not without limitations. First, use of benefit transfer values to calculate benefits associated with VOC, PM, and SO_2 emission changes relies on the assumption that values obtained from previous studies are applicable to the pulp and paper rule. Concentrations of criteria air pollutants are affected by the interactions of multiple pollutants, and geographic and meteorological conditions. Models exist to determine how the reduction of VOCs and PM would impact concentrations of the criteria air pollutants, however, they would require specific air quality information such as appropriately projected ambient levels of VOC, NO_x, PM, and SO_2 for each affected pulp and paper mill location. In addition to being information-intensive, these models are also time-intensive. The NAAQS RIA presents benefit calculations based on expected reductions in ambient ozone and PM concentrations resulting from reductions in emissions (in tons) of VOC, NO_x, PM and SO_2. It is assumed that the relationship of these emission changes with the health and welfare effects associated with the NAAQS-estimated ozone and PM concentrations would correspond to projected changes in emissions from the pulp and paper mills.

A second concern with the benefit transfer method is the failure to adjust for differences in exposure. Without time- and information-intensive evaluations of the exposed populations around pulp and paper mills, it is assumed that the distributions of exposed populations from these ozone and PM studies are similar. Although baseline concentrations and population densities from previous studies will occur in a multitude of combinations, the aggregate affect is expected to create a balancing out of variations in the true benefits per Mg ratio across areas. Thus, the transferred ratio, on average, is assumed to be representative.

4.2 WATER BENEFITS

For the proposed rule, EPA evaluated the potential benefits associated with implementation of the BAT/PSES requirements at 93 bleached papergrade kraft and soda and papergrade sulfite mills covered by the final rule for which EPA had discharge data. EPA quantified and monetized two categories of potential water-related benefits at the national level: human health risk reductions from recreational and subsistence fish consumption and recreational angling benefits. This section describes the revisions or modifications that EPA made to the methodologies for estimating these benefits since proposal. In Section 4.3, EPA also presents the methodology used to conduct an alternative sensitivity analysis of national benefits based on case study results.

4.2.1 Revised Estimates of Baseline Pollutant Loadings

To determine potential reductions and benefits achieved by BAT/PSES requirements, EPA modified its estimates of baseline pollutant loadings. EPA revised and simplified the methodology used to estimate baseline loadings in two ways: updating the data used, and simplifying the estimation procedure. In support of the 1993 proposal, EPA developed a procedure for estimating the baseline bleach plant and final effluent pollutant mass loadings for each mill. The procedure used all available data from each mill, and a model to estimate loads where data were not available. The model was used to estimate the average pollutant loadings achieved by mills using several combinations of pulping and bleaching technologies. The procedure was complicated and labor intensive; however, EPA received few public comments on the baseline estimation procedure.

Commenters objected to EPA’s use of data from the 1988 104-Mill Study to characterize the industry’s 1993 pollutant discharges on the grounds that the information was out of date. EPA addressed these comments by updating the estimate of the baseline pollutant loadings to mid-1995. Changes to the baseline estimate include:

- Updated data collected by EPA, NCASI, and individual facilities.
- Limited use of self-monitoring data from 1985-1992.
- Incorporation of results from NCASI's 1994 Dioxin Survey into the analysis (see Development Document).

EPA also simplified the methodology to estimate baseline loadings. The revised procedure uses three different industry models to estimate the baseline loadings for three pollutant groups at all mills. These models replace the complicated procedure of developing an industry model for most mills and using actual sampling data for some mills. The three pollutant groups modeled are:

- AOX, chlorinated phenolic compounds, TCDD, and TCDF
- Chloroform
- COD and color.

Three separate models are required because, for each group of pollutants, different process criteria are most predictive of pollutant loadings. For example, for final effluent AOX loads, the furnish pulped, use of extended pulping technologies, and percent chlorine dioxide substitution are strongly correlated to the pollutant loading. The criteria for the three models and associated groups of pollutants are summarized in Table 4-1. A detailed description of the methodology can be found in ERG, 1996.

The pollutant reductions calculated using the revised methodology for the regulatory alternatives are summarized in Appendix C. Table 4-2 presents a summary of the pollutant loadings and loadings reductions for the final BAT/PSES. EPA uses the conservative assumption of estimating pollutant loadings of dioxins and furans at one-half the detection limit for mills where chlorine-based bleaching compounds are used and quantities of dioxins and furans in discharges (if any) are below the detection limit.

TABLE 4-1

MODELS USED TO ESTIMATE BASELINE POLLUTANT LOADS

Model	Pollutants	Process Criteria Predictive of Pollutant Loadings
1	AOX, chlorinated phenolic compounds, TCDD, TCDF	furnish pulped; extended pulping status; percent ClO_2 substitution
2	Chloroform	hypochlorite use; percent ClO_2 substitution
3	COD, color	screen room status; pre-bleaching kappa number

TABLE 4-2

BASELINE AND POST-REGULATION WATER POLLUTION LOADINGS

Pollutant	Baseline	Final Rule	Percent change from baseline
TCDD (g/yr)	16	4.3	(73%)
TCDF (g/yr)	98	4.7	(95%)
AOX (kkg/yr)	38,000	10,000	(74%)
Chloroform (kg/yr)	51,000	9,000	(82%)
COD (kkg/yr)	1,200,000	1,100,000	(8%)
Color (kkg/yr)	2,100,000	2,100,000	(0.0%)
All 12 Chlorophenolics (kg/yr)	29,000	10,000	(66%)

4.2.2 Human Health Risk Assessment

EPA updated the human health risk assessment to reflect four primary revisions to the methodology since proposal. EPA revised 1) the approach used to estimate fish tissue concentrations, 2) the estimates of fish tissue consumption, 3) the approach used to estimate the exposed population, and 4) the input parameters for four chemicals. In addition, EPA conducted an assessment of individual cancer and non-cancer risk avoided by the BAT/PSES options to Native Americans.

For the proposed rule, EPA used the Office of Research and Development's Dioxin Reassessment Evaluation (DRE) model as well as a simple dilution model to estimate baseline and post-regulation fish tissue concentrations of 2,3,7,8-TCDD and 2,3,7,8-TCDF. EPA received comments that the use of the simple dilution model was inappropriate because EPA's DRE model provided more reliable information regarding the partitioning of TCDD and TCDF between sediment and the water column, and thus their bioavailability to fish. After analyzing the relevant research regarding the draft DRE model, EPA concurred. For the final rule, EPA used only the DRE model to estimate the cancer and non-cancer risks from these contaminants, and used the simple dilution model to estimate predicted exceedences of human health AWQCs for all other contaminants of concern.

EPA also revised its estimates of fish consumption. For the proposed rule, EPA estimated that recreational anglers consume 25 g/day and subsistence anglers consume 145 g/day. The ingestion rate of 25 g/day represented the midpoint of the reported range of average ingestion rates for recreational anglers of approximately 20 g/day to 30 g/day, as reported by Connelly (1990), Pierce et al. (1981), and West, et al. (1989). The average daily ingestion rate of 145 g/day for subsistence anglers was based on the assumption that a subsistence angler eats one average size fish meal per day, and is supported by a study conducted Pao, et al (1982). For the final rule, EPA assumed a fish consumption rate of 21 g/day for recreational anglers, and 48 g/day for subsistence anglers based on updated USDA food survey information. These consumption rates are based on the data provided by the "Continuing Survey of Food Intake by Individuals" (CSFII), conducted nationally by the U.S. Department of Agriculture (USDA, 1991).

EPA estimates individual cancer and systemic risks to Native Americans, and an upper bound estimate of exposure risks at the national level to tribes downstream from pulp and paper mills. To assess individual cancer and systemic risk to Native Americans for the final rule, EPA used fish tissue consumption rates of 70 g/day, which represents an average fish consumption rate for Native Americans, based on two studies on Native American subsistence fishing (CRITFC, 1994; Wolfe and Walker, 1989).

Native Americans fishing on (and frequently off) reservations are not required to obtain a license, so records of the number of Native Americans on reservations who are subsistence anglers are not available. To estimate an upper bound increased annual incidence of cancer for Native Americans from consuming TCDD/TCDF contaminated fish, EPA considered the total population of the eight tribes with treaty fishing rights near pulp and paper mills and, using the average consumption rates above, where effluent data were available, estimated the total potential baseline cancer cases and cancer cases avoided by the final BAT/PSES. Additionally, at the case study level, EPA used site-specific data to estimate risks and risk reductions for Native Americans at two sites (Penobscot River and the Lower Columbia River) which represent five of the eight subsistence angler tribes downstream from pulp and paper mills (see Sections 8.2 and 8.4).

At proposal, EPA assumed that 29 percent of all licensed anglers in counties adjacent to receiving streams of pulp and paper mill effluent discharges regularly use those streams for their fishing activities. For the final rule, EPA used a range of percentages to estimate the size of the exposed population. Since proposal, EPA considered additional creel survey and other supporting information (Alabama Department of Conservation and Natural Resources, 1994; Boucher, 1996; FIMS and FAA, 1993; James and Hale, 1995; Melcher and Watts, 1995; Tucker, 1987; and U.S. DOI, Fish and Wildlife Service, and U.S. Department of Commerce, Bureau of Census, 1993) and determined that a range of 10 percent to 33 percent of adjacent county licensed anglers would be a more appropriate estimate. The surveys that EPA examined implied results ranging from 2 percent to 54 percent, but the range EPA selected provides practical upper and lower bounds to the fishing effort expected on most affected stream segments. These percentages were applied only to the general angler population.

Finally, EPA revised input parameters for four chemicals. EPA compared the modeled in-stream pollutant concentrations to human health water quality criteria or other toxic effect values referred to as health-based ambient water quality concentrations (AWQCs). EPA changed the bioaccumulation factors (BCFs) and health-based AWQCs for 2,4,5-trichlorophenol and 2,4,6-trichlorophenol based on comments (and supporting information) received on the RIA for the proposed rule. The old and revised values are presented in Table 4-3.

TABLE 4-3

BIOACCUMULATION FACTORS AND HEALTH-BASED AWQCS

Measurement	**2,4,5-Trichlorophenol**		**2,4,6-Trichlorophenol**	
Parameter	**Old**	**New**[1]	**Old**	**New**[1]
BCF	1.91×10^3	1.77×10^2	3.1×10^2	1.06×10^2
AWQC-Organisms	4.9×10^2	2.23×10^3	1.6×10^0	2.37×10^0
AWQC-Organisms & Water	5.65×10^2	6.10×10^3	3.2×10^0	9.24×10^0

[1]Versar, 1996.

In addition, the biota/sediment accumulation factor (BSAF) for 2,3,7,8-TCDD and 2,3,7,8-TCDF used in the estimates of human health risk has changed from 0.09 to 0.2 based on data developed for EPA's dioxin reassessment (U.S. EPA, 1994).

4.2.3 Fish Consumption Advisory Analysis

For the proposed rule, EPA investigated the effect of reduced pollutant loadings on the status of then-current fish consumption advisories. At that time, EPA evaluated fish consumption advisories associated with effluent discharges from 20 bleaching pulp and paper mills. The advisories evaluated included those in place as of June 1993. Since then, the status of some fish consumption advisories has changed. For the final rule, EPA evaluated the effect of the rule on the status of fish consumption advisories in place as of December 1995 (as reported by EPA in June 1996). Discharges from 18 pulp and paper mills are associated with these fish consumption advisories. In addition, for the final rule, EPA evaluated fish consumption advisories that are in place farther downstream from some pulp and paper mill effluent discharges, but that can be associated with those discharges (i.e., in addition to the advisories in place on the stream segments where actual discharges occur). For these mills, the size of the potentially exposed population has increased to include populations of anglers in counties that were not included in the assessment for the proposed rule.

4.2.4 Limitations and Uncertainties

The methodologies EPA used to assess human health and recreational angling benefits for the final rule are subject to certain limitations and uncertainties. Some of the problems encountered in the analyses result from lack of available data or lack of research to evaluate methodological assumptions. Although EPA uses standard methods and approaches, some assumptions are still required. For example, for the evaluation of combined noncarcinogenic hazards from exposure to a chemical mixture, limited data are available for actually quantifying the potential synergistic and/or antagonistic relationships between chemicals in a chemical mixture.

Under baseline conditions and the BAT/PSES options, over 99 percent of the estimated cancer and non-cancer risks calculated in this study can be attributed to 2,3,7,8-TCDD and 2,3,7,8-TCDF (U.S. EPA 1997c). Therefore, the assumptions and methods used to analyze the dioxin and furan data affect the interpretation of the results of the regulatory impact analysis and comparisons. Areas of uncertainty relative to the dioxin and furan risk assessment include:

- Biota-sediment accumulation factors;
- Use of one-half the EPA-designated detection limit to estimate pollutant discharge loadings for all nondetect congeners;
- Use of aquatic life toxic effect values, cancer slope factors, and toxic equivalency factors, which are currently under review by EPA; and
- Use of fish tissue consumption rates.

Also, the methodology used to estimate fish advisory-related benefits assumes that the bleaching pulp and paper mills are the only source of the dioxin in the stream segment and does not incorporate background contributions either from contaminated sediments (due to previous discharge practices), other upstream sources, or air deposition (with the exception of case studies in Chapter 9) . Furthermore, although the discharge of these contaminants might cease or be minimized, sediment contamination and subsequent accumulation of dioxin in aquatic organisms might continue for years. Actual improvements can be determined only by site-specific biological monitoring to assess the appropriateness of eliminating fish consumption advisories.

Based on the record, EPA has determined that all dioxin advisories associated with mills will be lifted some time after the selected BAT/PSES technology is installed. Recent evidence indicates that dioxin fish tissue concentrations decline within several years of removing dioxin discharges, more rapidly than previously thought (see Chapter 9). EPA conservatively accounts for potential latent dioxin contributions from sediment to fish tissue by assuming a three-year lag before cancers from fish tissue consumption are reduced, or dioxin/furan fish advisories are lifted. In the case studies EPA has observed an average of two years following 100 percent substitution before advisories were lifted. These lags are incorporated into the present value of benefits presented in Chapter 10.

An additional area of uncertainty involves the estimates of populations exposed to contaminated fish tissue. EPA bases angler population estimates on data extrapolated from the number of fishing licenses sold in counties bordering receiving stream reaches and creel survey data. The actual number of people who actually use these receiving streams for their fishing activities is not known, nor is the proportion of time they fish in these streams. In addition, the estimated number of recreational anglers who change their fishing habits as a result of a fish consumption advisory is based on a few studies with relatively few data.

4.3 CASE STUDY EVALUATION OF BENEFITS

For the proposed rule, EPA presented three quantitative case studies to provide an alternative analysis of the potential benefits of the regulation. The case study approach was chosen because water quality-related benefits tend to be highly site-specific.

Public comments on the November 1993 RIA stated that the case studies, as an attempt to illustrate how the rule will yield benefits, seriously overestimate the locally available benefits. While EPA did not agree with this comment, it conducted more detailed case study analyses to ensure an accurate representation of reality. To expand on and strengthen the case study analysis for the final rule, EPA updates the representativeness criteria, selects four additional case studies, and presents new methodology to extrapolate aggregate case study benefits to the national level. The methodology to estimate air benefits for the case studies does not differ from that of Section 4.1. Therefore, Sections 4.3.1 through 4.3.3 discuss water benefits methodology for the case studies.

4.3.1 Representativeness

4.3.1.1 General Characteristics and New Case Studies

For the proposed rule, EPA analyzed the representativeness of the case study sites in terms of how well they mirror the universe of regulated sites. EPA evaluated representativeness by developing profiles of receiving water characteristics and user population (socioeconomic) characteristics for each mill, similar to the approach used by Naughton and Desvousges (1985) in the analysis of BCT regulations for the pulp and paper industry.

Receiving water characteristics included mean flow and low flow, percent reduction of regulated contaminants, exceedences of AWQCs eliminated by the rule, and consideration of water body type (river or bay). User population characteristics included population size and density, and personal income in the counties bordering the river reach. The analysis also considered whether any relatively prominent recreation areas or ecosystems are located within the region (indicating potentially higher recreation or existence values or above average recreation levels at a given site).

For user population characteristics, EPA ranked the mills according to their potential for benefits (low, medium, high, and very high). For example, high population in counties bordering the river reach is indicative of a high potential for benefits. EPA then compared the distribution of case study mills across each category with the distribution for all facilities. For receiving water characteristics, each attribute was evaluated individually. The RIA for the proposal offers a detailed description of the methodology.

For the final rule, EPA has updated its representativeness analysis to include two of the four new case studies (the Upper Columbia River/Lake Roosevelt case study was not included because some of the necessary information for the Celgar mill, which is located in Canada, is unknown; and the Lower Tombigbee and Mobile River case study was not included because, in general, although the Alabama mills have upgraded their pollution control, the facilities still require extensive upgrades to comply with the regulation (i.e., it is not a true retrospective case study). However, these two case studies do provide useful estimates of the benefits that may be expected at other sites around the country. In addition, exceedences of AWQCs eliminated by the rule have been dropped as a receiving water characteristic, and reduction in individual cancer risk has been added. With the addition of the two new case studies, the analysis of representativeness considers 13 of the 96 bleached papergrade kraft and papergrade sulfite mills affected by the regulation.

4.3.1.2 Receiving Water Characteristics and Representativeness

EPA uses two groups of characteristics to model the TCDD-reduction benefits resulting from the regulation: attributes of the receiving water, and sociodemographic characteristics of the surrounding population. EPA uses a combination of these two groups to develop “benefits profiles” for each facility affected by the regulation and to rank the facilities according to degree of benefits potential. The rankings are used to determine the degree to which the sites selected as case studies are representative of all mills, and to transfer benefits from the case studies to the universe of facilities. More detail on this methodology is contained in the proposal RIA (EPA, 1993).

EPA uses three receiving water characteristics to indicate benefits potential: (1) dilution of effluent upon entering the receiving waterway under low and mean flow conditions, (2) reduced loadings of TCDD and TCDF as a result of the regulation, and (3) the associated decrease in individual cancer risk. Dilution indicates the relationship between effluent and stream flow and determines the concentrations of TCDD and TCDF in the stream. In general, the lower the pollutant concentration, the lower the risk to human and environmental health. Other things equal, facilities with greater reductions will accrue greater benefits. Finally, EPA also ranks facilities based on the reduction in individual cancer risk levels due to TCDD and TCDF reductions. EPA assigns scores for each of these characteristics and combines them to obtain a total rank indicative of each facility's benefits potential from a receiving water quality perspective. Facilities that receive a combined score of 1-4 are ranked "low" in terms of benefits potential, facilities that receive a combined score of 5-8 are ranked "medium," and facilities that receive a combined score of 9-12 are ranked "high." (See Chapter 8 for results; for further details, see RIA for proposal [EPA, 1993]).

On the sociodemographic scale, EPA uses three population characteristics to develop profiles: population, population density, and average personal income. As each of these increases, the benefits potential also increases. EPA has developed scores for each of these characteristics and then has aggregated these scores to provide a site's overall sociodemographic rating. EPA also has made quantitative adjustments in ratings to account for the presence of unique features that will tend to increase benefits, such as a National Wildlife Reserve. EPA then combines the water body and sociodemographic scales to provide an overall score for each site.

EPA has assessed the representativeness of the case studies benefits by comparing the distribution of benefits potential for the case studies to the benefits potential distribution for the universe of affected facilities. Similarly, EPA has used the rankings of benefits potential to assign benefits to facilities for which case studies have not been conducted in order to develop approximations of expected national-level water quality benefits.

4.3.2 Development of New Case Studies

The new case studies describe the water quality-related benefits that have occurred at sites where one to several mills have already implemented controls similar to those required by the final regulations. As such, the case studies provide a retrospective look at the benefits actually realized at four locations. To the extent that the controls implemented achieve the limits set by the final regulation, the resulting benefits may be illustrative of those that can be expected at sites that will be affected by the rule. EPA estimates the potential benefits of both the selected BAT/PSES (Option A) and Option B for the new case studies, but only the selected BAT/PSES technology benefits for the three old case studies (see Chapter 9).

The new case study benefit-cost analyses are presented in Chapter 9, and cover 8 mills at the following sites:

- The Lower Tombigbee and Mobile rivers, in Alabama (5 mills)
- The Pigeon River, in North Carolina and Tennessee (1 mill)
- The Upper Columbia River and Lake Roosevelt, in British Columbia, Canada and Washington State in the United States (1 mill)
- The Samoa Peninsula, on the Pacific Ocean in California (1 mill)

4.3.3 Extrapolation to National Water Benefits

EPA also develops an alternative sensitivity analysis estimate of national water benefits, based on results from the case studies. The case study approach includes a number of site-specific benefit categories that are expected to improve as a result of the rule, and which cannot be included in EPA's national level estimate. Therefore, for the final rule, EPA uses the analysis of case study representativeness to gain additional insight into the potential range of national-level water quality benefits. Specifically, EPA characterizes the benefits potential associated with each regulated mill, based on how it compared to the characteristics noted above, classified according to the potential for low, medium, and high benefits. A comparable index was developed for water quality characteristics in the receiving waters. A combined measure of these two indices was used to assign a benefits potential level to every facility affected by the regulation, and the results from the case study facilities were then extrapolated to the universe of facilities based on how their benefits potential levels compared to benefits potential levels at facilities not included in the case studies. In this manner, benefits results from the case study mills were assigned to all facilities.[3]

EPA uses this case study basis only as a sensitivity analysis. The ability to generalize the case study benefits is more limited than the health effects and recreational fishing benefits used in the national benefits assessment because of the great diversity in receiving waters affected by this rule. For example, white water boating and surfing benefits are not available near many mills, but account for a large share of the benefits at two case study mills that have conditions conducive to these activities (see Chapter 9).

4.4 PRESENT VALUES AND ALTERNATIVE DISCOUNT RATES

For the proposed rule, EPA compared annual steady-state benefits to annualized costs. There are some instances in which the installation of control equipment or the implementation of process changes does not result in an immediate accrual of benefits. For example, for the final effluent guidelines, EPA assumes that it may take two to three years for improved water quality to result in reduced concentrations of dioxin in fish tissue and therefore improved angling benefits. Therefore, as an alternative way to evaluate benefits, EPA also evaluates the present value of benefits and costs using a 30 year period, a real discount rate of seven percent, and an alternative social rate of time preference of three percent (real). EPA assumed that some categories of benefits will phase in gradually, assuming an immediate realization of air benefits[4], a 2-year phase-in period for angling benefits (i.e., benefits are at their full level in the third year) and a 5-year phase-in period for human health and nonuse benefits. Since the expected capital lifetime is 20 years, EPA counted capital costs in years 1 and 21. EPA assumed O&M costs are incurred years 2 through 30. Present values are presented along with annual values in Chapter 10.

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[3]Benefits estimates for the two mills represented by the Pigeon River and Samoa Peninsula case studies are not included in the aggregated national-level benefits total because process changes that are comparable to the regulation have already been implemented at these sites, and benefits and costs already have been realized. The benefits and costs from these mills are considered in the baseline, not as a result of this rule. However, EPA used the already-realized benefits estimated for these mills, along with results from the other case studies, to model the benefits at mills located in areas with similar user population and receiving water characteristics that have not yet implemented the changes required to meet the limits set by the rule.

[4]It is assumed that the installation of control equipment or the implementation of process changes will result in the immediate improvement of air quality.

4.5 ENVIRONMENTAL JUSTICE

Executive Order 12898 established a presidential policy for incorporating environmental justice into Federal agency missions by directing agencies to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations. For example, to assist in identifying the need for ensuring protection of populations who rely principally on fish and/or wildlife for subsistence, the E.O. directs agencies, whenever practicable and appropriate, to collect, maintain, and analyze information on the consumption patterns of those populations, and to communicate to the public the risks of those consumption patterns.

For the proposed rule, EPA analyzed the risks to subsistence anglers fishing in the vicinity of bleached kraft mills from the consumption of dioxin-contaminated fish. Subsistence anglers may include both minority and low-income populations. In further keeping with the intent of E.O. 12898, EPA expanded on its assessment of risks to subsistence anglers to include Native American populations that were not captured in the original analysis. At the national level, EPA assessed individual cancer and non-cancer risk to Native Americans assuming fish tissue consumption rates of 70 g/day (see Section 4.2.2). EPA also estimated an upper limit to the exposed Native American subsistence population that will be affected by the pulp and paper rules. EPA assumed that the total population of the tribes with treaty-ceded fishing rights near pulp and paper mills consumed an average of 70 g/day of TCDD/TCDF contaminated fish. Additionally, in two case studies (Penobscot River and the Lower Columbia River)[5], EPA used site-specific data to estimate risks and risk reductions for five of the eight Native American tribes whose subsistence fishing is affected by pulp and paper mill discharges. EPA also examined county-level race and income data to assess whether bleached kraft mills have a disproportionate effect on minority and low income populations nationwide. Finally, EPA evaluated the effects on low income populations of paper price increases that may result from the increased compliance costs of the integrated pulp and paper rule. The individual cancer and systemic risk assessments for Native Americans, the nationwide summary of race and income data, and the effects of price increases are presented in Chapter 8. The case study level risk assessments for Native Americans are presented in Chapter 9.

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[5]The assessment of risks for the Penobscot tribe on the Penobscot River utilized consumption levels of 11 g/day and 48 g/day for the central and high estimates, respectively, based on the 1991 Penobscot Nation Survey. The central assumption of 11 g/day may underestimate potential risk reductions since tribal members that practice a traditional lifestyle are probably under represented in the survey.

4.6 REFERENCES

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CHAPTER 5

REGULATORY ALTERNATIVES DESCRIPTION, COSTS, POLLUTANT REMOVALS AND COST-EFFECTIVENESS

Effluent limitations guidelines and standards (EGLs) and Maximum Achievable Control Technology (MACT) emission standards are technology-based regulations. While the facility that is the source of the discharge or emission need not install any specific pollution control technology, the regulatory requirements (i.e., maximum emission or effluent limits) are based on a technology that can achieve the specified limits. The Development Document (EPA, 1997a) and Background Information Document (EPA, 1997b) detail the technology bases for the EGLs and MACT standards, respectively.

Section 5.1 discusses air pollution controls and Section 5.2 presents water pollution control options considered by EPA. Each section briefly describes technology options and their associated costs, emission reductions, pollutant removals, and cost-effectiveness. Section 5.3 describes the regulatory alternatives and costs for the set of mills subject to final effluent guidelines, final MACT I standards, and proposed MACT II standards. As mentioned in the Introduction, the chapter focuses primarily on changes in outcomes since the 1993 proposal.

All supporting computer printouts for this chapter (both CWA and CAA analyses) are located in the Pulp and Paper Water Docket, Section 27.4, "Cost and Impact Analysis." Almost all of this material is confidential.

5.1 AIR POLLUTION CONTROL COMPLIANCE COMPONENTS

There are three sets of control for hazardous air pollutants (HAPs) for the pulp and paper industry:

- MACT I—noncombustion sources
  Proposed in 1993 and promulgated in this rule, these requirements apply to vents, open processes, and condensate wastewaters located in either the pulping area or the bleaching areas.

- MACT II—combustion sources
  Proposed in this rulemaking, these requirements apply to recovery furnaces, lime kilns, smelt dissolving tanks, and other combustion sources associated with pulping operations.

- MACT III
  Promulgated in this rule, the requirements apply to mechanical pulping, non-chemical secondary fiber pulping, non-wood pulping, and paper machine additives.

The compliance components are described in Section 5.1.1 while associated costs are presented in Section 5.1.2.

5.1.1 Air Pollution Compliance Components—Description

At proposal, the Office of Air did not propose subcategories for mills subject to MACT I requirements. Since proposal, the Office of Air published a notice stating it planned to subcategorize the pulping and associated wastewater components to develop different MACT requirements (EPA, 1996a). The MACT I air standards would regulate all HAPs emitted from the 155 pulp and paper mills that chemically pulp wood fiber using kraft, sulfite, soda, or semichemical methods. The pulp and paper industry is subcategorized by these four chemical pulping processes for the purpose of selecting MACT technologies. Table 5-1 summarizes the air pollution control levels by subcategory. Where more than one subcategory is located within the same mill sharing the same piece of equipment, the more stringent standard applies.

MACT II standards are being proposed in this rulemaking. MACT II standards differ for each chemical pulping process subcategory: kraft and soda, sulfite, and semichemical. The control options for pulp and paper combustion sources include:

- two control options for particulate matter (PM) hazardous air pollutant (HAP) emissions from kraft and soda
  - recovery furnaces
  - lime kilns
  - smelt dissolving tanks (SDTs)

- one control option for total gaseous organic HAP (TGOHAP) emissions from kraft and soda non-direct contact evaporator (NDCE) recovery furnaces

TABLE 5-1
SUMMARY OF MACT I AND III EMISSION CONTROL REQUIREMENTS

Existing Source Requirements	New Source Requirements
KRAFT: 1) Reduce HAP emissions by 98% (or specified equivalent means) from:	
LVHC systems[1]	✓[2]
Specified Knotter and Screen systems	All Knotter and Screen systems
Pulp Washing systems	✓
Specified Decker systems	All Decker systems
Oxygen Delignification systems	✓
	Weak Liquor Storage Tanks
KRAFT: 2) Reduce HAP emissions by 92% (or specified equivalent means) from condensates from:	
Digester systems	✓
Turpentine recovery systems	✓
Evaporator Systems	✓
Closed vent collection systems	✓
SODA AND SEMI-CHEMICAL: Reduce HAP emissions by 98% (or specified equivalent means) from:	
LVHC systems	✓
	Pulp Washing systems
SULFITE: Reduce total HAP emissions to specified mass limit or percent reduction from:	
LVHC systems	✓
Pulp Washing systems	✓
	Weak and Strong Liquor Storage Tanks
	Acid Condensate Storage Tanks
BLEACH PLANTS AT KRAFT, SODA, SEMI-CHEMICAL, SULFITE, MECHANICAL, AND SECONDARY AND NON-WOOD FIBER MILLS:	
HAP emissions from bleaching stages where chlorinated compounds are introduced must be controlled by 98% or to 10 ppm.	✓
Comply with BAT as defined in the effluent guidelines.	✓

[1] Low Volume High Concentration systems include, but are not limited to, the digester, turpentine recovery, and evaporator systems and the steam stripper vents.

[2] ✓ means same requirement as existing source system to be controlled

- two control options for TGOHAP emissions from kraft and soda direct contact evaporator (DCE) recovery furnace systems (i.e., control of black liquor oxidation [BLO] vent emissions [kraft only] and conversion to an NDCE recovery furnace).
- two PM control options for sulfite combustion sources
- two TGOHAP control option for semichemical combustion sources.

MACT II controls are summarized in Table 5-2. The kraft and soda combustion source controls have been combined into four regulatory options (see Table 5-3). There are four options for kraft and soda, two for sulfite and two for semichemical. Only one option has been considered in the economic analysis for semichemical sources because the floor option is no control with no associated costs. Each kraft and soda option can be combined with one of two sulfite options to create eight possible cost configurations, called alternatives, for MACT II. Table 5-4 lists Alternatives A through H that reflect different combinations of these options.

MACT III standards cover mechanical pulping (e.g., groundwood, thermomechanical, and pressurized groundwood pulps), de-inked and non-deinked secondary fiber pulps, non-wood pulps, and paper machine additives. The final MACT III for these operations is "no add-on controls." As such, there are no associated costs or impacts with MACT III and it will not be discussed further in this report.

5.1.2 Air Pollution Compliance Control Costs

The costs for MACT I requirements for 155 mills are shown in Table 5-5. MACT I costs differ according to the BAT/PSES option selected for the 86 mills in the bleached papergrade kraft and soda subcategory because of the increased boiler capacity and emissions for oxygen delignification (OD) found in BAT/PSES Option B. With the selected BAT/PSES option, capital costs[1] are $501 million and annual

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[1]The MACT I capital costs coincide with those presented in the Background Information Document (BID). The BID, however, presents an annual cost based on a capital recovery factor whose value depends on the equipment lifetime and interest rate. It is similar to, but not the same as, the annualized cost presented in this document. The costs used here incorporate the 7 percent real discount rate recommended by OMB (OMB, 1992) with a 16-year time period in the cost annualization model discussed in detail in EPA, 1993a. The cost model was developed to calculate the pre- and post-tax annualized costs on the same basis, taking into account the timing effects of tax shields and depreciation as well as a clearly specified discount rate. The pre-tax annualized costs presented in Table 5-5 are most comparable to the annual costs presented in the BID and the values are within 13 percent of each other, with differences due to distinction in discount rates and equipment lifetimes.

TABLE 5-2

MACT II CONTROL OPTIONS BY POLLUTANT

	Kraft and Soda Combustion Sources					
Options	**NDCE Recovery Furnaces**	**DCE Recovery Furnaces**	**Lime Kilns**	**Smelt Dissolving Tanks**	**Sulfite Recovery Furnaces**	**Semichemical Combustion Sources**
Particulate matter (PM) Option I (MACT floor)	NSPS PM level of 0.044 gr/dscf OR Metals level of 1.82E-03 lb/ton BLS Monitoring protocol for ESP will be developed by mill	NSPS PM level of 0.044 gr/dscf OR Metals level of 1.82E-03 lb/ton BLS Monitoring protocol for ESP will be developed by mill	NSPS PM level of 0.067 gr/dscf OR Metals level of 1.25E-02 lb/ton BLS Monitoring protocol for ESP will be developed by mill	NSPS PM level of 0.020 gr/dscf OR Metals level of 3.14E-04 lb/ton BLS Monitoring of wet scrubber operating parameters	PM level of 0.04 gr/dscf Monitoring protocol for fiber-bed demister will be developed by mill	— —
Particulate Matter (PM) Option II (Tighter PM)	PM level of 0.01 gr/dscf OR Metals level of 4.14E-04 lb/ton BLS Monitoring protocol for ESP will be developed by mill	PM level of 0.01 gr/dscf OR Metals level of 4.14E-04 lb/ton BLS Monitoring protocol for ESP will be developed by mill	PM level of 0.01 gr/dscf OR Metals level of 1.89E-03 lb/ton BLS Monitoring protocol for ESP will be developed by mill	PM level of 0.12 gr/dscf OR Metals level of 1.88E-04 lb/ton BLS Monitoring of wet scrubber operating parameters	PM level of 0.02 gr/dscf Monitoring protocol for fiber-bed demister plus reverse-jet scrubber will be developed by mill	— —

NDCE: non-direct contact evaporator
DCE: direct contact evaporator
gr/dscf: grains per dry standard cubic foot
BLO: black liquid oxidation

BLS: black liquid solids
THC: total hydrocarbons
RTO: regenerative thermal oxidizer
ESP: electrostatic precipitator

TABLE 5-2 (continued)

MACT II CONTROL OPTIONS BY POLLUTANT

	Kraft and Soda Combustion Sources					
Options	**NDCE Recovery Furnaces**	**DCE Recovery Furnaces**	**Lime Kilns**	**Smelt Dissolving Tanks**	**Sulfite Recovery Furnaces**	**Semichemical Combustion Sources**
Total Gaseous Organic Hazardous Air Pollutant (TGOHAP) Option I (MACT floor)	No control No monitoring	No control No monitoring	— —	— —	— —	No control No monitoring
Total Gaseous Organic Hazardous Air Pollutant (TGOHAP) Option II (Wet to dry ESP system conversion for NDCEs; BLO control for DCEs; RTO for semichemical sources)	Methanol level of 0.025 lb/ton of BLS Equipment in place	98 percent reduction in BLO vent emissions or methanol level of 0.18 lb/ton of BLS for BLO vent	—	—	—	90 percent reduction in THC emissions or THC level of 2.76 lb/ton BLS Combustion temperature monitor
Total Gaseous Organic Hazardous Air Pollutant (TGOHAP) Option III (low-odor conversion for DCEs)	— —	Methanol level of 0.025 lb/ton of BLS Equipment in place	— —	— —	— —	— —

NDCE: non-direct contact evaporator
DCE: direct contact evaporator
gr/dscf: grains per dry standard cubic foot
BLO: black liquid oxidation
BLS: black liquid solids
THC: total hydrocarbons
RTO: regenerative thermal oxidizer
ESP: electrostatic precipitator

TABLE 5-3

SUMMARY OF MACT II REGULATORY OPTIONS FOR KRAFT AND SODA COMBUSTION SOURCES

Regulatory Alternatives	Kraft and Soda Combustion Sources			
	NDCE Recovery Furnaces	**DCE Recovery Furnaces**	**Lime Kilns**	**Smelt Dissolving Tanks**
RO I (MACT floor + RTO)	PM Option I & TGOHAP Option I	PM Option I & TGOHAP Option I	PM Option I	PM Option I
RO II (MACT floor + BLO control + RTO)	PM Option I & TGOHAP Option I	PM Option I & TGOHAP Option II	PM Option I	PM Option I
RO III (MACT floor + low-odor conversion + wet to dry ESP system conversion + RTO)	PM Option I & TGOHAP Option II	PM Option I & TGOHAP Option III	PM Option I	PM Option I
RO IV (Tighter PM + low-odor conversion + wet to dry ESP system conversion + RTO)	PM Option II & TGOHAP Option II	PM Option II & TGOHAP Option III	PM Option II	PM Option II

NDCE: non-direct contact evaporator
DCE: direct contact evaporator
ESP: electrostatic precipitator
BLO: black liquid oxidation
BLS: black liquid solids
THC: total hydrocarbons
RTO: regenerative thermal oxidizer

TABLE 5-4

PROPOSED MACT II ALTERNATIVES

MACT II Alternative	Subcategory Option Number		
	Kraft and Soda	**Sulfite**	**Semichemical[1]**
A	1	1	2
B	1	2	2
C	2	1	2
D	2	2	2
E	3	1	2
F	3	2	2
G	4	1	2
H	4	2	2

[1] Two control options are considered for semi-chemical sources. The floor level of control (Option 1) involves no add-on controls or control costs. This option has not been evaluated in the EA. Only the above-the-floor regulatory option (Option 2) that involves add-on controls and emission control costs is evaluated in the EA.

TABLE 5-5

SUMMARY OF COSTS BY MILL CATEGORY--MACT I ONLY
THOUSANDS OF 1995 DOLLARS

SUBCATEGORY	COST TYPE	NUMBER OF MILLS COSTED	REGULATORY ALTERNATIVE Selected BAT/PSES	Option B
Kraft and Soda		125		
	CAPITAL COST		$463,866	$601,706
	O&M EXPENSE		$71,889	$88,175
	ANNUALIZED COST		$77,272	$97,334
	ANNUALIZED PRETAX		$118,415	$148,708
Sulfite		14		
	CAPITAL COST		$25,148	$25,148
	O&M EXPENSE		$2,808	$2,808
	ANNUALIZED COST		$3,567	$3,567
	PRETAX COST		$5,369	$5,369
Semichemical		16		
	CAPITAL COST		$11,744	$11,744
	O&M EXPENSE		$22	$22
	ANNUALIZED COST		$929	$929
	ANNUALIZED PRETAX		$1,264	$1,264
TOTAL		**155**		
	CAPITAL COST		**$500,758**	**$638,598**
	O&M EXPENSE		**$74,718**	**$91,004**
	ANNUALIZED COST		**$81,767**	**$101,829**
	ANNUALIZED PRETAX		**$125,048**	**$155,342**

Notes: Factor for Converting $1989 to $1995: 1.1855, based on change in Engineering News Record Construction Cost Index from 1989 to 1995.
The annualized costs include cost savings that may be generated at some mills.

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operating and maintenance costs are $75 million. With BAT/PSES Option B, capital costs are $639 million and annual operating and maintenance costs are $91 million. The post-tax annualized costs are $82 million or $102 million, assuming implementation of the final BAT/PSES and Option B respectively, while the pre-tax annualized costs are estimated at either $125 million or $155 million.

Costs for proposed MACT II requirements are shown in Table 5-6. Capital costs associated with MACT II alternatives A to H range from approximately $258 million to $2.1 billion. Annual operating and maintenance costs range from an annual cost savings of $75 million to an annual expenditure of $24 million. The post-tax annualized cost range is approximately $23 million to $135 million, depending on the alternative considered. The pre-tax annualized cost ranges from $32 million to $173 million. The capital and annual operating and maintenance costs for the selected option (Alternative A) are $258 million and $5.2 million, respectively while the post-tax annualized cost is $23 million. The cost estimates for the MACT II alternatives do not include reporting and recordkeeping costs.

Combined costs for installing both final MACT I and proposed MACT II requirements at all facilities are shown in Table 5-7A for MACT I, assuming implementation of the selected BAT/PSES (Option A) (shown as MACT IA in Table 5-7A) and Table 5-7B for MACT I assuming implementation of BAT/PSES Option B (shown as MACT IB in Table 5-7B). Capital costs range from approximately $759 million to $2.7 billion for MACT IA and MACT II combined, depending on the MACT II alternative selected, while annual operating and maintenance costs range from $211 thousand to $99 million. The post-tax annualized cost is approximately $105 million to $217 million, depending on the MACT II alternative considered. The pre-tax annualized costs range from $157 million to $297 million. For MACT IB and MACT II combined costs, depending on the MACT II alternative selected, capital costs range from approximately $897 million to $2.8 billion while annual operating and maintenance costs range from $16.5 million to $115 million. The post-tax annualized cost is approximately $125 million to $237 million, depending on the alternative considered. The pre-tax annualized costs range from $188 million to $328 million. In the preferred scenario, if Alternative A is the selected MACT II option, the combined air pollution control costs for final MACT IA and proposed MACT II are: $759 million in capital costs, $80 million in annual operating and maintenance costs, $157 million in pre-tax annualized costs, and $105 million in post-tax annualized costs - i.e., the lowest combination of costs considered.

TABLE 5-6

SUMMARY OF PROPOSED MACT II ALTERNATIVE COSTS
THOUSANDS OF 1995 DOLLARS

		MACT II ALTERNATIVE COSTS*							
SUBCATEGORY	COST TYPE	A	B	C	D	E	F	G	H
Kraft and Soda	Capital	$218,893	$218,893	$343,307	$343,307	$1,454,893	$1,454,893	$2,079,197	$2,079,197
	O&M	($1,696)	($1,696)	$14,496	$14,496	($81,405)	($81,405)	($64,298)	($64,298)
	Posttax Annualized	$16,116	$16,116	$35,076	$35,076	$67,051	$67,051	$125,551	$125,551
	Pretax Annualized	$21,537	$21,537	$50,318	$50,318	$75,526	$75,526	$158,107	$158,107
Sulfite	Capital	$11,400	$19,580	$11,400	$19,580	$11,400	$19,580	$11,400	$19,580
	O&M	$4,043	$6,926	$4,043	$6,926	$4,043	$6,926	$4,043	$6,926
	Posttax Annualized	$3,199	$5,485	$3,199	$5,485	$3,199	$5,485	$3,199	$5,485
	Pretax Annualized	$5,105	$8,750	$5,105	$8,750	$5,105	$8,750	$5,105	$8,750
Semichemical	Capital	$28,096	$28,096	$28,096	$28,096	$28,096	$28,096	$28,096	$28,096
	O&M	$2,855	$2,855	$2,855	$2,855	$2,855	$2,855	$2,855	$2,855
	Posttax Annualized	$3,824	$3,824	$3,824	$3,824	$3,824	$3,824	$3,824	$3,824
	Pretax Annualized	$5,727	$5,727	$5,727	$5,727	$5,727	$5,727	$5,727	$5,727
Total	**Capital**	**$258,389**	**$266,569**	**$382,803**	**$390,983**	**$1,494,389**	**$1,502,569**	**$2,118,693**	**$2,126,873**
	O&M	**$5,202**	**$8,085**	**$21,394**	**$24,277**	**($74,507)**	**($71,624)**	**($57,400)**	**($54,517)**
	Posttax Annualized	**$23,139**	**$25,424**	**$42,099**	**$44,385**	**$74,075**	**$76,360**	**$132,574**	**$134,859**
	Pretax Annualized	**$32,368**	**$36,014**	**$61,150**	**$64,795**	**$86,357**	**$90,003**	**$168,938**	**$172,584**

*See Tables 5-3 and 5-4 for descriptions of alternatives.

TABLE 5-7A

SUMMARY OF FINAL MACT IA & PROPOSED MACT II ALTERNATIVE COSTS
THOUSANDS OF 1995 DOLLARS

		MACT IA AND MACT II ALTERNATIVE COSTS							
SUBCATEGORY	COST TYPE	A	B	C	D	E	F	G	H
Kraft and Soda	Capital	$682,759	$682,759	$807,173	$807,173	$1,918,758	$1,918,758	$2,543,063	$2,543,063
	O&M	$70,193	$70,193	$86,385	$86,385	($9,516)	($9,516)	$7,591	$7,591
	Posttax Annualized	$93,387	$93,387	$112,348	$112,348	$144,323	$144,323	$202,822	$202,822
	Pretax Annualized	$139,951	$139,951	$168,733	$168,733	$193,940	$193,940	$276,521	$276,521
Sulfite	Capital	$36,548	$44,728	$36,548	$44,728	$36,548	$44,728	$36,548	$44,728
	O&M	$6,851	$9,734	$6,851	$9,734	$6,851	$9,734	$6,851	$9,734
	Posttax Annualized	$6,766	$9,051	$6,766	$9,051	$6,766	$9,051	$6,766	$9,051
	Pretax Annualized	$10,474	$14,119	$10,474	$14,119	$10,474	$14,119	$10,474	$14,119
Semichemical	Capital	$39,840	$39,840	$39,840	$39,840	$39,840	$39,840	$39,840	$39,840
	O&M	$2,877	$2,877	$2,877	$2,877	$2,877	$2,877	$2,877	$2,877
	Posttax Annualized	$4,753	$4,753	$4,753	$4,753	$4,753	$4,753	$4,753	$4,753
	Pretax Annualized	$6,991	$6,991	$6,991	$6,991	$6,991	$6,991	$6,991	$6,991
Total	**Capital**	**$759,147**	**$767,327**	**$883,561**	**$891,741**	**$1,995,146**	**$2,003,326**	**$2,619,451**	**$2,627,631**
	O&M	**$79,921**	**$82,803**	**$96,113**	**$98,995**	**$211**	**$3,094**	**$17,318**	**$20,201**
	Posttax Annualized	**$104,906**	**$107,192**	**$123,867**	**$126,152**	**$155,842**	**$158,127**	**$214,341**	**$216,627**
	Pretax Annualized	**$157,416**	**$161,062**	**$186,198**	**$189,843**	**$211,405**	**$215,051**	**$293,986**	**$297,632**

TABLE 5-7B

SUMMARY OF FINAL MACT IB & PROPOSED MACT II ALTERNATIVE COSTS
THOUSANDS OF 1995 DOLLARS

		MACT IB AND MACT II ALTERNATIVE COSTS							
SUBCATEGORY	COST TYPE	A	B	C	D	E	F	G	H
Kraft and Soda	Capital	$820,599	$820,599	$945,013	$945,013	$2,056,598	$2,056,598	$2,680,903	$2,680,903
	O&M	$86,479	$86,479	$102,671	$102,671	$6,770	$6,770	$23,877	$23,877
	Posttax Annualized	$113,449	$113,449	$132,410	$132,410	$164,385	$164,385	$222,884	$222,884
	Pretax Annualized	$170,245	$170,245	$199,027	$199,027	$224,234	$224,234	$306,815	$306,815
Sulfite	Capital	$36,548	$44,728	$36,548	$44,728	$36,548	$44,728	$36,548	$44,728
	O&M	$6,851	$9,734	$6,851	$9,734	$6,851	$9,734	$6,851	$9,734
	Posttax Annualized	$6,766	$9,051	$6,766	$9,051	$6,766	$9,051	$6,766	$9,051
	Pretax Annualized	$10,474	$14,119	$10,474	$14,119	$10,474	$14,119	$10,474	$14,119
Semichemical	Capital	$39,840	$39,840	$39,840	$39,840	$39,840	$39,840	$39,840	$39,840
	O&M	$2,877	$2,877	$2,877	$2,877	$2,877	$2,877	$2,877	$2,877
	Posttax Annualized	$4,753	$4,753	$4,753	$4,753	$4,753	$4,753	$4,753	$4,753
	Pretax Annualized	$6,991	$6,991	$6,991	$6,991	$6,991	$6,991	$6,991	$6,991
Total	**Capital**	**$896,987**	**$905,167**	**$1,021,401**	**$1,029,581**	**$2,132,986**	**$2,141,166**	**$2,757,291**	**$2,765,471**
	O&M	**$96,207**	**$99,090**	**$112,399**	**$115,281**	**$16,498**	**$19,380**	**$33,605**	**$36,487**
	Posttax Annualized	**$124,968**	**$127,254**	**$143,929**	**$146,214**	**$175,904**	**$178,189**	**$234,403**	**$236,689**
	Pretax Annualized	**$187,710**	**$191,355**	**$216,492**	**$220,137**	**$241,699**	**$245,344**	**$324,280**	**$327,925**

5.1.3 Air Emission Reductions and Cost Effectiveness

The baseline emissions, emissions after MACT I is applied, and cost effectiveness for the MACT I final rule, the MACT II proposed rule (Alternative A), and the combined air rules are shown in Table 5-8. Total HAP reductions are estimated to be approximately 139,300 for MACT IA or 138,400 Megagrams per year for MACT IB. MACT I VOC reductions are 409,000 for MACT IA or 407,000 Megagrams per year for MACT IB. MACT I HAP cost-effectiveness is either $1,020 or $1,000 per Megagram (MACT IA or MACT IB, respectively) while MACT I VOC cost-effectiveness is either $330 or $360 per Megagram, again depending on the BAT/PSES option.

Under the proposed MACT II (Alternative A), HAP reductions are approximately 2,550 Megagrams with a cost-effectiveness of $16,400 per Megagram. VOC reductions are approximately 32,600 Megagrams with a cost-effectiveness of $1,300 per Megagram. (Note the MACT I and MACT II cost-effectiveness estimates include reporting and recordkeeping costs.)

For the combined final MACT I and proposed MACT II Alternative A, HAP and VOC reductions are 141,800 and 441,200 Megagrams, respectively, under the selected BAT/PSES. HAP cost-effectiveness is $1,300 per Megagram and VOC cost-effectiveness is $400 per Megagram. For example, VOC baseline emissions for combined MACT I and MACT II are 897,200 Megagrams, i.e., the sum of the first and fourth columns of numbers in Table 5-8. VOC emissions remaining after MACT I and MACT II are 456,000 Megagrams for a reduction of 441,200 Megagrams. If BAT/PSES Option B were to be selected, HAP and VOC reductions would be 140,900 and 439,200 Megagrams, respectively, and related HAP cost-effectiveness would be $1,200 per Megagram and VOC cost-effectiveness would be $420 per Megagram.

5.2 WATER POLLUTION COMPLIANCE COMPONENTS

5.2.1 Water Pollution Control Compliance Components—Description

Facilities are characterized not only by subcategory, but also by discharge status, i.e., direct (to water bodies) or indirect (through POTWs or sewage treatment plants). BAT and NSPS apply to direct dischargers; PSES and PSNS apply to indirect dischargers. BAT and PSES apply to existing dischargers, while NSPS and PSNS apply to new sources. In this rule, EPA is promulgating BAT/PSES and NSPS/PSNS

TABLE 5-8

PULP AND PAPER NATIONWIDE AIR EMISSION AND MACT COST IMPACTS FOR AFFECTED MACT MILLS

IMPACTS	MACT BASELINE EMISSIONS (Before MACT is Applied)				EMISSIONS After MACT Is Applied				
	MACT I & III			MACT II	Each MACT			Combined MACTs	
	Current (for affected sources)	After OW Opt. A[a,c]	After OW Opt. B[a,c]	Current (for affected sources)	MACT I & III[b] With OW Opt. A	MACT I & III[b] With OW Opt. B	MACT II	With OW Opt. A	With OW Opt. B
ENVIRONMENTAL (Megagrams per Year):									
Hazardous Air Pollutants:									
- Gaseous HAP	209,000	198,000	232,000	32,200	69,700	70,600	29,700	99,400	100,300
- Particulate HAP	-	-	-	220	-	-	147	147	147
- Total HAP	209,000	198,000	232,000	32,400	69,700	70,600	29,850	99,600	100,500
Volatile Organic Compounds	826,000	814,000	872,000	71,200	417,000	419,000	38,600	456,000	458,000
Particulate	-	(9)	(10)	64,400	83	84	40,600	40,700	40,700
Total Reduce Sulfur	145,000	142,000	144,000	4,040	66,100	66,100	4,040	70,140	70,140
Carbon monoxide	-	(840)	(1,100)	248,400	8,660	8,610	190,700	199,400	199,300
Nitrogen oxides	-	500	(1,820)	120,100	5,230	3,030	120,600	126,000	124,000
Sulfur dioxides	-	860	(3,800)	102,600	94,500	92,300	102,500	197,000	195,000
ENERGY (MMBtu/Yr):	-	2,710,000	(11,050,000)	-	33,250,000	21,300,000	(158,000)	33,100,000	21,100,000
Cost effectiveness:									
- $ / Mg of HAP					1,020	1,000	16,400	1,300	1,200
- $ / Mg of VOC					330	360	1,300	400	420

[a] Particulate, carbon monoxide, nitrogen oxide, and sulfur dioxide emissions are from secondary impacts of OW options.
[b] Particulate, carbon monoxide, nitrogen oxide, and sulfur dioxide emissions are increases from baseline due to OW options and after MACT is applied.
[c] Number in parenthesis indicates a decrease in pollutant or energy use.

for two subcategories: bleached papergrade kraft and soda (BPK) and papergrade sulfite (PS). EPA analyzed process change (pollution prevention) technologies as the keystone components common to both BAT and PSES technology options. These common process technology components serve as the basis for BAT limitations and PSES applied at the bleach plant for both direct and indirect discharging mills. End-of-pipe biological treatment already exists both at direct discharging mills and at POTWs receiving wastewaters from indirect discharging mills. Therefore, while existing end-of-pipe biological treatment is a necessary component for direct dischargers to achieve end-of-pipe BAT limitations (e.g., AOX), costs are not included as part of BAT. PSES limitations are applied at the bleach plant prior to discharge to the POTW sewer and therefore end-of-pipe biological treatment and associated costs are not a component of PSES technology for indirect discharging mills. Table 5-9 describes the two options considered for the bleached papergrade kraft and soda subcategory (EPA, 1996b).

EPA has segmented the papergrade sulfite subcategory (EPA, 1996b). The three segments are:

- calcium- and magnesium-based processes (6 mills)
- ammonium-based process (4 mills)
- specialty grade pulps (1 mill)

Specialty mills are those papergrade mills producing specialty grade pulp characterized by a high percentage of alpha cellulose and high brightness. The specialty grade segment also includes those mills where a major portion of production is in excess of 91 ISO brightness. Totally chlorine free (TCF) technology is the BAT/PSES basis for the calcium and magnesium segment. Elemental Chlorine Free (ECF; 100 percent chlorine dioxide substitution with peroxide enhanced extraction, and elimination of hypochlorite) is the BAT/PSES technology basis for the ammonium and specialty grade segments (see Table 5-10).

5.2.2 Water Pollution Compliance Control Costs

Table 5-11 summarizes the capital, O&M, post-tax, and pre-tax annualized costs for the bleached papergrade kraft and soda and papergrade sulfite subcategories. BAT/PSES applies to 86 mills in the bleached papergrade kraft and soda subcategory and to 11 mills in the papergrade sulfite category. (One mill produces in both subcategories.)

TABLE 5-9

CWA BAT/PSES OPTIONS CONSIDERED BY EPA FOR THE BLEACHED PAPERGRADE KRAFT AND SODA SUBCATEGORY

Option[1]	Abbreviated Description	Description
A	100% ClO_2	Complete (100%) substitution of chlorine dioxide for chlorine
B	OD **or** Ext. Cook + 100% ClO_2	Oxygen delignification or extended delignification achieving a kappa number $\leq$20 for softwood and $\leq$13 for hardwood, and complete (100%) substitution of chlorine dioxide for chlorine

[1] Both options in Table 5-9 include:

- Effective brownstock washing
- Elimination of hypochlorite
- Oxygen and peroxide enhanced extraction
- Closed brownstock pulp screen room operation
- High shear mixing of pulp and chlorine dioxide in the first bleaching stage
- Adequate wood chip size control, and elimination of defoamers containing dioxin precursors

TABLE 5-10

CWA BAT/PSES OPTIONS CONSIDERED BY EPA FOR THE PAPERGRADE SULFITE SUBCATEGORY

Segment	Abbreviated Description	Description
Calcium- and magnesium-based	TCF	Oxygen- and peroxide-enhanced extraction followed by peroxide bleaching, improved pulp cleaning, and elimination of hypochlorite
Ammonium-based	ECF	Complete (100%) substitution of chlorine dioxide for chlorine, peroxide-enhanced extraction, and elimination of hypochlorite
Specialty grade pulp	ECF	Complete (100%) substitution of chlorine dioxide for chlorine, oxygen- and peroxide-enhanced extraction, and elimination of hypochlorite

TABLE 5-11

BAT/PSES COSTS
THOUSANDS OF 1995 DOLLARS

	Subcategory		
	Bleached Papergrade Kraft and Soda		Papergrade Sulfite
Cost Type	Selected BAT/PSES	Option B	Selected BAT/PSES
Capital	$965,610	$2,129,056	$73,778
O&M	$151,421	$87,185	$6,992
Post-tax Annualized	$161,866	$215,978	$9,753
Pre-tax Annualized	$248,208	$309,436	$14,551

For the bleached papergrade kraft and soda subcategory, capital costs for the selected option (100 percent substitution) are $966 million, O&M costs are $151 million, and after-tax annualized costs are $162 million. The capital costs for Option B (100 percent substitution with oxygen delignification or extended cooking) are $2.1 billion, O&M costs are $87 million, and after-tax annualized costs are $216 million.

For the papergrade sulfite subcategory, capital costs for BAT are $74 million, O&M costs are $7.0 million, and after-tax annualized costs are $9.8 million.

5.2.3 Pollutant Removals and Cost-effectiveness of CWA Final Rule

There have been no changes to the cost-effectiveness methodology or calculation of toxic weighting factors described in EPA, 1993b. Cost-effectiveness (c-e) ratios are used by EPA to distinguish among options and to reject options that cost significantly more per quantity of pollutants removed. C-E is not used as a basis for determining economic achievability. Detailed tables of pollutant pounds to toxic pound-equivalent conversions are provided in Appendix B. Table 5-12 summarizes the incremental cost-effectiveness for direct dischargers in the bleached papergrade kraft and soda subcategory. By convention, the industry comparisons are presented in 1981 dollars (1995 dollar values are given in parentheses). The selected option and Option B incremental c-e values in 1981 dollars are $14/pe and $36/pe, respectively ($21/pe and $55/pe, respectively). Average c-e values are $14/pe for the selected option and $15/pe for Option B ($21/pe and $24/pe, respectively). For indirect dischargers (Table 5-13), the average c-e values range from $14/pe to $21/pe ($21/pe to $32/pe), with incremental c-e values of $14 for the selected option and $115 for Option B ($22/pe and $178/pe, respectively).

Table 5-14 summarizes the c-e analysis for the direct dischargers in the papergrade sulfite subcategory. Because only one option was examined, the average and incremental c-e values are the same, $13/pe ($20/pe). For direct and indirect dischargers combined, the average and incremental c-e values are $13/pe ($21/pe).

Table 5-15 combines the results for the two subcategories to provide the cost-effectiveness for the industry. Industry cost-effectiveness is $14/pe for both BAT and PSES. Appendix B contains the industry-wide pollutant-specific data for pounds and pounds-equivalents currently discharged. Tables B-6 and B-7 are

TABLE 5-12

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

	Total Annual		Incremental			
Option	Pound Equivalents Removed (PE)	Pre-tax Annualized Cost ($000, 1981)	Pound Equivalents Removed (PE)	Pre-tax Annualized Cost ($000, 1981)	Incremental Cost Effectiveness ($1981/PE)	Average Cost Effectiveness ($1981/PE)
Baseline	0	$0	N/A	N/A	N/A	N/A
A	10,755,545	$146,306	10,755,545	$146,306	$13.60	$13.60
B	11,641,298	$177,781	885,754	$31,475	$35.53	$15.27

TABLE 5-13

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

	Total Annual		Incremental			
Option	Pound Equivalents Removed (PE)	Pre-tax Annualized Cost ($000, 1981)	Pound Equivalents Removed (PE)	Pre-tax Annualized Cost ($000, 1981)	Incremental Cost Effectiveness ($1981/PE)	Average Cost Effectiveness ($1981/PE)
Baseline	0	$0	N/A	N/A	N/A	N/A
A	1,000,467	$14,070	1,000,467	$14,070	$14.06	$14.06
B	1,070,965	$22,156	70,498	$8,086	$114.70	$20.69

TABLE 5-14

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

	Total Annual		Incremental			
Option	Pound Equivalents Removed (PE)	Pre-tax Annualized Cost ($000, 1981)	Pound Equivalents Removed (PE)	Pre-tax Annualized Cost ($000, 1981)	Incremental Cost Effectiveness ($1981/PE)	Average Cost Effectiveness ($1981/PE)
Baseline	0	$0	N/A	N/A	N/A	N/A
A	699,061	$9,008	699,061	$9,008	$12.89	$12.89

TABLE 5-15

**COST-EFFECTIVENESS OF CWA POLLUTION CONTROL OPTIONS
PULP, PAPER, AND PAPERBOARD INDUSTRY**

	Total Annual		Incremental			
Subcategory	Pound Equivalents Removed (PE)	Pre-tax Annualized Cost ($000, 1981)	Pound Equivalents Removed (PE)	Pre-tax Annualized Cost ($000, 1981)	Incremental Cost Effectiveness ($1981/PE)	Average Cost Effectiveness ($1981/PE)
BAT						
Bleached Papergrade Kraft and Soda	10,755,545	$146,307	10,755,545	$146,307	$13.60	$13.60
Papergrade Sulfite	699,061	$9,008	699,061	$9,008	$12.89	$12.89
Industry Total	11,454,605	$155,314	11,454,605	$155,314	$13.56	$13.56
PSES						
Bleached Papergrade Kraft and Soda	1,000,467	$14,070	1,000,467	$14,070	$14.06	$14.06
Papergrade Sulfite	ND	ND	ND	ND	ND	ND
Industry Total	ND	ND	ND	ND	$14.33	$14.33

ND: not disclosed for reasons of confidentiality.
Note: Incremental costs and removals are calculated from the selected option and the preceding option in the subcategory cost-effectiveness analysis.

the industry comparisons for BAT and PSES, respectively. The pound-equivalents remaining, which is reported on Tables B-6 and B-7, is the difference between baseline loadings and removals.

5.2.4 Sensitivity Analysis of Cost-effectiveness of CWA Final Rule

EPA examined the c-e values based on after-tax (i.e., industry compliance) costs for BAT and PSES. Summary tables are located in Appendix B (Tables B-8 through B-11). In 1981 dollars, the incremental c-e values for bleached papergrade kraft and soda direct dischargers are $9/pe ($14/pe)and $32/pe ($50/pe) for the selected option and Option B, respectively. The average c-e values for the same set of mills are $9/pe ($14/pe) and $11/pe ($16/pe) for the selected option and Option B, respectively. For indirect dischargers in the bleached papergrade kraft and soda subcategory, the average and incremental c-e values for the selected option are both $9/pe ($15/pe). The average and incremental c-e values for Option B for the same set of mills are $15/pe ($23/pe) and $92/pe ($142/pe), respectively.

For the papergrade sulfite subcategory, average and incremental c-e values are $9/pe ($13/pe) for direct dischargers and $9/pe ($14/pe) for direct and indirect dischargers combined. For the pulp, paper, and paperboard industry, the selected options have a c-e value of $9/pe ($14/pe) for BAT and $10/pe ($15/pe) for PSES.

5.3 COSTS OF COMBINED PROPOSED AND FINAL AIR AND FINAL WATER REQUIREMENTS

5.3.1 BAT/PSES Options

Table 5-16 summarizes different cost combinations for the 96 mills for which BAT/PSES requirements are promulgated at this time (i.e., the bleached papergrade kraft and soda and papergrade sulfite[2] subcategories). Three sets of cost combinations are given:

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[2]Although there are two proposed MACT II options for sulfite mills, the costs for papergrade sulfite mills do not vary between the options; hence there is only one set of costs to reflect the combination of effluent guideline, MACT I, and proposed MACT II costs for this group of mills.

TABLE 5-16

**SUMMARY OF FINAL BAT/PSES, FINAL MACT I, AND PROPOSED MACT II COSTS FOR BLEACHED PAPERGRADE KRAFT AND SODA AND PAPERGRADE SULFITE MILLS
THOUSANDS OF 1995 DOLLARS**

		BAT/PSES Only		BAT/PSES and MACT I		BAT/PSES and MACT I: Selected Option				BAT/PSES and MACT I: Option B			
Subcategory	Cost Type	Selected Option	Option B	Selected Option	Option B	MACT II A,B	MACT II C,D	MACT II E,F	MACT II G,H	MACT II A,B	MACT II C,D	MACT II E,F	MACT II G,H
Column Number		1	2	3	4	5	6	7	8	9	10	11	12
Bleached Papergrade Kraft and Soda													
	Capital Cost	$965,610	$2,129,056	$1,305,760	$2,606,038	$1,428,156	$1,495,447	$2,224,759	$2,662,837	$2,728,434	$2,795,725	$3,525,038	$3,963,115
	O&M Expense	$151,421	$87,185	$202,429	$154,269	$200,709	$209,533	$150,578	$160,385	$152,549	$161,374	$102,418	$112,225
	Post-tax Annualized Cost	$161,866	$215,978	$217,553	$291,528	$226,124	$236,417	$259,661	$299,455	$300,099	$310,392	$333,636	$373,430
	Pre-tax Annualized Cost	$248,208	$309,436	$333,395	$424,606	$344,693	$360,325	$380,686	$436,515	$435,905	$451,536	$471,898	$527,727
Papergrade Sulfite													
	Capital Cost	$73,778	$73,778	$87,836	$87,836	$95,936	$95,936	$95,936	$95,936	$95,936	$95,936	$95,936	$95,936
	O&M Expense	$6,992	$6,992	$8,762	$8,762	$11,665	$11,665	$11,665	$11,665	$11,665	$11,665	$11,665	$11,665
	Post-tax Annualized Cost	$9,753	$9,753	$11,861	$11,861	$14,151	$14,151	$14,151	$14,151	$14,151	$14,151	$14,151	$14,151
	Pre-tax Annualized Cost	$14,551	$14,551	$17,745	$17,745	$21,402	$21,402	$21,402	$21,402	$21,402	$21,402	$21,402	$21,402
Total													
	Capital Cost	**$1,039,388**	**$2,202,835**	**$1,393,596**	**$2,693,874**	**$1,524,091**	**$1,591,383**	**$2,320,695**	**$2,758,773**	**$2,824,369**	**$2,891,661**	**$3,620,973**	**$4,059,051**
	O&M Expense	**$158,413**	**$94,177**	**$211,190**	**$163,030**	**$212,374**	**$221,198**	**$162,243**	**$172,050**	**$164,214**	**$173,038**	**$114,083**	**$123,890**
	Post-tax Annualized Cost	**$171,618**	**$225,731**	**$229,414**	**$303,389**	**$240,275**	**$250,568**	**$273,812**	**$313,606**	**$314,250**	**$324,543**	**$347,788**	**$387,582**
	Pre-tax Annualized Cost	**$262,760**	**$323,987**	**$351,140**	**$442,352**	**$366,095**	**$381,727**	**$402,089**	**$457,918**	**$457,307**	**$472,938**	**$493,300**	**$549,129**

- BAT/PSES (combined costs for bleached papergrade kraft and soda and papergrade sulfite subcategories: see Table 5-11 for costs by subcategory).
- BAT/PSES and MACT I (i.e., promulgated requirements).
- BAT/PSES, MACT I, and proposed MACT II.

For example, the combined costs for the selected BAT/PSES option and MACT I are in the third column of numbers from the left. The combined or total cost is $1.4 billion in capital costs, $211 million in O&M expenses, and $229 million in post-tax annualized expenses. The combined costs for the selected BAT/PSES option, MACT I, and the proposed MACT II Alternative A are in the fifth column. This combined total cost is $1.5 billion in capital costs, $212 million in O&M expenses, and $240 million in post-tax annualized expenses.

Table 5-17 summarizes different cost combinations for the 155 mills to which final MACT I and proposed MACT II apply. (The 96 mills for which costs are presented in Table 5-16 are a subset of the 155 mills for which costs are presented in Table 5-17. As a result, the figures in Table 5-17 are greater than the comparable figures in Table 5-16.) As noted in Section 5.1.2, MACT I costs differ by BAT/PSES option for the bleached papergrade kraft and soda subcategory. Costs associated with the final BAT/PSES (Option A) are in the top part of the table while those associated with BAT/PSES Option B are in the bottom part of the table. The first column of numbers is the MACT I costs and the second column is for the proposed MACT II alternative (Alternative A) costs. These costs reflect total compliance costs for all 155 mills to which MACT applies. The third column is the BAT/PSES costs for the 96 mills in the bleached papergrade kraft and soda and papergrade sulfite categories for which BAT/PSES is promulgated at this time. For example, costs for final MACT I, proposed MACT II (Alternative A), and the selected BAT/PSES option for bleached papergrade kraft and soda and papergrade sulfite mills are $1.8 billion in capital costs, $238 million in annual O&M expenses, and $277 million in post-tax annualized costs.

5.3.2 Sensitivity Analysis—TCF

EPA compared the costs of Option B and TCF for the bleached papergrade kraft and soda subcategory (Table 5-18). Capital costs are approximately $956 million (about 45 percent) greater for TCF than for Option B. The annual operating and maintenance costs of $783 million, however, are nearly 9 times

TABLE 5-17
SUMMARY OF FINAL MACT I AND PROPOSED MACT II ALTERNATIVE COSTS FOR KRAFT, SULFITE, SODA, AND SEMICHEMICAL MILLS AND FINAL BAT/PSES COSTS FOR BLEACHED PAPERGRADE KRAFT AND SODA AND PAPERGRADE SULFITE MILLS
THOUSANDS OF 1995 DOLLARS

		REGULATION			
SUBCATEGORY	COST TYPE	MACT IA	MACT II, ALT. A	SELECTED BAT/PSES OPTION*	**TOTAL**
Kraft and Soda					
	Capital	$463,866	$218,893	$965,610	**$1,648,369**
	O&M	$71,889	($1,696)	$151,421	**$221,614**
	Posttax Annualized	$77,272	$16,116	$161,866	**$255,253**
	Pretax Annualized	$118,415	$21,537	$248,208	**$388,159**
Sulfite					
	Capital	$25,148	$11,400	$73,778	**$110,326**
	O&M	$2,808	$4,043	$6,992	**$13,843**
	Posttax Annualized	$3,567	$3,199	$9,753	**$16,519**
	Pretax Annualized	$5,369	$5,105	$14,551	**$25,025**
Semichemical					
	Capital	$11,744	$28,096	n/a	**$39,840**
	O&M	$22	$2,855	n/a	**$2,877**
	Posttax Annualized	$929	$3,824	n/a	**$4,753**
	Pretax Annualized	$1,264	$5,727	n/a	**$6,991**
Total					
	Capital	**$500,758**	**$258,389**	**$1,039,388**	**$1,798,535**
	O&M	**$74,718**	**$5,202**	**$158,413**	**$238,334**
	Posttax Annualized	**$81,767**	**$23,139**	**$171,619**	**$276,525**
	Pretax Annualized	**$125,048**	**$32,368**	**$262,759**	**$420,175**

		REGULATION			
SUBCATEGORY	COST TYPE	MACT IB	MACT II, ALT. A	BAT/PSES, OPT. B*	**TOTAL**
Kraft and Soda					
	Capital	$601,706	$218,893	$2,129,056	**$2,949,655**
	O&M	$88,175	($1,696)	$87,185	**$173,664**
	Posttax Annualized	$97,334	$16,116	$215,978	**$329,427**
	Pretax Annualized	$148,708	$21,537	$309,436	**$479,681**
Sulfite					
	Capital	$25,148	$11,400	$73,778	**$110,326**
	O&M	$2,808	$4,043	$6,992	**$13,843**
	Posttax Annualized	$3,567	$3,199	$9,753	**$16,519**
	Pretax Annualized	$5,369	$5,105	$14,551	**$25,025**
Semichemical					
	Capital	$11,744	$28,096	n/a	**$39,840**
	O&M	$22	$2,855	n/a	**$2,877**
	Posttax Annualized	$929	$3,824	n/a	**$4,753**
	Pretax Annualized	$1,264	$5,727	n/a	**$6,991**
Total					
	Capital	**$638,598**	**$258,389**	**$2,202,834**	**$3,099,821**
	O&M	**$91,004**	**$5,202**	**$94,177**	**$190,384**
	Posttax Annualized	**$101,829**	**$23,139**	**$225,731**	**$350,699**
	Pretax Annualized	**$155,342**	**$32,368**	**$323,987**	**$511,697**

*BAT/PSES costs incurred only by mills in bleached papergrade kraft and papergrade sulfite subcategories only.
'n/a' = not applicable

TABLE 5-18

BLEACHED PAPERGRADE KRAFT AND SODA SUBCATEGORY
COMPARISON OF OPTION B AND TCF COSTS
THOUSANDS OF 1995 DOLLARS

	BAT/PSES Only		BAT/PSES and MACT I		BAT/PSES, MACT I, and MACT II A,B	
Cost Type	Option B	TCF	Option B	TCF	Option B	TCF
Capital Cost	$2,129,056	$3,084,873	$2,606,038	$3,561,854	$2,728,434	$3,684,250
O&M Expense	$87,185	$783,460	$154,269	$850,544	$152,549	$848,824
Post-tax Annualized Cost	$215,978	$688,330	$291,528	$763,880	$300,099	$772,450
Pre-tax Annualized Cost	$309,436	$1,081,925	$424,606	$1,197,095	$435,905	$1,208,393

greater. On a post-tax annualized basis, the TCF costs are more than 3.1 times the costs for Option B for BAT/PSES. The air pollution control (MACT I) costs are assumed to be the same for TCF as for Option B because boiler control requirements are likely to be the same. The post-tax annualized costs for TCF/MACT I/MACT II A are about 2.6 times greater than for Option B/MACT I/MACT II A.

5.4 REFERENCES

Reference material supporting Chapter 5 is located in the Pulp and Paper Water Docket.

OMB. 1992. Guideline and discount rates for benefit-cost analysis of Federal programs. Washington, DC: Office of Management and Budget. Revised circular No. A-94. Water Docket, DCN 14,301.

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U.S. EPA. 1993b. Cost effectiveness analysis of proposed effluent limitations guidelines for the pulp, paper, and paperboard industry. EPA/821/R-93/018. Washington, DC: Office of Water. Water Docket, DCN 33,595.

U.S. EPA. 1996a. National emission standards for hazardous air pollutants for source category: pulp and paper. Environmental Protection Agency. Notice of Availability. *Federal Register* 61(47):9383-9399. March 8, 1996. Water Docket, DCN 13,212.

U.S. EPA. 1996b. Effluent limitations guidelines, pretreatment standards, and new source performance standards: pulp, paper, and paperboard category; national emission standards for hazardous air pollutants for source category: pulp and paper production.   Environmental Protection Agency. Notice of Availability. *Federal Register* 61(136):36835-36858. July 15, 1996. Water Docket, DCN 13, 471.

U.S. EPA. 1997a. Supplemental development document for effluent limitations guidelines and standards for the for the pulp, paper, and paperboard category subpart B (bleached papergrade kraft and soda) and subpart E (papergrade sulfite). Washington, DC: Office of Water. Water Docket, DCN 14,487.

U.S. EPA. 1997b.   Pulp, paper, and paperboard industry—background information for promulgated air emission standards, manufacturing processes at kraft, sulfite, soda, semi-chemical, mechanical and secondary and non-wood fiber mills, final EIS. EPA-453/R-93-050b. Washington, DC: Office of Air Quality Planning and Standards. Water Docket, DCN 14,319.

CHAPTER 6

ECONOMIC IMPACT RESULTS

This chapter describes the economic effects resulting from compliance with the Cluster Rule on the pulp and paper industry, regions of the country where the industry is located, and the national economy. The economic impacts result from the pollution control costs discussed in Chapter Five. In this chapter, EPA evaluates the impacts of these costs using the models presented in Chapter Three. All supporting computer printouts are located in Section 27.4 "Cost and Impact Analysis" in the Pulp and Paper Water Docket. (DCN 14,340 through DCN 14,400). Almost all of the material is confidential.

Section 6.1 discusses New Source Performance Standards (NSPS) and Pretreatment Standards for New Sources (PSNS) under the Clean Water Act (CWA). Each of the remaining sections in the chapter contains a different level or type of analysis (industry, regional, national, or sensitivity). Within each section, the findings are ordered in the following sequence:

- Clean Air Act (CAA) Requirements (MACT)
- CWA Requirements (BAT/PSES)
- Combined CAA and CWA Requirements
  - final MACT I and BAT/PSES (Cluster Rule)
  - final MACT I, final BAT/PSES, and proposed MACT II

Section 6.2 presents the industry-level impacts (company failures, facility closures and direct impacts, see Section 3.3 for details). Section 6.3 discusses regional impacts and Section 6.4 summarizes the national-level impacts (more information is located in Section 3.3.2). With the exception of the company failure (bankruptcy) analysis, the impacts discussed in this chapter are based on the projected facility closures.

EPA examined the impacts under two scenarios: once under the assumption that the facility must absorb all the costs of incremental pollution control, and second, under the assumption that market conditions will allow a facility to pass on some of the additional costs to consumers in the form of a price increase. (Section 3.3.1.2 and Appendix A describe the price increase methodology.) This sensitivity analysis was performed throughout the various cost configurations considered; most tables have "No Price Increase" and

"Price Increase" divisions. Section 6.5 presents a summary of the sensitivity of closures to changes in the discount rate, changes in the timing of compliance implementation, increases in pulp prices for non-integrated mills due to mill closures, and totally chlorine free (TCF) costs for the bleached papergrade kraft and soda subcategory.

MACT III promulgates NESHAP for mechanical pulping, secondary fiber pulping, and non-wood pulping. MACT III has no costs; hence there are no impacts to discuss in Chapter 6.

6.1 NEW SOURCE PERFORMANCE STANDARDS AND PRETREATMENT STANDARDS FOR NEW SOURCES

6.1.1 Papergrade Sulfite

For NSPS/PSNS, EPA has chosen the following technologies: TCF for the calcium/magnesium sulfite segment, ECF for the ammonium sulfite segment, and bleach plant limits for the specialty grade segment. EPA considered the cost of NSPS/PSNS technology for new source mills and concluded that such costs were not sufficient to present a barrier to entry, because the cost of the NSPS/PSNS technology is an insignificant fraction of the capital cost of a new mill (less than 1 percent) and, therefore, if a mill is able to start up, it will have sufficient capital to meet these costs. Further, the costs of including the selected NSPS/PSNS technology are substantially less on a per ton basis than the costs of retrofitting existing mills and this technology is already being employed. Moreover, the increased chemical recovery and reduced operating costs for the NSPS/PSNS option allow firms to recover any increased capital cost associated with the NSPS/PSNS technology.

6.1.2 Bleached Papergrade Kraft and Soda—Elemental Chlorine Free (ECF) Technology

The Notice of Data Availability (61 FR 36835-36858) discussed an additional NSPS/PSNS option. This option is ECF including extended delignification (oxygen delignification or extended cooking) to produce softwood pulps with a kappa number of 20 or less (13 or less for hardwoods), followed by complete (100 percent) substitution of chlorine dioxide for chlorine (Option B). ERG and McCubbin, 1997 estimate the start-up costs (in 1995 dollars) for two new ECF 1,000 unbleached air-dried tons per day (UBADt/day) fiberlines. The capital and annual costs with complete substitution (100 percent) of chlorine dioxide for chlorine (i.e., the selected BAT technology) are $201 million and $39.2 million, respectively. The capital and annual costs for a new fiberline with Option B technology are $202 million and $35.6 million, respectively. The capital cost to start-up an Option B fiberline is only 0.5 percent more than for an Option A fiberline. Therefore, if a mill is able to start-up, it will have sufficient capital to meet these costs. The annual operating and maintenance costs are 9 percent lower for Option B than Option A. EPA therefore perceives no barrier to entry for Option B as the selected NSPS/PSNS for the bleached papergrade kraft and soda subcategory.

6.1.3 Bleached Papergrade Kraft and Soda—Totally Chlorine Free (TCF) Technology

EPA considered a TCF option for the bleached papergrade kraft and soda subcategory at proposal (FR, 1993) but concluded that TCF was not an available pollution prevention technology at that time for the reasons discussed in the preamble and elsewhere in the record to the rule. ERG and McCubbin, 1997 estimates costs for a new 1,000 UBADt/day TCF fiberline. The capital cost is $190.3 million; lower than either of the ECF fiberlines primarily because the TCF fiberline avoids the cost of manufacturing chlorine dioxide at the site, and requires only normal grades of stainless steel while ECF equipment requires more expensive alloys and plastics that can withstand the corrosive action of chlorine dioxide (ERG and McCubbin, 1997). Annual costs for the TCF fiberline are estimated at $33.9 million; lower than either ECF fiberline. Should TCF technology develop to the point where it produces full brightness pulps at domestic plants, and should the market provide sufficient demand for full brightness TCF pulps to warrant investment in new fiberlines, cost would not be considered a barrier to entry.

6.2 INDUSTRY-LEVEL IMPACTS

6.2.1 Company Failures

Many of the companies considered in the analysis own more than one pulp and paper facility. In the company failure analysis, EPA has identified conditions where it could make economic sense to upgrade each facility (i.e., the facility could absorb the costs of additional control and still remain profitable), but the company could not afford the total cost of upgrading all of the facilities that it owns. The larger the number of facilities that a company must upgrade, the greater the possibility of overextending the company's financial resources,[1] and pushing it into bankruptcy.

The company-level analysis is a bankruptcy analysis based on 1995 data. It examines publicly-held companies for which 1995 data are available: 36 companies for CAA requirements and 29 companies for CWA requirements. A number of pulp and paper firms affected by the integrated rules are privately held—for which no data were available. These were, therefore, not evaluated in the company failure analysis. EPA uses a standard and widely accepted measure— a weighted average of financial ratios called the Altman's Z score—as a predictor of company financial distress and failure (see Section 3.3.4; Altman, 1993; Brealy and Meyers, 1984; and Brigham, 1982). The Altman's Z score places a company into one of three categories:

- bankruptcy unlikely
- no prediction made
- bankruptcy likely

For each affected company, the company failure analysis evaluates the Altman's Z score both before and after the incurrence of compliance costs. If a company's Z-score drops below 1.81 (Altman's empirical estimate of the point at which bankruptcy becomes likely), as a result of the costs of compliance, EPA considers the company bankruptcy a result of the rule combination being evaluated.

[1]Depending on the financial items carried on a facility's books, it is possible for a company that must upgrade one facility to appear as a company failure but not as a facility closure. For example, a company with a high debt load may have difficulty making periodic interest payments. If interest payments or long-term debt are not carried at the facility level, it could appear that the facility could recoup the costs of a pollution control upgrade while, in truth, the company could not afford to make the upgrade.

6.2.1.1 CAA Requirements

There are 36 public companies with facilities to which final and proposed MACT apply.

Final MACT I

No companies move to the "bankruptcy likely" category as a result of final MACT I costs.

Proposed MACT II

Section 5.1 describes the eight alternatives (Alternatives A through H) evaluated for MACT II. Alternative A is the proposed MACT II. EPA projects no incremental business failures under Alternatives A through D. Under Alternatives E through H, one or more companies move into the "bankruptcy likely" category. Section 6.2.1.5 describes some of the ramifications of this shift.

Combined Final MACT I and Proposed MACT II Alternatives

EPA examined the combined cost of final MACT I and the alternatives considered for MACT II. EPA projects no additional bankruptcies for the combined cost of final MACT I and the proposed MACT II (Alternative A) or final MACT I and MACT II Alternatives B through D. Under final MACT I and MACT II Alternatives E through H, one or more companies move into the "bankruptcy likely" category, the same as with the MACT II alternatives alone.

6.2.1.2 CWA Requirements

A company may own facilities in more than one subcategory. The purpose of the company failure analysis is to identify the potential impacts of a rule for all costs, i.e. all subcategories, borne by a company. As such, the company failure analysis is not a subcategory-specific analysis. EPA, however, evaluated achievability for both the papergrade sulfite and bleached papergrade kraft and soda subcategories. EPA found the selected options for each subcategory to be economically achievable.

For the 29 public companies with facilities regulated by BAT/PSES, the final BAT/PSES option results in no additional bankruptcies. One or more companies move into the "bankruptcy likely" category with BAT/PSES Option B (100 percent substitution and either oxygen delignification or extended cooking).

6.2.1.3 Combined Final CAA (MACT I) and CWA (BAT/PSES) Requirements (Cluster Rule)

EPA estimates that the costs of the final BAT/PSES and final MACT I rules are not likely to cause any bankruptcies. As with BAT/PSES alone, one or more companies move into the "bankruptcy likely" category with BAT/PSES Option B combined with the final MACT I rule costs.

6.2.1.4 Combined Cluster Rule and Proposed MACT II

For the 29 public companies with facilities to which final BAT/PSES, final MACT I, and proposed MACT II apply, the combined costs for final BAT/PSES, final MACT I, and proposed MACT II Alternative (A) result in no additional failures. Final BAT/PSES, final MACT I, and MACT II Alternatives B-D costs also result in no additional failures. One or more companies move into the "bankruptcy likely" category when final BAT/PSES and final MACT I are combined with MACT II Alternatives E-H, or with BAT/PSES Option B and any MACT I or MACT II requirements.

6.2.1.5 Ramifications of Company Bankruptcy

Table 6-1 summarizes the cost configurations that lead to one or more companies moving into the "bankruptcy likely" category. The firms potentially affected—those whose Z-scores drop below 1.81 as a result of incurring compliance costs—represent a significant portion of the employment and facilities in the bleached papergrade kraft and soda and papergrade sulfite subcategories.

TABLE 6-1

SUMMARY OF ALTMAN'S Z SCORE BANKRUPTCY ANALYSIS

No Change	One or More Companies Move Into the "Bankruptcy Likely" Category
Final MACT I	
Proposed MACT II Alternative (A)	
MACT II Alternatives B-D	MACT II Alternatives E-H
Combined Final MACT I and Proposed MACT II Alternative (A)	
Combined Final MACT I and MACT II Alternatives B-D	Combined Final MACT I and MACT II Alternatives E-H
Combined Final BAT/PSES for Papergrade Sulfite and BAT/PSES for Bleached Papergrade Kraft and Soda	
Combined Final BAT/PSES for Papergrade Sulfite, BAT/PSES for Bleached Papergrade Kraft and Soda, and MACT I	
Combined Final BAT/PSES for Papergrade Sulfite, BAT/PSES for Bleached Papergrade Kraft and Soda, MACT I, and Proposed MACT II	Option B Bleached Papergrade Kraft and Soda with any combination of BAT/PSES for Papergrade Sulfite, MACT I, or MACT II alternatives

The magnitude of the effects that may arise from large firm bankruptcies is a substantial indicator of economic unachievability. The negative effects are somewhat indefinite and unquantifiable but range from stock price turmoil[2] to reduced workforces to nonproductive use of social resources. Which impacts occur would depend on the responses of the potentially affected firm(s) to the increased costs.

Companies that enter bankruptcy or near-bankruptcy are more likely to see their stock prices fall. In a study of 274 publicly-held companies that filed for bankruptcy between 1979 and 1989, Lawless et al., 1996 notes that the bankrupt firms experienced an average decline of 20 percent in stock value from the day before filing through the day of filing.

A company sells stock to raise capital. After stock has been issued to an investor, the shares may be sold and resold many times to subsequent owners. These transfers are private transactions between the buyer and seller and do not affect the existing capital of the firm. Stock price fluctuations, then, affect the current owners of the stock and price declines may cause substantial loss of investor value. The current owners of the stock may include:

- retirement funds
- mutual funds
- individuals, some of whom may be living on a fixed income and depend on stock dividends as income.

The number of people affected by a stock price decline is unknown, but has the potential to be in the thousands to millions of investors.

A decline in stock value, however, affects a company's ability to raise additional capital, which might be needed to address additional investment requirements (including pollution control) at all of its mills. New stock issues would reflect the lower market prices. To raise a certain amount of capital, a company would have to issue a larger-than-originally-planned amount of new stock; a move that could dilute and possibly further depress the value of outstanding stock. In addition to limiting its ability to raise capital by issuing

[2]An example of these effects includes Thomas, 1994 which shows a plot of Georgia-Pacific's stock price which peaked in 1989 just before the Great Northern Nekoosa hostile takeover, plummeted under the combined effects of increased debt load from the takeover and industry slowdown, and recovered since 1991.

stock, a company that enters bankruptcy or near-bankruptcy will have difficulty obtaining credit. A company that has difficulty paying its current obligations will have even more difficulty paying larger obligations. Even if a company finds a willing lender, the lender will be able to command a higher interest rate to offset the increased risk of default. So an affected company will have to pay more for the money it borrows, further constraining its ability to emerge from bankruptcy.

Bankruptcy affects not only the stock value of the company announcing but that of companies in the same industry. These effects may be positive (i.e., customers stop doing business with the bankrupt firm and therefore its competitors see an increase in business) or negative (e.g., if one company fails, the industry is presumed to be in a downturn and the remaining firms are expected to do poorly). Cheng and McDonald, 1996 and Rasmussen and Skeel, 1995 describe various interpretations for such “contagious” or “ripple” effects. For EPA’s purpose, however, it may suffice to note that a corporate bankruptcy contributes to stock market turmoil and stock price fluctuations.

Creditors and vendors are also affected by a company’s bankrupt or near-bankrupt state. The inability of a company to pay its current obligations means that creditors may receive only partial payments, thereby disrupting their income stream. Vendors run the risk of not being paid or not being paid in full for sales already concluded . Should a firm cease operations, i.e. vendors would also lose future sales to the company, thereby reducing their sales and revenues.

Low stock prices may make a company vulnerable to a hostile takeover by a domestic or foreign firm. Takeovers and mergers frequently result in employee layoffs as the new company tries to reduce costs through economies of scale (e.g., rather than 200 sales personnel in each of two offices, the company may consolidate operations into 300 sales personnel in one office for a net loss of 100 jobs). For example, Kimberly-Clark announced plans to cut 8,000 jobs after acquiring Scott Paper in 1995 (Byrne and Weber, 1996).

Some companies may downsize some operations without closing mills, thus potentially causing some job losses in communities that depend on the mill directly and/or indirectly for their economic well-being. Weaker companies might be forced to sell off blocks of assets to raise funds needed to preserve their corporate existence. Companies may choose to close marginal plants to avoid the cost of upgrade or to sell off mills both to avoid the costs of upgrade and to raise capital to upgrade the remaining mills. For example, Scott Paper's restructuring plan involved reducing staff by 34 percent or 11,000 jobs and selling the S.D.Warren mills to South Africa's Sappi, Ltd. These job losses were incurred prior to the sale of the remainder of Scott Paper to Kimberly-Clark (Pulp & Paper, 1994).

Finally, the bankruptcy proceeding itself has costs. Societal resources consumed in a bankruptcy proceeding are unavailable for other purposes. Rasmussen and Skeel, 1995 considers the costs of a Chapter 11 proceeding to be a major problem of the current Bankruptcy code, stating:

> "Thus, not only does the current system fail..., but it also consumes a good bit of a firm's assets in the process."

Examples cited include $770 million in professional fees in Southern District of New York Bankruptcies between 1989 and 1992, and combined attorney fees exceeding $250 million of the Eastern Airlines, Pan American Airlines, and LTV bankruptcies.

Although EPA cannot determine with certainty what the impacts would be if one or more large firms experience bankruptcy, EPA has reason to believe that they would likely be significant. The recent history of the pulp and paper industry in the U.S. indicates the kinds of results that could occur. In the last few years, financially weak companies have been acquired—through both friendly and hostile takeovers—by companies with stronger equity/cash positions relative to debt. The acquiring companies subsequently divested themselves of unproductive assets, closed a number of mills, and eliminated more than 15,000 jobs (Pulp and Paper, 1994; Byrne and Weber, 1996; and Pulp and Paper, 1995). Domestic owners have sold a number of mills to foreign companies (Auchard, 1994).

6.2.2 Facility Closures and Related Direct Impacts

As discussed in Chapter 3, the closure analysis focuses on individual facilities. It evaluates whether the present value of post-compliance net earnings is less than the salvage value of the mill. If this happens, the mill is projected to close because closure is more economically advantageous to the owner. The closure analysis does not evaluate whether the company that owns the facility has sufficient cash or credit to purchase and install the incremental pollution control. When the closure analysis projects a facility closure, all employment, production, and exports reported for the facility are considered lost. These are considered to be direct impacts of facility closure. The data for the direct impacts calculated from the closure analysis are taken from the 1990 survey with the value of output inflated to 1995 dollars.

EPA uses two approaches to protect confidential business information from disclosure in this report: 1) certain mill specific findings are not presented, and 2) results are presented for combined subcategories. The results for each subcategory and each mill, however, are located in the confidential portion of Pulp and Paper Water Docket, Section 27.4 "Cost and Impact Analysis."

6.2.2.1 CAA Requirements

EPA estimate that 155 mills will incur costs under MACT requirements.

Final MACT I

EPA projects no facility closures as a result of final MACT I costs. Therefore, there are no estimated losses in employment or output.

Proposed MACT II

Section 5.1 describes the eight alternatives (Alternatives A through H) evaluated for MACT II. EPA projects no facility closures solely as a result of the costs of any MACT II alternative. Therefore, there are no estimated losses in employment or output.

Combined Final MACT I and Proposed MACT II Alternatives

In response to comments and based on additional information in the record, EPA examined the combined compliance costs of final MACT I and the alternatives considered for MACT II. MACT I requirements have different costs depending on the water pollution control technology installed at the facility (see Table 5-5). Table 6-2 summarizes the closure analysis based on the combined costs of the final MACT I rule and eight proposed MACT II alternatives, with MACT I costs based on the assumption that the final BAT/PSES technology is in place at each facility. While EPA estimates that no mills close when either final MACT I or proposed MACT II costs are examined individually, at least one mill closes with the combined costs, with or without the assumption of a price increase. EPA projects a second mill closure under the combined costs of final MACT I and the most expensive MACT II option evaluated for the kraft and soda subcategory, and then only when the Agency assumes no price increase. The impacts of these two closures include up to 1,200 jobs lost, up to $386 million in lost shipments, and up to $2 million in lost exports.

EPA also examined the impacts of the final MACT I rule costs and proposed MACT II alternatives assuming that the Option B technology basis was selected for BAT/PSES, and more expensive MACT I controls were required. Table 6-3 summarizes the results. The results for final MACT I and MACT II Alternatives A-F are the same as those shown in Table 6-2. With Alternatives G and H, however, EPA projects two mills to close with a price increase and three without a price increase. The impacts include up to 1,600 jobs lost, up to $535 million in lost shipments, and up to $21 million in lost exports.

6.2.2.2 CWA Requirements

A subset of 96 of the 155 mills evaluated for MACT I and MACT II costs—those in the bleached papergrade kraft and soda and papergrade sulfite subcategories—will also experience water pollution control costs (see Figure 1-1 for the relationship between MACT- and BAT/PSES-regulated subcategories). EPA examined two[3] water pollution control options for the bleached papergrade kraft and soda subcategory and one water pollution control option for each of the three papergrade sulfite subcategory segments (see Development Document). These three papergrade sulfite segments are combined here and evaluated as one subcategory.

Table 6-4 summarizes the range in impacts for the bleached papergrade kraft and soda subcategory for the final CWA BAT/PSES and BAT/PSES Option B only. Under the selected option, EPA projects one incremental mill closure, whether or not prices increase. When the facility closes, approximately 400 jobs are

[3]The impacts projected for retrofitting existing facilities to TCF technology are discussed in Section 6.5.4.

TABLE 6-2

SUMMARY OF CLOSURES AND RELATED IMPACTS
COMBINED FINAL MACT I AND PROPOSED MACT II COSTS (WITH SELECTED BAT/PSES IN PLACE)
ALL SUBCATEGORIES
MILLIONS OF 1995 DOLLARS

		CLOSURES AND RELATED IMPACTS MACT I AND MACT II ALTERNATIVES A-H							
		A	B	C	D	E	F	G	H
No Price Increase									
Closures		1	1	1	1	1	1	2	2
Shipments	(millions)								
pulp	$6,288	$0	$0	$0	$0	$0	$0	$0	$0
paper	$20,202	$206	$206	$206	$206	$206	$206	$206	$206
paperboard	$6,145	$0	$0	$0	$0	$0	$0	$180	$180
total	$32,635	$206	$206	$206	$206	$206	$206	$386	$386
Exports	(millions)								
pulp	$2,715	$0	$0	$0	$0	$0	$0	$0	$0
paper	$298	$2	$2	$2	$2	$2	$2	$2	$2
paperboard	$758	$0	$0	$0	$0	$0	$0	$0	$0
total	$3,771	$2	$2	$2	$2	$2	$2	$2	$2
Employment	90,840	700	700	700	700	700	700	1,200	1,200
	(millions)								
Revenues	$33,013	$209	$209	$209	$209	$209	$209	$392	$392
Price Increase									
Closures		1	1	1	1	1	1	1	1
Shipments	(millions)								
pulp	$6,288	$0	$0	$0	$0	$0	$0	$0	$0
paper	$20,202	$206	$206	$206	$206	$206	$206	$206	$206
paperboard	$6,145	$0	$0	$0	$0	$0	$0	$0	$0
total	$32,635	$206	$206	$206	$206	$206	$206	$206	$206
Exports	(millions)								
pulp	$2,715	$0	$0	$0	$0	$0	$0	$0	$0
paper	$298	$2	$2	$2	$2	$2	$2	$2	$2
paperboard	$758	$0	$0	$0	$0	$0	$0	$0	$0
total	$3,771	$2	$2	$2	$2	$2	$2	$2	$2
Employment	90,840	700	700	700	700	700	700	700	700
	(millions)								
Revenues	$33,013	$209	$209	$209	$209	$209	$209	$209	$209

Notes: Employment rounded to nearest hundred. Shipment tonnage rounded to nearest thousand.
Supporting computer printout is located in Section 27.4 "Cost and Impact Results" in the confidential portion of the Pulp and Paper Water Docket.

TABLE 6-3

SUMMARY OF CLOSURES AND RELATED IMPACTS
COMBINED FINAL MACT I AND PROPOSED MACT II COSTS (WITH OPTION B BAT/PSES IN PLACE)
ALL SUBCATEGORIES
MILLIONS OF 1995 DOLLARS

		CLOSURES AND RELATED IMPACTS MACT I AND MACT II ALTERNATIVES A-H							
		A	B	C	D	E	F	G	H
No Price Increase									
Closures		1	1	1	1	1	1	3	3
Shipments	(millions)								
pulp	$6,288	$0	$0	$0	$0	$0	$0	$0	$0
paper	$20,202	$206	$206	$206	$206	$206	$206	$206	$206
paperboard	$6,145	$0	$0	$0	$0	$0	$0	$328	$328
total	$32,635	$206	$206	$206	$206	$206	$206	$535	$535
Exports	(millions)								
pulp	$2,715	$0	$0	$0	$0	$0	$0	$0	$0
paper	$298	$2	$2	$2	$2	$2	$2	$2	$2
paperboard	$758	$0	$0	$0	$0	$0	$0	$19	$19
total	$3,771	$2	$2	$2	$2	$2	$2	$21	$21
Employment	90,840	700	700	700	700	700	700	1,600	1,600
	(millions)								
Revenues	$33,013	$209	$209	$209	$209	$209	$209	$545	$545
Price Increase									
Closures		1	1	1	1	1	1	2	2
Shipments	(millions)								
pulp	$6,288	$0	$0	$0	$0	$0	$0	$0	$0
paper	$20,202	$206	$206	$206	$206	$206	$206	$206	$206
paperboard	$6,145	$0	$0	$0	$0	$0	$0	$148	$148
total	$32,635	$206	$206	$206	$206	$206	$206	$354	$354
Exports	(millions)								
pulp	$2,715	$0	$0	$0	$0	$0	$0	$0	$0
paper	$298	$2	$2	$2	$2	$2	$2	$2	$2
paperboard	$758	$0	$0	$0	$0	$0	$0	$19	$19
total	$3,771	$2	$2	$2	$2	$2	$2	$21	$21
Employment	90,840	700	700	700	700	700	700	1,100	1,100
	(millions)								
Revenues	$33,013	$209	$209	$209	$209	$209	$209	$362	$362

Notes: Employment rounded to nearest hundred. Shipment tonnage rounded to nearest thousand.
Supporting computer printout is located in Section 27.4 "Cost and Impact Results" in the confidential portion of the Pulp and Paper Water Docket.

TABLE 6-4

**SUMMARY OF CLOSURES AND RELATED IMPACTS -- BAT/PSES COSTS
BLEACHED PAPERGRADE KRAFT AND SODA SUBCATEGORY
MILLIONS OF 1995 DOLLARS**

		Closures and Related Impacts BAT/PSES Costs Only	
	Baseline	Final BAT/PSES	BAT/PSES Option B
No Price Increase			
Closures		1	2
Shipments (millions)			
total	$32,635	$150	$273
Exports (millions)			
total	$3,771	$19	$19
Employment	90,840	400	900
Revenues (millions)	$33,013	$153	$278
Price Increase			
Closures		1	2
total	$32,635	$150	$273
Exports (millions)			
total	$3,771	$19	$19
Employment	90,840	400	900
Revenues (millions)	$33,013	$153	$278

Notes: Employment rounded to nearest hundred.
Supporting computer printout is located in Section 27.4 "Cost and Impact Results" in the confidential portion of the Pulp and Paper Water Docket.

lost, $150 million in shipments are no longer shipped, and $19 million in exports are lost. No further details are provided due to reasons of confidentiality.

The number of facility closures and related direct impacts (other than firm failure) are roughly twice as large under BAT/PSES Option B than under the selected option. Under BAT/PSES Option B, EPA projects an additional mill closure (for a total of two), also without regard to a price increase.   Approximately 900 jobs are lost between the two closed mills. About $273 million worth of shipments is no longer made, and exports are reduced by $19 million.

EPA projects no closures or related economic impacts as a result of the compliance costs for the final BAT/PSES basis for the papergrade sulfite subcategory.

6.2.2.3 Combined Final CAA (MACT I) and CWA (BAT/PSES) Requirements (Cluster Rule)

EPA estimates that 96 mills in the bleached papergrade kraft and soda and papergrade sulfite subcategories will incur costs to comply with final BAT/PSES as well as to comply with final MACT I requirements. Table 6-5 summarizes the range of impacts resulting from projected mill closures. Impacts vary by the option selected for BAT/PSES and by whether or not a price increase is assumed.

As a result of combined final BAT/PSES and final MACT I costs, EPA projects two mill closures regardless of whether or not a price increase is assumed. These closures result in direct losses of 900 jobs, $273 million in shipments, and $19 million in exports.

Impacts are consistently higher as a result of the combined costs of under BAT/PSES Option B and final MACT I. EPA projects three to four mill closures (an assumed price increase allows one mill to remain open) under the combined costs. Assuming no price increase, the estimated impacts of Option B include up to 4,800 lost jobs, that is, approximately five times more jobs lost than under the selected option. EPA estimates lost shipments up to $1.3 billion; again, the losses are five times higher under BAT/PSES Option B than under the selected option. The Agency estimates lost exports up to $24 million under BAT/PSES Option B.

TABLE 6-5

SUMMARY OF CLOSURES AND RELATED IMPACTS
FINAL BAT/PSES AND FINAL MACT I COSTS
BLEACHED PAPERGRADE KRAFT AND SODA AND PAPERGRADE SULFITE SUBCATEGORIES
MILLIONS OF 1995 DOLLARS

		Closures and Related Impacts BAT/PSES and MACT I	
		Final BAT/PSES	Option B
No Price Increase			
Closures		2	4
Shipments			
pulp	$6,288	$27	$28
paper	$20,202	$98	$1,150
paperboard	$6,145	$148	$148
total	$32,635	$273	$1,327
Exports			
pulp	$2,715	$0	$0
paper	$298	$0	$4
paperboard	$758	$19	$19
total	$3,771	$19	$24
Employment			
	90,840	900	4,800
Revenues	$33,013	$278	$1,338
Price Increase			
Closures		2	3
Shipments			
pulp	$6,288	$27	nd
paper	$20,202	$98	nd
paperboard	$6,145	$148	nd
total	$32,635	$273	nd
Exports			
pulp	$2,715	$0	nd
paper	$298	$0	nd
paperboard	$758	$19	nd
total	$3,771	$19	nd
Employment			
	90,840	900	nd
Revenues	$33,013	$278	nd

'nd' not disclosed due to confidentiality

Notes: Employment rounded to nearest hundred.
Supporting computer printout is located in Section 27.4 "Cost and Impact Results" in the confidential portion of the Pulp and Paper Water Docket.

6.2.2.4 Combined Cluster Rule and Proposed MACT II

EPA examined the combined compliance cost impacts of final BAT/PSES, final MACT I, and all proposed MACT II alternatives (Table 6-6). EPA projects a third mill closure, with or without a price increase. Under these scenarios, EPA projects the loss of 1,700 jobs, reduced shipments of $479 million, and reduced exports of $22 million.

EPA also examined the impacts of final MACT I and proposed MACT II alternatives as costed in configuration with the compliance costs of the BAT/PSES Option B technology basis. Table 6-7 summarizes the results. Compared to Table 6-6, the impacts of BAT/PSES Option B are consistently greater than for the final BAT/PSES. With BAT/PSES Option B, EPA projects four to five mill closures. The number of closures varies based on whether a price increase is assumed, and which MACT II alternative is considered. These closures have estimated direct losses of up to 5,600 jobs, up to $1.5 billion in shipments, and up to $27 million in exports.

6.2.3 Price Increases

This section explains what price increases would result from the rule based on the supply and demand curves developed for the industry, as explained in Chapter 3, Section 3.3.1.2 above. Although the mills may stay open with a price increase, consumers pay the price increase. If paper goods form a substantially larger portion of a low-income family's purchases than a high-income family's purchases, the increased prices might create a greater burden for the low-income family than for the high-income family. Thus, price increases may involve questions of environmental justice.

TABLE 6-6

SUMMARY OF CLOSURES AND RELATED IMPACTS
FINAL BAT/PSES, FINAL MACT I, AND PROPOSED MACT II COSTS
BLEACHED PAPERGRADE KRAFT AND SODA AND PAPERGRADE SULFITE SUBCATEGORIES
MILLIONS OF 1995 DOLLARS

		Closures and Related Impacts Final BAT/PSES and MACT I			
		MACT II A,B	MACT II C,D	MACT II E,F	MACT II G,H
No Price Increase					
Closures		3	3	3	3
Shipments					
pulp	$6,288	$27	$27	$27	$27
paper	$20,202	$304	$304	$304	$304
paperboard	$6,145	$148	$148	$148	$148
total	$32,635	$479	$479	$479	$479
Exports					
pulp	$2,715	$0	$0	$0	$0
paper	$298	$3	$3	$3	$3
paperboard	$758	$19	$19	$19	$19
total	$3,771	$22	$22	$22	$22
Employment					
	90,840	1,700	1,700	1,700	1,700
Revenues	$33,013	$486	$486	$486	$486
Price Increase					
Closures		3	3	3	3
Shipments					
pulp	$6,288	$27	$27	$27	$27
paper	$20,202	$304	$304	$304	$304
paperboard	$6,145	$148	$148	$148	$148
total	$32,635	$479	$479	$479	$479
Exports					
pulp	$2,715	$0	$0	$0	$0
paper	$298	$3	$3	$3	$3
paperboard	$758	$19	$19	$19	$19
total	$3,771	$22	$22	$22	$22
Employment					
	90,840	1,700	1,700	1,700	1,700
Revenues	$33,013	$486	$486	$486	$486

'nd' not disclosed due to confidentiality

Notes: Employment rounded to nearest hundred.
Supporting computer printout is located in Section 27.4 "Cost and Impact Results" in the confidential portion of the Pulp and Paper Water Docket.

TABLE 6-7

SUMMARY OF CLOSURES AND RELATED IMPACTS
BAT/PSES OPTION B, FINAL MACT I, AND PROPOSED MACT II COSTS
BLEACHED PAPERGRADE KRAFT AND SODA AND PAPERGRADE SULFITE SUBCATEGORIES
MILLIONS OF 1995 DOLLARS

		Closures and Related Impacts BAT/PSES Option B and MACT I			
		MACT II A,B	MACT II C,D	MACT II E,F	MACT II G,H
No Price Increase					
Closures		5	5	5	5
Shipments					
pulp	$6,288	$28	$28	$28	$28
paper	$20,202	$1,356	$1,356	$1,356	$1,356
paperboard	$6,145	$148	$148	$148	$148
total	$32,635	$1,533	$1,533	$1,533	$1,533
Exports					
pulp	$2,715	$0	$0	$0	$0
paper	$298	$7	$7	$7	$7
paperboard	$758	$19	$19	$19	$19
total	$3,771	$27	$27	$27	$27
Employment					
	90,840	5,600	5,600	5,600	5,600
Revenues	$33,013	$1,546	$1,546	$1,546	$1,546
Price Increase					
Closures		4	4	5	5
Shipments					
pulp	$6,288	nd	nd	$28	$28
paper	$20,202	nd	nd	$1,356	$1,356
paperboard	$6,145	nd	nd	$148	$148
total	$32,635	nd	nd	$1,533	$1,533
Exports					
pulp	$2,715	nd	nd	$0	$0
paper	$298	nd	nd	$7	$7
paperboard	$758	nd	nd	$19	$19
total	$3,771	nd	nd	$27	$27
Employment					
	90,840	nd	nd	5,600	5,600
Revenues	$33,013	nd	nd	$1,546	$1,546

'nd' not disclosed due to confidentiality

Notes: Employment rounded to nearest hundred.
Supporting computer printout is located in Section 27.4 "Cost and Impact Results" in the confidential portion of the Pulp and Paper Water Docket.

6.2.3.1 CAA Requirements

Final MACT I

Estimated price increases as a result of final MACT I costs are less than 0.5 percent for bleached papergrade kraft and soda, dissolving kraft, dissolving sulfite, papergrade sulfite, and semichemical pulps and products. The estimated price increase for unbleached kraft pulp is almost 5 percent.

Proposed MACT II

Estimated price increases as a result of the costs of proposed MACT II alternatives are less than 0.5 percent for bleached papergrade kraft and soda, dissolving kraft, dissolving sulfite, papergrade sulfite, and semichemical pulps and products regardless of the alternative considered. The estimated price increase for unbleached kraft pulp ranges from 1.4 percent to 7.4 percent depending on the proposed MACT II alternative considered.

Combined Final MACT I and Proposed MACT II Alternatives

EPA estimates price increases as a result of combined final MACT I and MACT II compliance costs at less than 0.5 percent for dissolving kraft, dissolving sulfite, and semichemical pulps and products. Bleached papergrade kraft and soda and papergrade sulfite pulps show less than a 1.0 percent price increase for any of the cost combinations examined. Unbleached kraft pulps show the greatest sensitivity to increased costs; estimated price increases range from 6 percent under the proposed MACT II Alternative to 12 percent under Alternatives G and H.

6.2.3.2 CWA Requirements

The price increases estimated for the final BAT/PSES technology option are approximately 1.1 percent for both bleached papergrade kraft and soda pulps and papergrade sulfite pulps. The price increase estimated for BAT/PSES Option B for the bleached papergrade kraft and soda subcategory is 1.4 percent. The price increase for TCF for the bleached papergrade kraft and soda subcategory is 5 percent, i.e., more than four times larger than the increase projected for the selected option.

6.2.3.3 Combined Final CAA (MACT I) and CWA (BAT/PSES) Requirements (Cluster Rule)

EPA estimates that the price increases resulting from the integrated rule costs (final BAT/PSES and MACT I) are approximately 1.5 percent for both bleached papergrade kraft and soda pulps and papergrade sulfite pulps. The price increase estimated for BAT/PSES Option B for bleached papergrade kraft and soda is 1.9 percent when combined with MACT I. When TCF costs are combined with MACT I, bleached pulp prices increase by 5.5 percent.

6.2.3.4 Combined Cluster Rule and Proposed MACT II

EPA examined the combined impacts of final BAT/PSES, final MACT I, and proposed MACT II alternative compliance costs. The price increase resulting from the imposition of these costs for bleached papergrade kraft and soda pulps ranges from 1.5 to 1.9 percent. The price increase for papergrade sulfite is 1.6 percent.

EPA also examined the impacts of final MACT I and MACT II costs combined with the costs of BAT/PSES Option B. The price increase for bleached papergrade kraft and soda pulps is consistently higher than with the final BAT/PSES and ranges from 1.9 to 2.3 percent depending on the MACT II alternative analyzed. When TCF costs are combined with MACT I and the proposed MACT II alternative, bleached pulp prices increase by 5.5 to 6.0 percent.

6.3 REGIONAL EMPLOYMENT IMPACTS BASED ON PROJECTED CLOSURES

When a mill closes, all employment at the facility is considered lost. EPA examined the effect of mill closures on county unemployment rates. EPA obtained the 1991 employment count and unemployment rates for those counties for which EPA projected possible mill closures (Bureau of the Census, 1996). This analysis does not include regional impacts resulting from bankruptcy, discussed in Section 6.2.1, because EPA cannot predict whether there might be closures associated with corporate bankruptcy or which mills might close if such closures do occur as a result of bankruptcy. Thus, the impacts presented in Section 6.3 are likely to be underestimates of the impacts where company failures result in mill closures.

6.3.1 CAA Requirements

Tables 6-8 and 6-9 summarize the regional impacts that would result from mills incurring CAA compliance costs. Table 6-8 reflects the final MACT I costs and impacts if final BAT/PSES technology is in place at the facility, while Table 6-9 reflects the final MACT I costs and impacts if BAT/PSES Option B technology is in place at the facility. The closures in Table 6-8 correspond to those listed in Table 6-2. EPA projects no closures and thus no regional impacts as a result of final MACT I or proposed MACT II costs, when the regulations are considered separately. EPA estimates that the combined costs for final MACT I and proposed MACT II alternatives—assuming the final BAT/PSES technology is in place—might lead to 1 to 2 mill closures. The unemployment rates for the one to two counties affected by potential mill closures would increase from 5.9 percent to 7.0 percent (an absolute increase of 1.1 percentage points) and from 7.8 percent to 10.1 percent (an absolute increase of 2.3 percentage points), respectively.

EPA also examined the impacts of final MACT I and proposed MACT II requirements based on MACT costs that assumed BAT/PSES Option B technology is in place at each facility (see Table 6-9). The resulting closures listed in Table 6-9 correspond to those listed in Table 6-3. In addition to the two closures noted above, under certain proposed MACT II alternatives EPA projects a third mill may close when final MACT I costs are considered with the costs of MACT II Alternatives G and H, with or without a price increase. The unemployment rate for the additional county affected would increase from 4.3 percent to 4.7 percent (an absolute increase of 0.4 percentage points).

TABLE 6-8

**INCREASE IN REGIONAL UNEMPLOYMENT RATES
MACT-RELATED COSTS[1]**

Options/Regulatory Alternatives	**Number of Projected Closures/ Counties Affected**	**Absolute Increase in Unemployment Rate[2]**	**Relative Increase in Unemployment Rate**
MACT I Only	0	0%	none
MACT II Only	0	0%	none
Combined MACT I/MACT II A through F, no price increase A through G, price increase	1	1.1%	19%
Combined MACT I/MACT II G and H, no price increase	2	1.1% 2.3%	19% 29%

[1]Assuming BAT/PSES Option A technology is in place at each facility.
[2]In counties where mills close.

TABLE 6-9

**INCREASE IN REGIONAL UNEMPLOYMENT RATES
MACT-RELATED COSTS[1]**

Options/Regulatory Alternatives	Number of Projected Closures Affected Counties	Absolute Increase in Unemployment Rate[2]	Relative Increase in Unemployment Rate
MACT I Only	0	0%	none
MACT II Only	0	0%	none
Combined MACT I/MACT II A through F, no price increase A through F, price increase	1	1.1%	19%
Combined MACT I/MACT II G and H, price increase	2	1.1% 0.4%	19% 9%
Combined MACT I/MACT II G and H, no price increase	3	1.1% 0.4% 2.3%	19% 9% 29%

[1]Assuming BAT/PSES Option B technology is in place at each facility.
[2]In counties where mills close.

6.3.2 CWA Requirements

Table 6-10 summarizes the regional impacts under CWA requirements. Each row in the table reflects unemployment impacts in specific counties. The first row of the table presents the impacts of the final BAT/PSES option without taking final MACT I or MACT II requirements into account. The closures in Table 6-10 correspond to those listed in Table 6-4. Under the final BAT/PSES option, EPA projects one facility to close. The unemployment rate of the county affected would increase from 4.3 percent to 4.7 percent (an absolute increase of 0.4 percentage points).

EPA also examined the impacts of BAT/PSES Option B compliance costs as presented in the second row of Table 6-10. In addition to the closure noted above, EPA projects a second facility closure under BAT/PSES Option B requirements. The unemployment rate for the county affected would increase from 8.0 percent to 8.7 percent (an absolute increase of 0.7 percentage points).

6.3.3 Combined Final CAA (MACT I) and CWA (BAT/PSES) Requirements (Cluster Rule)

Table 6-11 summarizes the regional impacts under Cluster Rule requirements. The first row of the table presents the impacts of the final BAT/PSES option; the second and third rows of the table present the impacts of BAT/PSES Option B. The closures correspond to those listed in Table 6-5. Under the final BAT/PSES option, EPA projects two facility closures. The unemployment rates for the two counties affected by potential mill closures would increase from 8.0 percent to 8.7 percent (an absolute increase of 0.7 percentage points) and from 4.3 percent to 4.7 percent (an absolute increase of 0.4 percentage points), respectively.

EPA also examined the impacts if BAT/PSES Option B were in place at each facility. In addition to the two closures noted above, EPA projects one or two additional closures under BAT/PSES Option B, depending on whether a price increase is assumed. The unemployment rate for the counties affected would increase from 9.0 percent to 18.6 percent (an absolute increase of 9.6 percentage points) and from 7.2 percent to 8.9 percent (an absolute increase of 1.7 percentage points).

TABLE 6-10

**INCREASE IN REGIONAL UNEMPLOYMENT RATES
BAT/PSES COSTS**

Options/Regulatory Alternatives	Number of Projected Closures/ Counties Affected	Absolute Increase in Unemploy-ment Rate[1]	Relative Increase in Unemploy-ment Rate
Final BAT/PSES	1	0.4%	9%
BAT/PSES Option B	2	0.4% 0.7%	9% 9%

[1] In counties where mills close.

TABLE 6-11

INCREASE IN REGIONAL UNEMPLOYMENT RATES
CLUSTER RULE COSTS

Options/Regulatory Alternatives	Number of Projected Closures/ Counties Affected	Absolute Increase in Unemploy-ment Rate[1]	Relative Increase in Unemploy-ment Rate
Final BAT/PSES and Final MACT I	2	0.7% 0.4%	9% 9%
BAT/PSES Option B and Final MACT I price increase	3	0.7% 0.4% 9.6%	9% 9% 106%
BAT/PSES Option B and Final MACT I no price increase	4	0.7% 0.4% 9.6% 1.7%	9% 9% 106% 24%

[1] In counties where mills close.

6.3.4 Combined Cluster Rule and Proposed MACT II

EPA examined the regional impacts of final BAT/PSES, final MACT I, and proposed MACT II alternatives. Table 6-12 summarizes the regional impacts under combined Cluster Rule and MACT II requirements. The first row of the table presents the impacts of the final BAT/PSES option; the second and third rows of the table present the impacts of BAT/PSES Option B. The closures correspond to those listed in Tables 6-6 and 6-7. Under the final BAT/PSES option, EPA projects three facility closures. The unemployment rates for the three counties affected by potential mill closures would increase from 8.0 percent to 8.7 percent (an absolute increase of 0.7 percentage points), from 4.3 percent to 4.7 percent (an absolute increase of 0.4 percentage points), and from 5.9 percent to 7.0 percent (an absolute increase of 1.1 percentage points).

EPA also examined the impacts if BAT/PSES Option B is in place at the facility. In addition to the three closures noted above, EPA projects one to two more closures under BAT/PSES Option B. The unemployment rate for the counties affected would increase from 9.0 percent to 18.6 percent (an absolute increase of 9.6 percentage points) and from 7.2 percent to 8.9 percent (an absolute increase of 1.7 percentage points).

6.4 NATIONAL-LEVEL EMPLOYMENT AND OUTPUT IMPACTS BASED ON PROJECTED CLOSURES

EPA examined national-level annual impacts on employment and output from facility closure both directly (employment and output lost at the closed facility) and indirectly (employment and output lost from outside sources that had provided goods or services to the closed facility)[4]. As described in Section 3.3.2, direct effects are impacts on the pulp and paper industry, indirect effects are impacts that continue to resonate through the economy (effects on input industries), and induced effects are impacts on consumer demand. The U.S. Department of Commerce's Bureau of Economic Analysis (BEA) tracks these effects both nationally and regionally in massive "input-output" (I-O) tables. For every dollar spent in a "spending industry," these tables identify the portion spent in contributing or vendor industries (see Section 3.3.2 for examples). Total

[4]Employment is considered in terms of “full-time-equivalents” (FTEs), that is, an FTE is equal to 2,080 hours/year.

TABLE 6-12

**INCREASE IN REGIONAL UNEMPLOYMENT RATES
CLUSTER RULE AND PROPOSED MACT II COSTS**

Options/Regulatory Alternatives	Number of Projected Closures/ Counties Affected	Absolute Increase in Unemploy-ment Rate[1]	Relative Increase in Unemploy-ment Rate
Final BAT/PSES, Final MACT I, plus all MACT II alternatives	3	0.7% 0.4% 1.1%	9% 9% 19%
BAT/PSES Option B, Final MACT I, and MACT II A through D, price increase	4	0.7% 0.4% 1.1% 9.6%	9% 9% 19% 106%
BAT/PSES Option B, Final MACT I, and MACT II E through H, price increase BAT/PSES Option B, Final MACT I, and MACT II A through H, no price increase	5	0.7% 0.4% 1.1% 9.6% 1.7%	9% 9% 19% 106% 24%

[1] In counties where mills close.

impacts, both direct and indirect, were estimated with final demand national-level input-output multipliers from the U.S. Department of Commerce's Regional Input-Output Modeling System (RIMS II) (DOC, 1996; DOC, 1992). These are presented in Table 3-6 and appear in the left-hand column in Table 6-13 and related tables.

This analysis does not include national impacts resulting from bankruptcy, discussed in Section 6.2.1 above, because EPA cannot predict whether there would be closures associated with corporate bankruptcy or which mills would close if such closures occur as a result. Thus, the impacts presented in Section 6.4 would be underestimates of regional impacts of closures where company failures result in additional mill closures.

6.4.1 CAA Requirements

There are no closures estimated for final MACT I or proposed MACT II requirements when considered independently, hence there are no direct or indirect impacts estimated for these requirements. Table 6-13 summarizes the RIMS II-derived direct and indirect impacts of combined final MACT I and proposed MACT II requirements. MACT I costs differ according to the BAT/PSES technology in place at the facility. Assuming final BAT/PSES technology (100 percent substitution) in place at each mill, the combination of final MACT I and proposed MACT II costs result in 1 to 2 facility closures, depending on the MACT II alternative selected and whether a price increase is assumed. The total (direct and indirect) reduction in output resulting from these closures ranges from $599 million to $1.1 billion and the total loss in employment ranges from 4,300 to 8,100 (Table 6-13, middle two columns). Under final MACT I and the proposed MACT II alternative (Alternative A), one facility is projected to close (i.e., the lower estimate of national impacts). Table 6-2 provides a more complete analysis of direct impacts alone.

Assuming BAT/PSES Option B technology is in place at each mill, the combination of final MACT I and proposed MACT II costs result in an additional mill closure under MACT II Alternatives G through H with no price increase. Table 6-13 (right-hand columns) lists these closures and estimated direct impacts. Total direct and indirect impacts under BAT/PSES Option B range from $599 million to $1.6 billion in lost output and 4,300 to 11,200 in lost employment.

TABLE 6-13

DIRECT AND INDIRECT IMPACTS
MACT I AND MACT II ALTERNATIVE COSTS
ALL SUBCATEGORIES

	Final BAT/PSES in Place		BAT/PSES Option B in Place		
	MACT I** MACT II ALTERNATIVES A-F, no price increase ALTERNATIVES A-H, price increase	MACT I MACT II ALTERNATIVES G-H, no price increase	MACT I MACT II ALTERNATIVES A-F, no price increase ALTERNATIVES A-F, price increase	MACT I MACT II ALTERNATIVES G-H, price increase	MACT I MACT II ALTERNATIVES G-H, no price increase
Direct Impacts					
Closures	1	2	1	2	3
Loss in Shipments (millions, $1995)					
pulp	$0	$0	$0	$0	$0
paper	$206	$206	$206	$206	$206
paperboard	$0	$180	$0	$148	$328
total	$206	$386	$206	$354	$535
Loss in Shipments (millions, $1992)					
pulp	$0	$0	$0	$0	$0
paper	$188	$188	$188	$188	$188
paperboard	$0	$164	$0	$135	$299
total	$188	$352	$188	$323	$487
Direct and Indirect Impacts					
Loss in Output (millions, $1995)					
pulp	$0	$0	$0	$0	$0
paper	$599	$599	$599	$599	$599
paperboard	$0	$523	$0	$430	$953
total	$599	$1,121	$599	$1,029	$1,551
Loss in Employment					
pulp	0	0	0	0	0
paper	4,304	4,304	4,304	4,304	4,304
paperboard	0	3,760	0	3,092	6,852
total	4,304	8,064	4,304	7,396	11,156

* Multiplier for loss in employment is FTEs per million dollars.
** MACT I costs differ according to BAT/PSES technology in place at facility.

Notes: Employment multipliers are based on 1992 data, hence the loss in output needs to be in 1992 dollars.
Supporting computer printout is located in Section 27.4 "Cost and Impact Results" in the confidential portion of the Pulp and Paper Water Docket.

6.4.2 CWA Requirements

Total direct and indirect employment and output impacts estimated for CWA requirements are presented in Table 6-14 for both the final BAT/PSES and BAT/PSES Option B. The closures in Table 6-14 correspond to those listed in Table 6-4; the latter table describes direct impacts alone in more detail. The final BAT/PSES option alone, without accounting for final MACT I requirements, results in the closure of one facility, with estimated total losses of $430 million in output and 3,100 in direct and indirect FTEs.

EPA also examined the total impacts estimated for BAT/PSES Option B. The impacts on total employment and output are almost double those estimated for the final BAT/PSES option. Under BAT/PSES Option B, EPA projects two facility closures. Total annual output is reduced by $795 million and total employment is reduced by 5,700 FTEs.

6.4.3 Combined Final CAA (MACT I) and CWA (BAT/PSES) Requirements (Cluster Rule)

Total direct and indirect employment and output impacts estimated for Cluster Rule requirements are presented in Table 6-15 for both the final BAT/PSES and BAT/PSES Option B. The closures correspond to those listed in Table 6-5, which presents a more complete analysis of direct impacts alone. The final Cluster Rule option results in the closure of two facilities. The estimated total direct and indirect losses are $795 million in output and 5,700 FTEs.

EPA also examined the total impacts estimated for BAT/PSES Option B and final MACT I costs. In addition to the two facility closures projected under the final Cluster Rule option, EPA projects one to two more mill closures under BAT/PSES Option B, depending upon the assumption of a price increase (one mill closure with a price increase, two mill closures without a price increase). The total reduction in output estimated for BAT/PSES Option B and final MACT I ranges from $1.4 billion to $3.9 billion, while the total reduction in FTEs ranges from 9,900 to 27,700.

TABLE 6-14

DIRECT AND INDIRECT IMPACTS
BAT/PSES COSTS
BLEACHED PAPERGRADE KRAFT AND SODA AND PAPERGRADE SULFITE SUBCATEGORIES

	Final BAT/PSES	BAT/PSES Option B
Direct Impacts		
Closures	1	2
Loss in Shipments (millions, $1995)		
Total	$150	$273
Loss in Shipments (millions, $1992)		
Total	$135	$249
Direct and Indirect Impacts		
Loss in Output (millions, $1995)		
Total	$430	$795
Loss in Employment		
Total	3,094	5,711

* Multiplier for loss in employment is FTEs per million dollars.

Notes: Employment multipliers are based on 1992 data, hence the loss in output needs to be in 1992 dollars.
Supporting computer printout is located in Section 27.4 "Cost and Impact Results" in the confidential portion of the Pulp and Paper Water Docket.

TABLE 6-15

DIRECT AND INDIRECT IMPACTS
FINAL BAT/PSES AND FINAL MACT I COSTS
BLEACHED PAPERGRADE KRAFT AND SODA AND PAPERGRADE SULFITE SUBCATEGORIES

	Final BAT/PSES no price increase Final BAT/PSES price increase	BAT/PSES Option B price increase	BAT/PSES Option B no price increase
Direct Impacts			
Closures	2	3	4
Loss in Shipments (millions, $1995)			
pulp	$27	nd	$28
paper	$98	nd	$1,150
paperboard	$148	nd	$148
total	$273	nd	$1,327
Loss in Shipments (millions, $1992)			
pulp	$25	nd	$26
paper	$89	nd	$1,048
paperboard	$135	nd	$135
total	$249	nd	$1,209
Direct and Indirect Impacts			
Loss in Output (millions, $1995)			
pulp	$80	nd	$85
paper	$284	nd	$3,337
paperboard	$430	nd	$430
total	$795	$1,376	$3,852
Loss in Employment			
pulp	571	nd	601
paper	2,046	nd	23,999
paperboard	3,094	nd	3,094
total	5,711	9,887	27,695

* Multiplier for loss in employment is FTEs per million dollars.
'nd' not disclosed due to confidentiality

Notes: Employment multipliers are based on 1992 data, hence the loss in output needs to be in 1992 dollars.
Supporting computer printout is located in Section 27.4 "Cost and Impact Results" in the confidential portion of the Pulp and Paper Water Docket.

6.4.4 Combined Cluster Rule and Proposed MACT II

EPA examined the national-level impacts of final BAT/PSES, final MACT I, and proposed MACT II alternatives. Table 6-16 presents the total direct and indirect impacts estimated for combined Cluster Rule and MACT II alternative costs for both the final BAT/PSES and BAT/PSES Option B. The closures correspond to those listed in Tables 6-6 and 6-7, which present a more complete analysis of direct impacts alone. The final Cluster Rule option combined with any MACT II alternative results in the closure of three facilities. The estimated total direct and indirect losses are $1.4 billion in output and 10,000 FTEs annually.

EPA also examined the total impacts estimated for BAT/PSES Option B and final MACT I costs combined with MACT II alternatives. In addition to the three facility closures projected under the final Cluster Rule option combined with MACT II alternatives, EPA projects one to two more mill closures when MACT II alternatives are combined with BAT/PSES Option B. The total reduction in output estimated for BAT/PSES Option B and final MACT I combined with MACT II alternatives ranges from $2.0 billion to $4.5 billion, while the total reduction in employment ranges from 14,200 to 32,000.

6.5 SENSITIVITY ANALYSES

EPA performed four types of analyses to test the sensitivity of closures occurring under the Cluster Rule:

- company-specific vs. OMB-approved (7 percent real) discount rates,
- delayed implementation of air and water pollution control compliance costs (e.g., grace periods) and savings (discounted costs) which may accrue during those periods, and
- increased pulp costs for non-integrated mills (i.e., mills with only papermaking operations).
- TCF retrofit costs for the bleached papergrade kraft and soda subcategory

TABLE 6-16

DIRECT AND INDIRECT IMPACTS
FINAL BAT/PSES, FINAL MACT I, AND PROPOSED MACT II COSTS
BLEACHED PAPERGRADE KRAFT AND SODA AND PAPERGRADE SULFITE SUBCATEGORIES

	Final BAT/PSES MACT II A-H no price increase Final BAT/PSES MACT II A-H price increase	BAT/PSES Option B MACT II A-D price increase	BAT/PSES Option B MACT II A-H no price increase BAT/PSES Option B MACT II E-H price increase
Direct Impacts			
Closures	3	4	5
Loss in Shipments (millions, $1995)			
pulp	$27	$27	$28
paper	$304	$504	$1,356
paperboard	$148	$148	$148
total	$479	$679	$1,533
Loss in Shipments (millions, $1992)			
pulp	$25	$25	$26
paper	$277	$459	$1,236
paperboard	$135	$135	$135
total	$437	$619	$1,397
Direct and Indirect Impacts			
Loss in Output (millions, $1995)			
pulp	$80	$80	$85
paper	$882	$1,463	$3,935
paperboard	$430	$430	$430
total	$1,393	$1,974	$4,450
Loss in Employment			
pulp	571	571	601
paper	6,344	10,520	28,298
paperboard	3,094	3,094	3,094
total	$10,010	14,185	31,993

* Multiplier for loss in employment is FTEs per million dollars.

Notes: Employment multipliers are based on 1992 data, hence the loss in output needs to be in 1992 dollars.
Supporting computer printout is located in Section 27.4 "Cost and Impact Results" in the confidential portion of the Pulp and Paper Water Docket.

6.5.1 Discount Rate Analysis

EPA examined the sensitivity of closures in the bleached papergrade kraft and soda and papergrade sulfite subcategories to different discount rates. EPA used two different measures: (1) OMB-recommended 7 percent real discount rate (OMB, 1992) and (2) company-specific discount rates supplied in the survey and modified to reflect the 19 percent decline in the prime rate and corporate bond rates from 1989 to 1995 from 10.87 to 8.83 percent and from 10.18 to 8.20 percent, respectively.[5]

Table 6-17 summarizes costs, closures, and related impacts resulting from both types of discount rates for both the final BAT/PSES and BAT/PSES Option B combined with final MACT I and the proposed MACT II alternative. The discount rate makes no difference in the number of closures when no price increase is assumed. The final BAT/PSES/MACT I/MACT II A option results in three closures, with an estimated reduction of $479 million in shipments, $22 million in exports, and 1,700 in employment. The BAT/PSES Option B/MACT I/ MACT II A option results in five closures, with an estimated reduction of $1.5 billion in shipments, $27 million in exports, and 5,600 FTEs annually.

With a price increase, impacts differ under each discount rate scenario. Under the final BAT/PSES/MACT I/MACT II A option, the number of closures remains at 3 with the 7 percent discount rate, but drops to 2 with the company-specific discount rate. The related impacts drop accordingly with losses of $273 million in shipments, $19 million in exports, and 900 FTEs annually.

Under the BAT/PSES Option B/MACT I/ MACT II A option, four mills close when a price increase is assumed. However, a different set of mills closes with each discount rate. With the 7 percent discount rate, the four closures result in related losses of $679 million in shipments, $25 million in exports, and 2,500 in employment. With the company-specific discount rate, the four closures result in related losses of $1.3 billion in shipments, $24 million in exports, and 4,800 FTEs annually.

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[5]The discount rates submitted with the EPA survey (EPA, 1991) reflected each company's mix of debt and equity as well as rates for each of them. EPA did not request, nor did the companies supply, more detailed information on the relative proportions of debt and equity. Where a facility did not submit a discount rate in the survey, EPA annualized the costs using the industry average discount rate, see the EIA for proposal, Section 2.7 (EPA, 1993). For the sensitivity analysis, EPA assumes that the mix of debt and equity reflected in the survey data remained the same from 1989 to 1995. These company-specific rates were decreased by 19 percent for the sensitivity analysis.

TABLE 6-17

SUMMARY OF COSTS, CLOSURES, AND RELATED IMPACTS FOR 7% REAL DISCOUNT RATE AND COMPANY-SPECIFIC DISCOUNT RATES--BLEACHED PAPERGRADE KRAFT AND SODA AND PAPERGRADE SULFITE SUBCATEGORIES
1995 DOLLARS
FINAL BAT/PSES, FINAL MACT I, AND PROPOSED MACT II ALTERNATIVE A,B COSTS

		7% REAL DISCOUNT RATE		COMPANY-SPECIFIC DISCOUNT RATE	
		MACT II A,B		MACT II A,B	
		MACT I Final BAT/PSES	MACT I BAT/PSES Option B	MACT I Final BAT/PSES	MACT I BAT/PSES Option B
Costs (thousands, $1995)					
Capital Cost		$1,524,091	$2,824,369	$1,524,091	$2,824,369
O&M Expense		$212,374	$164,214	$212,374	$164,214
Post-tax Annualized Cost		$240,275	$314,250	$251,275	$338,636
Pre-tax Annualized Cost		$366,095	$457,307	$377,773	$482,878
No Price Increase					
Closures		3	5	3	5
Shipments	(millions)				
pulp	$6,288	$27	$28	$27	$28
paper	$20,202	$304	$1,356	$304	$1,356
paperboard	$6,145	$148	$148	$148	$148
total	$32,635	$479	$1,533	$479	$1,533
Exports	(millions)				
pulp	$2,715	$0	$0	$0	$0
paper	$298	$3	$7	$3	$7
paperboard	$758	$19	$19	$19	$19
total	$3,771	$22	$27	$22	$27
Employment					
	90,840	1,700	5,600	1,700	5,600
	(millions)				
Revenues	$33,013	$486	$1,546	$486	$1,546
Price Increase					
Closures		3	4	2	4
Shipments	(millions)				
pulp	$6,288	$27	$27	$27	$28
paper	$20,202	$304	$504	$98	$1,150
paperboard	$6,145	$148	$148	$148	$148
total	$32,635	$479	$679	$273	$1,327
Exports	(millions)				
pulp	$2,715	$0	$0	$0	$0
paper	$298	$3	$6	$0	$4
paperboard	$758	$19	$19	$19	$19
total	$3,771	$22	$25	$19	$24
Employment					
	90,840	1,700	2,500	900	4,800
	(millions)				
Revenues	$33,013	$486	$689	$278	$1,338

Notes: Employment rounded to nearest hundred.
Supporting computer printout is located in Section 27.4 "Cost and Impact Results" in the confidential portion of the Pulp and Paper Water Docket.

6.5.2 Delayed Implementation Compliance Schedule

EPA also examined the sensitivity of closures in the bleached papergrade kraft and soda and papergrade sulfite subcategories to different compliance implementation schedules. EPA used the same closure model and adjusted the costs for each mill according to the scenario investigated. EPA evaluated:

- 1996 start year for costs (original analysis)
- 1999 start year for costs (3-year delay, without discounting costs)
- 1999 start year for costs (3-year delay, discounting costs)
- 2001 start year for costs (5-year delay, without discounting costs)
- 2001 start year for costs (5-year delay, discounting costs)

To model interim potential savings to industry during the grace period, EPA discounted the present value of total costs by the 7 percent real discount rate to represent the time value of money. That is, EPA calculates the cost in the closure analysis (see Chapter Three) as:

$$\textit{present value of costs} = \textit{present value of costs} * \frac{1}{(1+K)^n}$$

where:

K = discount rate (7 percent)
n = number of years in grace period

For a 3-year grace period, the present value of costs will be 82 percent of the present value of costs for immediate implementation. For a 5-year grace period, the present value of costs will be 71 percent of the present value of costs for immediate implementation. If a company chooses to delay implementation costs, it could invest the money during the delay period at the discount rate assumed in the analysis (i.e., savings) or use it for other purposes (i.e., its value is the opportunity cost of that money).

Tables 6-18A and B summarize the results of the analysis for the bleached papergrade kraft and soda and papergrade sulfite subcategories. In general, a three-year grace period resulted in more severe impacts because the costs began during a projected downturn in the industry cycle. Cost savings, if assumed, mitigate the severity of the incurred impacts. (Cost savings are represented through discounting). During an industry downturn, however, cost savings may be less important to a company than meeting short-term obligations. For example, a company may pay the current portion of long-term debt rather than save the money or invest it elsewhere in the company.

A five-year grace period—assuming the company does not save the funds that would otherwise need to be spent on pollution control—generally had an indeterminate impact on closures for the bleached papergrade kraft and soda and papergrade sulfite subcategories (Table 6-18). In general, the number of closures is similar to the original analysis. Under a five-year grace period, no interim savings and no price increase, no change is seen from the original analysis (Table 6-18A). The five-year grace period with a savings assumption is the only scenario that generally shows smaller impacts than the original analysis. The number of closures with the final BAT/PSES and final MACT I costs combined with the proposed MACT II alternative (A) drops from 3 to 2. EPA still projects 3 mills to close with BAT/PSES Option B and final MACT I costs combined with the proposed MACT II alternative (A).

6.5.3 Increased Pulp Costs to Non-integrated Mills

Section 6.2.2 presents the closure analysis for Cluster Rule mills under two assumptions, with and without a price increase. If prices do not increase for market pulp, then there will be no impacts from the rule on non-integrated mills, i.e., those with only papermaking operations. EPA performed a sensitivity analysis to evaluate the potential impacts of higher market pulp prices on non-integrated mills. The analysis incorporated several conservative assumptions:

- The analysis incorporated price increase percentages for the bleached papergrade kraft and soda clustered alternatives because they were higher than those for papergrade sulfite.
- The only cost for the mill is market pulp.
- Price increases were not reduced by the tax shield on O&M costs.

TABLE 6-18A

SUMMARY OF CLOSURES
BLEACHED PAPERGRADE KRAFT AND SODA AND PAPERGRADE SULFITE SUBCATEGORIES
NO PRICE INCREASE

Year of Implementation	BAT/PSES Only		BAT/PSES and MACT I		Final BAT/PSES				BAT/PSES Option B			
	Final	Option B	Final	Option B	MACT II A,B	MACT II C,D	MACT II E,F	MACT II G,H	MACT II A,B	MACT II C,D	MACT II E,F	MACT II G,H
1996	1	2	2	4	3	3	3	3	5	5	5	5
1999	2	4	3	4	3	3	3	3	4	4	4	4
1999 w/ savings	2	2	2	4	2	2	2	2	4	4	4	4
2001	1	2	2	4	3	3	3	3	5	5	5	5
2001 w/ savings	1	1	1	2	2	2	2	2	3	3	3	3

TABLE 6-18B

SUMMARY OF CLOSURES
BLEACHED PAPERGRADE KRAFT AND SODA AND PAPERGRADE SULFITE SUBCATEGORIES
WITH PRICE INCREASE

Year of Implementation	BAT/PSES Only		BAT/PSES and MACT I		Final BAT/PSES				BAT/PSES Option B			
	Final	Option B	Final	Option B	MACT II A,B	MACT II C,D	MACT II E,F	MACT II G,H	MACT II A,B	MACT II C,D	MACT II E,F	MACT II G,H
1996	1	2	2	3	3	3	3	3	4	4	5	5
1999	2	4	2	4	2	2	3	3	4	4	4	4
1999 w/ savings	2	2	2	4	2	2	2	2	4	4	4	4
2001	1	2	1	4	2	2	2	3	5	5	5	5
2001 w/ savings	1	1	1	2	1	1	1	1	2	2	2	2

Note: Supporting computer printout is located in Section 27.4 "Cost and Impact Results" in the confidential portion of the Pulp and Paper Water Docket.

In reality, the overall percentage increase in a mill's costs would be lower because pulp is only one of several cost components (such as labor and chemicals), and the tax shield on operating costs offset the increased pulp prices. EPA reduced the present value of forecasted earnings for each mill by the percentage price increase for each Cluster Rule alternative (e.g., from 1.5 to 1.9 percent, see Section 6.2.3.3). No incremental closures resulted from the reduced earnings. In sum, the impacts presented in Section 6.2 are a fair and complete representation of the industry-wide impacts resulting from increased pollution control costs estimated for MACT and BAT/PSES requirements.

6.5.4 Sensitivity Analysis of Impacts from TCF Costs

Table 5-18 in Section 5.3.2 compares the costs for BAT/PSES Option B with those for retrofitting bleached papergrade kraft and soda mills with TCF technology. Table 6-19 summarizes the impacts. When BAT/PSES costs only are considered, 7 mills are projected to close under TCF requirements compared with 2 mills projected to close under BAT/PSES Option B requirements (i.e., 3.5 times the number of mills). The losses in shipments, employment, and revenues, however, are about 8 times higher under TCF than under BAT/PSES Option B. The loss in exports is more than 16 times higher under TCF than under BAT/PSES Option B.

When air pollution controls are included, 4 mills are projected to close under BAT/PSES Option B while 9 mills are projected to close under TCF. The losses in shipments, employment, and revenues are more than twice as large under TCF as they are under BAT/PSES Option B. The loss in exports is approximately 13 times as large under TCF as they are under BAT/PSES Option B.

When price increases are included, 7 mills are projected to close under BAT/PSES TCF costs and under BAT/PSES/MACT I TCF costs. The losses in shipments, exports, and employment are the same as those under BAT/PSES TCF costs without a price increase.

TABLE 6-19

SUMMARY OF CLOSURES AND RELATED IMPACTS -- BAT/PSES COSTS
BLEACHED PAPERGRADE KRAFT AND SODA SUBCATEGORY
MILLIONS OF 1995 DOLLARS

			ECF: Option B			TCF	
	Baseline	BAT/PSES	BAT/PSES MACT I	BAT/PSES MACT I MACT II A,B	BAT/PSES	BAT/PSES MACT I	BAT/PSES MACT I MACT II A,B
No Price Increase							
Closures		2	4	nd	7	9	9
Shipments	(millions)						
pulp	$6,288	$27	$28	nd	$535	$619	$619
paper	$20,202	$98	$1,150	nd	$1,619	$2,417	$2,417
paperboard	$6,145	$148	$148	nd	$148	$148	$148
total	$32,635	$273	$1,327	nd	$2,302	$3,184	$3,184
Exports	(millions)						
pulp	$2,715	$0	$0	nd	$278	$278	$278
paper	$298	$0	$4	nd	$11	$12	$12
paperboard	$3,013	$19	$19	nd	$19	$19	$19
total	$6,026	$19	$24	nd	$308	$310	$310
Employment							
	90,840	900	4,800	nd	7,100	10,200	10,200
	(millions)						
Revenues	$33,013	$278	$1,338	nd	$2,329	$3,211	$3,211
Price Increase							
Closures		2	3	3	7	7	7
Shipments	(millions)						
pulp	$6,288	$27	nd	nd	$535	$535	$535
paper	$20,202	$98	nd	nd	$1,619	$1,619	$1,619
paperboard	$6,145	$148	nd	nd	$148	$148	$148
total	$32,635	$273	nd	nd	$2,302	$2,302	$2,302
Exports	(millions)						
pulp	$2,715	$0	nd	nd	$278	$278	$278
paper	$298	$0	nd	nd	$11	$11	$11
paperboard	$3,013	$19	nd	nd	$19	$19	$19
total	$6,026	$19	nd	nd	$308	$308	$308
Employment							
	90,840	900	nd	nd	7,100	7,100	7,100
	(millions)						
Revenues	$33,013	$278	nd	nd	$2,329	$2,329	$2,329

'nd' not disclosed due to confidentiality

Notes: Employment rounded to nearest hundred.
Supporting computer printout is located in Section 27.4 "Cost and Impact Results" in the confidential portion of the Pulp and Paper Water Docket.

6.6 REFERENCES

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CHAPTER 7

REGULATORY FLEXIBILITY ANALYSIS AND UNFUNDED MANDATES REFORM ACT

This chapter examines the projected effects of the costs of the Cluster Rule on small entities as required by the Regulatory Flexibility Act (RFA, 5 U.S.C. 601 et seq., Public Law 96-354) as amended by the Small Business Regulatory Enforcement Fairness Act of 1996 (SBREFA, Public Law 104-121). The purpose of this legislation is to ensure, if possible, that agencies identify and consider ways of tailoring regulations to the size of regulated entities to minimize any rule's significant economic impact on a substantial number of small entities. The potential impacts from final MACT I, proposed MACT II, and final BAT/PSES are examined in Section 7.1. Section 7.2 discusses the requirements of and EPA's compliance with the Unfunded Mandates Reform Act.

The RFA and SBREFA both define a "small business" as having the same meaning as the term "small business concern" under Section 3 of the Small Business Act (unless an alternative definition has been approved). The U.S. Small Business Administration issues definitions of "small businesses" in 13 CFR 121. Businesses directly affected by the clustered rules fall into SIC codes 2611, 2621, and 2631 for which the small business maximum size standard is 750 employees. The analysis, then, focuses on companies (not facilities) with fewer than 750 employees.

7.1 IMPACTS FROM AIR AND WATER POLLUTION CONTROL REQUIREMENTS

The industry profile identified 11 companies in the kraft, soda, sulfite, and semichemical subcategories subject to final MACT I and proposed MACT II requirements with fewer than 750 employees. Four of these companies are subject to the final MACT I, proposed MACT II, and final BAT/PSES requirements. EPA examined economic impacts on the 11 small entities in three ways:

- Closures
- Altman's Z (bankruptcy analysis)
- Compliance costs as a percentage of annual sales

7.1.1 Closures

Among these small firms, there are no closures under:

- final MACT I-only
- proposed MACT II-only
- combined final MACT I and any proposed MACT II alternative
- final BAT/PSES

Among these small businesses, there is one closure under each of the following cost combinations:

- Option B
- final BAT/PSES and final MACT I
- final BAT/PSES, final MACT I, and any proposed MACT II alternative
- Option B and final MACT I
- Option B, final MACT I, and any proposed MACT II alternative.

7.1.2 Bankruptcy Analysis (Altman's Z)

Because the Altman's Z analysis was restricted to 1995 data for public companies, only one small business was included in the data set. That business does not move into the "bankruptcy likely" category under any cost combination—final MACT I-only, proposed MACT II-only, combined final MACT I/proposed MACT II, final BAT/PSES, Option B, final BAT/PSES and final MACT I, Option B and final

MACT I, final BAT/PSES and final MACT I plus any proposed MACT II alternative, and Option B and final MACT I plus any proposed MACT II alternative.

7.1.3 Compliance Costs as a Percentage of Annual Sales

EPA compared the pre-tax annualized compliance cost (in 1989 dollars) to the 1989 net sales for the small businesses to determine whether such cost exceeds either 1 percent or 3 percent of sales. EPA, 1997 provides interim guidance for implementing SBREFA and related provision of the RFA. The annualized compliance cost as a percentage of sales (EPA, 1997, Table 1, B.1 "Sales Test") is the preferred qualitative criteria for evaluating the economic impact of a rule on small businesses. No small business fails either the 1 percent or the 3 percent test under final MACT I costs, any proposed MACT II alternative costs, or combined final MACT I and the proposed MACT II alternative (Alternative A).

One small business fails the 1 percent test under either final BAT/PSES or Option B. No small business, however, fails the 3 percent test under final BAT/PSES or Option B costs.

One small business fails the 1 percent test under either final BAT/PSES and final MACT I, or Option B and final MACT I costs. No small business fails the 3 percent test under final BAT/PSES and final MACT I. One small business fails the 3 percent test under Option B and final MACT I.

Table 7-1 shows the results of the one and three percent of sales tests for the four small businesses that incur costs for combined BAT/PSES, final MACT I and proposed MACT II costs. Two to three small companies are affected at the one percent of sales level when costs are considered on a pre-tax basis. When the basis is changed to post-tax costs, only one company is affected. One business is affected at the three percent level on a pre-tax basis but only with Option B/MACT I/MACT II costs. It is not affected when costs are considered on a post-tax basis. Because MACT II is only proposed at this time, these are not impacts of the final Cluster Rule.

The analyses indicate that none of the regulatory requirements, either singly or in combination, significantly impact a substantial number of small entities in the pulp and paper industry. Because there are

TABLE 7-1

NUMBER OF SMALL BUSINESSES ADVERSELY AFFECTED BY REGULATORY COMPLIANCE COSTS BAT/PSES, FINAL MACT I, AND PROPOSED MACT II ALTERNATIVES

	FINAL BAT/PSES FINAL MACT I				OPTION B FINAL MACT I			
	MACT II A,B	MACT II C,D	MACT II E,F	MACT II G,H	MACT II A,B	MACT II C,D	MACT II E,F	MACT II G,H
1% of Annual Sales Test								
Pre-tax Annualized Costs	2	2	2	2	2	2	3	3
Post-tax Annualized costs	1	1	1	1	1	1	1	1
3% of Annual Sales Test								
Pre-tax Annualized Costs	0	0	0	0	1	1	1	1
Post-tax Annualized costs	0	0	0	0	0	0	0	0

Note: Four small entities are anticipated to incur costs of the integrated rule finalized at this time.

only 4 small businesses subject to CWA requirements under this rulemaking (11 for CAA requirements), there is not a substantial number of small entities.

7.2 UNFUNDED MANDATES

Title II of the Unfunded Mandates Reform Act of 1995 (Public Law 104-4; UMRA) establishes requirements for Federal agencies to assess the effects of their regulatory actions on State, local, and tribal governments as well as the private sector. Under Section 202(a)(1) of UMRA, EPA must generally prepare a written statement, including a cost-benefit analysis, for proposed and final regulations that "includes any Federal mandate that may result in the expenditure by State, local, and tribal governments, in the aggregate or by the private sector" of annual costs in excess of $100 million.[1] As a general matter, a federal mandate includes Federal Regulations that impose enforceable duties on State, local, and tribal governments, or on the private sector (Katzen, 1995). Significant regulatory actions require Office of Management and Budget review and the preparation of a Regulatory Impact Assessment that compares the costs and benefits of the action.

The clustered rules are not an unfunded mandate on state, local, or tribal governments because the cost of the regulation is borne by industry. EPA, however, is responsive to all required provisions of UMRA. The clustered rules are anticipated to cost the private sector in excess of $100 million/year for the time period analyzed. In particular, the Economic Analysis (EA) addresses:

- Section 202(a)(1)—authorizing legislation (see EA Chapter 1 and the preamble to the rule)
- Section 202(a)(2)—a qualitative and quantitative assessment of the anticipated costs and benefits of the regulation (see EA Chapters 4 and 8 through 10)
- Section 202(a)(3)(A)—accurate estimates of future compliance costs (as reasonably feasible; see EA Chapter 5)
- Section 202(a)(3)(B)—disproportionate effects on particular regions or segments of the private sector (see this chapter)

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[1]The $100 million in annual costs is the same threshold that identifies a "significant regulatory action" in Executive Order 12866.

- Section 202(a)(3)(B)—disproportionate effects on local communities (see Chapter 6)

- Section 202(a)(4)—estimated effects on the national economy (see EA Chapter 6)

- Section 205(a)—least burdensome option or explanation required (see this chapter)

The preamble to the final rule summarizes the extent of EPA's consultation with stakeholders including industry, environmental groups, states, local, and tribal governments. The preamble and comment response document contains responses to their comments collected during the public comment periods for the proposal and two subsequent Notices of Data Availability (UMRA, sections 202(a)(5) and 204). Because this rule does not “significantly or uniquely” affect small governments, section 203 of UMRA does not apply.

EPA estimated the reduction in property tax collection from projected mill closures and examined the impacts of the potential revenue losses at the city/town and county levels. The analysis is performed on the set of five potential Cluster Rule mills and a sixth mill that is regulated by MACT I and MACT II but not BAT/PSES for the bleached papergrade kraft and soda and papergrade sulfite subcategories. Of the six mills, financial data are available for only one city/town. While the mill closure may account for as much as one-third of the property tax collection for the city/town, it accounts for approximately 2 percent of all taxes and 1 percent of all government revenue for the city/town. At the county level, for the other five locations, reduced property tax collection from the potential mill closures are less than 4 percent of property taxes, less than 1.7 percent of all taxes, and less than 1.2 percent of all government revenue.

Pursuant to section 205(a)(1)-(2), EPA has selected the “least costly, most cost-effective or least burdensome alternative” consistent with the requirements of the CAA and CWA for the reasons discussed in the preamble to the rule. Under the CWA, EPA is required under BAT/PSES to require effluent limitations guidelines and standards based on Best Available Technology economically achievable considering factors listed in section 304 of the CWA and under NSPS/PSNS based on Best Available Demonstrated Technology considering factors listed in section 306 of the CWA. EPA determined that the rule constitutes the least burdensome alternative consistent with the CWA.

7.3 REFERENCES

Reference material supporting Chapter 7 is located in the Pulp and Paper Water Docket.

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CHAPTER 8

NATIONAL LEVEL BENEFITS RESULTS

This chapter presents the potential national level annual benefits of the final pulp and paper regulation. The benefits have been revised to reflect new information and comments received since proposal. The description of benefits generally follows the November 1993 RIA that accompanied the rule at proposal, focusing on changes since proposal. Potential annual air-related benefits are described in Section 8.1, potential water-related benefits are described in Section 8.2, and the combined estimates for air and water are presented in Section 8.3. Section 8.4 presents the results of analyses related to environmental justice, Section 8.5 presents the results of an analysis of case study representativeness and an alternative analysis of aggregate water benefits, and Section 8.6 describes potential benefits from implementation of totally chlorine free (TCF) technology. The annual benefits presented are at the levels that will be achieved when the benefits are fully realized (i.e., the maximum level where EPA expects a ramp-up or delay in benefits after compliance with the rule).

8.1 AIR BENEFITS

This section provides data on the quantified emission reductions[1] of air pollutants that will result from the implementation of MACT I and MACT II in combination with the water-related options. As noted in Chapter 5, MACT I costs and benefits differ depending on which BAT/PSES technology option is selected as the basis for setting water pollution control limits. The benefits that result from the integrated rule include both the primary impacts from application of control technologies or changes in operations and processes, and the secondary effects of the controls. Primary air impacts refer to the reduction in emissions directly attributable to the control option (i.e., the reduction of emissions due to the use of air pollution control devices or process modifications). Primary air pollutants include: particulate matter (PM), gaseous organic hazardous air pollutants (HAPs), PM HAPs, hydrochloric acid, volatile organic compounds (VOC), and total

[1]Detailed information on the method to calculate emission reductions is contained in the Background Information Document (BID) that accompanies the MACT rules (EPA, 1997a). Valuation methodology is described in Chapter 4 of this document.

reduced sulfur (TRS). The gaseous organic HAPs include HAP compounds such as acetaldehyde, benzene, formaldehyde, methanol, methyl ethyl ketone, methyl isobutyl ketone, phenol, styrene, toluene, and xylenes. The PM HAPs include HAP metals such as antimony, beryllium, cadmium, chromium, cobalt, lead, manganese, mercury, nickel, and selenium. Secondary air impacts refer to the indirect or induced impacts resulting from implementing a control option. These indirect or induced impacts result from changes in power boiler emissions of criteria pollutants such as PM, SO_2, NO_X, and CO. Some of the air pollutant reductions, therefore, are categorized as both primary and secondary impacts. The discussion below provides the net effect of both primary and secondary impacts.

Table 8-1 below shows emission reductions for MACT I and MACT II, respectively. The selection of regulatory options for the control of water pollutants affects the level of emission reductions achieved by the MACT I standard. As a result, MACT I emission reductions are delineated between Option A and Option B. The MACT II emission reductions are presented for each of the regulatory alternatives under consideration for proposal.

Not all of the emission reductions that are quantified in Table 8-1 can be monetized. Based on the methodologies discussed in Chapter 4, the following tables provide monetized benefits for VOCs, PM, and SO_2. Table 8-2 presents monetized benefits in 1995 dollars for MACT I and MACT II, respectively. As the table indicates, benefits associated with the final rule for MACT I are expected to range from negative benefits of $1,040 million to positive benefits of $1,054 million under Option A, and from ($1015) million to $1,049 million under Option B. For MACT II, air benefits of the selected alternative (A) range from $302 million to $384 million per year.

Combining the benefits of MACT I with the selected option for MACT II in Table 8-3 yields total monetized air benefits (disbenefits) of the final rule ranging from ($739) million to $1,438 million under the BAT/PSES Option A and from ($713) million to $1,433 million when considered with BAT/PSES Option B.

TABLE 8-1

AIR POLLUTANT EMISSION REDUCTIONS FOR MACT I AND MACT II (Mg/Yr)

	HAPs	VOCs (Total)	VOCs (Selected Areas)	PM	TRS	CO	NO_x	SO_2 East	SO_2 West	SO_2 Total
MACT I with:										
Option A	139,300	409,000	42,220	(83)	78,900	(8,660)	(5,230)	(78,500)	(16,000)	(94,500)
Option B	138,400	407,000	50,500	(84)	78,900	(8,610)	(3,200)	(77,000)	(15,600)	(92,600)
MACT II Alternatives:										
A	2,556	32,600	3,365	23,760	0	57,729	(466)	25	5	30
B	2,556	32,600	3,365	24,201	0	57,728	(466)	24	5	29
C	7,000	37,045	3,824	23,737	644	56,738	(511)	(422)	(86)	(508)
D	7,001	37,045	3,824	24,178	644	57,644	(511)	(422)	(87)	(509)
E	18,893	48,937	5,051	24,624	3,680	57,975	(337)	314	64	378
F	18,893	48,937	5,051	25,064	3,680	57,974	(210)	313	64	377
G	18,990	48,937	5,051	43,899	3,680	57,863	(396)	29,751	6,093	35,844
H	18,990	48,937	5,051	44,340	3,680	57,862	(396)	29,751	6,093	35,844

Note: Emission increases shown in parentheses.

TABLE 8-2

TOTAL MONETIZED AIR BENEFITS OF MACT I AND MACT II
(Millions of 1995 Dollars per Year)

	VOCs		PM	SO2 - East		SO2 - West		Total Value	
	Low	High		Low	High	Low	High	Low	High
MACT I with:									
Option A:	$24.1	$1,055.2	($1.0)	($985.2)	$0.0	($78.3)	$0.0	($1,040.4)	$1,054.2
Option B:	$28.8	$1,050.1	($1.1)	($966.4)	$0.0	($76.3)	$0.0	($1,014.9)	$1,049.0
MACT II Alternatives:									
A	$1.9	$84.1	$299.8	$0.1	$0.3	$0.0	$0.0	$301.9	$384.3
B	$1.9	$84.1	$305.4	$0.1	$0.3	$0.0	$0.0	$307.5	$389.8
C	$2.2	$95.6	$299.5	($5.3)	($2.4)	($0.4)	($0.4)	$296.0	$392.4
D	$2.2	$95.6	$305.1	($5.3)	($2.4)	($0.4)	($0.4)	$301.6	$397.9
E	$2.9	$126.3	$310.7	$1.8	$3.9	$0.3	$0.3	$315.7	$441.2
F	$2.9	$126.3	$316.3	$1.8	$3.9	$0.3	$0.3	$321.2	$446.8
G	$2.9	$126.3	$554.0	$168.6	$373.4	$25.0	$29.8	$750.4	$1,083.4
H	$2.9	$126.3	$559.5	$168.6	$373.4	$25.0	$29.8	$756.0	$1,089.0

TABLE 8-3

TOTAL MONETIZED AIR BENEFITS: MACT I AND MACT II COMBINED
(Millions of 1995 Dollars)

MACT II Alternatives:	MACT I with OW Option A		MACT I with OW Option B	
	Low Estimate	High Estimate	Low Estimate	High Estimate
A	($738.5)	$1,438.4	($713.0)	$1,433.3
B	($732.9)	$1,444.0	($707.4)	$1,438.8
C	($744.4)	$1,446.5	($718.9)	$1,441.4
D	($738.8)	$1,452.1	($713.3)	$1,446.9
E	($724.7)	$1,495.4	($699.2)	$1,490.2
F	($719.2)	$1,501.0	($693.7)	$1,495.8
G	($289.9)	$2,137.6	($264.4)	$2,132.4
H	($284.4)	$2,143.1	($258.9)	$2,138.0

8.2 WATER BENEFITS

For the proposed rule, EPA described the potential water related-benefits of the regulation both qualitatively and quantitatively. The qualitative assessment has not changed for the final rule and is not repeated here. Revised quantitative estimates of annual benefits expected from the rules are presented below.

8.2.1 Revisions to Quantitative Benefits

The water-related benefits that have been quantified at the national level are those that result from compliance with ambient water quality concentrations and human health standards, as well as national recreational angling benefits.

8.2.1.1 Compliance with Ambient Water Quality Concentrations

EPA compared the modeled in-stream pollutant concentrations to aquatic life and human health water quality criteria or other toxic effect values referred to as aquatic life and health-based ambient water quality concentrations (AWQCs). Exceedences of AWQCs indicate the potential of aquatic life or human health water quality problems. EPA quantified the reduction in exceedences of contaminant-specific AWQCs that would be attributable to the final regulation, but did not monetize these benefits because at present EPA is not able to translate exceedences into specific aquatic life impacts or types and durations of illness, and can therefore not monetize such effects.

Aquatic Life Benefits

EPA used the simple dilution approach to estimate exceedences of aquatic life AWQCs. This is a conservative approach that assumes all pollutants (including dioxin and furan) discharged to receiving streams are available to the biota. This analysis is also conservative because it uses one-half of the detection limit to estimate pollutant discharge loadings for all non-detectable congeners. Although hydrophobic chemicals such as dioxin and furan will be associated primarily with sediments, some residual concentrations will be found in the water column near the discharge point. This is particularly true if discharges are assumed to be continuous because even though the pollutants might become associated with suspended solids and sediment, they will also always be present in the water column in the vicinity of the discharge. Therefore, although it is conservative, EPA believes that the simple dilution approach provides a reasonable estimate of impacts to aquatic life.

EPA estimated that, under baseline conditions, none of the acute aquatic life AWQCs are exceeded at potentially regulated mills, and that chronic aquatic life AWQCs are exceeded at 19 mills. EPA also estimated that the number of exceedences would be reduced to six with the implementation of Option A, and to three with the implementation of Option B. All of the exceedences remaining after implementation are associated with 2,3,7,8,-TCDD.

Human Health Benefits

For the final rule, EPA used the simple dilution model to predict water column concentrations of human health contaminants, except dioxin and furan. EPA compared the modeled in-stream pollutant concentrations to human health water quality criteria or other toxic effect values referred to as health-based AWQCs. EPA has analyzed the health-based AWQCs for the ingestion of organisms and the ingestion of water and organisms. EPA estimates that, for ingestion of organisms only, no mills exceed the health-based AWQCs under baseline conditions or under the final rule. With respect to the ingestion of water and organisms, at baseline, three mills exceed AWQCs for two pollutants, chloroform and pentachlorophenol (a total of four exceedences). Under the rule, only one mill would exceed AWQCs and only for pentachlorophenol. These analyses are based on the conservative assumption that non-detectable pollutant discharges are represented as one-half of the EPA-designated detection limit.

For the final rule, EPA used the Dioxin Reassessment Evaluation (DRE) model to predict fish tissue concentrations of dioxin and furan in order to estimate cancer and non-cancer human health risks from these contaminants. This DRE analysis was used instead of the simple dilution approach because dioxin and furan are known to be hydrophobic and settle out of the water column into sediments.

8.2.1.2 Human Health Risk Assessment

EPA estimated the cancer and non-cancer human health risk reductions associated with the final regulation. To reflect differences in fish tissue consumption rates, EPA estimated individual lifetime risks and risk reductions for recreational, subsistence, and Native American anglers. In addition, EPA estimated the national-level benefits attributable to the final rule as a result of reductions in risks to recreational and subsistence anglers.

EPA only evaluated the human health benefits derived from reduced contaminant concentrations in fish caught by recreational/subsistence anglers. Commercially captured fish were not evaluated. Very few pulp mills discharge to commercial fisheries. Additionally, because commercially captured fish are distributed widely throughout a region or even the country, non-angling consumers eat fish taken from a wide variety of water bodies, contaminated and uncontaminated. Therefore, consumers of commercially captured fish taken from pulp and paper mill receiving streams will also consume a large portion of fish taken from uncontaminated receiving streams and ocean waters. They do not restrict their diet primarily to fish taken from a single water body. The levels of contaminants in fish taken from pulp and paper mill receiving streams will, therefore, be diluted by the consumption of uncontaminated fish, thereby reducing risk to consumers of commercially captured fish. Recreational/subsistence anglers on the other hand can reasonably be expected to regularly use the same receiving stream for their fishing activities. These individuals, therefore, would be regularly exposed to contaminants found in that receiving stream and would be at the greatest risk.

Cancer Risk Reductions

EPA based the cancer risk reductions on estimates of fish tissue concentrations of five carcinogens: chloroform; pentachlorophenol; 2,3,7,8-TCDD; 2,3,7,8-TCDF; and 2,4,6-trichlorophenol.

Recreational and Subsistence Angler Populations

Average individual lifetime cancer risks for recreational and subsistence angler populations at baseline and after implementation of the final regulation are shown in Table 8-4. The estimates of statistical cancer cases per year related to dioxin contamination in receiving water bodies are shown in Table 8-5. EPA estimated that for both recreational and subsistence anglers, combined implementation of Option A would eliminate between 0.73 and 2.41 statistical cancer cases per year and Option B would eliminate between 0.75 and 2.50 statistical cancer cases per year. The range in values is based on low and high estimates of the exposed population (10 percent to 33 percent of licensed anglers in adjacent counties). The estimated reduction in annual cancer cases is associated with reductions in dioxin/furan contamination. There would be no increased incidence of dioxin/furan-related cancer cases under TCF. EPA estimated that the baseline number of cancer cases per year related to all analyzed contaminants except dioxin/furan is zero.

Based on an estimated value of a statistical life of $2.5 million to $9.0 million (American Lung Association, 1995) and assuming all cancers are fatal,[2] EPA estimated that the potential human health benefits from implementation of Option A on a national basis are between $1.8 and $21.7 million per year. This estimate is for recreational and subsistence anglers and does not include nonlicensed anglers such as Native Americans with treaty-ceded fishing rights. These benefits are summarized in Table 8-6.

Native American Angler Population

Estimated average individual lifetime cancer risks for subsistence anglers in Native American populations nationwide under baseline conditions and after the implementation of Option A, Option B, and TCF are shown in Table 8-7. With the implementation of either Option A or Option B at papergrade kraft/soda facilities, EPA estimates that dioxin-related cancer risks to exposed Native American subsistence anglers nationwide would be reduced from the 10^{-4} level to the 10^{-5} level. The difference between Option A and Option B is insignificant. Under TCF, there would be no risk associated with dioxin/furan. For papergrade sulfite mills, EPA estimates that the reduction in risk to Native American subsistence anglers

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[2]All cancers may not be fatal. Also, research indicates that the value of a statistical life is lower for the population aged 65 years and older (approximately $1.9 to $6.8 million) (American Lung Association, 1995). Thus, EPA's assumptions may result in an overestimate of benefits.

TABLE 8-4

AVERAGE INDIVIDUAL LIFETIME CANCER RISKS FOR EXPOSED RECREATIONAL AND SUBSISTENCE ANGLER POPULATIONS UNDER BASELINE CONDITIONS AND BAT OPTIONS[a]

	Recreational Anglers[b]						Subsistence Anglers[c]					
	Dioxin[d]			All Other Contaminants			Dioxin[d]			All Other Contaminants		
		Options			Options			Options			Options	
Subcategory	**Baseline**	**A**	**B**	**Baseline**	**A**	**B**	**Baseline**	**A**	**B**	**Baseline**	**A**	**B**
Papergrade Kraft/Soda	6.8×10^{-5}	1.3×10^{-5}	1.0×10^{-5}	3.0×10^{-8}	6.3×10^{-9}	5.1×10^{-9}	3.6×10^{-4}	6.8×10^{-5}	5.3×10^{-5}	1.6×10^{-7}	3.4×10^{-8}	2.7×10^{-8}
Papergrade Sulfite	3.9×10^{-5}	3.5×10^{-6}	NA	4.2×10^{-9}	7.9×10^{-10}	NA	2.1×10^{-4}	1.9×10^{-5}	NA	2.2×10^{-8}	4.2×10^{-9}	NA

EPA, 1997b

[a]Does not include nonlicensed anglers such as Native American anglers with treaty-ceded fishing rights.
[b]Based on a fish tissue consumption rate of 21 g/day.
[c]Based on a fish tissue consumption rate of 48 g/day.
[d]Under TCF, there would be no risk associated with current discharges from pulp and paper mills due to dioxin/furan.

NA: not applicable.

TABLE 8-5

STATISTICAL CANCER CASES PER YEAR DUE TO DIOXIN FOR POTENTIALLY EXPOSED RECREATIONAL AND SUBSISTENCE ANGLER POPULATIONS UNDER BASELINE CONDITIONS AND BAT OPTIONS[a]

	Recreational Anglers[b]			Subsistence Anglers[c]		
		Options			Options	
Subcategory	**Baseline**	**A**	**B**	**Baseline**	**A**	**B**
Papergrade Kraft/Soda	0.59-1.94	0.08-0.26	0.06-0.19	0.18-0.62	0.02-0.08	0.02-0.06
Papergrade Sulfite	0.05-0.16	0.00-0.01	NA	0.01-0.04	0.00-0.00	NA
Total	0.64-2.10	0.08-0.27	0.06-0.20[d]	0.19-0.66	0.02-0.08	0.02-0.06[d]

EPA, 1997b

[a]Does not include nonlicensed anglers such as Native Americans with treaty-ceded fishing rights. Range is based on low and high estimates of exposed population (10% to 33% of licensed anglers in counties adjacent to receiving streams).

[b]Based on a fish tissue consumption rate of 21 g/day.

[c]Based on a fish tissue consumption rate of 48 g/day.

[d]Cancer cases associated with selected papergrade sulfite options added to cancer cases associated with papergrade kraft/soda Option B.

TABLE 8-6

POTENTIAL NATIONAL HUMAN HEALTH BENEFITS OF BAT/PSES OPTIONS TO LICENSED ANGLERS[a]

	Annual Reduction in Cancer Cases		Annual Monetized Benefits[b] (millions of 1995 dollars)	
Angler Group	**Option A**	**Option B**	**Option A**	**Option B**
Recreational Anglers	0.56-1.83	0.58-1.90	$1.4-$16.5	$1.5-$17.1
Subsistence Anglers[c]	0.17-0.58	0.17-0.60	$0.4-$5.2	$0.4-$5.4
Total	0.73-2.41	0.75-2.50	$1.8-$21.7	$1.9-$22.5

Source: EPA, 1997b

Note: Detail may not add to total due to rounding.

[a]Benefits reflect reductions in cancer risk resulting from reduced levels of 2,3,7,8-TCDD and 2,3,7,8-TCDF in fish tissue. Range is based on low and high estimates of exposed population (10% to 33% of licensed anglers in counties adjacent to receiving streams).

[b]Based on an estimated value of a statistical life of $2.5 million to $9.0 million ($1995).

[c]Does not include nonlicensed anglers such as Native Americans with treaty-ceded fishing rights.

TABLE 8-7

AVERAGE INDIVIDUAL LIFETIME CANCER RISKS DUE TO DIOXIN FOR EXPOSED NATIVE AMERICAN ANGLER POULATIONS (NATIONWIDE) UNDER BASELINE CONDITIONS AND BAT/PSES OPTIONS [a]

	Average Individual Lifetime Cancer Risk					
	Dioxin [b]			All Other Contaminants		
		Options			Options	
Subcategory	Baseline	A	B	Baseline	A	B
Papaergrade Kraft/Soda	5.3×10^{-4}	9.9×10^{-5}	7.7×10^{-5}	2.3×10^{-7}	4.9×10^{-8}	3.9×10^{-8}
Papergrade Sulfite	3.0×10^{-4}	2.8×10^{-5}	NA	3.3×10^{-8}	6.1×10^{-9}	NA

Note: a 10^{-5} risk means the risk of one cancer case out of 100,000 individuals exposed to a given level, a 10^{-6} risk means the risk of one cancer case out of 1,000,000 individuals exposed, etc.

[a] Based on modeled fish tissue levels below 92 mills and a fish tissue consumption rate of 70 g/day.

[b] Under TCF, there would be no risk associated with dioxin/furan.

NA: not applicable.

nationwide would also be from the 10^{-4} level to the 10^{-5} level. For all pollutants other than dioxin/furan, EPA estimates that baseline risks to exposed Native American subsistence anglers nationally are at the 10^{-7} level for papergrade kraft/soda mills anand at the 10^{-8} level for papergrade sulfite mills. These risks would decrease to the 10^{-8} level for papergrade kraft/soda mills and the 10^{-9} level for papergrade sulfite mills. EPA does not consider these risk levels to be of significant concern.

EPA did not have accurate estimates of the population of Native American anglers or their families nationwide who would actually be exposed to contamination from pulp and paper mills by eating fish. To estimate the maximum number of potential annual cancer cases for Native Americans, EPA considered the entire population of tribes with treaty fishing rights downstream from pulp and paper mills and assumed every tribal member would consume 70 grams/day of dioxin-contaminated fish. EPA estimates that the dioxin/furan-related cancer risks for Native American subsistence anglers with treaty-ceded fishing rights would be at the 10^{-4} level under baseline conditions, would be reduced to the 10^{-5} level under Options A and B (Table 8-8), and would be reduced to zero under TCF. EPA estimates that a maximum of approximately 23,000 Native Americans would be exposed at this level. This would represent a baseline cancer risk of 0.14 cancer cases per year, which would decline to 0.008 cases per year with Option A and 0.007 cases per year with Option B, a reduction of about 95 percent for either option. Under a totally chlorine-free option, the residual number of cancer cases per year would be 0.0.

For all pollutants other than dioxin/furan, EPA estimates that baseline risks to Native American subsistence anglers with treaty-ceded fishing rights would be reduced from the 10^{-8} level under baseline conditions to the 10^{-9} level under Options A and B.

Non-Cancer Hazard Reductions

EPA based the non-cancer hazard reductions on estimates of fish tissue concentrations of six toxicants: chloroform; pentachlorophenol; 2,3,7,8-TCDD; 2,3,7,8,-TCDF; 2,3,4,6-tetrachlorophenol; and 2,4,5-trichlorophenol. EPA did not monetize these benefits because accurate translation of risk into cases of illness, and subsequently dollars, is not possible at present.

TABLE 8-8

AVERAGE INDIVIDUAL LIFETIME CANCER RISKS AND ANNUAL INCREASED INCIDENCE OF CANCER DUE TO DIOXIN/FURAN AND ALL OTHER POLLUTANTS FOR EXPOSED NATIVE AMERICAN ANGLER POPULATIONS WITH TREATY-CEDED FISHING RIGHTS UNDER BASELINE CONDITIONS AND BAT/PSES OPTIONS

	Dioxin/Furan [a]			**All Other Contaminants**		
		Options			**Options**	
	Baseline	**A**	**B**	**Baseline**	**A**	**B**
Cancer Risk	3.5×10^{-4}	2.3×10^{-5}	1.9×10^{-5}	5.6×10^{-8}	7.3×10^{-9}	6.3×10^{-9}
Annual Increased Incidence of Cancer	0.14	0.008	0.007	0	0	0

Note: a 10^{-5} risk means the risk of one cancer case out of 100,000 individuals exposed to a given level, a 10^{-6} risk means the risk of one cancer case out of 1,000,000 individuals exposed, etc.

[a] Under TCF, dioxin/furan risk and annual incidence of cancer would be zero.

Recreational and Subsistence Angler Populations

EPA examined the current discharge of four pollutants that have reference doses (RfDs) contained in EPA's Integrated Risk Information System (IRIS) (chloroform, pentachlorophenol, 2,3,4,6-tetrochlorophenol, and 2,4,5-trichlorophenol) to determine if any chemical-specific non-cancer hazard quotient exceeds 1.0 under baseline conditions or under options A or B. None of the four pollutants with RfDs in IRIS are estimated to exceed a non-cancer hazard quotient of 1.0 under either baseline or BAT/PSES conditions for recreational, subsistence or Native American subsistence anglers.

EPA did not use the reference dose approach to evaluate potential non-cancer effects associated with dioxin/furan. The use of a RfD for dioxin/furan presents special problems. If EPA were to establish a RfD for dioxin/furan using the standard conventions of uncertainty, the RfD value would likely be one to two orders of magnitude below average background population exposure (Farland, 1997). The RfD is a level that is likely to be without an appreciable risk; it is not an "action level" or exposure level where non-cancer effects are predicted. Where the RfD is below background levels, and where effects are not readily apparent at background levels, it is not appropriate to use the RfD for quantifying benefits.

As an alternative to using the RfD, EPA evaluated potential non-cancer effects of dioxin/furan by comparing the modeled incremental exposure of dioxin/furan from fish consumption (based on results from the DRE model) to ambient background levels (i.e., 120 picograms of toxic equivalents/day [pgTEQ/day]). EPA estimates that adverse impacts associated with dioxin/furan exposures may occur at or within one order of magnitude of average background exposures. As exposures increase within and above this range, the probability and severity of human non-cancer effects most likely will increase. EPA's analysis shows that the estimated incremental exposure at baseline exceeds ambient background exposure by an order of magnitude for two mills, with the size of the exposed population ranging from 4,910 to 16,205 recreational and subsistence anglers (Table 8-9). The selected BAT/PSES reduced incremental exposure from fish consumption to a level that was not significantly different from ambient background exposure. The size of the recreational and subsistence angler population exposed to dioxin/furan doses exceeding one order of magnitude greater than the background level would be zero under the BAT/PSES options.

Assuming 10 percent to 33 percent of licensed anglers in adjacent counties regularly use pulp and paper mill effluent receiving streams for their fishing activities, EPA estimated that as many as 4,910 to

TABLE 8-9

NUMBER OF MILLS WITH ESTIMATED EXPOSURES POSING A POTENTIAL NONCANCER HAZARD FOR EXPOSED RECREATIONAL AND SUBSISTENCE ANGLER POPULATIONS

Option	Maximum Estimated Dose (pg/day)		# Mills Exceeding Background Dose By An Order of Magnitude		Size of the Population Exposed to Doses Exceeding Background Doses By An Order of Magnitude					
	0	0	0	l	Recreational		Subsistence		Total	
	Rec	Sub	Rec	Sub	10%[a]	33%[b]	10%[a]	33%[b]	10%[a]	33%[b]
Baseline	1,004	2,387	~1	2	4,491	14,820	419	1,385	4,910	16,205
Option A	92	212	0	0	—	—	—	—	—	—
Option B	62	143	0	0	—	—	—	—	—	—
TCF	0	0	0	0	—	—	—	—	—	—

[a]Assumes 10% of licensed anglers in counties adjacent to receiving stream regularly use the receiving stream for fishing
[b]Assumes 33% of licensed anglers in counties adjacent to receiving stream regularly use the receiving stream for fishing

16,205 recreational and subsistence anglers are exposed to dioxin/furan levels that could result in a non-cancer effect under baseline conditions. This number is reduced to zero under Option A, Option B, or TCF (Table 8-9).

Native American Angler Populations

For Native American subsistence anglers nationally, EPA estimates that no mills will exceed the oral RfDs for any of the four contaminants with EPA-approved RfDs contained in IRIS (under either baseline conditions or any BAT/PSES option). EPA also estimates nationally, potential Native American dioxin/furan exposures from consumption of contaminated fish associated with three mills (all papergrade kraft/soda mills) exceed ambient background exposures by an order of magnitude under baseline conditions. Under Option A, Option B, and TCF, no mills are associated with dioxin/furan exposures greater than an order of magnitude above background exposures.

For Native American subsistence anglers with treaty-ceded fishing rights, the maximum dioxin/furan exposure under baseline conditions is projected to be 803 pg TEQ/day, which is less than one order of magnitude above the background exposure, 120 pg TEQ/day (Table 8-10). Under the selected BAT/PSES option, the maximum incremental dioxin/furan exposure is reduced to 39 pg TEQ/day, which is less than one order of magnitude above background exposure. EPA estimates that no Native American subsistence anglers with treaty-ceded fishing rights would receive a maximum dioxin/furan exposure greater than one order of magnitude above background under baseline conditions or the selected BAT/PSES option (i.e., exposures are less than the level of concern).

8.2.1.3 National Recreational Angling Benefits

For proposal, EPA analyzed the lifting of fish consumption advisories and estimated the number of anglers affected by such advisories. EPA used these results to estimate monetized recreational angling benefits on a national basis. This section presents the results of the fish consumption advisory analysis for the final rule.

TABLE 8-10

MILLS EXCEEDING BACKGROUND EXPOSURES OF DIOXIN/FURAN (TEQ: 120 pg/DAY) FROM FISH TISSUE CONSUMPTION FOR NATIVE AMERICANS WITH TREATY-CEDED FISHING RIGHTS

Option	Maximum Estimated Exposure (pg/day)	Number of Mills Exceeding Background Exposure by an Order of Magnitude
Baseline	803	0
Option A	39	0
Option B	39	0
TCF	0	0

Typically, much of the water-related benefits from environmental controls are derived from recreational uses of a water body. However, these types of benefits are also highly site specific, making them difficult to estimate on a national or regional scale. EPA conducted detailed case studies of water-related benefits at a number of sites, but it is difficult to extrapolate from case study results to aggregate estimates (see Section 8.2.3 below for further discussion).

As EPA described in the RIA for the proposed rule, the methodology used to estimate recreational angling benefits at the national level relies on wide generalizations such as assumptions about the number of recreational anglers using affected water bodies, and does not consider the site-specific characteristics of the receiving streams that will influence recreational use (e.g., substitute sites). EPA derived estimates for this category of benefits to present a more complete picture of potential benefits at the national level. Therefore, the results are intended to provide only a rough approximation of the potential magnitude of recreational angling benefits that can be expected to result from the regulation.

Fish Consumption Advisory Analysis

As of December 1995, dioxin-related fish consumption advisories were in place near or downstream from 18 pulp and paper mills affected by the final effluent guideline rule (as reported in EPA's June 1996 National Listing of Fish Consumption Advisories). These 18 chlorine-bleaching pulp and paper mills affect 17 different receiving water bodies (seventeen water bodies are under advisories, but 2 of these water bodies have advisories in 2 states for a total of 19 advisories; see Table 8-11). These facilities were analyzed to assess the impact of the final regulation on existing fish consumption advisories by comparing modeled 2,3,7,8-TCDD and 2,3,7,8-TCDF fish tissue (fillet) concentrations for each BAT option to state-specific fish consumption advisory threshold levels.

EPA used the DRE model to project the effect of the final rule on existing dioxin-related fish consumption advisories. The results of this analysis indicate that the dioxin-related fish consumption advisories associated with all 18 facilities could potentially be lifted after implementation of Options A or B. However, three of the streams for which dioxin-related advisories are projected to be lifted will still have advisories in place for other contaminants. Consequently, EPA estimated that the number of recreational anglers on these streams will not increase.

TABLE 8-11

WATER BODIES WITH DIOXIN-RELATED FISH CONSUMPTION ADVISORIES ASSOCIATED WITH PULP AND PAPER MILLS

Water Body	State(s)	# Mill(s)	Name of Mill	City	Type of Advisory	Other Chemicals
Androscoggin River Androscoggin River	NH ME	1 2	James River Corp. Boise Cascade Intern. Paper Co.	Berlin Rumford Jay	fish fish	
Bayou LaFourch Wham Brake Lake Irwin	LA LA LA	1	Intern. Paper Co.	Bastrop	crappie, fish fish buffalo-small mouth	
Blackwater River Chowan River	VA TN	1	Union Camp Corp.	Franklin	bottom fish all fish except herring, shad, and shellfish	
Escatawpa River	MS	1	Intern. Paper Co.	Moss Point	buffalo, catfish	mercury
Houston Ship Channel	TX	2	Simpson Pasadena Paper Co . Champion Intern.	Pasadena Houston	catfish, blue crab	
Kennebec River	ME	1	Scott Paper Co.	Hinckley	fish	
Menominee River	MI	1	Champion Intern.	Quinnesec	carp	PCBs mercury
Niches River	TX	1	Temple-Inland Forest Prod.	Evadale	fish	
Penobscot River	ME	2	Lincoln Pulp & Paper James River Corp.	Lincoln Old Town	fish	
Pigeon River Pigeon River	NC TN	1	Champion Intern.	Canton	carp, catfish, fish fish	
Roanoke River Albemarle Sound Welch Creek	NC NC NC	1	Weyerhaeuser Paper	Plymouth	all fish except herring, shad, and shellfish all fish except herring, shad, and shellfish fish	
Wisconsin River	WI	3	Nekoosa Papers Nekoosa Papers Consolidated Paper	Nekoosa Port Edwards Wisconsin Rapids	white bass, carp	mercury

Total # of Water Bodies with Advisories = 17
Total # of Advisories = 19
Total # of Facilities Associated with Advisories = 8

Based on this analysis and assuming 10 percent to 33 percent of licensed anglers in adjacent counties regularly use these streams for their fishing activities, EPA estimated that after implementation of the final rule, the number of recreational anglers could increase from 35,932 to 118,529 anglers currently fishing these streams to 43,742 to 144,349 anglers.

EPA assumes that dioxin-related fish consumption advisories will be lifted three years after dioxin discharges from pulp and paper mills are reduced as a result of implementation of the final rule. In support of this assumption, several examples exist of fish consumption advisories that have been rescinded as a result of reduced concentrations of dioxins in fish taken from pulp and paper mill effluent receiving streams. Within the last few years, dioxin-related fish consumption advisories have been lifted on a number of receiving streams after pulp and paper mills instituted chlorine bleaching changes. These include the Sacramento River in California, the Ouichita River and Red River in Arkansas, the North Branch of the Potomac River in Maryland, the Escanaba River in Michigan, the Leaf River in Mississippi, Codorus Creek in Pennsylvania, and several water bodies in Alabama (see Chapter 9). Most recently, the fish consumption advisories on Lake Irwin in Louisiana and the Neches River in Texas were rescinded in 1997 due to reduced levels of dioxin in fish taken from these pulp and paper mill receiving streams. The physical, chemical, and biological conditions of a water body will determine how long dioxins will persist in the sediments and in fish tissue from that water body. However, EPA believes that implementation of the final rule will virtually eliminate the discharges of dioxins to pulp and paper mill receiving streams and will result in the lifting of dioxin-related fish consumption advisories, as has already been demonstrated by the removal of advisories at a number of mills that have implemented technologies similar to those required under the final rule.

Benefits Derived From Lifting of Fish Consumption Advisories

The lifting of fish consumption advisories may generate benefits by increasing both angling participation and the value of existing angling trips. As for the proposal, EPA estimated the increase in value of the fishery to the angler based on research conducted by Lyke (1993). EPA also derived estimates of a potential increase in angling activity; however, there is no way to determine what portion of these benefits would reflect merely a distributional shift in national-level angling activity.

Value of a Contaminant-Free Fishery

EPA estimated that the baseline value of fisheries at sites that currently have a fish consumption advisory for dioxin (and no other advisories) is $18.8 million to $61.9 million per year (with the range based on low and high estimates of anglers affected by fish consumption advisories). As in the proposal, EPA calculated the baseline value by multiplying the number of recreational anglers at each site (U.S. EPA, 1997b) by the average number of angling days per angler in each state (U.S. DOI, 1993) and by the average consumer surplus per day of fishing (Walsh et al., 1990) (see Appendix D).

For this analysis, Lyke's results were used to estimate benefits at those sites where advisories are expected to be lifted. Lyke (1993) estimated that if Wisconsin's Great Lakes trout and salmon fishery were completely free of contaminants that may threaten human health, the increase in consumer surplus for current users would be between 11.1 percent and 31.3 percent of the value of the fishery under current conditions. Such a scenario may be equated by anglers with the lifting of consumption advisories. Given a baseline value of the fisheries of $18.8 million to $61.9 million per year, EPA estimated potential benefits (11.1 percent to 31.3 percent of baseline value) of $2.1 million to $19.4 million per year. In reality, this method provides only a general sense of the magnitude of the recreational angling benefits that may arise from the regulation nationwide. Applying benefits transfer in this broad fashion is likely to underestimate benefits for some areas and overestimate them at others (e.g., many of the sites evaluated in this analysis differ greatly from the Great Lakes trout and salmon fishery; and the analysis excluded nonlicensed anglers such as Native Americans with treaty-ceded fishing rights).

Benefits from Increased Angling Participation

Recision of fish consumption advisories may also have a positive impact on the level of angling effort. In calculating recreational angling populations for the final rule, EPA assumed (based on the literature) that fish consumption advisories reduced potential anglers at a site by 20 percent (U.S. EPA, 1997b). For those sites where the regulation is expected to result in a lifting of the advisory, angling participation can be assumed to increase by this proportion. EPA estimated that benefits associated with a 20 percent increase in anglers on fishing days total $4.7 million to $15.5 million per year (range based on low and high estimates of anglers affected by fish consumption advisories) (see Appendix D). In theory, these benefits could be added to the monetized benefits estimated above. However, as described above, no attempt has been made to account for substitute sites or to discern the extent to which these benefits reflect merely a shift in fishing activity from reaches unaffected by pulp and paper mill effluent to the reaches adjoining mills. Some gain in anglers' consumer surplus would be expected in any case, or the transfers would not occur. However, EPA is not able to estimate this increase precisely.

Summary of National-Level Recreational Angling Benefits

Based on a transfer of benefits estimated for a contaminant-free Great Lakes fishery (Lyke, 1993), EPA estimated that potential national-level recreational angling benefits from the regulation may be in the range of $2.1 million to $19.4 million per year. These benefits may be conservative in that they reflect only values for current licensed anglers at sites with advisories in place. Also, benefits from potential increases in angling are not included since it was not possible to account for substitute sites. EPA estimated national-level benefits to ensure that this important benefit category was not omitted from a comparison of benefits and costs. However, because of the wide range of assumptions necessary to produce national-level estimates (the assumptions, and the expected impact on the benefits estimates, were summarized in the RIA for the proposed rule), these results are intended to provide only a general indication of the potential magnitude of angling benefits.

8.2.1.4 Benefits from Land Disposal of Sludge

At proposal, EPA estimated that facilities could save approximately $56 million ($1992) annually in sludge disposal costs as a result of the pulp and paper rule. Because of dioxin removals, sludge from pulp and paper mills may be disposed of through land application, instead of more costly landfilling or incineration. EPA received comments that this estimate was too high due to changes implemented by the industry. When EPA updated its baseline to 1995, potential dioxin removals were far lower than at proposal, because dioxin discharges had decreased in the interim. At proposal (1992 baseline) EPA estimated that the industry discharged 70 grams per year of TCDD and 341 grams per year of TCDF. For the mid-1995 baseline, EPA estimates that the industry discharges 16 grams per year of TCDD and 122 grams per year of TCDF. As a result, EPA estimates that revised mill sludge disposal cost savings, compared to the new baseline (in terms of dioxin-equivalents), is a maximum of 28 percent of the 1992 value, or approximately $14 million in $1992 or $16 million in $1995 (EPA notes that these benefits are based on dioxin loadings to wastewater and are consistent with, but not identical to, reductions in contaminated sludge presented in Section 11 of the Supplemental Technical Development Document). EPA estimates these values based on the reduced tonnage of expected dioxin-contaminated sludge, which in turn is based on the same proportional reduction of dioxin in effluent to dioxin in sludge that was used at proposal (Kaplan, 1996). To address uncertainty, EPA uses a value of one-half of this estimated discharge to identify a range of $8 million to $16 million ($1995) in potential sludge disposal benefits.

8.2.1.5 Summary of Water-Related Benefits

Table 8-12 provides a summary of the estimated water-related benefits for the regulatory options in the final rule. EPA estimates that total water-related benefits from Option A range from $11.9 million to $57.1 million per year and that the water-related benefits from Option B range from $12.0 to $57.9 million per year.

8.3 COMBINED MONETIZED BENEFITS

Table 8-13 presents combined water- and air-related benefits associated with implementation of the selected regulatory options. EPA estimates that total benefits from the selected regulatory options range from ($727) million to $1,496 million per year.

8.4 CASE STUDY REPRESENTATIVENESS AND ALTERNATIVE AGGREGATE WATER BENEFITS

The results of EPA's analysis of case study representativeness, and the interpretation of the representativeness analysis to develop an alternative estimate of aggregate water quality benefits, are presented below. EPA did no such comparable estimate of air quality representativeness, so the results described in this section are generalizable only for water; that is, extrapolation of air-related benefits for the

TABLE 8-12

POTENTIAL ANNUAL BENEFITS OF THE REGULATORY OPTIONS
(Millions of 1995 Dollars)

Benefit Category	**Option A**	**Option B**
Water-Related Benefits[a]		
Human health[b]	\$1.8-\$21.7	\$1.9-\$22.5
Recreational angling		
"Contaminant-free" fishery	\$2.1-\$19.4	\$2.1-\$19.4
Increased participation[c]	+	+
Sludge	\$8.0-\$16.0	\$8.0-\$16.0
Total Water-Related Benefits[d]	\$11.9-\$57.1	\$12.0-\$57.9

[+] Positive benefits expected but not estimated.
[a] Option A is the selected water option.
[b] Does not include reductions in noncancer health effects and risk reductions (cancer and noncancer) to unlicensed anglers such as Native Americans with treaty-ceded fishing rights.
[c] For example, an increase in participation of 20% would generate benefits on the order of \$5 million to \$15 million annually.
[d] National-level water benefits are not inclusive of all categories of benefits that can be expected to result from the regulation.

TABLE 8-13

POTENTIAL ANNUAL MONETIZED BENEFITS OF THE SELECTED REGULATORY OPTIONS[a]

Benefit Category	**(Millions of 1995 dollars)**
Water-Related Benefits[b]	$11.9-$57.1
Air-Related Benefits	($738.5)-$1,438.4
Total Combined Benefits	($726.8)-$1,495.5

[a]Option A, MACT I, and MACT II.
[b]Neither national-level water nor air benefits are inclusive of all categories of benefits that can be expected to result from the regulation.

case study areas to all mills is less meaningful than extrapolation of water-related benefits. Estimates of case study air quality benefits are derived using the same methods used in Section 8.1. The alternative benefits estimate is presented to provide an alternative picture of the potential magnitude of national-level benefits, for comparison with the estimates presented in Section 8.3. However, EPA notes that there is no precise methodology for extrapolating from case study estimates of water quality benefits to national-level estimates, and there are serious limitations to the generalizability of EPA's case study results to all mill sites. Therefore, the results should be considered only as order-of magnitude approximations.

8.4.1 Representativeness from a Benefits Perspective

EPA uses water-related site characteristics to categorize mill sites by degree of expected benefits. The results of assessing representativeness in the receiving water dimension, the sociodemographic dimension, and overall are presented in the following sections.

8.4.1.1 Receiving Water Characteristics

Table 8-14 shows the distribution of the total rankings for receiving water attributes for all facilities and for the case studies alone. Total benefits ranked in the sum of water characteristics. The first row shows this distribution for all facilities. The second row shows the distribution for the Penobscot River, Wisconsin River, Lower Columbia River, Pigeon River, and Samoa Peninsula case study facilities (the five case study areas have a total of 13 facilities[3]). The case studies are representative of all facilities in the sense that they cover the range of benefits potential. However, a greater percentage of the case studies fall into the "low" category compared to all facilities. As a result, the case studies may under represent the universe of facilities in terms of potential benefits from a receiving water characteristic perspective.

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[3]The Upper Columbia/Lower Roosevelt case study was not included because the facility is in Canada, and the Lower Tombigbee/Mobile River case study was not included because the facilities still require extensive upgrades to comply with the regulation.

TABLE 8-14

RECEIVING WATER POTENTIAL BENEFITS RANKING DISTRIBUTIONS

	Benefits Category		
	Low	**Medium**	**High**
All Facilities (91)	31 (34.1%)	38 (41.8%)	22 (24.2%)
Case Study Facilities (13)	8 (61.5%)	2 (15.4%)	3 (23.1%)

8.4.1.2 Sociodemographic Characteristics

Table 8-15 shows the distribution of the total rankings for sociodemographic characteristics for all 91 facilities and for the case studies alone. Again, the first row shows this distribution for all 91 facilities, and the second row shows the distribution for the Penobscot River, Wisconsin River, Lower Columbia River, Pigeon River, and Samoa Peninsula case study facilities. The percentage of case study facilities in the low and high categories is less than the percentage of all facilities in each of these categories. As a result, the case studies underrepresent the universe of facilities on the low and high end in terms of benefits potential from a sociodemographic perspective.

8.4.1.3 Overall Representativeness From a Benefits Perspective

Using the overall ranking system, EPA then ranked each facility based on its individual receiving water and sociodemographic rankings. Table 8-16 compares the distribution of the overall rankings for all facilities and the case study facilities alone. Based on these results, the benefits at the case study facilities may underrepresent the aggregate potential benefits of the regulation.

8.4.2 Alternative Aggregate Water Benefits

EPA developed an alternative estimate of aggregate water benefits by transferring benefits levels estimated in the case studies to facilities not included in the case studies and then aggregating across all affected facilities. To perform this transfer, benefits for the “low,” “medium,” and “high” rank categories were estimated using the case study estimated benefits. First, the rankings for each site in a case study were combined to arrive at an overall rank for each case study. Table 8-18 displays how benefits ranges were assigned to each overall benefits category. In the overall ranking, the Samoa Peninsula and Wisconsin River sites received a “low,” the Columbia River and Penobscot River sites received a “medium,” and the Pigeon River sites received a “high.” The estimated benefits for the Samoa Peninsula and the Wisconsin River case studies were averaged to arrive at a benefits range for “low” ranked sites. Similarly, the estimated benefits for the Penobscot River and the Columbia River case studies were averaged to arrive at a benefits range for the “medium” ranked sites.

TABLE 8-15

SOCIODEMOGRAPHIC POTENTIAL BENEFITS RANKING DISTRIBUTIONS

	Benefits Category		
	Low	**Medium**	**High**
All Facilities	13 (14.3%)	60 (66.0%)	18 (19.8%)
Case Study Facilities	0 (0.0%)	12 (92.3%)	1 (7.7%)

TABLE 8-16

COMPARISON OF OVERALL RANKINGS OF WATER BENEFITS POTENTIAL FOR ALL FACILITIES AND CASE STUDY FACILITIES[a]

Rank	Case Study Facilities	All Facilities
Low	8 (61.5%)	26 (28.5%)
Medium	2 (15.4%)	45 (49.5%)
High	3 (23.1%)	20 (22.0%)

[a]Number of facilities in each category are reported in the cells. Percentage of facilities is reported in parentheses.

TABLE 8-17

ANNUALIZED WATER-RELATED COSTS OF THE SELECTED OPTION (OPTION A) FOR CASE STUDY FACILITIES AND ALL FACILITIES

Site	Annualized Cost ($1995 Millions)
Wisconsin River	$5.8
Columbia River	$7.0
Penobscot River[a]	-
Pigeon River	$5.8
Samoa Peninsula	$3.9
Total for Case Studies	**$22.5**
All Facilities	$258

[a]Confidentiality agreements preclude disclosure of total costs for this site.

TABLE 8-18

ASSIGNMENT OF ANNUAL BENEFITS RANGES TO OVERALL BENEFITS CATEGORIES ($1995)

Benefits Category	**Case Studies Included**	**Estimated Annual Benefits (Million $)**	**Averaged Annual Benefits Range (Million $)**
Low	Samoa Peninsula	$0.1-$1.4	$0.1-$1.5
	Wisconsin River	$0.1-$1.5	
Medium	Penobscot River	$0.7-$2.3	$1.1-$5.5
	Columbia River	$1.5-$8.6	
High	Pigeon River	$2.7-$8.7	$2.7-$8.7

EPA then transferred these ranges of benefits to each of the affected facilities based on their overall rank. The benefits were then summed over all of the facilities (including those in the Lower Tombigbee/Mobile case study) to arrive at an alternative aggregate range of water benefits. Table 8-19 shows that aggregate annual water benefits for all facilities affected by the regulation, estimated using this alternative method, range from $91 to $451 million ($1995).

8.5 ENVIRONMENTAL JUSTICE

In this section, EPA evaluates the environmental justice aspects of the integrated pulp and paper rules. EPA considers three aspects of environmental justice:

- an assessment of the effects of the integrated pulp and paper rules on Native American subsistence anglers;
- a comparison of county and state-level demographic (race, income and employment) information; and
- an evaluation of the effects of pulp and paper compliance costs on paper price increases, and the resulting impacts on low income consumers.

8.5.1 Native American Subsistence Anglers

EPA assessed the individual-level risk to Native Americans from the consumption of fish contaminated with dioxin and other contaminants (Section 8.2.1.2). The results of this assessment indicate that the dioxin- related individual cancer risk to Native Americans will be reduced by an order of magnitude for average and upper end consumption anglers. For Native American subsistence anglers with treaty-ceded fishing rights, the rule will reduce the upper bound annual cancer risk by 0.13 cancer cases, out of a baseline exposure from pulp and paper mills of 0.14 annual cancer cases.

EPA also investigated the fishing habits of 48 Native Americans tribes located downstream from pulp mills in 15 states and determined that eight of these—the Flathead (Montana), Micmac (Maine), Tulalip (Washington-Puget Sound), Nez Perce, Umatilla, Warm Springs, Yakama (all Lower Columbia River in

TABLE 8-19

POTENTIAL NATIONAL-LEVEL ANNUAL BENEFITS OF THE FINAL BAT/PSES, MACT I AND PROPOSED MACT II BASED ON EXTRAPOLATION OF THE CASE STUDY RESULTS (Millions of 1995 Dollars)

Overall Rank	**Number of Facilities in Rank**	**Benefits Range by Category**	**Total Benefits by Category**
Low	25	$0.1-$1.5 million	$3-$38
Medium	45	$1.1-$5.5 million	$50-$248
High	19	$2.0-$8.7 million	$38-$165
Total Water	89 [a]	-	$91-$451
Air Benefits	155		($739)-$1,438
Total			**($648) -$1,889**

[a]Benefits are aggregated for only 89 facilities since the Samoa Peninsula and Pigeon River sites are excluded.

Oregon and Washington), and Penobscot (Maine)—have treaty-ceded fishing rights and engage in subsistence fishing in waters potentially affected by pulp and paper mill effluent. The Flathead, Micmac, and Tulalip tribes have very limited information on fish consumption in mill-affected waters. The Lower Columbia River and Penobscot River tribes are considered in detail in two case studies EPA conducted for this rule. The results of the case studies are reported in Chapter 9. EPA has determined that members of these tribes have elevated health risks from consuming contaminated fish due to higher consumption levels. EPA expects that the rule will reduce cancer risks by an order of magnitude (i.e., tenfold) for members of the Penobscot Nation, and by slightly less for the Lower Columbia River tribes, who consume greater quantities of fish. EPA makes the assumption that Native American populations from tribes other than those with treaty fishing rights are similar to either recreational or non-Native American subsistence anglers, and are addressed in risk estimates for those groups.

8.5.2 Racial and Income Characteristics of Affected Counties and States

EPA also compares the racial and income makeup of counties with pulp and paper mills to the racial and income makeup of the state as a whole. EPA uses county-based data to estimate all exposed risk for anglers in its water quality benefit analysis; as a result, county-level data are also the most appropriate for evaluating race and income considerations. EPA has determined that within-state comparisons were the most accurate means to account for inter-regional demographic differences. The results are reported in Table 8-20.

The results indicate that, of the twenty six (26) states with bleached papergrade kraft mills:

- Fifteen states had a minority (i.e., nonwhite) mill county population percentage that was less than the state in which they were located, while 11 states had a minority mill county population that was greater than the state;
- Sixteen states had mill counties with an African-American population percentage that was less than or equal to the state, while 10 states had mill county populations that were greater than the state average. Seven of these ten states had mill counties with an African American population at least 3 percentage points greater than the state (in Arkansas, the African American population was 22 percentage points greater in counties with mills than the state as a whole);
- Five states had mill counties with an American Indian population percentage that was double the American Indian population percentage for the state.

TABLE 8-20

RACE AND INCOME CHARACTERISTICS IN STATES AND COUNTIES WITH BLEACHED KRAFT MILLS[1]

State	% White	% Black	% American Indian	% Asian	% Other	Median Income[2]	% Below Poverty Level	% Unemployed[2]
Alabama								
Total in Counties with Mills	64.5%	33.9%	0.9%	0.6%	0.1%	$21,373	23.66%	8.99%
Total in State	73.6%	25.2%	0.5%	0.5%	0.1%	$23,597	18.34%	6.87%
Arkansas								
Total in Counties with Mills	61.0%	38.0%	0.5%	0.3%	0.2%	$20,576	24.13%	9.49%
Total in State	82.7%	15.9%	0.6%	0.5%	0.3%	$21,147	19.07%	6.76%
California								
Total in Counties with Mills	92.6%	0.7%	3.9%	1.9%	0.9%	$24,688	15.46%	8.68%
Total in State	69.1%	7.4%	0.8%	9.6%	13.1%	$35,798	12.51%	6.65%
Florida								
Total in Counties with Mills	79.9%	17.2%	0.8%	1.6%	0.5%	$24,250	16.74%	7.01%
Total in State	83.1%	13.6%	0.3%	1.2%	1.8%	$27,483	12.69%	5.78%
Georgia								
Total in Counties with Mills	63.4%	34.5%	0.3%	1.4%	0.5%	$27,551	16.15%	6.13%
Total in State	71.1%	26.9%	0.2%	1.1%	0.6%	$29,021	14.65%	5.74%
Idaho								
Total in Counties with Mills	93.9%	0.2%	4.9%	0.6%	0.5%	$25,219	12.03%	7.31%
Total in State	94.4%	0.4%	1.5%	0.9%	2.8%	$25,257	13.25%	6.15%
Kentucky								
Total in Counties with Mills	97.5%	2.3%	0.1%	0.0%	0.1%	$22,717	17.66%	11.56%
Total in State	92.1%	7.1%	0.2%	0.5%	0.2%	$22,534	19.03%%	7.37%
Louisiana								
Total in Counties with Mills	65.3%	32.7%	0.3%	1.3%	0.5%	$25,037	20.64%	9.07%
Total in State	67.3%	30.8%	0.5%	0.9%	0.5%	$21,949	23.58%	9.65%

Table 8-20 (continued)

State	% White	% Black	% American Indian	% Asian	% Other	Median Income[2]	% Below Poverty Level	% Unemployed[2]
Maine								
Total in Counties with Mills	98.1%	0.4%	0.7%	0.6%	0.1%	$28,028	11.26%	6.64%
Total in State	98.4%	0.4%	0.5%	0.6%	0.1%	$27,854	10.80%	6.65%
Maryland								
Total in Counties with Mills	97.3%	2.1%	0.0%	0.4%	0.1%	$21,546	16.50%	8.16%
Total in State	71.0%	24.9%	0.3%	2.9%	0.9%	$39,386	8.27%	4.30%
Michigan								
Total in Counties with Mills	88.2%	9.7%	1.1%	0.4%	0.6%	$25,043	14.49%	8.35%
Total in State	83.5%	13.9%	0.6%	1.1%	0.9%	$31,020	13.12%	8.24%
Minnesota								
Total in Counties with Mills	95.5%	0.2%	3.6%	0.3%	0.4%	$24,367	12.50%	7.75%
Total in State	94.5%	2.2%	1.1%	1.8%	0.5%	$30,909	10.22%	5.15%
Mississippi								
Total in Counties with Mills	73.0%	26.0%	0.2%	0.7%	0.2%	$24,739	18.83%	8.21%
Total in State	63.5%	35.6%	0.3%	0.5%	0.1%	$20,136	25.21%	8.43%
Montana								
Total in Counties with Mills	96.2%	0.2%	2.3%	1.0%	0.3%	$23,388	16.99%	7.22%
Total in State	92.8%	0.3%	6.0%	0.5%	0.5%	$22,988	16.07%	6.96%
New Hampshire								
Total in Counties with Mills	99.3%	0.1%	0.2%	0.2%	0.2%	$25,897	10.12%	8.56%
Total in State	98.0%	0.6%	0.2%	0.8%	0.3%	$36,329	6.42%	6.22%
New York								
Total in Counties with Mills	97.5%	1.4%	0.3%	0.5%	0.3%	$28,340	10.32%	7.63%
Total in State	74.5%	15.9%	0.3%	3.8%	5.5%	$32,965	13.03%	6.88%

Table 8-20 (continued)

State	% White	% Black	% American Indian	% Asian	% Other	Median Income[2]	% Below Poverty Level	% Unemployed[2]
North Carolina								
Total in Counties with Mills	75.4%	22.5%	1.2%	0.4%	0.5%	$22,727	16.59%	6.67%
Total in State	75.6%	22.0%	1.2%	0.8%	0.4%	$26,647	12.97%	4.79%
Ohio								
Total in Counties with Mills	92.6%	6.5%	0.2%	0.5%	0.1%	$24,286	17.75%	9.71%
Total in State	87.8%	10.6%	0.2%	0.8%	0.5%	$28,706	12.54%	6.60%
Oregon								
Total in Counties with Mills	96.9%	0.2%	1.3%	0.7%	0.8%	$26,462	12.56%	7.18%
Total in State	92.8%	1.6%	1.5%	2.4%	1.8%	$27,250	12.42%	6.20%
Pennsylvania								
Total in Counties with Mills	95.6%	3.3%	0.1%	0.5%	0.5%	$28,524	10.11%	5.56%
Total in State	88.6%	9.2%	0.1%	1.1%	1.0%	$29,069	11.13%	5.97%
South Carolina								
Total in Counties with Mills	64.0%	34.4%	0.4%	0.8%	0.4%	$28,548	14.29%	5.47%
Total in State	69.1%	29.8%	0.3%	0.6%	0.3%	$26,256	15.37%	5.58%
Tennessee								
Total in Counties with Mills	97.1%	2.2%	0.3%	0.3%	0.0%	$23,898	15.09%	6.64%
Total in State	83.0%	15.9%	0.3%	0.6%	0.2%	$24,807	15.70%	6.41%
Texas								
Total in Counties with Mills	67.1%	18.5%	0.3%	3.6%	10.6%	$31,210	15.25%	6.78%
Total in State	75.3%	11.9%	0.4%	1.9%	10.6%	$27,016	18.10%	7.11%
Virginia								
Total in Counties with Mills	71.4%	27.7%	0.6%	0.2%	0.1%	$28,324	12.60%	5.87%
Total in State	77.5%	18.8%	0.3%	2.6%	0.9%	$33,328	10.25%	4.48%

Table 8-20 (continued)

State	% White	% Black	% American Indian	% Asian	% Other	Medain Income[2]	% Below Poverty Level	% Unemployed[2]
Washington								
Total in Counties with Mills	90.5%	3.3%	1.5%	3.6%	1.1%	$32,069	9.92%	5.53%
Total in State	88.6%	3.0%	1.7%	4.3%	2.3%	$31,183	10.92%	5.72%
Wisconsin								
Total in Counties with Mills	98.1%	0.1%	0.4%	1.3%	0.1%	$28,263	8.90%	5.21%
Total in State	92.3%	5.0%	0.8%	1.1%	0.8%	$29,442	10.70%	5.20%

[1]Data is from 1990 Census of Population and Housing and may not be representative of current employment conditions.

[2]For "Total Counties with Mills," medium income is calculated as a weighted average across counties using median income and population.

Source: Census of Population and Housing. 1990. Summary Tape File 3 on CD-ROM. Prepared by the Bureau of the Census, Washington: The Bureau, 1992.

- In 14 states, there is no statistically significant difference in ethnic makeup between the counties with mills and the state as a whole, while in several other states, the percentage of minorities in counties with mills is significantly less than the percentage of minorities in the state;

- Fifteen states had a percent of the mill county population below the poverty line that was greater than the state. However, for all mill counties, the average percent of the population below the poverty line was 15 percent, while the average for all mill states was 14.1 percent. EPA has determined that this difference is not statistically significant;

- In 19 of the 26 states with bleached kraft mills, there is no statistically significant difference between the percentage of the population below the poverty level in counties where bleached kraft mills are located compared to the state as a whole. In several states, the percentage of the population below the poverty level is less in counties where bleached kraft mills are located;

- Eighteen states had average unemployment rates in mill counties that were higher than the state unemployment rate;

- The average median income for all mill counties is $25,657, compared to $28,157 for the states.

These data show no persuasive trends regarding low income or minority populations of mill counties compared to their respective states. The differences shown vary from state to state, which makes it difficult to conclude that minority and low-income populations are disproportionately affected by pulp and paper discharges and emissions and would therefore disproportionately benefit from regulations. The differences in income levels may be correlated with urban and rural distinctions, and pulp mills are often located near wood supplies in lower income rural areas.

Low income populations may also be the most adversely affected economically if mills close as a result of the pulp and paper integrated rules. EPA notes that the implementation of BAT Option B technology would be likely to increase the number of individuals below the poverty line in up to five counties where mills are projected to close, compared to three for the final and proposed rules. The cost of totally chlorine free technology would likely increase the number of individuals below the poverty level in up to nine counties where mills would be predicted to close.

8.5.3 Price Effects on Low Income Consumers

As shown in Chapter 6, the compliance costs associated with the various air and water pollution control options will have some effect on increasing prices as a result of increasing supply costs. In Chapter 6, EPA estimates that the price effect will benefit the regulated community, i.e., one or more mills may remain open that would otherwise close if they could not pass on some of their increased compliance costs. However, consumers must ultimately pay these increased prices, with the burden falling most heavily on those consumers who use the most paper on a per capita basis, or for whom paper products consume a disproportionate share of income. EPA evaluated the price effects on low income consumers by identifying:

- price increases associated with various combinations of MACT and BAT/PSES technology options,
- average paper consumption for low income people (Census, 1995a); and
- the effects of price increases on low income populations, both in absolute ($) and relative (percent of income) terms.

For the bleached papergrade kraft and soda subcategory, the pulp and paper price increase associated with the final rules (BAT/PSES and MACT I) combined with the proposed MACT II rule is 1.5 percent (see Section 6.2.3). With Option B, MACT I and MACT II, prices would increase 1.9 percent. Were TCF to be selected as BAT, EPA predicts pulp prices would increase by 5.3 percent when combined with final MACT I and proposed MACT II. Paper price increases would be expected to be somewhat less, since pulp is only one factor of paper production.

EPA estimates that low income consumers (those with incomes under $10,000) spend an average of 2.09 percent of their pre-tax income on paper products (Census, 1995b). The pulp and paper rule will increase this to 2.13 percent of pre-tax income, while TCF would increase this to 2.2 percent of income. The aggregate effect on low income consumers would be increased annual expenditures of up to $26.1 million for the selected rules, $33.0 million for Option B and $91.7 million for TCF. Clearly, selecting very stringent pollution control technologies such as TCF may significantly affect low income consumers, who seldom have discretionary income to spend and must make trade offs with other necessities to sustain paper price increases. More detail is provided in Appendix F.

8.5.4 Environmental Justice Summary

Individual Native Americans (from tribes without treaty fishing rights) that engage in subsistence fishing downstream from pulp mills have elevated individual cancer risks from pulp and paper discharges compared to the general population or non-native anglers. The rule will lower dioxin-related cancer risks by an order of magnitude for anyone consuming fish at average and upper end consumption rates. Native American tribes located on the Lower Columbia and Penobscot Rivers have treaty-ceded fishing rights and engage in subsistence fishing in waters located downstream from bleached kraft pulp and paper mills. Based on case studies of these tribes, EPA estimates that the rule will reduce individual cancer risks by a factor of ten for the Penobscot Nation (from 3.5×10^{-5} to 3.09×10^{-6}), and somewhat less for the Lower Columbia River Tribes (from 1.15×10^{-4} to 1.03×10^{-4}).

Demographic and income data show no persuasive trends regarding low income or minority populations of mill counties compared to their respective states. Observed differences vary from state to state, which makes it difficult to conclude that minority and low-income populations are disproportionately affected by pulp and paper discharges and emissions and would therefore disproportionately benefit from regulations. Unemployment rates in mill counties generally exceed the related state unemployment rates. Mill closures have the potential to increase the unemployment rates as well as the number of people below the poverty level in these areas.

Low income people are adversely affected by paper price increases caused by the pulp and paper rules, particularly for technology options with very high costs, such as TCF.

8.6 TOTALLY CHLORINE FREE TECHNOLOGY

EPA conducted a sensitivity analysis estimate of the benefits of implementing TCF bleaching technology. For this analysis, EPA assumes that the air benefits of TCF technology would be the same as for Option B because similar technology is used. However, a detailed air pollution control technology assessment was not conducted for TCF. EPA assumes that the only difference between TCF and Option B is related to the expected water benefits.

For both recreational and subsistence anglers, EPA estimated that implementation of TCF would eliminate between 0.8 and 2.8 cancer cases per year, compared to the baseline. This is based on the assumption that the estimated number of baseline cancer cases would be reduced to zero because all potential TCDD and TCDF would be eliminated. Based on an estimated value of a statistical life of $2.5 million to $9.0 million (American Lung Association, 1995), EPA estimated that potential human health benefits would range from $2.0 million to $25.2 million per year. EPA also estimated that implementation of TCF would reduce the number of mills with exposures posing a potential non-cancer hazard for exposed recreational and subsistence anglers from 20 and 31 respectively, to zero. For recreational angling and sludge disposal, EPA estimates that benefits are the same as under options A and B, due to the removal of all fish advisories and restrictions on sludge disposal, respectively (see Section 8.2).

Table 8-21 provides a summary of the estimated water-related benefits for the regulatory options in the final rule. EPA estimates that the total water-related benefits from the implementation of TCF would range from $12.1 million to $60.6 million per year. As noted in Section 8.4, implementation of TCF would reduce cancer and non-cancer risk among recreational, subsistence and Native American anglers, but would increase unemployment in some counties with unemployment rates already above state and national averages, and may disproportionately adversely affect low-income consumers.

8.7 REFERENCES

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TABLE 8-21

POTENTIAL MONETIZED BENEFITS OF IMPLEMENTING TOTALLY CHLORINE FREE TECHNOLOGY
(Millions of 1995 Dollars per Year)

Benefit Category	**Annual Value**
Water-Related Benefits[a]	
Human health[b]	$2.0-$25.2
Recreational angling	
"Contaminant-free" fishery	$2.1-$19.4
Increased participation[c]	+
Sludge	$8.0-$16.0
Total Water-Related Benefits[d]	$12.1-$60.6

[+]Positive benefits expected but not estimated.

[a]Does not include reductions in noncancer health effects and risk reductions (cancer and noncancer) to unlicensed anglers such as Native Americans with treaty-ceded fishing rights.

[b]For example, an increase in participation of 20% would generate benefits on the order of $5 million to $15 million annually.

[c]National-level water benefits are not inclusive of all categories of benefits that can be expected to result from the regulation.

Kaplan. 1996. Revised sludge benefits with updated baseline information. Memorandum to Matthew Clark, U.S. EPA from Maureen F. Kaplan, Eastern Research Group. December 26. Water Docket, DCN 14,399.

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CHAPTER 9

BENEFIT-COST CASE STUDIES

This chapter presents case studies of the potential benefits and costs of the final pulp and paper regulation. EPA developed four new case studies since proposal, which this chapter provides in entirety. The RIA for the proposed rulemaking included three case studies, which are not repeated here. However, the chapter does present revisions to the old case studies.

The new case studies include:

- the Lower Tombigbee and Mobile rivers in Alabama (Section 9.1)
- the Pigeon River in North Carolina and Tennessee (Section 9.2)
- the Upper Columbia River and Lake Roosevelt in British Columbia, Canada, and Washington State (Section 9.3)
- the Samoa Peninsula on the Pacific Ocean in California (Section 9.4).

These case studies provide a retrospective look at the benefits and costs of process controls associated with water pollution control requirements that the selected bleached kraft mills have already implemented over the past 6 to 8 years. To the extent that the controls implemented reflect selected regulatory technologies and the receiving water in those streams are comparable to those of facilities affected by the rule, the case studies illustrate the benefits and costs that may be expected at sites where the regulation will mandate comparable treatment performance. EPA estimated potential benefits both from the selected BAT/PSES (Option A, 100 percent substitution) and Option B (100 percent substitution and oxygen delignification) for the new (retrospective) case studies.

The original RIA case studies include:

- the Penobscot River in Maine (Section 9.5)
- the Wisconsin River in Wisconsin (Section 9.6)

- the Lower Columbia River in Washington (Section 9.7).

The revised benefits estimates for the old case studies are in 1995 dollars. EPA estimated benefits for these case studies only for Option A. Original baseline values come from the November 1993 RIA and were updated using the Consumer Price Index.

This chapter presents revisions to the water-related benefits (human health benefits only),[1] air-related benefits, and costs for these case studies.[2] In response to comments that environmental justice issues were not adequately considered, this chapter also presents two new analyses — human health risk assessments for tribal populations in the Penobscot River and Columbia River case studies. Additionally, EPA incorporated changes to address comments received on the Penobscot River case study.

The same methodology used to quantify air benefits in Chapter 8 are employed here to value the air benefits of each case study. The air benefits are the result of reductions that will be achieved from the implementation of the final MACT I rule and the proposed regulatory alternative for MACT II. The estimate of VOC reductions are applicable to MACT I as a result of mill-specific information. EPA is unable to reasonably extrapolate estimated VOC reductions associated with MACT II to these cases studies, however, it is likely that the VOC reductions associated with MACT II would be low and not influence the case study analysis significantly. The PM emission changes incorporate both minimal emission increases from MACT I (i.e., usually less than one ton) and emission decreases estimated for MACT II.

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[1]For the proposal, potential benefits in categories other than human health were estimated to result from a lifting of fish consumption advisories issued for the case study areas. Because the regulation is still expected to result in a lifting of the advisories, these benefits are not revised for analysis of the final regulation.

[2]Subsequent to revising case study analyses, EPA made final revisions to estimated reductions in loadings expected to result from the rule. These changes are reflected in the national level results but have not been incorporated at the case study level. The changes are expected to have a minor impact on the case study results.

9.1 LOWER TOMBIGBEE AND MOBILE RIVER CASE STUDY

Ten bleached kraft pulp and paper mills discharge to Alabama waters. In 1990, the Alabama Department of Environmental Management (ADEM) revised the discharge permits for all 10 mills to require reduced discharges of dioxin. The mills implemented a number of process changes to reduce the concentrations of dioxin in their effluent (water). Since that time, concentrations of dioxin in fish tissue samples collected near the mills have declined and the Alabama Department of Public Health (ADPH) has lifted fish consumption advisories (FCAs) associated with the mills.

This case study provides estimates of the benefits resulting from the process changes implemented at the Alabama mills on the Lower Tombigbee and Mobile rivers. To the extent that these changes reflect the requirements of the current CWA regulation and that the receiving waters in the case studies reflect water quality conditions nationwide, the estimated benefits may indicate the potential for benefits at sites nationwide where similar process changes have not yet been made. This section compares the estimated benefits associated with process changes at mills on the Lower Tombigbee and Mobile rivers to the potential benefits associated with the rulemaking. Since the process changes relate to water discharges, this case study focuses primarily on water-related benefits.

9.1.1 Location of Bleached Kraft Mills in Alabama

Alabama's bleached kraft mills are in the western and central regions of the state. Table 9-1 lists the mills' locations and receiving water bodies, and Figure 9-1 shows these graphically.

9.1.2 Water Quality Problems Associated with the Mills

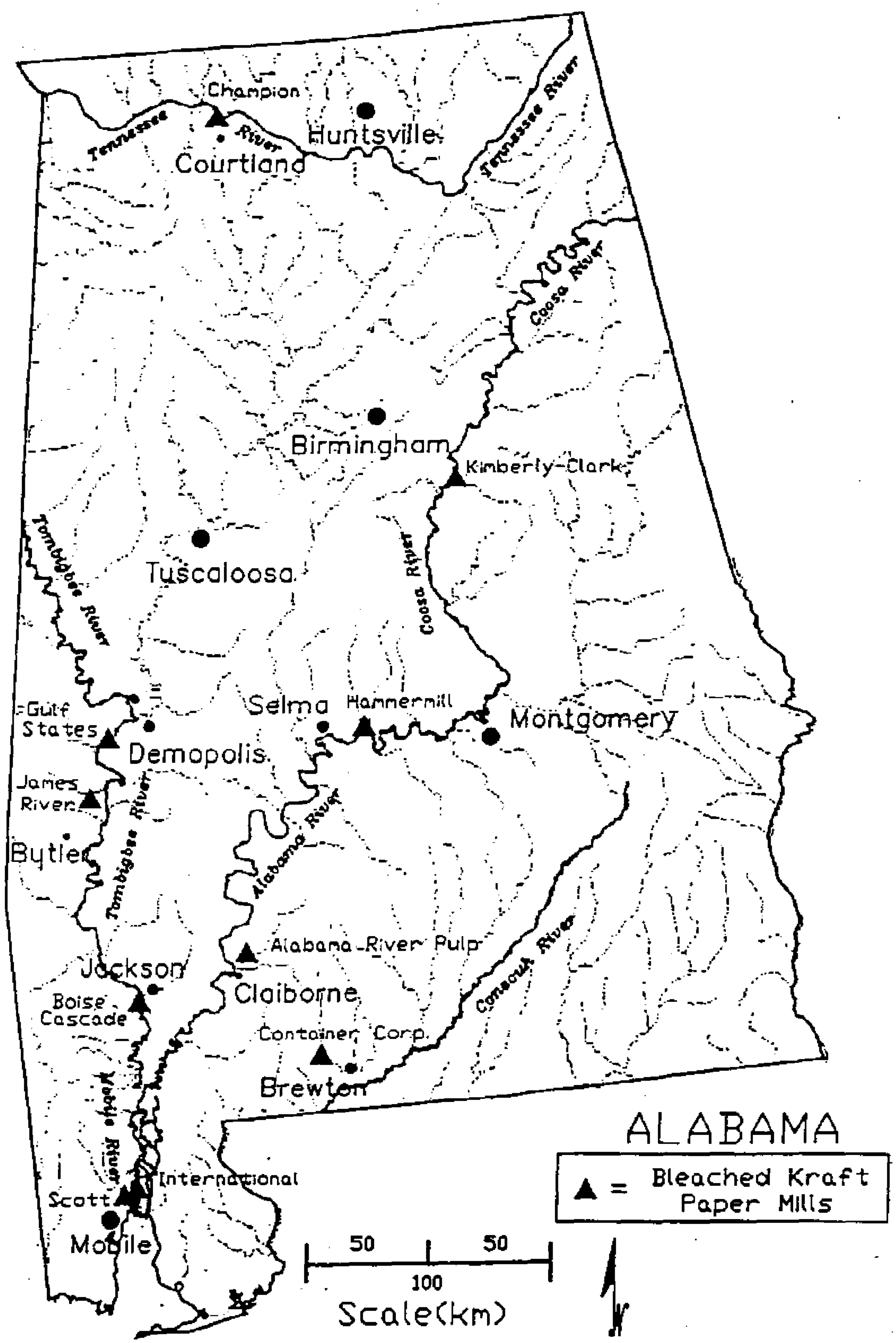
Fish tissue samples collected below the mills in 1990 and prior years contained elevated concentrations of dioxin. For example, in 1984, a bass fillet below the Alabama River Pulp mill contained 12 ppt dioxin, a predator species below the International Paper and Scott Paper mills in 1990 contained 20.3 ppt dioxin, and a channel catfish fillet near the Boise Cascade mill in 1990 contained 39.4 ppt dioxin. Alabama

TABLE 9-1

BLEACHED KRAFT MILLS IN ALABAMA

Mill	Location	Receiving Water Body
Alabama River Pulp	Claiborne	Alabama River
Boise Cascade Corporation	Jackson	Tombigbee River
Champion International Corporation	Courtland	Tennessee River
Container Corporation of America	Brewton	Conecuh River
Gulf States Paper Corporation	Demopolis	Tombigbee River
Hammermill Papers	Selma	Alabama River
International Paper Company	Mobile	Mobile River
James River Corporation	Butler	Tombigbee River
Kimberly-Clark Corporation	Coosa Pines	Coosa River
Kimberly-Clark Corporation	Mobile	Mobile River

Figure 9-1
Map of Bleached Kraft Mills in Alabama



uses an EPA-recommended dioxin concentration of 7 ppt in issuing fish consumption advisories (C. Lamar, ADEM, personal communication, 1995).

The ADPH issued an FCA for the Coosa River below the Kimberly-Clark mill in September 1990 for largemouth bass and carp; it was optional for other species (Alabama Department of Public Health, 1990). The FCA advised children (under 15 years), pregnant or breast-feeding women, and women of reproductive ages likely to become pregnant to avoid consumption. Other consumers were advised to limit consumption to once per week or less.

In May 1991, the ADPH issued advisories for the Tombigbee River below the Boise Cascade mill, and for the Mobile River below the International Paper and Scott Paper mills (Alabama Department of Public Health, 1991). The Tombigbee River advisory was for channel catfish. The Mobile River advisory, which was for Alabama shad, covered the area below the two mills to Mobile Bay. Both FCAs advised that children (under 15 years), pregnant or breast-feeding women, and women of reproductive ages likely to become pregnant avoid consumption. Other consumers were advised to limit consumption to no more than once per month.

9.1.3 Alabama DEM Actions

In 1990, ADEM revised the permits for all 10 mills to require reductions in dioxin production by 1993 to achieve Alabama's instream standard of 1.2 parts per quadrillion (ppq) and required fish tissue sampling each fall (ADEM, 1994). All of the mills achieved compliance with the permit limits in 1991 (ADEM, 1994).

In July 1994, ADEM amended Alabama's state water quality regulations to increase the fish consumption rate used in formulas to establish human health water quality standards (ADEM, 1995a). Based on a recent study of fish consumption in Alabama (FIMS and FAA, 1993),[3] the state increased the estimated fish consumption rate from 6.5 grams per day (gpd) to 30 gpd. This change resulted in a 70 percent

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[3]FIMS is Fishery Information Management System, Inc., and FAA is the Alabama Department of Fisheries and Allied Aquaculture.

reduction in the allowable instream concentration limits of dioxin and about 100 other toxic pollutants (ADEM, 1995a).

9.1.4 Mill Improvements

All of the mills implemented chlorine substitution or changes that will improve the mills' ability to use chlorine substitution. Two of the mills, Alabama River Pulp and Champion International Corporation, also implemented oxygen delignification. Table 9-2 describes the process changes implemented and planned at the 10 mills, as of May 1992, to meet the revised permit limits. The aggregate costs of these changes were not publicized. EPA estimated these costs for this analysis as shown in Section 9.1.8.

9.1.5 Reduced Fish Tissue Dioxin Concentrations

Following the revision of the mills' permit limits, ADEM observed reduced concentrations of dioxin in fish tissue samples collected below the mills. Table 9-3 shows the fish tissue sampling results for bass and catfish at Alabama River Pulp, Boise Cascade, and Hammermill Papers. The samples were collected by independent consultants hired by the mills and shipped to private labs for analysis (ADEM, 1995a). As shown by the graphs, dioxin concentrations show a downward trend during the 1990s, and many of the samples indicate dioxin concentrations below detection levels in recent years.

9.1.6 Assessment of Benefits

The receiving waters for bleached kraft mill effluent in Alabama support diverse lake and river sport and commercial warm water fisheries, including popular tournament fisheries (e.g., Wheeler Reservoir). Game or sport species include bass, smallmouth bass, crappie, bluegill, blue catfish, channel catfish, flathead catfish, bream, spotted bass, striped bass, and hybrid striped bass. State, federal, and municipal boat landings provide public access to these fishing locations. For example, Figure 9-2 shows public boat landings on the Wheeler Reservoir and the Tennessee River; Figure 9-3 shows public boat landings on the

TABLE 9-2

DIOXIN REDUCTION EFFORTS BY BLEACHED KRAFT MILLS IN ALABAMA
(status as of May 26, 1992)

Mill	Completed Projects	Planned Projects
Alabama River Pulp	- 100% chlorine dioxide substitution capability - Dual reactor oxygen delignification system - Two stage pressure diffuser washing - Extended modified continuous cooking Kamyr digester for maximum pulp strength at a minimum Kappa number - Capability for hydrogen peroxide addition for brightness adjustment	
Boise Cascade Corporation	- Chlorine stage modification to reduce amount of chlorine used by increasing efficiency - Chlorine dioxide generator to increase ability to substitute chlorine dioxide for chlorine - Brown stock washer to decrease bleaching required (in progress, estimated completion June 1992)	
Champion International Corporation*	- Use of less reactive defoamer - Decreased organic content of hardwood pulp prior to bleaching - Partial chlorine substitution - Oxygen delignification	- Increase chlorine substitution - Decrease organic content of pulp prior to bleaching
Container Corporation of America*	- Partial chlorine substitution	
Gulf States Paper Corporation*	- Use of less reactive defoamer - Chlorine dioxide substitution for chlorine (in progress)	- Hydrogen peroxide substitution for chlorine

TABLE 9-2 (continued)

Mill	Completed Projects	Planned Projects
Hammermill Papers	- Partial substitution of chlorine dioxide, peroxide, and oxygen for chlorine	- Increase production of chlorine dioxide to increase ability to substitute for chlorine
International Paper Company	- Extended delignification prior to bleaching - Elimination of defoamers containing high concentrations of dioxin precursors - Use of oxygen and hydrogen peroxide to augment bleaching process - Elimination of the use of chlorine hypochlorite - Conversion of the chlorine dioxide generator to the R8 process in order to obtain enough chlorine free chlorine dioxide to sustain a high substitution rate of chlorine dioxide for chlorine	
James River Corporation	- Substitution of chlorine dioxide for chlorine - New brown stock washers to decrease organic content of pulp prior to bleaching - Modification to bleach plants - New “broke system”	
Kimberly-Clark Corporation	- 50% substitution of chlorine dioxide for chlorine - Use of nonreactive defoamer - Improved effluent suspended solids removal — reduction from about 50 mg/L to less than 15 mg/L	- 100% substitution of chlorine dioxide for chlorine
Scott Paper Company	- Modification and upgrade of bleaching process	

* Did not submit update in response to April 1992 request.

Source: ADEM, 1992.

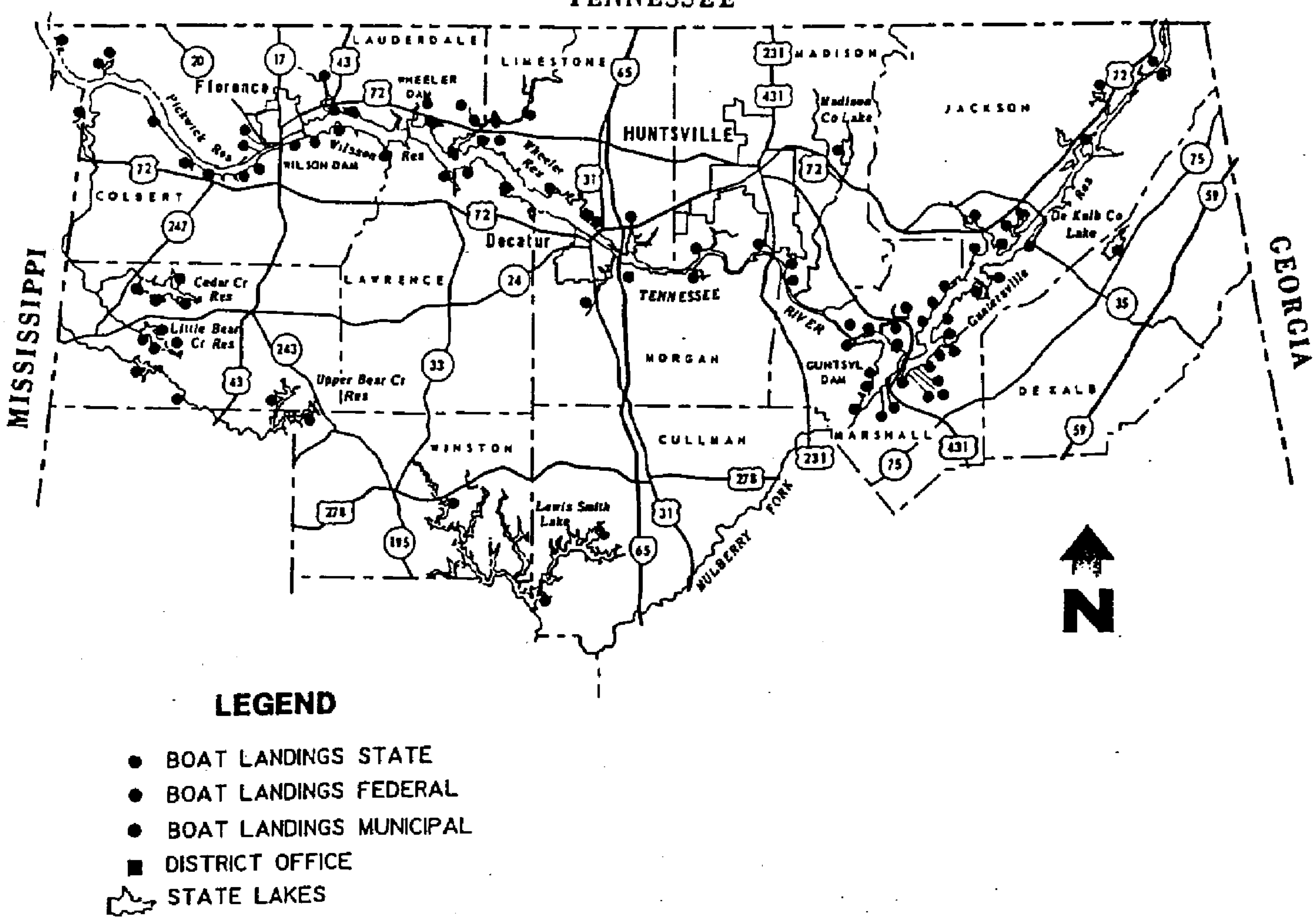
TABLE 9-3

DIOXIN CONCENTRATIONS IN FISH TISSUE SAMPLES TAKEN BELOW THE ALABAMA RIVER PULP, BOISE CASCADE CORP., AND HAMMERMILL PAPERS MILLS IN ALABAMA
(parts per trillion)

	1984	1986	1990	1991	1992	1993	1994
Bass[1]							
Alabama River Pulp	12.0	3.4-5.3	0.8-1.2	0.8-2.1	<0.3	<0.3	<0.2
Boise Cascade Corp.	—	4.3	1.5-1.8	0.3-1.8	0.4-0.6	<0.1-0.7	<0.1-0.4
Hammermill Papers	—	2.2	3.9-7.7[2]	0.9-2.8[3]	0.3-1.2	<0.5	0.4-0.8
Catfish[1]							
Alabama River Pulp	—	—	—	3-3.7	0.8-1.0	<0.4-1	<0.3-<0.4
Boise Cascade Corp.[4]	—	—	ND[4]-39.4[5]	2-5.3	0.7-1.4[6]	<0.1-0.4	0.5-0.6
Hammermill Papers	—	—	3.6-6.8[7]	0.7-0.9[6]	0.2-0.3[8]	<0.5-0.6[6]	—

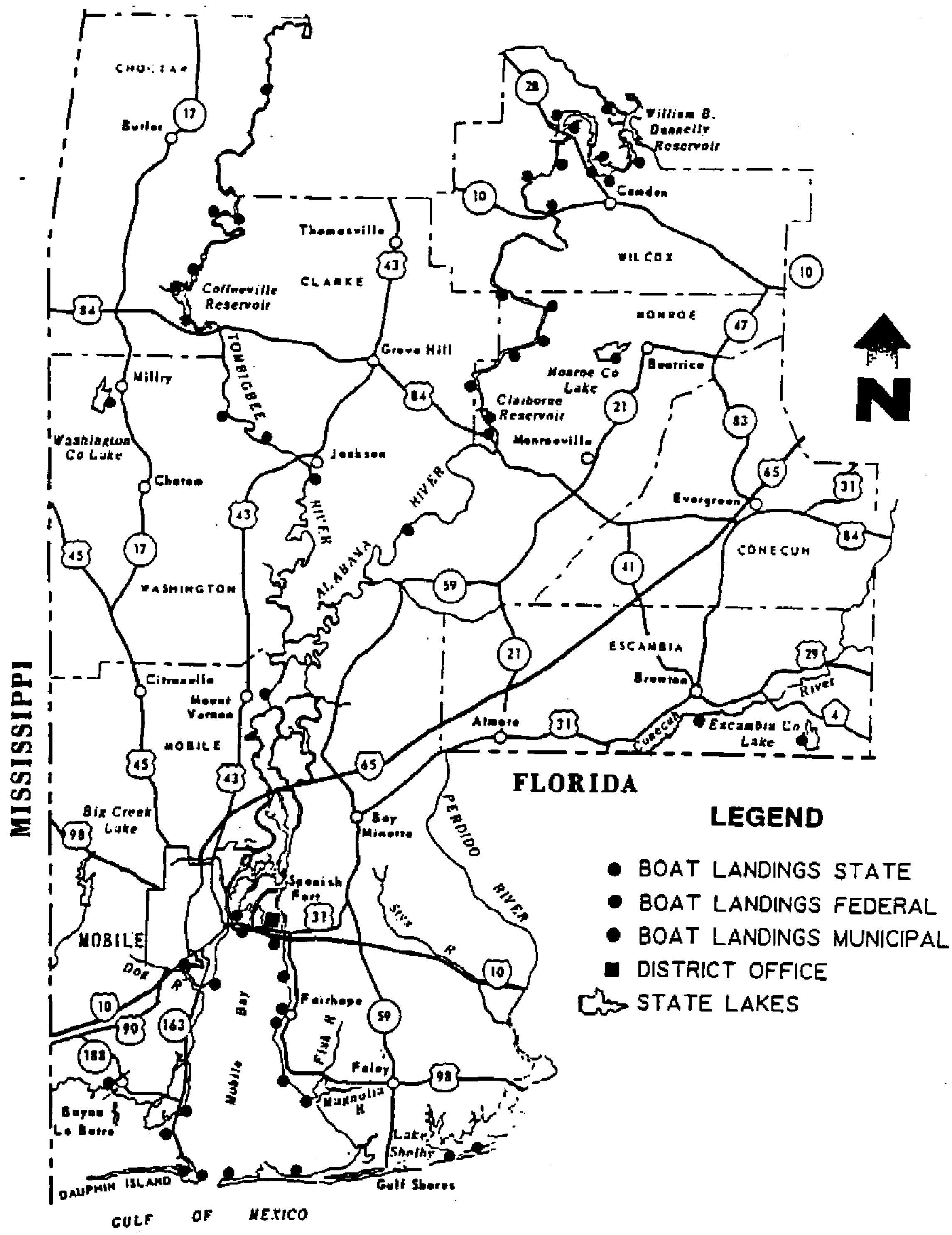
[1]Data from 1984-1990 represent fillets. Data from 1991-1994 represent composite fillets of fillets from six fish. Ranges represent different samples and may represent different sites.
[2]Data are for largemouth bass.
[3]Data for July 1991 show an average dioxin level of 2.2 ppt based on 17 samples. Four samples from July 1991 showed no detection of dioxin, however, the detection limit was not reported and these samples could not be included in the average.
[4]Nondetect.
[5]Upstream samples had concentrations ranging from ND to 1.2 ppt.
[6]Blue catfish.
[7]Flathead catfish.
[8]Yellow catfish.

Figure 9-2
Map of Public Boat Landings on the Wheeler Reservoir and the Tennessee River



Source: Alabama Department of Conservation and Natural Resources, 1990.

Figure 9-3
Map of Public Boat Landings on the Tombigbee and Alabama Rivers



Source: Alabama Department of Conservation and Natural Resources, 1990.

Tombigbee and Alabama rivers and in the Mobile area. Public access exists near all of the mill sites (Alabama Department of Conservation and Natural Resources, 1990).

Mill process changes reduced instream and fish tissue dioxin concentrations, and ended the FCAs in these waters, which most likely resulted in benefits in a variety of categories, including sportfishing, nonconsumptive use such as observing wildlife and feeding birds, human health benefits, and passive use benefits such as preserving resources for current and future use. The following sections describe estimated benefits to the extent feasible. However, because benefits are highly site specific and data are limited, these sections focus on a subregion of the state encompassing the Lower (south of Demopolis) Tombigbee River and Mobile River. Five mills are located in, and angler trip data are available for, this subregion.

Recreational Angling Benefits

Sportfishing is a popular activity in Alabama. A telephone survey of 1,000 Alabama households indicated that 72 percent of the respondents have been freshwater fishing, and 58 percent of the respondents own fishing equipment (Alabama Department of Conservation and Natural Resources, date unknown). In fiscal year 1993-1994, 560,229 residents and nonresidents bought Alabama fishing licenses (Alabama Department of Conservation and Natural Resources, 1994). According to Tucker (1987), bass is the most sought-after species, followed by crappie, bream, catfish, and striped bass. A recent study of freshwater fish consumption in Alabama found that fishing occurs near pulp and paper mill outfalls (FIMS and FAA, 1993).

Toxicity reductions from pulp and paper mills may result in significant benefits to recreational fishing, although limited data on the interrelated effects of reducing toxicity, recreational use, and site-specific economic values create uncertainty in the estimation of those benefits. From 1988 to 1991, the dioxin contamination from mills on the lower Tombigbee River and the Mobile River was widely publicized, and FCAs that advised limited or no fish consumption from these rivers were issued in 1991. Concerns about the health effects of eating contaminated fish may have reduced the value of the recreational fishery because the desirability of consuming fish may be an important attribute of the overall fishing experience (Knuth and Connelly, 1992; Vena, 1992; FIMS and FAA, 1993; West et al., 1993). The reduction in value may consist of two components: fewer fishing trips taken because of the FCAs, and the reduced value of trips that continue to be taken.

EPA estimated the recreational fishing benefits associated with the process changes at the pulp and paper mills on the Lower Tombigbee River and the Mobile River based on improvements resulting from the lifting of the FCAs: The estimates presented here include only the value of the increased number of fishing trips that may have resulted from removal of the FCAs. There is insufficient information in the literature to conduct a benefit transfer of the increased value of existing fishing trips. Only one study indicates the potential magnitude of reduction in quality resulting from toxic contaminants in a fishery (Lyke, 1993). This study showed an 11 percent to 31 percent increase in baseline value to Great Lakes trout and salmon anglers for a fishery that is "free of contaminants that may threaten human health." EPA did not use the Lyke study to estimate benefits for this case study because Great Lakes trout and salmon angling is appreciably different from warm water river fishing in Alabama. However, Lyke's results suggest that the recreational fishing benefits of a "contaminant-free" fishery may be substantial.

Table 9-4 presents evidence regarding the behavioral responses of anglers to FCAs. Another Wisconsin study provides supporting evidence: it asked anglers about the relative importance of various factors that played a part in choosing not to fish in the Great Lakes (Bishop et al., 1994). Roughly 55 percent of the respondents identified "PCB and other contamination in the fish" as a "somewhat important" or "very important" factor (no specific values were associated with these factors). No other single factor was cited by a higher proportion of respondents.

The studies cited in Table 9-4 suggest that between 10 percent and 37 percent of anglers take fewer trips in response to fish consumption advisories. However, these anglers may not eliminate trips to contaminated waters. Therefore, EPA conservatively assumed a 5 percent to 10 percent reduction in trips results from FCAs on the Lower Tombigbee River and in Mobile River Delta. The most recent data available show that recreational anglers took 542,000 trips to the Lower Tombigbee River and in Mobile River Delta in 1981 (FAA, 1983). EPA used this estimate as the number of trips before the publicity and FCAs since angler license sales in Alabama were relatively constant from 1981 through 1987. Thus, between 27,000 and 54,000 trips per year may have been lost as a result of the FCAs ($542,000 \times 0.05$; $542,000 \times 0.10$).

Table 9-5 shows estimated values for warm water fishing from the literature that may be appropriate for valuing fishing in Alabama. These studies show very similar values per day, and suggest a range of $21-

TABLE 9-4

BEHAVIORAL RESPONSES OF ANGLERS TO FISH CONSUMPTION ADVISORIES[1]

Study	Location	Reported Behavioral Response	
Fiore et al. (1989)	Lake Michigan and Green Bay, Wisconsin	57%	Reported changing fishing habits and/or fish consumption habits
Knuth, Connelly and Shapiro (1993)	Ohio River	37% 26% 26% 22% 17% 13%	Took fewer trips Changed fishing locations Changed species sought Changed cleaning methods Changed size of fish consumed Changed cooking methods
Vena (1992)	Lake Ontario, New York	53% 31% 30% 20% 16% 16%	Ate less fish Changed preparation methods Changed fishing locations Changed species sought No longer ate fish Took fewer trips
Silverman (1990)	Lake St. Clair Detroit River Lake Erie	56% 56% 41% 31% 31% 28% 21% 10%	Ate less fish Changed cleaning methods Ate smaller fish Changed fishing locations Ate different species Changed cooking methods Fished for different species Took fewer fishing trips
Knuth and Connelly (1992)	New York	70% 17% 40%	Ate less fish No longer ate sport caught fish Cooked fish differently
West et al. (1993)	Michigan	86% 80% 75% 46% 27%	Cooked fish differently (Great Lakes anglers) Ate less fish (Great Lakes anglers) Cleaned fish differently Ate less fish (overall) Cooked fish differently (overall)

[1]In addition to the studies reporting changes in behavior, in a study of Alabama anglers (FIMS and FAA, 1993), 83% reported that they would not eat fish from their fishing location if there were a health advisory warning against consuming fish caught at the site (James McIndoe, ADEM, personal communication, August, 1996). About 4% of Alabama recreational anglers do not eat their catch for fear of contamination of fish (FIMS and FAA, 1993). This behavior may stem in part from the FCAs and publicity in recent years.

TABLE 9-5

WARM WATER RECREATIONAL FISHING STUDIES

Study	Location	Unit Valued	Mean Reported Value[1]	Mean Reported Value[1] (1995 Dollars)
Palm and Malvestuto (1983)	Georgia and Alabama	Day	8.90 ($1978)	$20.80
Hay (1988)	All U.S. (bass)	User day	$13 ($1985) ($10-$16, 95% confidence interval)	$18 ($14-$23)
McCollum et al. (1990)	Southeast U.S. (incl. Alabama)	Day	$10.93 ($1986)	$15.20
Ziemer et al. (1980)	Georgia	Fishing occasion	$26.46 ($1980)	$48.94
Alabama Power Co. (1993)	Coosa River, Alabama	Hour	$4.19[2] ($1993)	$4.42[2]
Walsh et al. (1990)	All U.S.	User day	$23.55 ($1987)	$31.59

[1]Consumer surplus.
[2]A 4-hour fishing day would imply a value of $17-$18.

$31[4] for warm water fishing in Alabama [this range reflects Palm and Malvestuto's (1983) study of Alabama on the low end, and Walsh et al. (1990) on the high end]. Multiplying by the estimated reduction in trips provides potential benefits of between $567,000 and $1.7 million per year. As described above, this result may be conservative because it does not consider increases in the value of existing trips with improved water quality; it values only the new trips taken following the lifting of the FCAs.

Nonconsumptive Use Benefits

In 1991, Alabama residents spent approximately 2.5 million days involved in nonconsumptive recreational activities such as observing wildlife, visiting public areas, feeding wild birds or other wildlife, and photographing wildlife (U.S. DOI, Fish and Wildlife Service, and U.S. Department of Commerce, 1993). The activity days took place at locations greater than one mile from the recreationist's home. Thus, these days provide a conservative estimate of nonconsumptive use levels in Alabama since they do not include activities within one mile of the recreationist's home, or activities by nonresidents. A breakdown of activity level for the Lower Tombigbee River and Mobile River Delta is not available, however.

Reduced toxicity from pulp and paper mills, changes in the perceptions of contamination, and the removal of FCAs may result in nonconsumptive recreation benefits. Recreators often take fishing and nonconsumptive recreational trips together, and make decisions about what sites to visit depending on how attractive sites are for both types of recreation. Individuals who participate in nature viewing might accompany anglers on a fishing trip, but do not fish themselves. For example, in a recent study conducted at rivers and streams in southwestern Montana, nonfishing recreationists accompanied about 20 percent of all anglers (Morey et al., 1995). This finding from Montana suggests that increases in fishing trips to a site would be accompanied by increases in nonconsumptive recreational trips.

The increase in nonconsumptive recreation trips from reduced toxicity in Alabama rivers and streams will probably be smaller than the increase in recreational angling trips because of the direct effect of the removal of FCAs on angler trip-taking behavior. The effect on nonanglers is not expected to be so direct

[4] All values in 1995 dollars unless otherwise noted. Value inflated to 1995 dollars using the Consumer Price Index.

because the issue of consumption of contaminated fish is not involved. In the Montana study, which estimated the effect on trip taking when a site contaminated with heavy metals from mining waste was returned to “no-injury” conditions, the estimated ratio of the increase in nonconsumptive recreational use to the increase in fishing was about 0.2. Multiplying the estimated reduction in fishing trips to the Lower Tombigbee River and the Mobile River Delta as a result of FCAs (27,000 to 54,000) by 0.2 gives an estimate of the potential increase in nonconsumptive recreation with the stricter toxicity limitations: Between 5,400 to 10,800 additional nonconsumptive recreation days each year in the Lower Tombigbee and Mobile River Delta region.

Table 9-6 shows nonconsumptive recreation studies from the literature that may be appropriate for valuing nonconsumptive recreation in Alabama. The studies in Table 9-6 focus on the southeastern United States, and consistently reflect values in the range of $15-$30 per day. Transferring this range of values to the Lower Tombigbee and Mobile River area, and multiplying by the additional number of nonconsumptive recreation days, produces an estimate of potential benefits of between $81,000 to $324,000 per year.

Human Health Benefits

The ADEM observed significant decreases in fish tissue dioxin levels following the implementation of process changes at the Alabama bleached kraft mills. These reductions have benefited Alabama anglers who consume fish caught near the mills by reducing their risk of dioxin-related health effects. A recent study of freshwater fish consumption in Alabama found anglers and their family members consume fish caught in proximity to the mills’ outfalls (FIMS and FAA, 1993). This section describes the data and assumptions used to estimate the cancer risk reduction benefits that accrued in the Lower Tombigbee-Mobile River as a result of the lower fish tissue dioxin concentrations. The methodology employed below assumes that the pre-process change levels of dioxin in fish tissue would have continued without the controls.

Exposed Population. EPA used data on fishing license sales to residents to estimate the number of resident recreational anglers on the Lower Tombigbee and Mobile rivers (Alabama Department of Conservation and Natural Resources, 1994). Work by Tucker (1987) shows that approximately 5 percent of fishing trips by licensed anglers were to areas of the Lower Tombigbee and Mobile rivers. A fish consumption survey of Alabama freshwater anglers conducted from August 1992 to July 1993 found that the

TABLE 9-6

NONCONSUMPTIVE RECREATION STUDIES

Study	Location	Unit Valued	Reported Values[1]	1995 Value[1]
Bell (1981)	Atchafalaya River Basin, Louisiana	Day	$11.10 ($1975)	$31.44
Loomis et al. (1995)	Nashville, Tennessee region	Day-use	$7.96-$12.96 ($1980)	$14.72-$23.91
McCollum et al. (1990)	Southeast U.S. (incl. Alabama)	Day	$19.75 ($1986)	$27.46
Walsh et al. (1990)	All U.S.	User day	$22.20 ($1987)	$29.78

[1]Consumer surplus.

mean number of people eating fish at each meal was 3.9 (FIMS and FAA, 1993). Thus, the exposed population from the Lower Tombigbee and Mobile River area was estimated as 89,660 (421,906 anglers × 0.054 × 3.9 persons per meal).

Sport-Caught Fish Consumption. In the freshwater fish consumption survey conducted for the Alabama Department of Environmental Management from August 1992 to July 1993 to estimate the daily per capita consumption of fish from all Alabama rivers and reservoirs, anglers were interviewed at 23 tail-water sites and 6 reservoir sites. Consumption estimates were derived using two methods: (1) a harvest method, in which anglers identified the fish from their current catch to be consumed and the dressing method to be used, and (2) a 4-oz serving method, in which the palm of the hand was used as visual representation of the portion size. The study estimated consumption of all Alabama sport fish at 43 grams per person per day (gpd) and 46 gpd for the harvest and 4-oz serving methods, respectively (FIMS and FAA, 1993). For meals from fish harvested at only the study sites, the consumption estimates were 33 and 30 gpd for the harvest and 4-oz serving methods, respectively (FIMS and FAA, 1993).

Daily per capita consumption of fish harvested at study sites near bleached kraft mills was higher than daily per capita consumption of fish harvested at the other study sites. Consumption estimates based on seven study sites near bleached kraft mills were 45.1 and 38.3 gpd for the harvest and 4-oz serving methods, respectively (FIMS and FAA, 1993; E. Meredith, FIMS, personal communication, 1995). For the mill sites on the Lower Tombigbee and Mobile rivers, the study obtained higher estimates of 66.6 and 40.8 gpd for the harvest and 4-oz serving methods, respectively. Because the harvest method result (66.6 gpd) reflects a small sample size and may misrepresent consumption, EPA used the lower, statewide harvest method estimate in the calculation of risk in this area.

Fish Tissue Dioxin Levels. EPA calculated health risks based on exposure to dioxin (2,3,7,8-TCDD). ADEM (1995b) provided fish tissue contamination data. For the Lower Tombigbee and Mobile rivers area, the average dioxin level in 1990 fillet samples was 6.03 ppt. This average value includes samples from all five bleached kraft mills in the area. After the 1991 process changes, the average dioxin level in fillet samples from 1992 to 1994 was 0.30 ppt, which represents a 95 percent reduction from the 1990 average, and includes samples from all five area mills with nondetects set equal to one-half the detection limit.

Exposure Assumptions. Human health risks were calculated using the bleached kraft mill consumption estimates described above. Standard EPA assumptions were used regarding length of exposure (70 years) and body weight (70 kilograms) (U.S. EPA, 1989b).

Estimated Risk Reduction Benefits. Estimated risk reduction benefits resulting from the process changes implemented by the bleached kraft mills are estimated under the assumption that the mills cause the dioxin levels in fish near the mills. An appendix to this chapter provides the benefits calculations. The observed 95 percent reduction in fish tissue dioxin levels at the Lower Tombigbee and Mobile River sites would reduce excess cancer cases among area anglers and their families by between 0.040 and 0.044 cases per year. Based on the estimated value of a statistical life of $2.5 million to $9.0 million (American Lung Association, 1995), this reduction in cancer cases represents annual benefits from the process changes of between $93,000 and $370,000.

Uncertainties in the Estimation of Risk. There are numerous sources of uncertainties in the estimate of baseline risks, and in the estimated reduction in risks from implementation of the regulation. Variations in health risks may occur, depending upon the following factors:

- ***Type and Size of Fish Consumed.*** Bottom-feeding fish or older, larger fish are generally more contaminated than sport fish or young, small fish.

- ***Type of Fish Processing and Cooking Techniques Used.*** The estimate of baseline human health risks and the estimated reduction in risks from implementation of the regulation may vary because the analyses do not account for fish processing (such as removing the skin) and cooking techniques. For example, Stachiw et al. (1988) found that cooking to well done or applying high heat substantially reduced TCDD levels in fish fillets. Stachiw et al. (1988) examined the reductions of TCDD residue resulting from roasting and charbroiling restructured carp fillets (deboned carp fish parts) prepared from fish taken from Saginaw Bay. The reductions in TCDD residue ranged from 34 percent to 67 percent, depending on the method and temperature of cooking. In addition, a preliminary study using charbroiling of three carp fillets from Michigan rivers reported losses of TCDD ranging from 30 percent to 70 percent (Kaczmar, 1983, as cited in Stachiw et al., 1988).

Other studies report substantial decreases in toxic residues from cooking and processing. For example, Puffer and Gossett (1983, as cited in Stachiw et al., 1988) reported that panfrying white croaker reduced DDT compounds by 74 percent and 39 percent for fish caught from Santa Monica Bay and in Orange County, respectively. Zabik et al. (1993) reported percentage reductions of pesticides and total PCBs of approximately one third attributable to cooking and processing carp, chinook salmon, lake trout, walleye, and white bass caught from the Great Lakes. Removing the skin significantly reduced the level of pesticides in carp and chinook salmon.

The reduction in dioxin residues associated with cooking fish may vary by species, size of fish, and cooking methods. There is insufficient information to estimate the effect of cooking methods on risks to Alabama anglers; however, the studies mentioned above suggest that baseline risks and the risks associated with fish consumption after implementation of the regulation may be lower than estimated here.

- ***Other Contaminants in Fish.*** Baseline risks are calculated for dioxin only, since that is the focus of the benefits analysis for the regulation. Other contaminants that are not reduced by the regulation may be present in fish tissue. The presence of such contaminants would increase the baseline of cancer risk, but would not alter the marginal risk reduction.

- ***Age.*** Risks are calculated using total reservation populations; however, risks to children and elderly persons may not be accurately represented by these estimates.

- ***Pregnant and Nursing Mothers.*** Risks to unborn children and infants may result from the consumption of contaminated fish by pregnant and nursing mothers, and these risks may occur at lower levels than those posing risks to adults. Risks to fetuses and infants may not be accurately represented by these estimates.

- ***Genetic Differences.*** Genetic differences in the exposed population may affect susceptibility to carcinogens.

- ***Availability of Health Care.*** It is possible that quality health care is not as readily available for minority or lower income populations, which might result in increased health risks to these populations from exposure to contaminants.

- ***Other Modes of Toxicity.*** Other modes of toxicity such as endocrine disruption may not be addressed by the cancer slope factors and oral reference doses used in this analysis.

Passive Use Benefits

Passive use values may include bequest values for the availability of resources for use by others now and in the future, and existence values for the protection of resources even if they are never used. The literature (e.g., Boyle and Bishop, 1987; Bowker and Stoll, 1988) documents the values held by nonusers for the preservation of species. These values are most likely more significant for unique resources such as threatened and endangered species. In the case study area, Alabama households may value the reduced risk to piscivorous wildlife, including threatened and endangered species, resulting from the reduced concentrations of dioxin in fish near the mills.

The levels of dioxin in fish in Alabama rivers prior to the change in Alabama permits and the institution of controls listed in Table 9-2 may have posed some risk to wildlife. Dioxin concentrations of 6 pg/g (equivalent to ppt) in whole body fish are associated with low risk to avian wildlife, and concentrations of 60 pg/g are associated with high risk to avian species (U.S. EPA, 1993). Avian species in the Lower Tombigbee and Mobile rivers area include threatened and endangered species such as the bald eagle, which is listed as endangered in Alabama (U.S. Fish and Wildlife Service, 1994). For mammalian species, concentrations of 0.7 pg/g and 7 pg/g in fish are associated with low and high risk, respectively (U.S. EPA, 1993). As shown in Table 9-3, fillet concentrations, which tend to be lower than whole body concentrations, have been reported at levels that may pose risk to wildlife.

Without carefully designed and executed primary research, passive use values are difficult to estimate. Contingent valuation is the only method available for measuring passive use benefits. EPA is not aware of any studies of the potential magnitude of passive use values held by Alabama households for reduced dioxin contamination. However, research shows that passive use values may be substantial, and that leaving them out of benefit-cost analyses may cause a significant underestimation of benefits and misallocation of resources based on such estimates (Fisher and Raucher, 1984).

Fisher and Raucher found that passive use benefits are generally *at least* half as large as recreational fishing benefits, and that if these values are applicable to a policy action, using a 50 percent approximation with proper caveats is preferred to omitting passive use values from a benefit-cost analysis. This rule of thumb suggests that the potential magnitude of passive use values in the Lower Tombigbee and Mobile River Delta associated with reduced dioxin toxicity and removal of the FCAs is between $0.3 million to $0.9 million per year. Using this approach may provide a conservative estimate of benefits: studies in the literature have found a ratio of passive use values to use values of approximately 2.0 or greater (Sanders et al., 1990; Sutherland and Walsh, 1985).

Total Value Approach

Total values for the water quality improvements resulting from the stricter effluent limitations include both active uses and passive uses. The previous sections evaluated active and passive uses separately. This section addresses values associated with total use. The total use value is simply the value placed on natural resources by the public regardless of the motivation for the value. For active users of a resource, the total value may consist of both active use values and passive use values. For those holding only a passive use value, the total value is equal to the passive use value.

Although a theoretical distinction can be made between values arising from active uses and values arising from passive uses, separating these values is difficult both in theory and practice. Instead, a total value is often measured. Because total value estimates can include both active and passive use values, they should not be added to active use values. Because the number of passive users may greatly exceed the active users, even very small values per passive user can result in total values that substantially exceed active use values.

Table 9-7 describes studies measuring total use values that may be useful for a benefits transfer. Although there are no studies specifically for Alabama, the nature of the contamination and cleanup is similar to the water quality improvements experienced in Alabama. Perhaps the most similar are Devousges et al. (1987) and Croke et al. (1986). Devousges et al. measured willingness to pay to improve water quality conditions from boatable to fishable on a portion of the Monongahela River in Pennsylvania. Croke et al. estimated the value of improving all Chicago-area rivers to fishable conditions, and sampled users and nonusers living in the Chicago area. The water quality improvements valued in both of these studies are similar to the lifting of the FCAs on the Lower Tombigbee and Mobile rivers such that the rivers obtain “fishable” status . Devousges et al. and Croke et al. found values ranging from $27 to $64 per year for these improvements. Other relevant studies in Table 9-7 estimate even higher values.

Both active and passive use values for many environmental resources can be expected to be highest for people living near a site, and to decrease with distance. For direct use, this occurs because the probability of visiting a site decreases with distance, and the number of substitute sites increases with distance. Similar reasoning holds for passive use. Those closer to a site are more likely to be concerned about passing on the site to future generations and are more likely to be concerned with local environmental quality. Those farther

TABLE 9-7

CONTINGENT VALUATION STUDIES OF TOTAL VALUES FOR LOCAL HOUSEHOLDS ASSOCIATED WITH WATER QUALITY IMPROVEMENTS

Study	Resource Valued	Households Identified	Mean Values Reported in Study (1995 Dollars)
Desvousges et al. (1987)	Improvement in water quality from boatable conditions to fishable conditions along the Pennsylvania portion of the Monongahela River.	Households in PA Monongahela River counties	$27 to $62 per year
Croke et al. (1986)	Improvement in the water quality at Chicago area rivers to fishable conditions.	Households in the Chicago area	$64 per year
Schulze et al. (1995)	Complete cleanup of four NPL sites in Clark Fork, Montana where injuries have resulted in 80% reductions in trout stocks along 140 miles of river.	Montana households within approx. 100 driving miles from the site	$77 per year for ten years
Rowe et al. (1985, 1986)	Cleanup of hazardous waste sites in Colorado, including small mountain mines contaminating rivers.	Households in county of or city near site	$25 to $99 each year for ten years

from the sites may still hold appreciable values for the natural resources at the site, but may be more concerned with environmental (and other) issues closer to where they live.

To capture this effect, a range of values of $20-$60 per household per year based on Devousges et al. and Croke et al. is transferred to the approximately 200,000 households in counties adjacent to the Lower Tombigbee and Mobile River Delta. This results in estimated total benefits of the reduced toxicity levels and lifting of FCAs in the Lower Tombigbee and Mobile River Delta of between $4 million and $12 million. This estimate may be conservative because it does not account for values held by nonlocal residents. For example, Schulze et al. (1995) found that Montana households approximately 500 driving miles from the Clark Fork River were willing to pay $17 per year (1995 dollars) for 10 years to clean up National Priority List sites that had reduced river trout stocks. Rowe et al. (1985, 1986) found nonlocal households in Colorado were willing to pay $15 to $26 per year (1995 dollars) for 10 years to clean up mountain mines that contaminated rivers. Nonlocal values may be smaller but can also be significant because they may be held by a greater number of people.

The estimated total benefits range ($4 million to $12 million) can be expected to be higher than the sum of the direct use categories ($1 million to $3 million) estimated above. This is because there are categories of benefits that EPA did not explicitly estimate because of a lack of data and information (e.g., swimming, hunting, increased value of existing recreational trips, commercial fishing, noncarcinogenic human health risk reductions, agricultural and commercial/industrial uses). Also, as described above, EPA may have underestimated passive use values.

9.1.7 Summary of Water Quality Based Benefits

Table 9-8 provides a summary of the estimated water quality based benefits from the implementation of process changes at Alabama's bleached kraft pulp and paper mills. Benefits for the Lower Tombigbee and Mobile rivers region, which includes 5 of the 10 bleached kraft mills in the state, may be between $1 million and $12 million per year.

Table 9-9 shows key omissions, biases, and uncertainties associated with the benefits analysis. It is difficult to assess the overall impact of the omissions, biases, and uncertainties on the benefits estimates

TABLE 9-8

SUMMARY OF ANNUAL WATER BENEFITS FROM PROCESS CHANGES AT BLEACHED KRAFT PULP AND PAPER MILLS ON THE LOWER TOMBIGBEE AND MOBILE RIVERS (Millions of 1995 Dollars)

Benefit Category	Annual Value
Recreational Angling	$0.6-$1.7
Nonconsumptive Recreation	$0.1-$0.3
Human Health (cancer risk)	$0.1-$0.4
Passive Use	$0.3-$0.9
Omitted Benefits[1]	+
Total Explicitly Estimated Benefits Categories	$1.1-$3.3
Alternative Total Value Approach	$4.0-$12.0

[1]Benefits not quantified or monetized in this case study include systemic health risk reductions and the increased value of existing recreational angling trips from reductions in contaminant levels.
+ Positive benefits expected but not monetized.

TABLE 9-9

KEY OMISSIONS, BIASES, AND UNCERTAINTIES IN THE BENEFITS ANALYSIS FOR THE LOWER TOMBIGBEE AND MOBILE RIVERS

Omissions/Biases/Uncertainties	Direction of Impact on Benefit/Cost Estimates	Comments
The estimation of benefits by category omitted some categories (e.g., increased value of existing recreation trips)	(-) The omission of potential benefit categories will cause benefits to be underestimated.	Insufficient data and information to evaluate the potential magnitude of these benefits. Lyke (1993) found increase in value to Great Lakes anglers from a toxic-free fishery to be significant (between 11% and 31% of the value of existing trips).
Benefits were estimated using benefits transfer.	(?) It is unknown what bias the selected studies have on benefits.	Studies of Alabama or the south eastern U.S. were used if available. Transferred values are supported by a number of studies.
The estimation of human health benefits assumes all cancers are fatal.	(+) Assuming all cancers are fatal may cause an overestimate of benefits.	The "statistical value of a life" may not be appropriate for cancers that are survived for a number of years.
Passive use values are estimated as 50% of recreational angling benefits.	(-) The omission of the increased value of existing recreational angling trips may result in an underestimate. Use of the 50% figure may also result in a conservative estimate.	The increase in value of existing trips may be significant (see above). The ratio of passive use values to use values may be as high as 2.0 or greater (Sanders et al., 1990; Sutherland and Walsh, 1985).
Overall Impact on Benefits Estimates	(-)	The omission of potential benefit categories may result in an underestimate of benefits.

\+ Potential overestimate.
\- Potential underestimate.
? Uncertain impact.

because the direction and magnitude of bias is not known. However, omitting potential recreational angling benefits (increased value of existing trips), and basing passive use benefits on recreational angling values that do not include these values, may result in an underestimate of benefits.

9.1.8 Air Benefits

Table 9-10 provides a summary of the estimated emissions reductions and air-related benefits at Alabama's bleached kraft pulp and paper mills. These results were derived by using the national estimates methodology to model the Alabama mills. Annual air-related benefits for MACT I for the Lower Tombigbee and Mobile rivers region, which includes 5 of the 10 bleached kraft mills in the state, range from a disbenefit of $136.8 million to a benefit of $113.2 million under Option A and from a disbenefit of $135.3 million to a benefit of $133.4 million under Option B. Benefits of the proposed MACT II standard resulting from particulate matter reductions are valued at $81.7 million per year.

9.1.9 Comparison of Benefits and Costs

Retrospective Benefits and Costs

Table 9-11 provides a summary of the retrospective benefits from implementation of process changes at the mills on the Lower Tombigbee and Mobile rivers, and the estimated cost of these controls. EPA estimated a reduction in operating costs as a result of the process changes. Estimated capital costs of $26.3 million and operating and maintenance cost savings of $4.6 million per year for 30 years combine to result in net annualized cost savings of $1.8 million per year (ERG, 1996a) compared to annualized costs prior to the process changes.

TABLE 9-10

POTENTIAL ANNUAL AIR-RELATED BENEFITS OF THE SELECTED OPTIONS FOR BLEACHED KRAFT PULP AND PAPER MILLS ON THE LOWER TOMBIGBEE AND MOBILE RIVERS

Regulatory Option	Emission Reductions (Mg/yr)	Annual Value[1] (Millions of $1995)
Option A and MACT I		
VOC	0-43,897	$0-$113.2
Particulate Matter	(1.24)[2]	$0[3]
SO_2	(10,898)[2]-0	($136.8)-$0
TOTAL Monetized Benefits	NA	($136.8)-$113.2
Option A and MACT II		
Particulate Matter	6,472	$81.7
Option B and MACT I		
VOC	0-51,707	$0-$133.4
Particulate Matter	(3.83)[2]	$0[4]
SO_2	(10,776)[2]-0	($135.3)-$0
TOTAL Monetized Benefits	NA	($135.3)-$133.4
Option B and MACT II		
Particulate Matter	6,472	$81.7

[1] Benefits may not add due to rounding.
[2] Numbers in parentheses represent emissions increases and related increased social costs.
[3] Disbenefits of $15,648 per year.
[4] Disbenefits of $48,331 per year.
NA = Not applicable.

TABLE 9-11

BENEFITS AND COSTS OF THE WATER QUALITY PROCESS CHANGES IMPLEMENTED AT THE MILLS ON THE LOWER TOMBIGBEE AND MOBILE RIVERS

	Millions of 1995 Dollars
Annual Monetized Benefits Associated with Water Quality Improvements[1]	$1.1-$12.0
Annualized Costs for Improvements[2]	savings of $1.8
TOTAL Monetized Net Benefits[3]	$2.9-$13.8

[1]Not all benefits categories have been quantified and monetized.
[2]Based on annualized present value of pretax compliance costs, reflecting a 7% real discount rate and a 16 year accounting period.
[3]Retrospective benefits plus cost savings.

Benefits and Costs Comparable to the Regulation

All but one of the Alabama mills will still require extensive upgrading to comply with Option A guidelines[5], and assumed additional air controls will be required by the rule. At sites nationwide where effluent treatment systems resemble those in place at the Alabama mills before the changes in the 1990s, the regulatory benefits and costs that can be expected would include those that mills have already incurred (as described above), plus the costs and benefits of additional required upgrades. Table 9-12 shows the benefits and costs for the case study mills that are comparable to the current rulemaking. EPA has estimated the costs of the additional necessary upgrades for water treatment; however, it is not known what additional benefits would result from these further upgrades. The estimated costs and benefits for the air controls required by the rule are also shown in Table 9-12 (any associated costs and benefits potentially associated with upgrades in the early 1990s are not estimated).

9.1.10 Conclusions

In the early 1990s bleached kraft mills in Alabama implemented process changes to reduce the concentrations of dioxin in their effluents. All of the mills implemented chlorine substitution or changes that improved the mill's ability to use chlorine substitution. Two of the mills also implemented oxygen delignification. EPA estimates that the total annual benefits for the Lower Tombigbee and Mobile rivers region, which includes 5 bleached kraft mills, range from a disbenefit of $54.0 million to a benefit of $206.9 million under the selected regulatory options (Option A, final MACT I, and proposed MACTII Alternative A). This range of monetized benefits does not include all benefit categories and EPA anticipates that additional water-related benefits could be achieved from implementation of the rule. Associated annualized costs are estimated to be $32.5 million.

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[5]Option B is a Tier 1 incentive. The reader is directed to the preamble published in the *Federal Register* accompanying this rule for a discussion on incentives.

TABLE 9-12

ANNUAL BENEFITS AND COSTS COMPARABLE TO THE FINAL PULP AND PAPER REGULATION FOR THE LOWER TOMBIGBEE AND MOBILE RIVERS[1] (Millions of 1995 Dollars)

	Compliance with Option A	**Compliance with Option B**
Annual Monetized Benefits		
Water[2] (retrospective)	$1.1-$12.0	$1.1-$12.0
Air[3] (MACT I)	$(136.8)-$113.2	($135.3)-$133.4
Air (MACT II)	$81.7	$81.7
Water and MACT I	($135.7)-$125.2	($134.2)-$145.4
Water, MACT I, and MACT II	($54.0)-$206.9	($52.5)-$227.1
Annualized Costs[4,5]		
Water	$22.4	$28.3
Water and MACT I	$32.0	$37.9
Water, MACT I, and MACT II	$32.5	$38.4

[1] Option A is the Agency's selected BAT/PSES option.
[2] Steady state benefit levels omitting nonmonetizable benefits and potential benefits from additional upgrades to meet compliance with rule.
[3] Estimated air benefits do not include any benefits that may have occurred as a result of past upgrades.
[4] Based on annualized pretax compliance costs, reflecting a 7% real discount rate and a 16 year accounting period.
[5] Includes retrospective and forthcoming water costs and forthcoming air costs.

9.2 PIGEON RIVER CASE STUDY

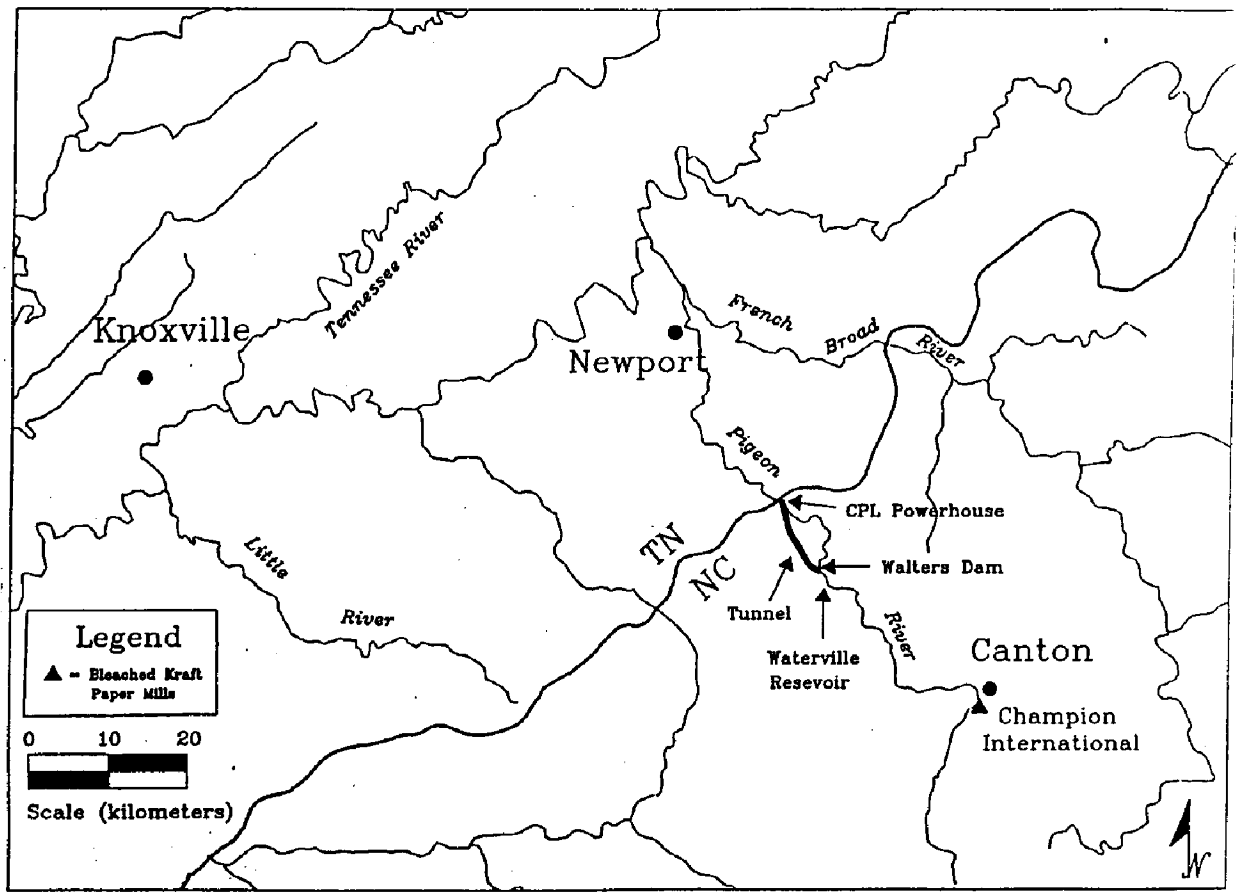
The Champion International pulp and paper mill in Canton, North Carolina, covers 200 acres on the banks of the Pigeon River. Operations at the bleached papergrade kraft mill include pulping, bleaching, and converting hardwood and softwood into uncoated business paper and bleached paper board for the liquid packaging industry. The mill has been discharging effluent to the Pigeon River since 1907.

The Pigeon River flows from the mountainous region of western North Carolina and crosses into eastern Tennessee approximately 38 miles downstream from the Champion International mill (see Figure 9-4). In the past, water quality and aesthetic problems limited recreation on and in the Pigeon River, as did a lack of predictable flow levels because of unscheduled hydroelectric project releases. EPA's National Dioxin Survey first documented dioxin contamination of the Pigeon River in 1988. As a result, both Tennessee and North Carolina issued FCAs for all species of fish.

In the early 1990s, Champion International initiated a large modernization project at the mill, including installation of oxygen delignification and chlorine dioxide substitution to 100 percent (actually surpassing the BAT option considered in this rule). Since the modernization, the water quality of the Pigeon River has improved and beneficial uses of the river have increased. The North Carolina Department of Environment, Health, and Natural Resources (DEHNR) and the Tennessee Wildlife Resources Agency (TWRA) have noted an increase in the diversity of fish species populating the river downstream from the mill, and the FCAs on the river have been partially lifted (advisories for carp and catfish remain in effect). In addition, there has been increased use of the river for whitewater boating, and decreased complaints about color and odor (U.S. EPA, 1994).

This case study provides estimates of the benefits realized from the process changes implemented at the Champion International mill. To the extent that these process changes reflect the final rule Tier 1 incentives (Option B), the costs of the process changes and the associated benefits may indicate the potential benefits at facilities where similar processes have not yet been implemented.

Figure 9-4
Map of Pigeon River



9.2.1 Water Quality Issues on the Pigeon River

As early as the 1940s, water quality studies conducted on the Pigeon River indicated that discharges from the Champion International mill severely degraded the river. In 1988, sampling of the Pigeon River found dioxin at a level of 22.1 ppt in the whole body of a carp.

Additional furan isomers increased the relative concentration to 25.2 ppt in carp, according to the Tennessee Department of Environment and Conservation (TN DEC, 1992). Further sampling confirmed that dioxin presented a potential health problem from the consumption of Pigeon River fish, and by 1989 both Tennessee and North Carolina issued “no consumption” advisories for all fish from the Pigeon River.

In addition to the dioxin studies, fish community structure sampling, performed by the DEHNR in 1987, indicated that the Pigeon River’s fish community below Champion International was severely degraded to the North Carolina border (rated Fair-Poor, Poor, or Very Poor). Species diversity and fish abundance levels were greatly below expectations, and darter and intolerant species were absent. Many fish were diseased (from 8 percent to 66 percent), a clear indication of toxic substances in the water. DEHNR also sampled the Pigeon River at two locations above the Champion mill, and both of these sites were rated as Good (North Carolina DEHNR, undated).

In addition, color, odor, and foam have historically been significant problems on the Pigeon River and have detracted from recreation in the area. North Carolina rated the river downstream from Canton as Class C water, which indicates that immersion should be infrequent. In Tennessee, the river has historically failed to meet state requirements for aquatic life or recreational uses (Kask and Shogren, 1994).

These water quality problems are attributed largely to the discharges from the Champion International mill. No other industries discharge to the Pigeon River. Two municipal wastewater treatment plants (WWTPs) and the Dayco Corporation discharge to tributaries of the Pigeon River; however, the contribution of these tributaries to the degradation of the Pigeon River is limited. In a benthic study these tributaries were rated as Good-Fair and Good (NC DEHNR, undated). Pollutants originating from nonpoint source runoff may contribute to the detriment of the Pigeon River, but there is no evidence that they are significant compared to the effects of Champion’s discharge in Canton (Saylor et al., 1993).

In the late 1980s, water quality and aesthetic problems severely limited recreational use of the Pigeon River. Unofficial estimates indicate that fewer than 200 recreational boaters (rafts, kayaks, and canoes) used the river annually (M. Fagg, Tennessee Wildlife Resources Agency, personal communication, 1995). The FCAs, low species diversity, and low catch rates limited the use of the river for fishing. In addition, the odor, color, and foam limited enjoyment of activities along the river banks.

9.2.2 Modernization of the Champion International Mill

The Champion International mill in Canton has been upgraded on numerous occasions. However, Champion's most recent modernization, completed in 1994, addressed citizen concerns about pollution of the river and complied with a revised NPDES permit issued in October 1989 (U.S. EPA, 1994). Concern about pollution of the Pigeon River resulted from BOD and color discharges as well as dioxin contamination.

The Champion International mill upgrade included:

- installation of medium consistency oxygen delignification (OD)
- new compaction baffle washers for the pine bleach line
- closed screen room (with pressure-type screens)
- upgrade of pulping area condensate stripping (installation of stripper)
- increase in chlorine dioxide substitution to 100 percent
- elimination of the use of elemental chlorine and calcium hypochlorite
- oxygen and peroxide (for pine) enhanced extraction
- improved spill control
- redesign of activated sludge treatment plant
- maintenance work on the recovery boilers, including replacing lower windboxes and, for one boiler, replacing the screen tubes.

The mill spent approximately $52.2 million in capital costs for the environmentally important parts of the upgrade and annual operating costs increased by approximately $1.8 million (1995 dollars)(ERG, 1996a). These upgrades exceed EPA's Option A because the mill installed oxygen delignification in both fiber lines, but correspond quite closely with (and supersedes) EPA's Option B. The only additional costs that the mill will incur as a result of the regulation (under either Option A or Option B) will be for effluent monitoring.

9.2.3 Water Quality Improvements

Champion International and the Carolina Power & Light Company report that the dioxin concentration of mill effluent has been below the detection limit since 1989, when the mill began using chlorine substitution (NC DEHNR, undated). However, sediment contamination can persist, and pollutants can continue to accumulate in organisms; therefore, it is important to evaluate actual fish tissue concentrations of dioxin.

Sampling of dioxin concentrations of Pigeon River fish has been limited. However, sampling conducted by Champion International and the Carolina Power & Light Company indicates that fish tissue concentrations improved every year between 1990 and 1995 (NC DEM, unpublished). The improvements in the river reach above Waterville Reservoir have resulted in a lifting of the North Carolina fish consumption advisory for all species except carp and catfish taken from the Pigeon River (Table 9-13).

Table 9-14 illustrates the decline in dioxin concentration at a sampling points in Waterville Reservoir. Dioxin concentrations in fillet tissue of middle feeding group fish (such as redbreast sunfish and smallmouth buffalo) declined from an average of 7.7 ppt (total TEQ) in 1988 to an average of 0.2 ppt in 1995, and average dioxin concentrations in tissue of predator feeding group fish (such as smallmouth bass) declined from an average of 21.0 ppt in 1988 to an average of 0.9 ppt in 1995. For bottom feeding fish, such as carp and catfish, dioxin concentrations in fish tissue remain above North Carolina's action level of 3 ppt for fish consumption advisories. Fish taken from the Pigeon River upstream of Waterville Reservoir (closer

TABLE 9-13

FISH CONSUMPTION ADVISORIES ISSUED FOR THE PIGEON RIVER BELOW THE CHAMPION INTERNATIONAL PULP AND PAPER MILL

	Action Level	**FCA Status 1988**	**FCA Status 1996**
Tennessee	7 ppt (no consumption) 0.7 ppt (partial advisory)	No consumption all species	Limited consumption carp, catfish, and redbreasted sunfish
North Carolina	30 ppt (no consumption) 3 ppt (partial advisory)	No consumption all species	No consumption carp and catfish

TABLE 9-14

AVERAGE FISH TISSUE DIOXIN CONCENTRATIONS IN WATERVILLE RESERVOIR, NORTH CAROLINA[1]

	Total TEQ	2,3,7,8-TCDD	2,3,7,8-TCDF
Bottom Feeding Group			
1988	8.6	8.6	
1989	—	—	—
1990	—	—	—
1991	13.8	13.7	1.2
1992	8.7	8.6	0.8
1993	6.8	6.1	0.7
1994	7.8	7.7	1.0
1995	4.2	4.0	0.8
Middle Feeding Group			
1988	7.7	6.8	8.0
1989	—	—	—
1990	—	—	—
1991	0.3	0.3	0.6
1992	0.2	0.2	0.2
1993	0.2	0.1	0.6
1994	0.1	0.1	0.1
1995	0.2	0.1	0.3
Predator Feeding Group			
1988	21.0	19.7	9.4
1989	—	—	—
1990	—	—	—
1991	0.9	0.9	0.4
1992	0.3	0.3	0.1
1993	0.6	0.7	0.5
1994	0.2	0.1	0.2
1995	0.9	0.7	0.4

Source: NC DEM, unpublished.
[1]No data available for 1989 or 1990. Based on 77 samples in the bottom feeding group, 44 samples in the middle feeding group, and 30 samples in the predator feeding group.

to the Champion mill) showed similar reductions in dioxin concentrations, although the concentrations in bottom feeding fish were not as high as in fish from Waterville Reservoir[6] (Table 9-15).

The Pigeon River crosses the state line into Tennessee just below the reservoir, and Tennessee applies a more stringent action level for FCAs (see Table 9-13). As with the data for the portion of the Pigeon River in North Carolina, data from the Tennessee Department of Environment and Conservation (TN DEC) indicate that dioxin concentrations in fish tissue from samples taken between the Waterville Reservoir and Newport, Tennessee, declined between 1988 and 1994. As a result, the TN DEC lifted the FCA for all species of fish, except for carp and catfish. The advisory for carp and catfish, has been relaxed to an advisory to limit consumption of carp, catfish, and red breasted sunfish to 1.2 pounds per month (children and pregnant or nursing women should not consume these species) (TN DEC, 1996).

As shown in Table 9-16, dioxin concentrations in the tissue of middle feeding group fish such as redbreast sunfish and smallmouth buffalo declined from 3.9 ppt (total TEQ) in 1988 to 0.2 ppt in 1995. Dioxin concentrations in the tissue of predator feeding group fish such as smallmouth bass declined from 4.0 ppt in 1988 to 0.4 ppt in 1995. For bottom feeding fish such as carp and catfish, dioxin concentrations in fish tissue declined from 19.6 ppt in 1988 to 0.8 ppt in 1995 (TN DEC, unpublished).

Champion International's oxygen delignification process reduces the color of the effluent, the instream concentrations of BOD and TSS, and conductivity (NC DEHNR, 1994). The mill renovation resulted in a 65 percent to 70 percent reduction in color discharged from the bleach plant (U.S. EPA, 1994). Before the upgrade, BOD discharges from the mill averaged 4,500 pounds per day. In 1994, the mill discharged 1,500 pounds per day, and the need to supplement the river with oxygen was greatly reduced (U.S. EPA, 1994).

The North Carolina DEHNR used benthic macroinvertebrate information to assess the water quality improvements due to the process changes at the Champion. Between 1988 and 1994, the measures of biotic health improved at monitoring sites downstream of the mill, while remaining relatively constant at monitoring

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[6]The higher concentrations in bottom feeding fish in the reservoir as compared to the river may reflect a longer retention time of dioxin in the reservoir and the dependence of the fish in the reservoir on these contaminated waters for their food supply (B. Tracey, North Carolina Department of Environmental Management, personal communication, 1996).

TABLE 9-15

AVERAGE FISH TISSUE DIOXIN CONCENTRATIONS IN THE NORTH CAROLINA PORTION OF THE PIGEON RIVER[1]

	Total TEQ	**2,3,7,8-TCDD**	**2,3,7,8-TCDF**
Bottom Feeding Group			
1987	5.8	5.2	5.6
1988	—	—	—
1989	—	—	—
1990	—	—	—
1991	6.1	6.1	—
1992	—	—	—
1993	4.2	3.3	—
1994	1.5	1.5	—
1995	1.9	1.5	1.2
Middle Feeding Group			
1987	10.2	9.9	—
1988	—	—	—
1989	—	—	—
1990	—	—	—
1991	0.7	0.7	—
1992	—	—	—
1993	0.3	—	—
1994	0.1	0.1	—
1995	0.2	0.1	0.1

Source: NC DEM, unpublished.

[1]No data available for 1988, 1989, 1990, and 1992, and for 1993 and 1994 for 2,3,7,8-TCDD. Based on 11 samples in the bottom feeding group and 18 samples in the middle feeding group.

TABLE 9-16

AVERAGE FISH TISSUE DIOXIN CONCENTRATIONS IN THE TENNESSEE PORTION OF THE PIGEON RIVER[1]

	Total TEQ
Bottom Feeding Group	
1988	19.6
1989	—
1990	—
1991	6.2
1992	3.6
1993	2.9
1994	2.1
1995	0.8
Middle Feeding Group	
1988	3.9
1989	—
1990	—
1991	1.3
1992	1.5
1993	0.8
1994	0.1
1995	0.2
Predator Feeding Group	
1988	4.0
1989	—
1990	—
1991	0.5
1992	0.5
1993	0.3
1994	0.1
1995	0.4

Source: TN DEC, unpublished.
[1]No data available for 1989 and 1990. Based on 24 samples in the bottom feeding group, 25 samples in the middle feeding group, and 13 samples in the predator feeding group.

sites above the mill. "A marked improvement in the biological integrity of the Pigeon River was noted at the Hepco Bridge location (just above Waterville Reservoir) relative to a survey conducted there in 1988" (NC DEHNR, 1994). As a result, the portions of river reach below the mill were upgraded from "Poor" or "Fair" bioclassifications to "Fair" or "Good/Fair" bioclassifications. Given the consistently "Good" bioclassifications above the mill, the modernization project at Champion International appears to have improved water quality conditions on the Pigeon River (NC DEHNR, 1994). Tennessee has also seen improvements in species diversity (G. Denton, Tennessee Water Pollution Control, personal communication, 1996).

9.2.4 Qualitative Assessment of Benefits

The modernization project resulted in aesthetic improvements in water quality and reductions in both instream and fish tissue dioxin contamination. These improvements increase the opportunities for recreational uses of the river such as boating, angling, and noncontact uses (wildlife viewing, picnicking). This discussion includes benefits that are quantified, as well as other, qualitative benefits that are difficult to value.

Recreational Boating

The increased use of the river for rafting, kayaking, and canoeing is the principal benefit of the Champion mill modernization. The river downstream of the hydroelectric project has Class III and IV whitewater rapids, which are in high demand in the area. [7] Many of the nearby controlled-release rivers with

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[7]The International Standard for classifying the difficulty of rivers and rapids is as follows:
Class I: Easy. Waves small and regular.
Class II: Rapids of medium difficulty.
Class III: Waves numerous, high, irregular; rocks, narrow passages.
Class IV: Long rapids; powerful, irregular waves; dangerous rocks; boiling eddies.
Classes V & VI: Suitable for kayaks and decked canoes only. Not suitable for rubber rafts. (Wheat, 1983).

comparable whitewater opportunities, such as the Ocoee[8] and the Nantahala, have significant overcrowding problems. The Ocoee and the Nantahala rivers each had more than 180,000 users in 1992 (Manuel, 1993).

Boating activity on the Pigeon River increased because of both the water quality improvements resulting from Champion International's modernization project and a newly implemented schedule of predictable releases from the hydroelectric project, which is controlled by Carolina Power & Light Company. Here the benefits associated with the increase in recreational boating will be attributed equally to both the modernization project and the release schedule.

In the past, poor water quality was a significant deterrent to recreational boating on the Pigeon River. Frequent water contact and occasional swimming occur during whitewater rafting, kayaking, or canoeing, and North Carolina's recreational rating of the river recommended that users avoid frequent immersion in the Pigeon River.

In conjunction with Champion's efforts to improve the water, the Tennessee Wildlife Resources Agency (TWRA) used the FERC licensing process to create a schedule of releases that would provide greater certainty for users planning recreational activities on the river. During the 1994 boating season, Carolina Power & Light voluntarily operated a toll-free telephone number that identified when releases would be made; beginning in 1995, the hydroelectric project scheduled releases on a regular basis during the boating season (FERC, 1994).

As a result of the water quality improvements and the availability of release information, recreational boating use of the river increased from approximately 200 annual users in 1993 to 24,600 and 42,000 annual users in 1994 and 1995, respectively. Recreational use of the river will increase to approximately 55,000 to 60,000 annual users in 1996 (P. Lucas, Carolina Power & Light Company, personal communication, 1996). This estimate is conservative because it does not include rafting on a 10-mile stretch of river in North Carolina that is considered a good "brown" (slow moving) water rafting run (Kask and Shogren, 1994).

[8]Site of the 1996 Olympic kayaking events.

Recreational Angling

Because of its length and topography, the river reach below the Champion mill has the potential of supporting significant smallmouth bass and redbreast sunfish fisheries (J. Borawa, North Carolina Wildlife Resources Department, Boating and Inland Fisheries, personal communication, 1996). Unlike many of the smallmouth bass fisheries in the area, much of the Pigeon River below the Champion mill is suitable for wading or canoeing-based angling (J. Borawa, North Carolina Wildlife Resources Department, Boating and Inland Fisheries, personal communication, 1996). In addition, the tributaries to the Pigeon River are trout streams and, in periods of cool weather, trout can be found in the Pigeon River.

Angling activity increased after the lifting in August 1994 of the FCA on the North Carolina portion of the river for all species except carp and catfish, and in January 1996 of the FCA on the Tennessee portion of the river for all species except carp and catfish. The increased angling activity can be attributed to the process changes at the Champion mill and, in the Tennessee portion of the river, the minimum flow requirements in the Carolina Power & Light Company FERC license. In the Tennessee portion of the river, fluctuation in flow is one of the dominant factors adversely influencing the structure of benthic communities (EA Engineering, Science, and Technology, Inc., 1988).

Noncontact Recreational Activities

Improved aesthetic conditions of the Pigeon River may also increase noncontact use of the area. The river has the potential to be an attractive recreational site with easy access from Interstate 40 and proximity to the Pisgah National Forest and the Great Smoky Mountains National Park, which is the most frequently visited national park in the country (I. McMann, Newport Tourism Department, personal communication, 1996). A National Park Service campground is located within 3.2 km of the major access point for boating activities, just below the hydroelectric plant (Bach and Barnett, 1987).

Ecological and Passive Use Benefits

The decreased concentrations of dioxin in plant effluent and in fish tissue most likely resulted in reduced risks to piscivorous avian and mammalian species, and individuals may value this ecologic benefit apart from any values associated with their direct or indirect use of the Pigeon River. Dioxin has been found to pose a risk to aquatic-associated wildlife, and the most sensitive ecologically important endpoints for mammals and birds are reproductive effects (U.S. EPA, 1993). Before the Champion modernization project, dioxin concentrations in whole body fish samples from the Pigeon River were as high as 92.1 ppt (NC DEM, unpublished).

Fish tissue concentrations at this level pose a high risk to both avian and mammalian piscivorous species. For piscivorous avian species, consumption of fish with dioxin concentrations above 6 ppt is low risk, and consumption of fish with concentrations above 60 ppt is high risk (U.S. EPA, 1993). For piscivorous mammalian species, risks occur at much lower concentrations: above 0.7 ppt is low risk and above 7 ppt is high risk (U.S. EPA, 1993).[9]

Piscivorous avian species in the area surrounding the Pigeon River include federally threatened and endangered species such as the bald eagle (C. McGrath, North Carolina Wildlife Resources Commission, Nongame & Endangered Wildlife Program, personal communication, 1996). In addition, two otters were sighted below Waterville Reservoir after a project to reintroduce the otter in the area (J. Borawa, North Carolina Wildlife Resources Department, Boating and Inland Fisheries, personal communication, 1996).

9.2.5 Quantitative Assessment of Benefits

The following analysis provides a quantitative assessment of those types of benefits that can be readily valued in the case study area. The benefits are generally estimated as a range of values in order to provide a credible estimate of potential benefits and to allow for an order of magnitude comparison to costs.

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[9]The high bioaccumulation potential and toxicity of TCDD result in water concentrations of concern that are below ordinary analytical detection limits; therefore, the effects of dioxin are often expressed in terms of concentrations in the diet rather than environmental concentrations (U.S. EPA, 1993).

Recreational Boating Benefits

In 1994 and 1995, Carolina Power & Light Company documented approximately 24,600 and 42,000 annual users of the river, respectively; this is in contrast to fewer than 200 annual users in previous years. Additionally, based on use to date, Carolina Power & Light is estimating 55,000 to 60,000 users in 1996.

This dramatic increase in use has led to concern about overcrowding on the river. The Tennessee Legislature passed a law in the 1995 session allowing Cocke County to issue permits for commercial outfitters on the river. The legislation allows the county to control the use of the river and to prevent the type of overcrowding problems that are common on other Tennessee whitewater rivers such as the Ocoee (I. McMann, Newport Department of Tourism, personal communication, 1996).

In addition, the TWRA has negotiated with other interested parties to ensure, through the hydroelectric project's FERC license, that releases are scheduled to provide greater certainty for individuals planning to use the river for recreational boating and to ensure that the number of scheduled releases increase to accommodate greater use of the river. The FERC license requires that when the number of rafters and boaters who use the Pigeon River exceeds 50,000 annually during the hours of scheduled releases, the hydroelectric project will schedule a release during one additional weekday of each week (FERC, 1994). The number of release days was negotiated between all interested parties to meet the varied demands on the river (e.g., maintaining levels in Waterville Reservoir, alleviating overcrowding on the river).

The capacity of the launch site constrains the carrying capacity of the river for whitewater recreation. Based on the physical capacity of the launch site, the estimated carrying capacity of the Pigeon River is approximately 288 users per hour (Kleinschmidt Associates, 1995). Using this estimate and the number of hours of scheduled releases required by the plant's FERC license, the carrying capacity of the river is calculated to be 110,392 annual users. The estimate of carrying capacity is based on four release days per week, the maximum number of scheduled release days required by the current FERC license. This is a conservative estimate because it does not account for releases that are not required by the FERC license but are announced through the toll-free telephone line and that attract additional commercial and noncommercial users. Carolina Power & Light estimates that in a typical year, they will be able to announce frequent releases through their toll-free telephone number. For much of the 1995 season, the hydroelectric project was able to announce six scheduled release days per week (P. Lucas, Carolina Power & Light Company, personal communication, 1996).

EPA developed two scenarios for the growth in recreational boating use of the river to provide a range of estimated benefits associated with improvement in water quality. In the low growth scenario, use increases at a 5 percent annual rate. This growth rate is moderate, reflecting local efforts to prevent overcrowding; it is probably conservative in light of the increase in recreational activity from 1994 to 1996. At a 5 percent rate of growth, total annual users will reach 109,985 in 2010. It is assumed that river use in subsequent years will be limited to 110,392 by the carrying capacity of the river.

In the high growth scenario, use levels reach the carrying capacity of the river (110,392 annual boating days) in three years (by 1999), and total annual users will be restricted to this level in subsequent years.

Table 9-17 shows user day value estimates in the literature for nonmotorized boating. No studies on North Carolina or Tennessee whitewater rafting are available, and only one study in the southeastern part of the United States was identified. A range of values from $20 to $34 is used to estimate benefits in this analysis. This excludes the value from Bishop et al. (1989) and the value from Alabama Power Company (1993). Bishop et al. (1989) may be considered a high-end estimate because of the unique character of the Colorado River, and Alabama Power Company (1993) was not used because the activity occasion is valued per hour rather than per trip.

Combining the use level pattern and the range of user day values ($21-$34) results in a range of estimates for the value of recreational boating use of the Pigeon River over a 20 year period (Table 9-18). Because it is unlikely that the estimated boating benefits would have occurred without both the improvement in water quality and the certainty of sufficient water levels for recreation, these benefits are attributed 50 percent to the process changes at the mill and 50 percent to the scheduling of releases.

As shown in Table 9-18, estimated annual benefits attributable to the process changes at the mill in 1996 are between $0.58 million and $0.94 million. At peak capacity, annual recreational boating benefits may be between $1.16 million and $1.88 million.

TABLE 9-17

NONMOTORIZED BOATING STUDIES

Study	Location	Type of Boating	Unit Valued	Mean Reported Value[1]	1995 Value[1]
Bishop et al. (1989)	Colorado R. below Glen Canyon Dam	Commercial, whitewater rafting	Day	$30.00 (1985)	$42.00
Alabama Power Co. (1993)	Coosa R., Alabama	Whitewater rafting	Hour	$6.19 [2] (1993)	$6.52 [2]
Rosenthal et al. (1984)	Upper Delaware River	Kayaking and canoeing	Day	$13.68 (1983)	$20.93
Walsh et al. (1990)	U.S.	All types	Day	$25.36 (1987) [3]	$34.02 [3]

[1]Consumer surplus.
[2]A trip down the Pigeon River is approximately 1.5 hours (Big Pigeon River Council, personal communication), which would imply a value of $9.29 (1993) or $9.78 (1995).
[3]Adjusted for different methodological and empirical approaches and study dates. The median is reported here because of the notable difference between the mean and the median (suggesting that the frequency distribution is skewed such that relatively few extremely high estimates substantially increase the mean).

TABLE 9-18
BOATING BENEFIT ESTIMATES FOR THE PIGEON RIVER

Year	Growth in Users[1]	Stream of Annual Benefits[2]	
		Joint Benefits[3] (Millions $1995)	Process Change Benefits[4] (Millions $1995)
Use Increase Based on River Counts			
1994	24,400	$0.51-$0.83	$0.27-$0.41
1995	41,800	$0.88-$1.42	$0.44-$0.71
1996	55,550	$1.17-$1.89	$0.58-$0.94
Projected Use Increase			
1997	58,328-72,215	$1.22-$2.46	$0.61-$1.23
1998	61,244-93,880	$1.29-$3.19	$0.64-$1.60
1999	64,306-110,392	$1.35-$3.75	$0.68-$1.88
2000	67,521-110,392	$1.42-$3.75	$0.71-$1.88
2001	70,897-110,392	$1.49-$3.75	$0.74-$1.88
2002	74,442-110,392	$1.56-$3.75	$0.78-$1.88
2003	78,164-110,392	$1.64-$3.75	$0.82-$1.88
2004	82,073-110,392	$1.72-$3.75	$0.86-$1.88
2005	86,176-110,392	$1.81-$3.75	$0.90-$1.88
2006	90,485-110,392	$1.90-$3.75	$0.95-$1.88
2007	95,009-110,392	$2.00-$3.75	$1.00-$1.88
2008	99,760-110,392	$2.01-$3.75	$1.05-$1.88
2009	104,748-110,392	$2.20-$3.75	$1.10-$1.88
2010	109,985-110,392	$2.31-$3.75	$1.15-$1.88
2011	110,392	$2.32-$3.75	$1.16-$1.88
2012	110,392	$2.32-$3.75	$1.16-$1.88
2013	110,392	$2.32-$3.75	$1.16-$1.88

[1]Range based on a low estimate of a 5% annual rate of growth capped at carrying capacity and a high estimate of a 30% annual rate of growth capped at carrying capacity.
[2]Based on range of user day values $21-$34.
[3]Benefits due to both pulp and paper mill process changes and scheduling of dam releases.
[4]Pulp and paper process change benefits assumed to be 50% of total "joint" benefits.

Recreational Angling Benefits

The water quality improvements in the Pigeon River have created new opportunities for recreational angling in both the North Carolina and Tennessee portions of the river.

Angling on the North Carolina Portion of the River. It is estimated that lifting the fish consumption advisory on the North Carolina portion of the Pigeon River for all species of fish except carp and catfish affected approximately 21.8 river miles and the 340 acres of Waterville Reservoir (the bypass for the Carolina Power & Light Company's hydroelectric project not included)(NC DEHNR, undated). No studies of angler use have been completed since the lifting of the advisory.

The demand for freshwater fishing in North Carolina appears to be high. The 1990 North Carolina Anglers Opinion Survey reported that 26 percent of respondents indicated that crowding limited the quality of their fishing experience, and 23 percent indicated that "too few places to fish" limited the quality of their experience (NCWRC, 1993).

No historical studies of angler activity on the Pigeon River are available. However, because of the documented degradation of the fish population and the advisory against consumption of all Pigeon River fish, it is estimated that the angling effort on the river before the lifting of the advisory was insignificant. Because there are no applicable data to indicate the current (or future) use levels on these river miles, EPA used recreation planning standards for Georgia to estimate the potential number of angler days on the North Carolina portion of the Pigeon River. The river reach in North Carolina below the Champion mill and above Waterville Reservoir would optimally support 191,339 angler days per year, and Waterville Reservoir would optimally support 28,900 angler days per year.[10] Because planning standards estimate angler use days based on use at peak capacity, the optimal number of angler days is a high end estimate of use. Therefore, EPA uses a conservative estimate of actual use to account for less than peak demand of the fishing site (i.e., due to angler concerns about fish toxicity, limited access, or use of alternative sites). If actual angling effort on the Pigeon River after the partial lifting of the FCA would be 10 percent to 40 percent of the estimated optimal

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[10]These use estimates are based on the Georgia Outdoor Recreation Assessment and Policy Plan's (1984) planning standards, which estimate a carrying capacity of 8,777 fishing trips per mile per year for cold water fishing in rivers and 85 fishing trips per acre per year warm water fishing in lakes and reservoir

number of users per year, the estimated range of additional angler use associated with the Champion mill modernization would be between 22,024 and 88,096 user days per year.

Table 9-5 shows estimated values for warm water fishing from the literature that may be appropriate for valuing fishing from the Pigeon River. These studies primarily address locations in the southeastern part of the United States. In addition to the values for warm water recreational fishing represented in Table 9-5, Whitehead (1991) estimated the value for fishing on the Tar-Palmico River in North Carolina to be $16. These studies show very similar values per day, and suggest a range of $21-$31 for warm water fishing in the North Carolina portion of the Pigeon River [this range reflects Palm and Malvestuto's (1983) study of Alabama on the low end, and Walsh et al. (1990) on the high end]. Applying these unit values to the potential use of the river for fishing, angling benefits associated with the process changes at the Champion mill are estimated to be between $0.46 million and $2.73 million per year.

An analysis of the current trend in fish tissue dioxin data indicates that concentrations in carp and catfish may drop below the action level of 3 ppt in the near future. If the FCA for carp and catfish is lifted and the angler effort at that time increases to between 25 percent and 55 percent of optimal use, then the estimated range of additional angler use on the North Carolina portion of the Pigeon River associated with the Champion mill modernization will increase to between 55,060 and 121,131 user days per year, and estimated annual benefits would increase to between $1.16 and $3.76 million.

Angling on the Tennessee Portion of the River. The precautionary advisory still in effect after January 1996 for carp, catfish, and redbreast sunfish advises individuals to limit consumption of these species to 1.2 pounds per month (TN DEC, 1996). Because of improvements in species diversity and other ecological indicators, fishing opportunities have already improved, and Cocke County officials submitted a request to the Tennessee Wildlife Resources Agency to consider stocking the river with trout (G. Denton, Tennessee Water Pollution Control, personal communication, 1996). Again, these improvements can be attributed to both the improvements in water quality and the minimum flow requirements.

Lifting the FCA affected approximately 25.9 river miles (EA Engineering, Science, and Technology, Inc., 1988). Applying Georgia's recreational planning standards to estimate the potential number of angler days on the Tennessee portion of the Pigeon River indicates that the river reach would optimally support 227,324 anglers per year. The angling effort is assumed to be less than optimal due to limitations in access (there are approximately 5 miles of whitewater descending through a scenic gorge between the dam and Hartford, Tennessee) and a relatively small population base from which to draw anglers. If it is assumed that actual angling effort on the Tennessee portion of the Pigeon River increased to between 10 percent and 40 percent of optimal use, then the estimated range of additional anglers will be between 22,732 and 90,930 users per year, and annual benefits are estimated to be between $0.48 million and $2.82 million (based on a value of $21-$31 for a day of warm water fishing). Because it is unlikely that the estimated angling benefits to the Tennessee portion of the river would have occurred without both the water quality improvement and the certainty of sufficient water levels, these benefits are attributed 50 percent to the process changes at the mill and 50 percent to the scheduling of releases. Therefore, the angling benefits in Tennessee attributable to the process changes at the Champion mill are estimated to be between $0.24 million and $1.41 million per year.

If the FCA for carp, catfish, and redbreasted sunfish is lifted in the future and angler effort then increases to between 25 percent and 55 percent of optimal use, the estimated range of additional angler use on the Tennessee portion of the Pigeon River will increase to between 56,831 and 125,028 users per year, and estimated annual benefits will increase to between $1.19 million and $3.88 million. The angling benefits for the Tennessee portion of the Pigeon River attributable to the process changes at the Champion mill would be between $0.60 million and $1.94 million per year.

Passive Use or Ecological Benefits

As noted earlier, Fisher and Raucher (1984) estimate that passive use benefits are generally half as large as recreational fishing benefits. Using a 50 percent approximation suggests that the potential magnitude of passive use values associated with improvements in water quality and partial removal of the FCAs on the Pigeon River is between $0.35 million and $2.07 million per year. With complete removal of the FCAs in the future, these estimated benefits would increase to between $0.88 million and $2.85 million per year.

9.2.6 Summary of Water-Related Benefits

Table 9-19 provides a summary of the estimated benefits from implementation of process changes at the Champion International mill on the Pigeon River. Table 9-20 describes key omissions, biases, and uncertainties in the estimation of benefits. Because the direction of many of these uncertainties is unknown, the overall impact on the estimated benefits is unknown.

9.2.7 Distributional Impacts

Benefits may also accrue to local economies through secondary spending impacts. Secondary benefits may be of interest to policy makers because of distributional impacts. As shown below, the town of Newport, Tennessee, a relatively low-income community for the region, is expected to benefit substantially from water quality improvements in the Pigeon River.

Business opportunities related to boating, lodging, dining, and other retail may be significant in Newport. The town has a tourism plan centered on the renewed recreational opportunities on the Pigeon River, and recently hired a tourism director. Local economic stimulation (secondary) benefits are generated when there is an increase in expenditures by visitors from outside the region, and an increase in expenditures made by local residents, which without the water quality improvements would have gone to other areas. A portion of this increase in expenditures for goods and services will remain in the area and generate additional or secondary employment and income benefits for the region.

The Pigeon River is likely to draw many whitewater recreational visitors from outside the region. A recent study of five whitewater recreation areas across the country indicated that 71 percent to 95 percent of commercial whitewater rafters were from out of state (English and Bowker, 1996). Since unemployment in Cocke County averaged 11.4 percent in 1993 and 11.6 percent over the past five years, well above the national average of 6.7 percent in 1993 and 6.5 percent over the past five years, secondary impacts could be substantial (Newport/Cocke County Economic Development Commission, personal communication, 1996; U.S. Bureau of the Census, 1995). Thus, nonresident expenditures are likely to yield real net gains in local income and employment.

TABLE 9-19

ANNUAL MONETIZED RETROSPECTIVE BENEFITS OF THE CHAMPION INTERNATIONAL MILL PROCESS CHANGES (Millions of 1995 Dollars)

Benefits Category	1996	Future Years[1]
Boating	$0.6-$0.9	$1.2-$1.9
Recreational Angling	$0.7-$4.1	$1.8-$5.7
Noncontact Recreation	+	+
Ecological and Passive Use[2]	$0.4-$2.1	$0.9-$2.9
Total	$1.7-$7.1+	$3.9-$10.5+

+ Positive benefits expected but not estimated.
[1]Annual value estimated based on boating use at peak capacity and full lifting of FCAs.
[2]Based on a range across the estimates from both approaches applied.

TABLE 9-20

KEY OMISSIONS, BIASES, AND UNCERTAINTIES IN THE BENEFIT-COST ANALYSIS FOR THE PIGEON RIVER

Omissions/Biases/ Uncertainties	Direction of Impact on Benefit/Cost Estimates	Comments
The estimation of benefits by category omitted some categories (e.g., wildlife viewing, picnicking, and swimming or wading).	(-) The omission of potential benefit categories will cause benefits to be underestimated.	Insufficient data and information to evaluate the potential magnitude of these benefits.
Benefits were estimated using benefits transfer.	(?) It is unknown what bias the selected studies have on benefits.	Studies of the southeast U.S. were used if available. Transferred values are supported by a number of studies.
Boating benefits in future years were estimated based on two scenarios of growth in boating use.	(?) It is unknown what bias the growth scenarios have on benefits.	The use of both a low and a high growth scenario provides a range of potential benefits.
Increased angling was estimated based on planning standards.	(?) It is unknown what bias the estimates of increased angling effort have on benefits.	No studies on angler use since the mill implemented process changes are available.
One approach used to estimate passive use values is based on recreational angling values.	(?) It is unknown what bias estimating passive use values based on recreational angling values has on benefits.	The uncertainties in estimating recreational angling benefits are inherent in the estimation of passive use benefits in this manner.
One approach used estimates passive use values as 50% of recreational angling benefits.	(-) Passive use benefits may be underestimated.	The ratio of passive use values to use values may be as high as 2.0 or greater (Sanders et al., 1990; Sutherland and Walsh, 1985).
Overall Impact on Benefits Estimates	(?)	The direction of bias of many of the uncertainties is unknown.

+ Potential overestimate.
- Potential underestimate.
? Uncertain impact.

Secondary spending impacts are measured by multipliers derived from economic models. Estimates of income multipliers for tourism-related industry in small, rural regions of Tennessee are typically low, in the range of 1.1 to 2.0 (M. Murray, University of Tennessee; J. Gonzalez, Tennessee Valley Authority, personal communication, 1996). A study of the economic impact of commercial river outfitters indicates that typical income multipliers in economies with river recreation rafting are between 2.1 for the Chattooga in Georgia and South Carolina and 2.4 for the Kennebec in Maine (English and Bowker, 1996).[11] Both rivers offer challenging trips to a regional audience.

EPA used the income multipliers from the English and Bowker study to estimate local income gains resulting from water quality improvements on the Pigeon River. The three locations studied by English and Bowker that are most similar to the Pigeon River in terms of the challenge of the whitewater, length of trip, and ease of access are the Nantahala, the Kennebec, and the Chattooga. A review of the results for these three rivers indicates that the direct income impact per person is between $24 and $88. Updating these values to 1995 dollars results in an estimated direct expenditure per person of between $26 and $96. This represents the direct income impacts from spending for the trip to the river and within the state where the river outfitter is located. It does not include expenditures made while visiting other sites on the same trip (English and Bowker, 1996).

Nonresidential commercial use of the Pigeon River can be estimated by multiplying the proportion of nonresidential outfitter use on the three comparable rivers (74 percent; English and Bowker, 1996) by the total outfitter use on the Pigeon River (Kleinschmidt Associates, 1995). This approach results in an estimate of 37,000 annual nonresident commercial users in 1996 and 73,500 at peak capacity. Applying the values for direct expenditures to the estimated annual number of nonresident commercial user days, annual direct expenditures associated with whitewater recreation on the Pigeon River in 1996 will be between $1.0 million and $3.6 million. When the river reaches its carrying capacity, it is estimated that annual direct expenditures will be between $1.9 million and $7.1 million.

Applying a range of income multipliers estimated for the Nantahala, Chattooga, and Kennebec Rivers [(2.1 to 2.4) English and Bowker, 1996] to the anticipated level of use on the Pigeon River results in

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[11] Response rates for the surveys about trip length, number of other sites visited, group demographics, and expenditures ranged from about 45 percent for the Middle Fork of the Snake River to about 25 percent on the Nantahala River (English and Bowker, 1996).

an estimated income effect of $2.1 million to $8.6 million in 1996, and $4.0 million to $17.0 million at peak capacity.

9.2.8 Air Benefits

Table 9-21 presents the estimated emission reductions and air-related benefits of the selected options for the Champion mill on the Pigeon River. The Champion mill is in an area with the potential to violate the current or newly promulgated ozone standards. Therefore, EPA estimated that VOC emissions would be reduced by 2,200 Mg/yr under both the low and high end estimates of emission reductions (for location without a potential violation of the ozone standards, EPA estimates a range of VOC emission reductions with the upper bound set at zero). Annual air-related benefits for MACT I range from a disbenefit of $5.8 million to a benefit of $5.7 million under Option A and from a disbenefit of $5.5 million to a benefit of $5.7 under Option B. Benefits of the proposed MACT II standard resulting from particulate matter reductions are valued at $2.1 million per year.

9.2.9 Comparison of Benefits to Costs

Retrospective Benefits and Costs

Table 9-22 provides a summary of the retrospective benefits from the process changes at the Champion mill, and the estimated cost of these controls. The mill currently corresponds quite closely to Option B of the final pulp and paper regulation, and has gone beyond what is required in Option A. Additional benefits and costs for air controls, and any additional upgrades for water treatment to meet the regulatory options, are described below.

Benefits and Costs Comparable to the Regulation

The benefits and costs in Table 9-22 reflect effluent controls that are more stringent than required under Option A, but similar to Option B. Therefore, the total annualized costs that would correspond to

TABLE 9-21

POTENTIAL ANNUAL AIR-RELATED BENEFITS OF THE SELECTED OPTIONS FOR THE CHAMPION MILL ON THE PIGEON RIVER

Regulatory Option	Emission Reductions (Mg/yr)	Annual Value[1] (Millions of $1995)
Option A and MACT I		
VOC	2,200	$1.3-$5.7
Particulate Matter	(0.04)[2]	$0[3]
SO_2	(559)[2]-0	($7.0)-$0
TOTAL Monetized Benefits	NA	($5.8)-$5.7
Option A and MACT II		
Particulate Matter	165	$2.1
Option B and MACT I		
VOC	2,200	$1.3 - $5.7
Particulate Matter	(0.04)[2]	($0)[3]
SO_2	(536)[2]-0	($6.7)-$0
TOTAL Monetized Benefits	NA	($5.5)-$5.7
Option B and MACT II		
Particulate Matter	165	$2.1

[1] Benefits may not add due to rounding.
[2] Numbers in parentheses represent emissions increases and related increased social costs.
[3] Disbenefits of $505 per year.
NA = Not applicable.

TABLE 9-22

ANNUAL MONETIZED BENEFITS AND COSTS OF THE PROCESS CHANGES AT THE CHAMPION INTERNATIONAL MILL ON THE PIGEON RIVER (Millions of 1995 Dollars)

	Annual Value in 1996	**Annual Value Future Years**
Annual Monetized Benefits Associated with Water Quality Improvements[1]	$1.7-$7.1 +	$3.9-$10.5 +
Annualized Costs for Mill Upgrade[2]	$7.3	$7.3

+ Positive benefits expected but not estimated.
[1]Includes boating and recreational angling benefits associated with an increase in participation, and ecological and passive use benefits.
[2]Based on annualized present value of pretax compliance costs, reflecting a 7% real discount rate and a 16 year accounting period.

Option A are less than what has already been spent for upgrades at the mill, and the total annualized costs that would correspond to Option B are only slightly more than what has already been spent.

Costs and benefits of the regulation that are not shown in Table 9-22 relate to air controls. Table 9-23 shows the estimated costs and benefits for both water and air controls (any air-related costs and benefits associated with upgrades implemented in the early 1990s not estimated).

Benefits and Costs for Option B. The only additional costs that the mill will incur for compliance with Option B are for effluent monitoring ($610,000 in capital costs and $200,000 in annual operating costs) (ERG, 1996a). Therefore, the benefits estimated for the retrospective case study represent the benefits to be expected under Option B.

Benefits and Costs for Option A. The mill exceeded Option A by installing oxygen delignification in both fiber lines. Consequently, the benefits and costs estimated above and associated with oxygen delignification cannot be attributed to Option A. EPA estimated that to upgrade from the pre-1990 status to Option A, the mill would incur capital costs of approximately $22.6 million, and operating costs at the mill would increase by approximately $3.4 million per year for an annualized total cost of $5.8 million per year (W. Grome, ERG, personal communication, 1996).

Under the final rule, both options are expected to result in lifting of the FCA associated with the Champion mill (U.S. EPA, 1997). Therefore, the estimated recreational angling and passive use benefits, which are based on lifting of the FCA, are the same for both Option A and Option B.

To estimate the proportion of boating benefits attributable to Option A and Option B, EPA used the national-level estimates of the reductions in color expected for all kraft mills under the two options.[12] For kraft mills, the reductions in color under Option A are estimated to be 8 percent of the reductions in color under Option B (ERG, 1996b). Based on reports from rafting companies, on-site color is a determinant of boating quality. EPA assumed there is a linear relationship between color and boating benefits. However, changes in color may not fully explain boating improvements. For example, the Champion mill modernization virtually eliminated toxic discharges which may have kept people from using the river. Option

[12]Color is a major contributor to the achieved boating benefits.

TABLE 9-23

ANNUAL MONETIZED BENEFITS AND COSTS COMPARABLE TO THE FINAL PULP AND PAPER REGULATION FOR THE PIGEON RIVER[1]
(Millions of 1995 Dollars)

Benefits and Costs	Compliance with Option A	Compliance with Option B
Annual Monetized Benefits		
Water[2]	$2.7-$8.7	$3.9-$10.5
Air[3] (MACT I)	($5.8)-$5.7	($5.5)-$5.7
Air (MACT II)	$2.1	$2.1
Water and MACT I	($3.1)-$14.4	($1.6)-$16.2
Water, MACT I, and MACT II	($1.0)-$16.5	$0.5-$18.3
Annualized Costs[4]		
Water	$5.8[5]	$7.6[6]
Water and MACT I[7]	$6.7	$8.5
Water, MACT I, and MACT II[7]	$7.1	$8.9

[1]Option A is the Agency's selected option.
[2]Steady state benefit levels omitting nonmonetizable benefits and based on future years when benefits of past improvements in water quality are fully realized.
[3]Estimated air benefits do not include any benefits that may have occurred as a result of past upgrades.
[4]Based on annualized pretax compliance costs, reflecting a 7% real discount rate and a 16 year accounting period.
[5]Estimated cost to upgrade from pre-1990 status to compliance with Option A.
[6]Cost of controls already implemented plus additional cost for effluent monitoring.
[7]Includes retrospective costs and forthcoming costs. Estimated air costs do not include any costs for air controls that may have been incurred in past upgrades.

A would also eliminate these discharges. These differences should be interpreted as the maximum potential value of Option B compared to Option A. Applying this percentage to the 50 percent of boating benefits estimated under Option B results in estimated annual boating benefits under Option A of $0.09 to $0.15 million in future years. Adding these boating benefits to the estimates shown above for the other benefit categories results in estimated total benefits attributable to Option A of between $2.7 and $8.7 million per year.

9.2.10 Conclusions

In the early 1990s, the Champion International mill on the Pigeon River initiated a large modernization project, including installation of oxygen delignification and chlorine dioxide substitution to 100 percent. The process changes at the mill currently exceed those that would be required under either Option A or Option B. Therefore, in this case study the water-related benefits that may be illustrative of the benefits of the rule may be somewhat less than the benefits already achieved. EPA estimates that the total annual benefits for the Pigeon River range from a disbenefit of $1.0 million to a benefit of $16.5 million under the selected regulatory options (Option A, final MACT I, and proposed MACTII Alternative A). This range of monetized benefits does not include all benefit categories (e.g., wildlife viewing, picnicking, and swimming or wading). Associated annualized costs are estimated to be $7.1 million.

9.3 UPPER COLUMBIA RIVER/LAKE ROOSEVELT CASE STUDY

The Celgar Pulp Mill, a Canadian bleached kraft pulp and paper mill, is located on the Columbia River just north of the U.S. border. Studies initiated in 1988 found high concentrations of dioxins in fish tissue below the mill and as far downstream as Lake Roosevelt, Washington. Fish consumption advisories and the perceived taste and odor of captured fish discouraged fishing in the vicinity of the mill. Although the mill is not the sole source of water quality problems on the river, it may have been a major deterrent in the development of a world-class trout fishery.

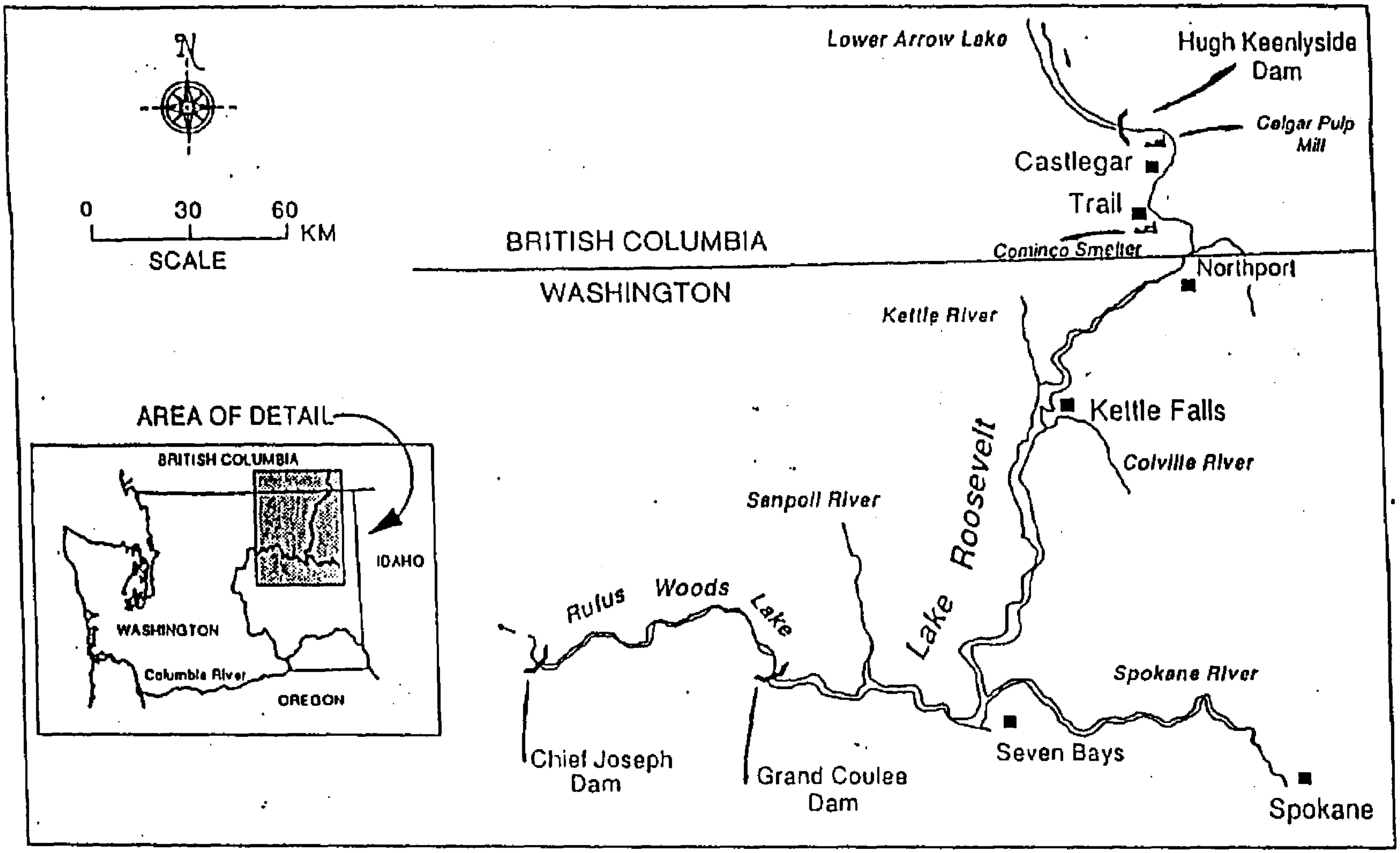
The Celgar mill began implementing process changes to reduce dioxin concentrations in its effluent in 1988, and modernization of the mill was completed in 1993. Although the mill is not subject to EPA effluent limitations, the water quality improvements and resulting benefits of the modernization illustrate the water quality benefits that may accrue throughout the United States from the final rule. This case study provides monetary estimates of those benefits (to the extent feasible) for comparison to available cost estimates.

9.3.1 Description of the Site

The Celgar Pulp Mill is about 50 miles upstream from the U.S. border (Figure 9-5). The town of Castlegar, British Columbia (population 7,400), is just below the mill, and the remainder of the river stretch to the border flows through primarily forested area. This stretch is one of the few remaining free-flowing stretches of the river. Just below the U.S. border, the river flows into Lake Roosevelt, a 151-mile-long reservoir in northeastern Washington formed by the construction of Grand Coulee Dam in 1941 (Serdar, 1993). The lake is bounded by the Colville and Spokane Indian Reservations and Douglas, Ferry, Stevens, Lincoln, and Okanogan counties.

Both the Columbia River stretch and Lake Roosevelt provide water-based recreation opportunities in a region that has few other large water bodies. Local residents enjoy the Upper Columbia River, which supported an estimated 150,000 visitor days in 1991 (Portland Interagency Team, 1994). Furthermore, given its natural conditions and large instream flows, it is potentially a world-class trout fishery (G. Mallette, Frasier Basin Management Program, personal communication, 1995; F. Mah, Environment Canada, personal

Figure 9-5
Upper Columbia River and Lake Roosevelt Case Study Area



communication, 1995). Lake Roosevelt is one of the largest reservoirs in the United States, supporting considerable recreational activity levels for local and destination recreators.

The Portland Interagency Team (1994) estimates total visitor days to Lake Roosevelt to be almost 1.8 million in 1993. The Columbia River system is also an important source of water and hydropower in the region.

9.3.2 Water Quality Issues

The mill's effluent originally contained a number of contaminants that affected water quality in the Columbia River, including BOD, liquor, adsorbable organic halogens (AOX), and polychlorinated dioxins (PCDD) and furans (PCDF). Beginning in 1988, studies conducted by the British Columbia Ministry of Environment, Celgar Pulp Mill, Washington State Department of Ecology, and others found high concentrations of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) in sediments and fish tissue directly below the mill. They also detected other PCDD and PCDF congeners. Early studies showed dioxin toxic equivalent measurements (TEQs) were the highest in lake whitefish and mountain whitefish.[13] Environment Canada (1988, as cited in Serdar, 1993) reported TEQs for lake whitefish ranging from 71.3 ppt to 101.3 ppt; Crozier (1990, as cited in Serdar, 1993) found concentrations in mountain whitefish ranging from 5.5 ppt to 30.4 ppt.

Additional studies confirmed the elevated concentrations in Canadian fisheries, and detected elevated concentrations in Lake Roosevelt fisheries. In 1990, lake whitefish TEQs were between 9.0 ppt and 17.7 ppt in the upper portion of the lake (Kettle Falls); TEQs in rainbow trout at Northport ranged from 3.2 ppt to 6.3 ppt; and TEQs in white sturgeon in the Kettle Falls area ranged from 8.0 ppt to 24.8 ppt (Johnson et al., 1991, as cited in Serdar, 1993).

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[13]The toxicity of individual PCDD and PCDF congeners is described relative to the toxicity of TCDD, the most toxic of the PCDD congeners, in terms of toxicity equivalency factors (TEFs) (WDOH, 1991; Serder, 1993). TCDF has a TEF of 0.1, which means that it is estimated to be 1/10th as toxic as TCDD (Barnes et al., 1989, as cited in WDOH, 1991). TEFs are then added together to derive the TCDD toxicity equivalent measurement (TEQ) (WDOH, 1991).

Fish Consumption Advisories

The dioxin levels in lake and mountain whitefish led to Canadian consumption advisories in 1989 and 1990, which were reissued in 1992 (Jolly and Leckrone, 1993). Canadian consumption advisories are based on Health and Welfare Canada's legal limit of 20 ppt TCDD, applied to TEQs, and B.C. Ministry of Environment's more restrictive limit of 11.4 ppt TEQ (Kirkpatrick, 1989, as cited in Serdar, 1993). The advisories for the Columbia River recommended limiting consumption of mountain whitefish caught in the vicinity of the Hugh Keenleyside Dam to the American border to one meal (7 oz) per week (B.C. Environment Ministry of Health, 1995). Consumption of lake whitefish was advised to be limited to 1.4 oz per week (B.C. Environment Ministry of Health, undated).

The State of Washington Department of Health (WDOH) issued an advisory in 1990 suggesting that young children should not eat lake whitefish from Lake Roosevelt. However, WDOH revised the warning in 1991 to advise that children and adults could eat fish but should follow several steps to reduce exposure, including removing fat and skin from fish before eating; allowing fat to drip off during cooking; using smaller fish, which are less contaminated; reducing the size of portions consumed; and reducing the number of fish meals consumed per month (WDOH, 1991).[14]

Aesthetic Impacts

BOD discharges from the mill did not adversely affect downstream dissolved oxygen levels because the river flows were usually very high (i.e., averaging 40,000 cfs) (Celgar Pulp Company, 1995). However, BOD discharges caused a layer of scum to form on top of the river, which discouraged water contact recreation activities (G. Mallette, Frasier Basin Management Program, personal communication, 1995). Furthermore, discharges of black liquor into the river produced a visible plume of discolored water downstream. This discoloration, coupled with an odor, also discouraged recreation on the river downstream from the mill.

[14]The Washington Department of Health's position regarding the health risk of consuming fish from Lake Roosevelt was based on its conclusion that the toxicity equivalent factor for dioxin of 0.1 may be too high (stating that a value of 0.03 to 0.05 should be considered) and because of uncertainties regarding adverse effects (WDOH, 1991).

Other Water Quality Issues

Factors other than the Celgar mill also affect the Columbia River and Lake Roosevelt. High concentrations of lead, zinc, cadmium, and mercury have been found in sediments and fish in the Upper Columbia River and Lake Roosevelt. The primary source is believed to be the Cominco Ltd. lead/zinc smelter located in Trail, British Columbia, which discharged an average of 360 metric tons per day of slag into the Columbia River (Serdar, 1993). Smelter discharges were discontinued in 1995. Other potential sources of the metals are the mining operations in the Coeur d'Alene basin (Serdar, 1993).

The hydroelectric dams located along the Upper Columbia River in both Canada and the United States also affect the river and lake. The Hugh Keenleyside Dam is located a few miles upstream from the pulp mill in British Columbia. Discharges from the dam affect instream flows in the Canadian portion of the Upper Columbia River. For example, low dam releases in July 1991 dewatered downstream spawning beds, after which the Canadian government instituted minimum flow requirements (G. Mallette, Frasier Basin Management Program, personal communication, 1995). Similarly, Grand Coulee Dam in northeastern Washington regulates the pool elevation and water retention time in Lake Roosevelt.

9.3.3 Improvements at the Mill

The Celgar Pulp Mill was built in 1961 to produce fully bleached kraft pulp from softwood chips generated by sawmills throughout the southwestern Canada and northwestern U.S. region. The original mill produced up to 560 air-dry tonnes per day (Adt/d), and from 1961 until 1991 discharged minimally treated effluent into the Columbia River; existing treatment primarily controlled particulates and fiber content in the effluent.

Between 1989 and 1991, process changes instituted at the original mill to reduce PCDD/PCDF concentrations in the effluent included the following (Serdar, 1993):

- stopped using defoamers that contain PCDD/PCDF precursors
- substituted partial (20 percent-40 percent) chlorine dioxide for chlorine in the bleaching process

- began using high shear mixers in the chlorination stages
- used hydrogen peroxide in the delignification process.

The process changes greatly reduced TCDF discharges to the river by 1992, and TCDD discharges remained below the measurable concentration prescribed by the Canadian government (Celgar Pulp Company, 1993).

In 1993, a new mill roughly doubled output by increasing production capacity to 1,200 Adt/d. The modernization cost an estimated $700 million (Canadian dollars) and incorporated recently adopted provincial and federal regulations pertaining to effluent treatment and air emission controls. Thus, despite the production increase, regional water and air quality improved markedly since the new mill began production in mid-1993.

Process upgrades at the new mill include (Celgar Pulp Company, 1995):

- extended cooking and oxygen delignification of pulp
- 70 percent-100 percent chlorine dioxide substitution for chlorine in bleaching process
- chemical and fiber spill diversion to spill ponds
- secondary (biological) treatment of mill effluent.

As a result of these upgrades, no TCDD or TCDF has been detected in the new mill’s effluent since operations began. These upgrades are roughly equivalent to EPA’s BAT/PSES Option B, which would have required 100 percent chlorine dioxide substitution and spent liquor controls.

Improvements in Fish Tissue Dioxin Levels

Data for lake and mountain whitefish show that TCDD/TCDF levels in fish tissue below the mill declined following the process changes. This downward trend is shown in Table 9-24. As a result of the lower concentrations found below the mill in 1994, Canadian authorities removed the consumption advisory

TABLE 9-24

TCDD TEQ FISH TISSUE CONCENTRATIONS OF COLUMBIA RIVER MOUNTAIN WHITEFISH, 1989-1994

	1989	1990	1991	1992	1993	1994
Celgar Discharge Area	12.7 [1]	23.9 [2]	—	—	7 [3]	5.5 [4]
Upstream from Trail, B.C. [5]	—	22.2 [6]	50.8 [7]	10.3 [8]	—	3.3 [9]
Colville River Area	—	14.5 [10]	—	6.9 [11]	—	2.5 [12]

[1]Average of 5 BCMOE samples (BCMOE, 1990, as cited in Sedar, 1993).
[2]Average of 9 Celgar and BCMOE samples (E.V.S. Consultants, Ltd., 1990 and Crozier, 1991, as cited in Serdar, 1993).
[3]Average of 6 BCMOE samples (Liebe et al., 1994).
[4]One Celgar sample (Axys Analytical Services, Ltd., 1994).
[5]From Genelle to Murphy Creek.
[6]Average of 7 BCMOE samples (Crozier, 1991, as cited in Serdar, 1993).
[7]Average of 6 Department of Fisheries and Oceans samples (Boyles et al., 1992, as cited in Serdar, 1993).
[8]Average of 14 Department of Fisheries and Oceans samples (Liebe et al., 1994).
[9]One Celgar sample (AXYS Analytical Services, Ltd., 1994).
[10]Average of 6 Washington Department of Ecology samples (Johnson et al, 1991, as cited in Serdar, 1993).
[11]Average of 6 Washington Department of Ecology samples (Serdar et al., 1993, as cited in Serdar, 1993).
[12]Average of 21 U.S. EPA samples (Tetra Tech, 1995).

for mountain whitefish in March 1995 (B.C. Environment Ministry of Health, 1995). The Washington Department of Health recommendations on whitefish consumption for Lake Roosevelt are still in force.

Other Improvements

Because of biological treatment, average daily loads of BOD declined from 15-20 tonnes per day to less than the permit level of 6 tonnes per day (Celgar Pulp Company, 1995). As a result, the scum often found downstream from the mill disappeared. AOX loads declined from about 3 kg/tonne to less than 0.5 kg/tonne; the permit monthly average is 1.5 kg/tonne (Celgar Pulp Company, 1995). Discharges of suspended solids also changed. The lime mud and fiber discharges from the old mill caused a fiber mat to form on the river bed downstream from the mill. “Bugs” or biological solids from the biological treatment process, which tend to remain suspended and be consumed in the river as part of the food chain, replaced these effluent constituents, and the fiber mat disappeared.

9.3.4 Assessment of Benefits

The reduced instream and fish tissue dioxin concentrations along with the other water quality improvements (e.g., aesthetic) from the process changes most likely resulted in benefits to recreational anglers and consumers of fish caught downstream from the mill. In addition, benefits probably accrued to nonconsumptive users and nonusers of the Upper Columbia River and Lake Roosevelt. This section derives monetary estimates of benefits to the extent feasible given limited data availability. The water quality benefits from Celgar’s upgrades may indicate the potential benefits at similar sites in the United States as a result of the effluent limitation guidelines. The Celgar mill would fall between Options A and B; although it has not achieved 100 percent substitution, it has installed oxygen delignification.

Recreational Angling Benefits

The recreational resources of the Upper Columbia River are unique in the Columbia River Basin, and include a unique sport fishery (Portland Interagency Team, 1994). The Upper Columbia reach is one of the last large river habitats with abundant rainbow trout in western North America (Mallette, 1992, as cited in Portland Interagency Team, 1994). It is a potentially world-class trout fishery. However, pollution from the pulp mill (and from the smelter farther downstream) prevented recreation development, and local residents accounted for most of the past recreation use. Thus, a potentially large benefit of process changes at the pulp mill is the future development of this river segment as a destination fishery, which includes primary recreation benefits and secondary benefits of regional economic growth.[15]

Benefits may also accrue to recreational anglers who use Lake Roosevelt. Important target species in the lake are rainbow trout, walleye, kokanee, and sturgeon (Peone et al., 1990). Less important species are the lake and mountain whitefish species affected by the consumption advisories. However, given the importance of the Lake Roosevelt fishery, even small changes in fishing effort may produce substantial benefits. Furthermore, anecdotal evidence indicates that health concerns led to less fishing effort for the more popular sportfishing species in the area (the Upper Columbia River), which showed concentrations below advisory limits (G. Mallette, Frasier Basin Management Program, personal communication, 1995). The potential magnitude of recreational angling benefits for the Upper Columbia River and Lake Roosevelt is estimated below.

Recreational Angling Benefits for the Upper Columbia River. As mentioned above, the segment of the river below the mill is a potentially world-class trout and walleye fishery, comparable to the Kootenai River in northwestern Montana. The relevant segment of the Kootenai River is downstream from Libby Dam, which developed into a rainbow trout fishery with success rates similar to the top blue-ribbon streams in Montana (Portland Interagency Team, 1994). The Kootenai River is in a forested, sparsely populated region similar to the Upper Columbia River, but it is a popular fishing site . Creel census data indicate 33,000 visitor days to the Kootenai River downstream from Libby Dam in 1989 (Portland Interagency Team, 1994).

The 33,000 angler days for the popular Kootenai River compare to the 6,811-14,850 angler days estimated for the Upper Columbia River (ARA Consulting Group, Inc., 1992; Portland Interagency Team,

[15]Secondary benefits are typically not considered in a national benefits analysis because they often represent a transfer or redistribution of resources rather than real economic gains or losses. Secondary benefits are not estimated here.

1994).[16] If reduced contaminant levels on the Columbia River result in the development of a destination fishery, fishing effort might reasonably be expected to double from current levels.[17] Valuing the additional days by the range of estimated consumer surplus per trip for the Kootenai River of between $52 and $79 (Duffield, 1990; updated to 1995 dollars)[18] results in benefits of between $0.35 million and $1.17 million per year. Annual benefits in earlier years would be less as the fishery develops.

The estimated benefits for the Upper Columbia River may be conservative in that they do not account for increased satisfaction from the fishing experience for current anglers. A 1991 telephone survey of area anglers found that not only had approximately one-third of anglers (including 15 percent of anglers currently fishing the Columbia River) reduced their frequency of fishing the Columbia River due to pollution concerns, but approximately 50 percent of Columbia River anglers refused to eat or restricted their consumption of fish caught in the river (ARA Consulting Group Inc., 1992). The Celgar Pulp Mill was cited by approximately 62 percent of Columbia River anglers as the industrial development or source of pollution that most affected their fishing activity. Thus, the reduced contaminant levels may result in an added value of current trips that may be substantial.

There are no similar findings to those of Lyke (1993) for Great Lakes trout and salmon anglers (described in Section 9.2). However, Lyke's estimates suggest that the increased value of a "contaminant-free" fishery to current anglers may be between $39,000 and $364,000. EPA obtained this range by first valuing the 6,811 to 14,850 current angling days by a range of estimated consumer surplus per trip for the Kootenai River of $52 to $79 (Duffield, 1990; updated to 1995 dollars), and then multiplying by 11 percent to 31 percent.

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[16]Pertains to activity on the Upper Columbia from the northern tip of Lake Roosevelt to Hugh Keenleyside Dam, which is just above the Celgar mill (Portland Interagency Team, 1994).

[17]This level of increased use (from 6,811-14,850 days to 13,622-29,700 days) places the lower end estimate below the current upper end estimate, and results in a high end estimate that is below the use on the Kootenai River. This estimate appears reasonable since the Upper Columbia River may suffer from lingering perception problems regarding contamination from the mill.

[18]The lower end of the range reflects estimation using the contingent valuation method, and the upper end of the range reflects the results of a travel cost model.

Approximately 60 percent of the angling effort on the Upper Columbia River occurs between the mill and Trail, the location of the Cominco smelter (ARA Consulting Group, 1992). Since the improvements at the Celgar mill resulted in a lifting of B.C.'s fish consumption advisory, the mill may be credited with achieving the "contaminant free" status on this stretch of the river. The mill may also be credited with approximately 50 percent of the benefits associated with achieving a contaminant-free fishery on the stretch of the Upper Columbia River below Trail, which accounts for the remaining 40 percent of angling effort. This is because two advisories affected this river segment, only one of which was lifted as a result of improvements at the mill; a second advisory for mercury is associated with discharges from the smelter. Therefore, the mill may be attributed with benefits to current anglers of between $31,000 to $291,000 per year.[19]

Recreational Benefits for Lake Roosevelt. Lake Roosevelt is an important recreational resource. In 1990, anglers made an estimated 171,765 fishing trips to the lake (Griffith and Scholz, 1990). Important species in terms of total annual harvest on the lake in 1990 included rainbow trout, walleye, kokanee salmon, yellow perch, and smallmouth bass. In comparison, the more contaminated lake whitefish comprise less than one-tenth of one percent of total catch (Peone et al., 1990). Nonetheless, as mentioned above, there is some indication that concerns over contamination caused reduced effort for the popular sport species in the Upper Columbia River. Thus, the reduced contaminant levels are likely to increase effort on Lake Roosevelt as well as increase satisfaction from the fishing experience.

Because there were no consumption advisories issued for target species in Lake Roosevelt, the change in angler effort may be small. However, even a small increase in fishing effort can have sizable benefits because of the importance of the fishery. For example, a 1 percent to 5 percent increase in angler trips would result in an additional 1,718 to 8,588 trips per year. Valuing these trips by a range of estimated consumer surplus per trip for the Kootenai River at between $52 and $79 (Duffield, 1990; updated to 1995 dollars) results in annual benefits of between $89,000 and $678,000.

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[19]The calculation for the low end of the range is equal to the estimated increased value for a contaminant free fishery for the stretch of river between the mill and the Cominco smelter, which is approximately 60 percent of the total estimated value, plus half of the value for the remaining 40 percent of the river use [(0.60 × $39,000) + 0.5(0.40 × $39,000)]. The same calculation was used to develop the high end of the range [(0.60 × $364,000) + 0.5(0.40 × $364,000)]. The range in values reflects different estimation techniques.

Finally, concerns have been raised about the viability of the white sturgeon fishery in Lake Roosevelt. White sturgeon are important target species for sport anglers; approximately 11 percent of fishing effort in 1990 was targeted at sturgeon (Griffith and Scholz, 1990). However, fishing restrictions have gradually moved toward the current requirement of strict catch-and-release fishing (B. Merritt, National Park Service, personal communication, 1995). Existing pressures on the fishery include habitat changes (e.g., dams) and over-harvesting. Average dioxin and furan TEQs of 17 ppt were found in white sturgeon in the upper portion of Lake Roosevelt in 1990 (Johnson et al., 1991, as cited in Serdar, 1993). Although reduced dioxin levels in sturgeon may have recreational benefits, because the sturgeon population are constrained by the dams and overfishing. EPA did not estimate sturgeon-related recreational benefits.

Recreational Boating Benefits

The Columbia River downstream from the Celgar mill provides one of the few accessible river boating opportunities in the Upper Columbia Basin (Portland Interagency Team, 1994). Boating is also popular on Lake Roosevelt. Numerous facilities around the lake support boating, including facilities operated by the Colville and Spokane tribes. Houseboat rentals are increasingly popular on Lake Roosevelt, as is boating upstream from the lake to the reservoirs in Canada.

The scum on the Columbia River directly below the mill discouraged all types of boating activity in that area. Since its disappearance, and the concurrent improvement in air quality near the mill, anecdotal evidence suggests that boating activity has increased (G. Mallette, Frasier Basin Management Program, personal communication, 1995). It is not clear that the pulp mill's effluent has had an appreciable effect on pleasure boating activities on Lake Roosevelt. However, anecdotal evidence reveals that recreators canceled reservations for houseboats operated by the Colville Tribe following announcements of elevated concentrations of dioxins and furans in fish (G. Pismire, Environmental Trust, personal communication, 1995). These boats are primarily used for pleasure boating rather than fishing. Data on the potential increase in nonfishing boating days for the Upper Columbia River and Lake Roosevelt are not available; therefore, boating benefits are quantified here.

Nonconsumptive Use Benefits

Sightseeing and picnicking are the most popular form of near-stream recreation use of the Upper Columbia River area (Portland Interagency Team, 1994). Visitors made approximately 119,150 trips for picnicking and sightseeing (including from vehicles) to the area in 1991 (Portland Interagency Team, 1994). Nonconsumptive use of Lake Roosevelt is greater. For example, based on total visitation and historical breakdowns of visitation by activity, visitors took approximately 443,700 trips for picnicking near Lake Roosevelt.[20] This activity level does not include nonconsumptive activities such as wildlife viewing that are not conducted along with picnicking.

Reduced toxicity and aesthetic improvements (including air quality) from the pulp and paper mill should result in nonconsumptive recreation benefits. Cleaner and clearer water, changes in the perceptions of contamination, the removal of FCAs, and improved aesthetics all can be expected to yield benefits on the Upper Columbia. Additionally, many studies have shown that fishing and nonconsumptive recreational trips are taken together, and decisions about what sites to visit are made jointly, depending on how attractive sites are for both types of recreation. Individuals who participate in nature viewing might accompany anglers on a fishing trip, but do not fish themselves. For example, the Montana study (Morey et al., 1995) described in Section 9.2 suggests that, generally, increases in nonconsumptive recreational trips would accompany increases in fishing trips to a site.

The percentage increase in nonconsumptive recreation trips from reduced toxicity in the Upper Columbia River and Lake Roosevelt is expected to be smaller than the percentage increase in recreational angling trips because of the direct effect of the removal of FCAs on angler trip-taking behavior and the potential development of a world-class fishery on the Upper Columbia. If non-consumptive trips increase

[20]This results from the multiplication of the 5-year average total visitation to Grand Coulee/Lake Roosevelt (1837.94 thousand days) by the proportion of 50-year average picnicking activity to 50-year average total recreation days (283393.1/1173994.7) for a base case operating strategy for the dam. The data are from Portland Interagency Team (1994).

commensurately,[21] the air and water quality improvements results in an additional 1,706 to 4,688 nonconsumptive recreation days each year on the Upper Columbia River and Lake Roosevelt.

Table 9-25 shows nonconsumptive recreation studies from the literature that may be appropriate for valuing nonconsumptive recreation in Washington. These studies focus on the northwestern United States, and reflect values in the range of $20-$40 per day [omitting the high end estimate in Butkay (1989)].

Valuing the 1,706 to 4,688 additional days by a range of estimated consumer surplus per day for nonconsumptive recreational activity of $20-$40 results in incremental nonconsumptive recreation benefits from water and air quality improvements of $34,000 to $188,000 per year.

Human Health Benefits

The process changes at the Celgar mill led to significant decreases in dioxin levels in fish tissues. These reductions benefit Upper Columbia River and Lake Roosevelt anglers who consume fish caught downstream from the mill by reducing their risk of dioxin-related health effects. This section describes the data and assumptions used to estimate the cancer risk reduction benefits that accrued in the case study area as a result of the lower fish tissue dioxin concentrations. The methodology employed below assumes that the pre-process change levels of dioxin in fish tissue would have continued without the controls.

Exposed Population. The exposed population estimates come from creel census data and recreation survey data from several sources. The estimated population exposed to Upper Columbia River fish (from Celgar to the border) was 1,061 [6,811 angler days/13.3 days per angler × 2.9 persons per household/1.4 anglers per household (ARA Consulting Group, 1992)]. The estimated population exposed to Lake Roosevelt fish was 80,199 (171,765 angler days/5.6 days per angler × 2.6 persons per household/1 angler per household). These reflect Griffith and Scholz's (1990) estimate of angling days and data on days per angler, persons per household, and anglers per household reported in Hagler Bailly (1995).

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[21]Non-consumptive trip increases are estimated by multiplying the 0.2 ratio from the Montana study by the estimated increase in fishing trips (8,529 to 23,438 days, for both the Upper Columbia and Lake Roosevelt.

TABLE 9-25

NONCONSUMPTIVE RECREATION STUDIES

Study	Location	Unit Valued	Reported Values[1]	1995 Value[1]
Butkay (1989)	Bitterroot River, Montana	User day	$89.00 ($1989)	$109.38
Hay (1988)	Washington	User day	$20.00 ($1985)	$28.33
McCollum et al. (1990)	Oregon and Washington	User day	$14.20 ($1990)	$19.74
Wade et al. (1989)	Reservoirs, lakes, and river delta areas, California	User day	$16-$29 ($1985)	$22.66-$41.07
Walsh et al. (1990)	All U.S.	User day	$22.20 ($1987)[2]	$29.78[2]

[1]Consumer surplus.
[2]Adjusted for different methodological and empirical approaches and study dates.

Angler Fish Consumption. No studies of fish consumption rates among Upper Columbia River and Lake Roosevelt anglers are currently available. The State of Washington is conducting a consumption survey for Lake Roosevelt; however, results will not be available until the end of 1996. Because of the lack of case study site-specific information, lower and upper bound estimates [20.0 and 58.7 grams per person per day (gpd), respectively] come from the available literature. EPA (1989a) reports estimated consumption for sport fishing populations of 20 gpd. A survey of fish consumption among Native Americans fishing the Lower Columbia River found an average fish consumption rate for adults of 58.7 gpd (Columbia River Intertribal Fish Commission, 1994).

Fish Tissue Dioxin Levels. Health risks were calculated based on exposure to 2,3,7,8-TCDD. Fish tissue contamination data for the Upper Columbia River came from Serdar (1993) and Celgar (Axys Analytical Services, Ltd., 1994). The average 2,3,7,8-TCDD TEQ level in fillet samples in 1990 (the baseline year) was 17.1 ppt. This average value includes the values measured in 57 samples collected from the Celgar discharge area to the border, with nondetects set equal to one-half the detection limit. Following the process changes implemented by the mill, the average 2,3,7,8-TCDD TEQ level in fillet samples from 1994 was 2.3 ppt. The 1994 average value represents a 87 percent reduction from the 1990 average, and includes two samples from the discharge area and two samples taken just upstream from the city of Trail, with nondetects set equal to one-half the detection limit.

Fish tissue contamination data for Lake Roosevelt came from Serdar (1993) and EPA (Tetra Tech, 1995). For Lake Roosevelt, the average 2,3,7,8-TCDD TEQ level in 1990 fillet samples was 7.1 ppt. This average includes 44 Washington Department of Ecology samples from the Northport area to the Seven Bays area (as cited in Serdar, 1993). Following the process changes, the average 2,3,7,8-TCDD TEQ level in fillet samples from 1994 was 1.1 ppt. The 1994 average value represents a 85 percent reduction from the 1990 average, and includes 99 samples from the upper, middle, and lower sections of the lake with nondetects set equal to one-half the detection limit.

Other Exposure Assumptions. Standard EPA assumptions were used regarding length of residence (70 years) and body weight (70 kilograms) (U.S. EPA, 1989b).

Estimated Risk Reduction Benefits. The estimates of risk reduction benefits resulting from the process changes at the Celgar mill assume that dioxin levels in fish downstream from the mill are entirely attributable to the mill. Appendix C provides the benefits calculations. The observed 87 percent reduction in fish tissue dioxin levels in fish from the Upper Columbia River is estimated to reduce excess cancer cases among area anglers and their families by between 0.010 and 0.028 cases per year. Based on the estimated value of a statistical life of $2.5 million to $9.0 million (American Lung Association, 1995), this reduction in cancer cases represents annual benefits from the process changes of between $24,083 and $254,464. For Lake Roosevelt, the observed 85 percent reduction in fish tissue dioxin levels would reduce excess cancer cases among anglers and their families by between 0.294 and 0.862 cases per year. Valuing these reductions using the value of a statistical life results in annual benefits of between $734,577 and $7.76 million. Combined health risk reduction benefits for the Upper Columbia River and Lake Roosevelt range from $0.8 million to $8.0 million per year and, based on the bounding estimates of consumption utilized, should be considered lower and upper bounds on potential benefits.

Uncertainties in the Estimation of Risk. There are numerous sources of uncertainties in the estimate of baseline risks, and in the estimated reduction in risks from implementation of the regulation. Variations in health risks may occur, depending upon the factors described in Section 9.1.6.

Passive Use Benefits

Passive use values reflect the values individuals place on reducing toxic concentrations in the Upper Columbia River and Lake Roosevelt apart from any values associated with their direct or indirect use of the resource. The reduced concentrations of dioxin in fish near the mills have potential implications for reducing the risk to piscivorous wildlife. In addition, the contamination of fishery resources in Lake Roosevelt may have affected cultural values among the Native American tribes in the region.

There are no studies of the passive use values associated with reducing the levels of dioxin in the Upper Columbia River and Lake Roosevelt. Using Fisher and Raucher’s (1984) 50 percent approach (see Section 9.1.6) implies passive use values from the process controls of between $235,000 and $1.07 million per year.

9.3.5 Summary of Benefits

Table 9-26 provides a summary of the estimated benefits. Annual monetized benefits range from $1.5 million to $11.5 million. Table 9-27 lists key omissions, biases, and uncertainties in the estimation of benefits. Because the direction of bias of many of these uncertainties is unknown, the overall impact on the benefits estimates is unknown.

9.3.6 Comparison of Benefits and Costs

The total costs associated with upgrading the old mill to comply with Option A should be compared to the portion of benefits estimated above that would have resulted from implementation of Option A. However, the costs of upgrading the old mill are unavailable. Therefore, the average cost for bleached papergrade kraft mills is used to provide a rough comparison of the costs and benefits associated with the final rule. EPA estimates that the average cost for bleached papergrade kraft mills to upgrade to Option A is $11.5 million in capital and an increase of approximately $1.3 million in annual O&M for an annualized cost of $3.0 million. For Option B, EPA estimates that the average cost is $25.3 million in capital and $24,000 in annual O&M for an annualized cost of $3.7 million[22] (W. Grome, ERG, personal communication, 1996).

The benefits estimated above reflect improvements resulting from the construction of the new mill, which corresponds more closely to Option B. Therefore, the benefits should be compared to the cost of Option B. Table 9-28 shows the benefits and costs for the case study that are comparable to Option B of the current rulemaking. It is not possible to estimate the benefits for the case study that are comparable to Option A.

Finally, the costs and benefits of the cluster rule will also reflect MACT I and MACT II technologies. The mill modernization included reductions in air emissions, reportedly resulting in dramatic improvements in air quality. The costs and benefit of these improvements, and their similarity to MACT I and MACT II controls, were not estimated.

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[22] Annualized cost includes GAC at 4 percent of annual capital cost.

TABLE 9-26

ANNUAL MONETIZED RETROSPECTIVE BENEFITS FOR THE UPPER COLUMBIA RIVER AND LAKE ROOSEVELT (Millions of 1995 Dollars)

Benefit Category	Annual Benefits
Recreational Angling	
‣ Upper Columbia River Destination Fishery[1]	
— New anglers	$0.4-$1.2
— Current anglers	$0.0-$0.4
‣ Lake Roosevelt	$0.1-$0.7
‣ Lake Roosevelt White Sturgeon Fishery	+
Recreational Boating	
‣ Upper Columbia River	+
‣ Lake Roosevelt	+
Nonconsumptive Use	$0.0-$0.2
Human Health[2]	$0.8-$8.0
Passive Use	$0.2-$1.1
Total Monetized Benefits	$1.5-$11.6

[1]Annual benefits in early years will be less as the development of the fishery occurs.
[2]Lower and upper bound benefits estimates.
+ Positive benefits expected but not estimated.

TABLE 9-27

KEY OMISSIONS, BIASES, AND UNCERTAINTIES IN THE BENEFITS ANALYSIS FOR THE UPPER COLUMBIA RIVER AND LAKE ROOSEVELT

Omissions/Biases/ Uncertainties	Direction of Impact on Benefit/Cost Estimates	Comments
The estimation of benefits by category omitted some categories (e.g., the Lake Roosevelt white sturgeon fishery, recreational boating).	(-) The omission of potential benefit categories will cause benefits to be underestimated.	Insufficient data and information to evaluate the potential magnitude of these benefits.
Benefits were estimated using benefits transfer.	(?) It is unknown what bias the selected studies have on benefits.	Studies of the northwest U.S. were used if available. Transferred values are supported by a number of studies.
The increase in nonconsumptive benefits was estimated based a ratio of nonconsumptive recreational use to recreational angling use.	(?) It is unknown what bias estimating nonconsumptive use based on recreational angling use has on benefits.	The uncertainties in estimating recreational angling benefits are inherent in the estimation of nonconsumptive benefits in this manner.
The estimation of human health benefits assumes all cancers are fatal.	(+) Assuming all cancers are fatal may cause an overestimate of benefits.	The "statistical value of a life" may not be appropriate for cancers that are survived for a number of years.
Human health benefits are based on fish consumption estimates from available literature, rather than case study-specific estimates.	(?) It is unknown what bias the use of estimates from the literature has on benefits.	Case study-specific estimates for fish consumption are not available.
Passive use values are based on recreational angling values.	(?) It is unknown what bias estimating passive use values based on recreational angling values has on benefits.	The uncertainties in estimating recreational angling benefits are inherent in the estimation of passive use benefits in this manner.
Passive use values are estimated as 50% of recreational angling benefits.	(-) Passive use benefits may be underestimated.	The ratio of passive use values to use values may be as high as 2.0 or greater (Sanders et al., 1990; Sutherland and Walsh, 1985).
Overall Impact on Benefits Estimates	(?)	The direction of bias of many of the uncertainties is unknown.

+ Potential overestimate.
- Potential underestimate.
? Uncertain impact.

TABLE 9-28

ANNUAL MONETIZED BENEFITS AND COSTS COMPARABLE TO THE WATER CONTROLS OF THE FINAL PULP AND PAPER REGULATION FOR THE UPPER COLUMBIA RIVER AND LAKE ROOSEVELT[1]
(Millions of 1995 Dollars)

	Compliance with Option A	Compliance with Option B
Annual Monetized Benefits Associated with Water Quality Improvements[2]	NE	\$1.5-\$11.6
Annualized Costs Associated with Water Controls[3]	\$3.0	\$3.7

NE = Not estimated
[1]Option A is the Agency's selected option.
[2]Steady state benefit levels omitting nonmonetizable benefits.
[3]Based on annualized pretax compliance costs, reflecting a 7% real discount rate and a 16 year accounting period. Estimated average cost for U.S. bleached papergrade kraft mills.

9.3.7 Conclusions

A major modernization of the Celgar mill was undertaken in the early 1990s, and resulted in essentially a new mill on the old site with doubled capacity and a modern effluent treatment system. The process technology includes extended cooking, a closed screen room, oxygen delignification, and ECF bleaching. The estimated water-related benefits of this modernization are approximately $1.5 million to $11.6 million per year. These benefits most likely illustrate the benefits of Option B; air-related benefits were not estimated. The corresponding costs of these improvements cannot be accurately discerned because of the increased capacity developed at the mill concurrent to modernizing the effluent treatment system. However, the average cost for bleached papergrade kraft mills does provide a rough comparison of the costs and benefits associated with the final rule. The estimated average cost for bleached papergrade kraft mills to comply with Option B is $3.7 million per year.

9.4 SAMOA PENINSULA CASE STUDY

The Louisiana-Pacific Corporation Samoa mill is a bleached kraft mill on the Samoa Peninsula near the city of Eureka, California (see Figure 9-6). The mill was constructed in 1964 and, until recently, it used conventional chlorine bleaching technologies. Until 1993, the Simpson Paper Company also operated a mill located on the peninsula. Both mills discharged effluent to the Pacific Ocean; beginning in 1987, NPDES permits regulated these discharges.

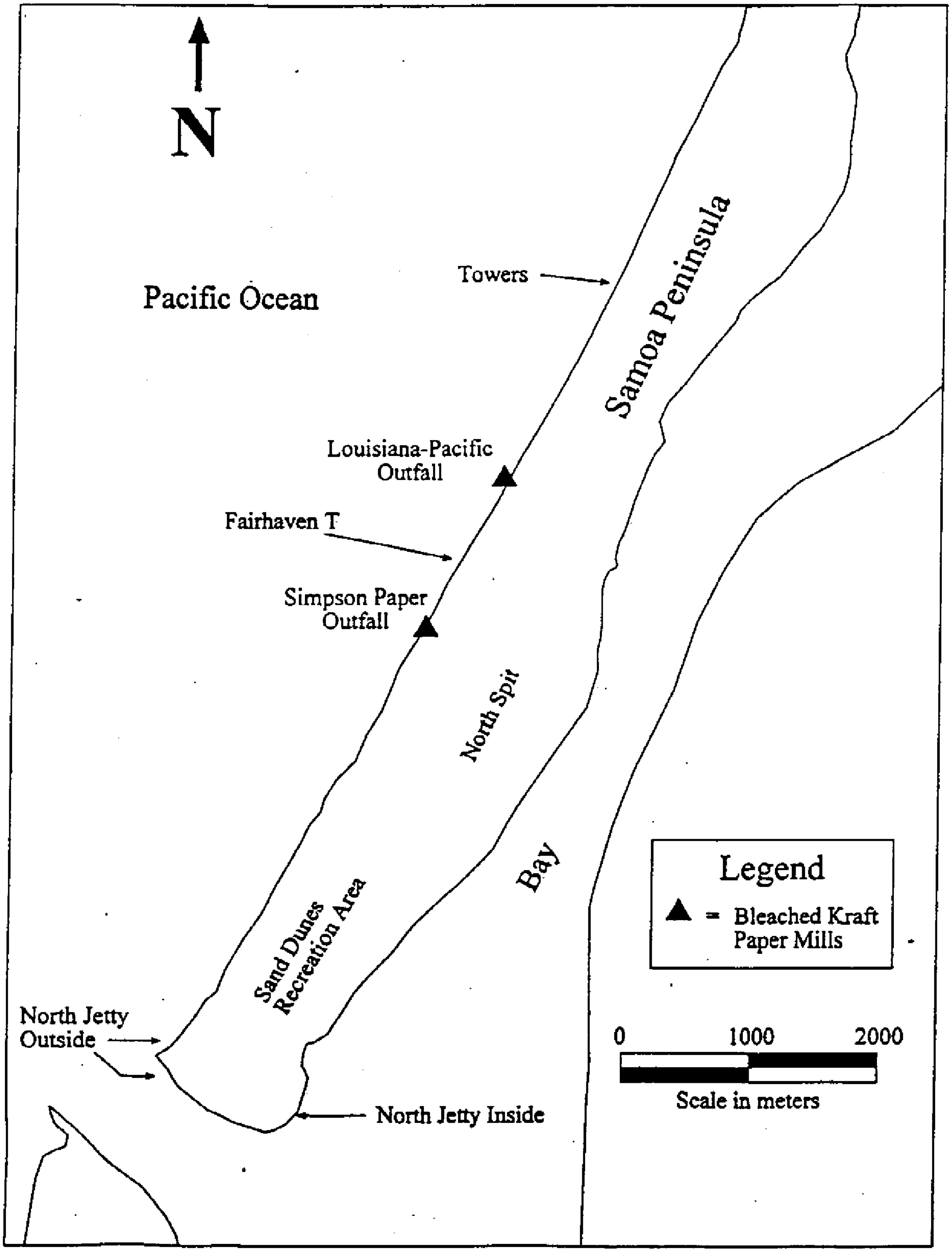
In the past, surfers and other people recreating in the waters surrounding the Samoa Peninsula frequently complained about the foul odor, foam, and discoloration caused by the mill discharges. In 1989, EPA and the Surfrider Foundation filed a Clean Water Act (CWA) enforcement action against the mills. In 1993, the Simpson Paper mill closed and stopped discharging to the Pacific Ocean. In contrast, the Louisiana-Pacific mill installed an oxygen delignification system in 1989, stopped using chlorine in January 1994, and recently began taking steps to recycle 100 percent of bleach plant wastewater. As a result, the pollution from the mill effluent has been sharply reduced and the quality of the ocean waters has improved.

This case study provides estimates of the benefits realized from the process changes at the Louisiana-Pacific mill, and compares these benefits to the potential benefits associated with the rulemaking. The process changes implemented by Louisiana-Pacific exceed what will be required under either Option A or Option B. As a result, the case study illustrates the potential for benefits and the potential costs of implementing totally chlorine free (TCF) technology. In the notice of availability for the cluster rule (July 1996), EPA strongly encouraged further development and implementation of TCF technologies and products and indicated the intent to provide regulatory incentives for mills to adopt TCF and closed cycle processes.

9.4.1 Water Quality Issues near the Samoa Peninsula

In the late 1980s, pulp and paper mill discharges to the Pacific Ocean caused concern about potential adverse health and ecological effects from dioxin contamination. However, the primary water quality concern associated with the Samoa Peninsula pulp and paper mills has been the degradation of aesthetic quality and the consequent effect on recreational use of the Peninsula beach areas.

Figure 9-6
Map of the Samoa Peninsula in Humboldt County, California



In September 1990, concern over dioxin concentrations in the water led the California Department of Health Services to issue a health consumption advisory for fish and shellfish taken from the discharge region surrounding the Samoa Peninsula. The advisory was based on findings released by EPA, which indicated significant dioxin contamination of fish near pulp mills. California issued this advisory as a prudent public health action since there was little data on seafood taken from the area around the Samoa Peninsula. The state lifted the advisory in 1994 after monitoring results from 1992, 1993, and 1994 indicated that the levels of dioxin in fish and seafood taken from the waters surrounding the Samoa Peninsula were not significantly above background levels (Fan, 1994).

Although the dioxin concentrations found in seafood did not pose a threat to human health, there were significant concerns about the chronic toxicity of the mill effluent to aquatic organisms. A study to identify the constituents of the mills' wastewater that contributed to chronic toxicity found that the very high molecular weight polar compounds accounted for most of the toxicity to sea urchin cells. The study also found that the relatively nonpolar methylene chloride and acetonitrile fractions, which contain resin and fatty acids as well as low molecular weight chlorinated organic compounds, accounted for minor amounts of toxicity to sea urchin cells (Beveridge and Diamond, PC, 1988).

Also, comments made during the NPDES permitting process illustrated the extent of citizen complaints regarding the foul odor and discoloration of the mill effluent discharges. These comments also contended that the mill effluent caused eye and skin irritation and nausea (HSU, 1988).

In response to these comments, EPA and the North Coast Regional Water Quality Control Board (NCRWQB) included provisions in the 301(m) permits for the mills requiring a Recreational Activity Impact Assessment Program (RAIAP) (HSU, 1988). The RAIAP presented substantial evidence that the aesthetic condition of the waters and beaches of the peninsula were degraded, that surfers experienced more adverse health effects at the peninsula than at other surfing locations, and that some users perceived a health risk from contact with the waters or consumption of fish and shellfish from the area (HSU, 1988). Specifically, the recreational study found that:

- 37 percent of individuals surveyed noticed unusually colored foam, unusual floating debris, unusually colored water, or a strange taste to the water

- 19 percent of the respondents indicated that these conditions decreased their enjoyment of their visit

- 17 percent of the respondents avoided the Samoa Peninsula (or portions of the area) during some of the year

- 35 percent of individuals interviewed at nearby beaches avoided the Samoa Peninsula for aesthetic or health related reasons

- of the respondents participating in diving, kayaking, skimboarding, surfing, and swimming, 62 percent reported health effects at some time in the past that they attributed to recreating at the Samoa Peninsula; eye irritation and nausea were the most common reported symptoms.

This recreational study played an important role in determining the appropriate pulp mill modifications to address water quality concerns on the Samoa Peninsula.

9.4.2 Modernization of the Louisiana-Pacific Samoa Pulp Mill

The Louisiana-Pacific mill made capital improvements throughout its period of operation. However, the mill started a major modernization of the plant in response to the CWA enforcement action. In 1989, the mill installed an oxygen delignification unit. In 1994, the mill stopped using chlorine and chlorine containing compounds in the bleaching process,[23] and recently started to take steps to recycle 100 percent of bleach plant wastewater (Jaegel and Girard, 1995).

Using totally chlorine free (TCF) bleaching in 1994 made the Samoa mill the first North American kraft pulp mill to permanently produce bleached pulp without the use of chlorine or chlorine containing compounds. The TCF bleaching process uses hydrogen peroxide and oxygen (Jaegel and Girard, 1995).

The mill is also one of the leaders in developing closed cycle bleaching in North America. Louisiana-Pacific was awarded $650,000 through the U.S. Department of Energy and EPA National Industrial Competitiveness through Energy, Environment and Economics program for research on closed cycle

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[23]After the mill implemented oxygen delignification and converted to TCF, and the water quality improved, the mill extended its outfall. The extension of the outfall was completed in December 1994.

processing (Girard and Jaegel, 1996). In May 1995, the mill demonstrated 100 percent recycling of all alkaline peroxide bleaching wastewater. In May 1996, the mill installed an advanced green liquor filtration system to increase the capture and purge capability of other nonprocess elements, and it is running a series of full scale mill trials through 1996 (Girard and Jaegel, 1996).

The corrosivity of residual chlorine compounds in the wastewater limits the potential to recycle bleaching wastewater. However, the noncorrosive chemistry of TCF bleaching chemicals and the similarity of pH and temperature conditions in bleaching stages make it easier to recycle bleaching wastewater. Other key technologies enabling high recycling rates are:

- extended digester cooking
- improved brownstock washing
- closed pulp screening
- oxygen delignification
- high efficiency recovery boiler
- advanced green liquor filtration.

The Louisiana-Pacific mill reduced the volume of effluent discharged into the Pacific Ocean from approximately 20 million gallons of untreated pulp effluent per day to approximately 1.1 million gallons of effluent treated to reduce the color, conventional pollutants, and chronic toxicity. (The closure of the Simpson Paper mill reduced the total volume of effluent discharged into the Pacific Ocean by roughly 20 million gallons per day.)

EPA estimated that the upgrade cost approximately $50.0 million in capital costs and increased annual operating costs by a net amount of approximately $1.0 million (1995 dollars; ERG, 1996a). This includes an estimated[24] $30 million for oxygen delignification capital costs and screen room closure (a $2

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[24]EPA's estimates differ from actual Samoa mill costs, but are based on an average mill in the Samoa mill's circumstances. EPA's estimates for oxygen delignification costs overstate the Samoa mill costs by (continued...)

million savings in O&M costs) plus an estimated $20 million capital cost for installation of TCF bleaching (a $3 million increase in O&M costs)   The mill's upgrades exceed Options A and B because of the oxygen delignification and the reduced effluent discharges because of eliminating chlorine dioxide and recycling a high proportion of bleaching effluents.

Costs Avoided due to TCF Bleaching

As a result of the TCF process and the high levels of wastewater recycling, the Louisiana-Pacific mill has been able to achieve significant offsetting cost savings associated with (Girard and Jaegel, 1996):

- secondary wastewater treatment and solid waste disposal costs (or costs of regulatory exemption to these requirements)
- more efficient bleaching chemical use
- conservation of energy
- conservation of water.

Although the Louisiana-Pacific mill has not monetized all of its cost savings, one of the reasons it implemented the change was its expectation that "long-term process economy would be achieved by preventing the generation of waste and recycling energy, water and chemicals back into the process instead of discharging them as waste products" (Girard and Jaegel, 1996). As of mid-1996, the mill reduced its freshwater consumption by 15 percent (3 million gallons per day), reduced bleach plant energy consumption by 50 percent (1.7 megawatts a year), and reduced its solid waste stream to green liquor dregs and lime grit that are being beneficially used as an agricultural liming agent and municipal landfill cover (Girard and Jaegel, 1996).

Additionally, the mill had previously been operating under a variance to the technologically based effluent limitations that it obtained because the mill discharges to the Pacific Ocean and is located in a sensitive coastal dune habitat, which limits expansion of the mill facilities. The costs associated with this

[24](...continued)
about $8 million.

exemption (monitoring costs and a research and development fee imposed as a condition of the exemption) were approximately $0.68 million annually (A. Jaegel, Louisiana-Pacific mill, personal communication, 1996). As a result of the process changes at the mill, these costs are no longer being incurred (Girard and Jaegel, 1996).

9.4.3 Water Quality Improvements

Using oxygen delignification and TCF bleaching significantly improved the quality of the mill's wastewater discharges. The process changes reduced concentrations of dioxin, furans, and AOX in the mill's effluent to below detection levels, and also reduced the chronic toxicity of the effluent as measured by early life stage marine organisms in a laboratory setting (Jaegel and Girard, 1995). Oxygen delignification reduced whole effluent color by about 40 percent, and other process changes that reduced discharges resulted in an additional 82 percent reduction in color (Jaegel and Girard, 1995). The volume of the mill's effluent was reduced from approximately 20 million gallons per day to about 1.1 million gallons per day, and BOD and COD loadings were also reduced (Jaegel and Girard, 1995). These improvements have decreased the deleterious effects on the aesthetic quality of the Pacific Ocean waters near the mill and peninsula.

9.4.4 Qualitative Assessment of Benefits

The following discussion provides an assessment of changes in uses of the Samoa Peninsula attributable to both the process changes at the Louisiana-Pacific mill and the closure of the Simpson mill. EPA divided the benefits estimated in this section equally between the two mills because the mills each historically discharged approximately 20 million gallons per day of untreated mill effluent, both mills would have faced similar process controls, and the improvement in the effluent from the Louisiana-Pacific mill improved water quality to the point that it does not apparently diminish recreational enjoyment significantly.

Aesthetic improvements in water quality increased the quality of recreational uses such as beachwalking, wildlife viewing, and surfing. In addition, benefits likely accrued to nonusers of the Samoa Peninsula. This discussion includes both quantitative benefits as well as qualitative benefits that are difficult to value.

Recreational Activities at the Samoa Peninsula

In 1989, the Bureau of Land Management received a state grant for $250,000 from the Off Highway Vehicle (OHV) program to develop 300 acres on the Samoa Peninsula for OHV use (B. Cann, Bureau of Land Management, Samoa Dunes Recreation Area, personal communication, 1996). The project area encompassed most of the public access areas of the Samoa Peninsula. The grant funded removing junk and debris, repairing roads, developing a parking lot for trailers, installing restroom and picnic facilities, developing a scenic overlook, and protecting threatened plants and wetlands (B. Cann, Bureau of Land Management, Samoa Dunes Recreation Area, personal communication, 1996).

Thus, users of the Samoa Peninsula benefited from both improved water quality and improved recreational facilities. The final section below comparing costs and benefits apportions the benefits between the process changes at the mill and the development of the recreation area.

The number of visits to the beaches of the peninsula increased significantly after the water quality improved and the recreational area was developed. In 1988. There were 40,827 total visitor days to the affected regions of the Samoa Peninsula (Towers, Fairhaven T, and the North Jetty). In 1993, visitor use at the newly developed Samoa Dunes Recreation Area increased to 175,000 and has remained at this level since then (BLM, unpublished). The 300 acre Samoa Dunes Recreation Area encompasses the entire North Jetty, but does not include the Towers and the Fairhaven T; therefore, visitor use counts underestimate the total number of visitors to affected areas. No visitor estimates for the beach areas outside of the Samoa Dunes Recreation Area are available; however, it is unlikely that these beaches attract some recreational users because they do not allow OHVs.

The change in recreational use of the North Jetty of the Samoa Peninsula is described below in terms of (1) increased use and improved quality of the recreational experience for surfers, and (2) increased use and improved quality of the recreational experience for all types of beach activities.

Recreational Surfing. The aesthetic and toxicity improvements in the Pacific Ocean waters off of the Samoa Peninsula have contributed to an increase in the number of surfers using in the area. Anecdotal evidence indicates that recreational users notice a significant difference in the water quality in the area, and that the primary reason for the increased surfing at the Samoa Peninsula is the improved water quality (C. Guzzi, Surfrider Foundation, personal communication, 1996).

Since 1988, the number of surfers at the North Jetty increased from an estimated 4,550 annual visits in 1988 to approximately 26,250 in 1993 and to a projected 43,750 in 1996 (HSU, 1988; BLM, unpublished; B. Cann, Bureau of Land Management, Samoa Dunes Recreation Area, personal communication. 1996). Although total visitor use leveled off in recent years, the number of surfers increased as a proportion of users; therefore, the estimate of annual surfer visits for 1996 is higher than the estimate for 1993 (B. Cann, Bureau of Land Management, Samoa Dunes Recreation Area, personal communication, 1996). The increased popularity of surfing in the area led the Surfrider Foundation to install an emergency call box and to develop plans to install shower facilities in the area (B. Cann, Bureau of Land Management, Samoa Dunes Recreation Area, personal communication, 1996).

The North Jetty is considered one of the best local surfing areas during conditions of southerly winds and swells (HSU, 1988). Therefore, EPA assumed that the increase in the number of surfing visits represents a net increase in surfing recreation of 39,200 surfing days rather than simply a transfer from one location to another. Additionally, existing surfers are likely to experience an increase in the value of their trips to the extent that they no longer perceive a health risk associated with contact with the water or eating fish and shellfish from the area.

Recreational Beach Use. Aesthetic improvements in water quality and reductions in toxicity improved the quality of recreation at the Samoa Peninsula. Recreational users include hikers, sightseers, beach walkers, picnickers, wildlife viewers, surfers, divers, kayakers, swimmers, skimboarders, anglers, and OHV riders. The improvements in aesthetic water quality most directly affected the users that participate in full-body water contact activities (primarily surfing, but also diving, kayaking, swimming, and skimboarding). However, according to the RAIAP survey, individuals participating in noncontact activities were also affected by the degraded water quality. Just under half of the respondents observing an unusual aesthetic condition at one of the study sites on the North Jetty were involved in noncontact activities (HSU, 1988).

Ecological and Passive Use Benefits

The Samoa Peninsula supports a number of endangered species, including the peregrine falcon and the California brown pelican, as well as endangered or threatened plants such as the Menzies' wallflower, the Point Reyes bird beak, and habitats such as the Northern California Salt Marsh (G. Munroe, California Department of Fish and Game, personal communication, 1996). In developing the Samoa Dunes Recreation Area, the Bureau of Land Management protected approximately 40 acres for endangered or threatened plants as well as 135 acres of wetlands (B. Cann, Bureau of Land Management, Samoa Dunes Recreation Area, personal communication, 1996).

Dioxin poses a risk to aquatic-associated wildlife, and the most sensitive ecologically important endpoints for mammals and birds are reproductive effects (U.S. EPA, 1993). The process changes at the Samoa mill dramatically reduced the toxicity of the mill's effluent to early life stage marine organisms. As measured by bioassay tests, there has been a 91 percent reduction in sea urchin toxicity, a 41 percent reduction in red abalone toxicity, a 65 percent reduction in giant kelp germination toxicity, and a 70 percent reduction in kelp germ tube growth toxicity (Girard and Jaegel, 1996).[25]

9.4.5 Quantitative Assessment of Benefits

Benefits from Recreational Activities at the Samoa Peninsula

Water quality improvements have both increased the number of visits to the Samoa Peninsula and improved the quality of recreational experiences on the peninsula. Benefits may be associated with two types of visits to the beach area: (1) the number of new visits made for which there are no comparable local substitute recreation opportunities (i.e., surfing), and (2) the improved quality of the annual visits for other types of recreational activities.

[25]The sea urchin, red abalone, and giant kelp toxicity tests are critical life stage tests and are considered to be among the most sensitive bioassay tests in regulatory use (Jaegel and Girard, 1995).

The benefits either fully attributable to the water quality improvements or jointly attributable to the water quality and the recreational facility improvements are estimated below. These benefits are then attributed to the respective improvements.

Recreational Surfing Benefits. Because the Samoa Peninsula is a unique location for surfing, net benefits may be associated with the increase of 39,200 annual surfing visits since 1988. However, this is an underestimate of new users because it does not include surfing outside of the Samoa Dunes Recreation Area. Although much of the surfing is done at the North Jetty, surfers recently began using the area just north of the Louisiana-Pacific mill (B. Cann, Bureau of Land Management, Samoa Dunes Recreation Area, personal communication, 1996).

The literature does not contain user day value estimates specifically for surfing, although one study did estimate the value of water-dependent activities, which included surfing as one of several activities. Table 9-29 presents studies that valued similar activities and therefore may be useful for a benefits transfer.

Although Dornbusch et al. (1987) is specific to Humboldt County and the water-dependent activities valued include surfing, the study uses an older travel cost method and, therefore, provides only a lower-bound estimate of benefits. An upper bound for benefits comes from the value for nonmotorized boating in Walsh et al. (1990) because it provides a rough value for a comparable, equipment-intensive water sport. Multiplying the range of estimated values ($6 to $34) by the estimated increase in the number of surfers suggests annual surfing benefits for additional activity in the range of $0.23 to $1.33 million. Attributing these benefits equally between the Louisiana-Pacific mill and the Simpson mill results in estimated annual benefits of between $0.11 and $0.66 million from the process changes at the Louisiana-Pacific mill.

Recreational Beach Use Benefits. Since 1993, visitors spent an estimated 131,250 annual beach user days (excluding surfers) at the Samoa Dunes Recreation Area. Adjusting this value to exclude OHV users, because it is unlikely that they benefited significantly from the improvements in water quality, and accounting for existing users produces an estimate of 65,800 annual beach user days resulting from both the mill process changes and the improvements in the recreation area.

TABLE 9-29

VALUES FOR WATER-BASED RECREATIONAL ACTIVITIES

Study	Location	Type of Activity	Mean Reported Value[1] (per day)	1995 Value[1]
Dornbusch et al. (1987)	Humboldt County, CA	Water-dependent activities (swimming, scuba and snorkeling, body surfing, and board surfing)	$3.50 (1982)	$5.53 [2]
Rosenthal and Cordell (1984)	Upper Delaware River	River recreation (boating, including kayaking and canoeing)	$13.68 (1983)	$20.93
Walsh et al. (1990)	U.S.	Nonmotorized boating	$25.36 (1987) [3]	$34.02 [3]
Walsh et al. (1990)	U.S.	Swimming	$22.97 (1987) [4]	$30.81 [4]

[1]Consumer surplus.
[2]Relies on an older, less robust travel cost model.
[3]Adjusted for different methodologies, empirical approaches, and study dates. The median was used instead of the mean because of the notable difference between the mean and median values (suggesting that the frequency distribution is skewed such that relatively few extremely high estimates substantially increase the mean).
[4]Adjusted for different methodologies, empirical approaches, and study dates.

Beach user day values in the literature are typically associated with specific activities at the site (e.g., swimming, sunbathing, picnicking, wildlife observation). Table 9-30 presents studies that valued beach use or similar activities.

This analysis uses a range of user day values for beach outings of $8 to $45, based on the range of values described above, omitting the high and low end values. Applying this range of values to the estimated 65,800 new beach user days per year to the site, the annual benefits of new beach user days are $0.53 million to $2.96 million. Because both water quality improvements and park development contributed to increased recreational use, benefits are attributed jointly. Both changes were necessary conditions for improving recreation on the peninsula. In lieu of allocating benefits between these improvements, EPA included the costs of upgrading the recreational quality in its cost estimates for the case study.[26] Attributing these benefits equally between the Louisiana-Pacific mill and the Simpson mill results in estimated annual benefits of between $0.27 and $1.48 million from the process changes at the Louisiana-Pacific mill.

Passive Use Benefits

Individuals may value reduced toxic concentrations and improved aesthetic conditions of the Pacific Ocean waters apart from any values associated with their direct or indirect use of the resource. These passive use values are difficult to estimate absent carefully designed and executed primary research, but benefits transfer techniques can provide a rough sense of the potential magnitude of these values.

Approach 1: Rule of Thumb. Applying the Fisher and Raucher (1984) 50 percent rule of thumb to the relevant recreational activities for this case study — beach use and surfing — suggests a potential magnitude of passive use values associated with improvements in water quality of the Pacific Ocean of $0.19 million to $1.07 million per year. The method may also be conservative; studies in the literature report a ratio of passive use values to use values of two or more (Sanders et al., 1990; Sutherland and Walsh, 1985).

Approach 2: Comparable Water Quality Improvements. EPA found no studies of the value to nonusers of water quality improvements similar to those experienced on the Samoa Peninsula. Bockstael et

[26]See Table 9-34 and footnote to table.

TABLE 9-30

CONTINGENT VALUATION STUDIES OF VALUES FOR BEACH USE

Study	Location	Type of Activity	Mean Reported Value[1] (per day)	1995 Value[1]
Dornbusch et al. (1987)	Humboldt County, CA	Water-enhanced beach activities (picnicking, hiking, backpacking, nature appreciation, visiting scenic areas, sunning, beachcombing, beach games, and camping)	$4.98 (1982) [2]	$7.86 [2]
Hay (1988)	California	Nonconsumptive wildlife-related recreation (observing, photographing, or feeding)	$32 (1985)	$45
Leeworthy et al. (1991)	Pismo State Beach	Beach use	$4.98 (1990)	$5.81
Leeworthy and Wiley (1993)	Southern California	Beach use	$8.16-$51.94 (1989)	$10.03-$63.84
Kaoru (1994)	State Beach, Martha's Vineyard, MA	Beach use by local residents	$15.38-$18.03 (1991)	$17.21-$20.17

[1]Consumer surplus.
[2]Relies on an older travel cost method.

al. (1989) conducted a contingent valuation study to value improvements in water quality in the Chesapeake Bay, which is adversely affected by nutrient overenrichment and toxic substances, to a condition that the respondent considers acceptable for swimming. Nonusers were willing to pay $51 annually (updated to 1995 dollars) for such an improvement. Applying this result to the approximately 46,617 individuals in the county surrounding the Samoa Peninsula produces an estimate of $2.38 million per year in passive use benefits. Attributing these benefits equally between the Louisiana-Pacific mill and the Simpson mill results in an estimated $1.19 million per year in passive use benefits.

Summary of Water-related Benefits

Table 9-31 provides a summary of the estimated benefits from the process changes at the Louisiana Pacific mill and the OHV program. Attributing these benefits evenly between the Louisiana-Pacific mill and the Simpson mill results in annual benefits of between $0.6 and $3.4 million attributable to the process changes at the Louisiana-Pacific mill and the improvements in the recreation area.

Table 9-32 lists key omissions, biases, and uncertainties in the estimation of benefits. Because the direction of many of these uncertainties is unknown, the overall impact on the estimated benefits is unknown.

9.4.6 Air Benefits

Table 9-33 presents the estimated emission reductions and air-related benefits of the selected options for the Louisiana-Pacific mill. Annual air-related benefits for MACT I range from a disbenefit of $5.0 million to a benefit of $10.1 million under Option A. Under Option B, the lower end of this range is increased to a disbenefit of $4.8 million per year. EPA estimated no additional benefits resulting from the implemenation of MACT II in the case study area.

TABLE 9-31

ANNUAL MONETIZED BENEFITS OF WATER QUALITY AND RECREATIONAL FACILITY IMPROVEMENTS AT THE SAMOA PENINSULA FOR LOUISIANA PACIFIC PROCESS CHANGES [1]
(Millions of 1995 Dollars)

Benefits Category	Annual Value (1995)
Recreational Surfing	\$0.1-\$0.7
Recreational Beach Use	\$0.3-\$1.5
Ecological and Passive Use	\$0.2-\$1.2
Other Benefits [2]	+
Total Monetized Benefits	\$0.6-\$3.4

[1]Includes benefits from both process changes at the mill and recreational facility improvements from a state grant for \$250,000. Excludes benefits attributable to Simpson mill closure.
[2]Excludes increased value of existing recreational trips from reduced adverse health effects to surfers and benefits to recreational users at affected sites on the peninsula outside of the Samoa Dunes Recreation Area.

TABLE 9-32

KEY OMISSIONS, BIASES, AND UNCERTAINTIES IN THE BENEFIT-COST ANALYSIS FOR THE PACIFIC OCEAN

Omissions/Biases/Uncertainties	Direction of Impact on Benefit/Cost Estimates	Comments
Benefits Estimates		
The estimation of benefits was limited to only a portion of the affected area (e.g., recreation at affected beach areas outside of the Samoa Dunes Recreation Area).	(-) The omission of affected recreation areas will cause benefits to be underestimated.	Insufficient data and information to evaluate the potential magnitude of these benefits.
Benefits were estimated using benefits transfer.	(?) It is unknown what bias the selected studies have on benefits.	Studies of similar recreational activities were used, and transferred values are supported by a number of studies.
One approach used to estimate passive use values is based on recreational use values.	(?) It is unknown what bias estimating passive use values based on recreational use values has on benefits.	The uncertainties in estimating recreational use benefits are inherent in the estimation of passive use benefits in this manner.
One approach used to estimate passive use values is based on a contingent valuation study of the Chesapeake Bay in which water quality improves from an impaired condition to a condition considered acceptable for swimming.	(+) Passive use values for a unique and well known water body such as the Chesapeake Bay may be higher than passive use values for the Samoa Peninsula.	It is unknown how the change in water quality and passive use value at the Samoa Peninsula compares to the change in water quality and passive use value for the Chesapeake Bay.
Benefits were attributed equally between the process changes at the Louisiana-Pacific mill and the closure of the Simpson mill.	(?) It is unknown what bias the assumption of equal attribution has on benefits.	Each of the mills were evaluating similar process changes and had similar levels of discharge before the Simpson mill closed.
Overall Impact on Benefits Estimates	(?)	The direction of bias of many of the uncertainties is unknown.

\+ Potential overestimate.
\- Potential underestimate.
? Uncertain impact.

TABLE 9-33

POTENTIAL ANNUAL AIR-RELATED BENEFITS OF THE SELECTED OPTIONS FOR THE LOUISIANA-PACIFIC MILL LOCATED ON THE SAMOA PENINSULA

Regulatory Option	Emission Reductions (Mg/yr)	Annual Value[1] (Millions of $1995)
Option A and MACT I		
VOC	0-3,928	$0-$10.1
Particulate Matter	(0.05)[2]	$0[3]
SO_2	(1,025)[2]-0	($5.0)-$0
TOTAL Monetized Benefits	NA	($5.0)-$10.1
Option A and MACT II		
Particulate Matter	0	$0
Option B and MACT I		
VOC	0-3,928	$0-$10.1
Particulate Matter	(0.05)[2]	$0[3]
SO_2	(984)[2]-0	($4.8)-$0
TOTAL Monetized Benefits	NA	($4.8)-$10.1
Option B and MACT II		
Particulate Matter	0	$0

[1] Benefits may not adde due to rounding.
[2] Numbers in parentheses represent emissions increases and related increased social costs.
[3] Disbenefits of $631 per year.
NA = Not applicable.

Retrospective Benefits and Costs

Table 9-34 provides a comparison of the estimated benefits and costs from the process changes implemented at the Louisiana-Pacific mill located on the Samoa Peninsula. Annualized costs of the mill upgrade are somewhat greater than the annual monetized benefits. The estimated annual monetized portion of benefits ranges from $0.6 million to $3.4 million, and the annualized cost of the upgrade is approximately $5.6 million (ERG 1996a, based on a 7 percent real discount rate and a 16 year accounting period).

Benefits and Costs Comparable to the Regulation

The benefits and costs in Table 9-34 reflect effluent controls more stringent than both Option A and Option B. Therefore, the total annualized costs that would correspond to Options A and B are less than what has already been spent for upgrades at the mill and, similarly, the corresponding monetizable portion of benefits could be a subset of the benefits estimatedin Table 9-34.

Costs and benefits of the regulation related to air controls are not shown in Table 9-34. Table 9-35 shows the estimated costs and benefits for water and air controls (any air-related costs and benefits associated with upgrades implemented in the early 1990s have not been estimated). Table 9-35 shows the benefits and costs for the case study that are comparable to the current rulemaking.

Benefits and Costs for Option B. The mill exceeded Option B by pursuing TCF technologies and recycling bleaching effluent. Consequently, not all the benefits (and costs) estimated above and associated with these new technologies can be attributed to Option B. After the upgrade in 1989 to install oxygen delignification and related modifications, the mill was close to Option B, but was not as environmentally advanced because chlorine dioxide substitution was only 5 percent to 16 percent instead of 100 percent. EPA estimated that to upgrade from the pre-1990 status to Option B, the mill would have incurred capital costs of approximately $34.0 million and the operating costs at the mill would have increased by approximately $1.1 million per year for an annualized cost of $4.7 million dollars (W. Grome, ERG, personal communication, 1996).

TABLE 9-34

BENEFITS AND COSTS OF THE PROCESS CHANGES IMPLEMENTED AT THE LOUISIANA-PACIFIC MILL LOCATED ON THE SAMOA PENINSULA (Millions of 1995 Dollars)

	Annual Value
Annual Monetized Benefits Associated with Water Quality Improvements [1]	\$0.6-\$3.4
Annualized Costs for Mill Upgrade [2]	
Upgrade (both 1989 [3] and in 1994 [4])	\$6.3
Costs Avoided due to 1994 Upgrade [5]	(\$0.7)
Costs of Recreational Facility Improvements [6]	\$0.0
Total Upgrade Costs	\$5.6

[1]Includes boating and recreational angling benefits associated with an increase in participation, and ecological and passive use benefits.
[2]Based on annuatized present value of pretax compliance costs, reflecting a 7% real discount rate and a 16 year accounting period.
[3]Included oxygen delignification and 5%-16% chlorine dioxide substitution.
[4]Began elimination of chlorine dioxide and recycling of bleaching effluents.
[5]Annual costs associated with a wastewater discharge exemption.
[6]State grant for \$250,000 from the Off-Highway-Vehicle program to develop recreational facilities averaged over 16 years.

TABLE 9-35

ANNUAL BENEFITS AND COSTS COMPARABLE TO THE FINAL PULP AND PAPER REGULATION FOR THE SAMOA PENINSULA [1] (Millions of 1995 Dollars)

Benefits and Costs	Compliance with Option A	Compliance with Option B
Annual Monetized Benefits		
Water [2] (retrospective)	$0.1-$1.4	$0.6-$3.4
Air [3] (MACT I)	($5.0)-$10.1	($4.8)-$10.1
Air (MACT II)	$0	$0.0
Water and MACT I	($4.9)-$11.5	($4.2)-$13.5
Water, MACT I and MACT II	($4.9)-$11.5	($4.2)-$13.5
Annualized Costs [4]		
Water [5]	$3.9	$4.7
Water and MACT I [6]	$4.8	$5.6
Water, MACT I, and MACT II [6]	$5.0	$5.8

[1]Option A is the Agency's selected option.
[2]Steady state benefit levels omitting nonmonetizable benefits.
[3]Estimated air benefits do not include any benefits that may have occurred as a result of past upgrades.
[4]Based on annuatized pretax compliance costs, reflecting a 7% real discount rate and a 16 year accounting period.
[5]Estimated cost to upgrade from pre 1989 status to compliance with the rule.
[6]Includes retrospective and forthcoming costs. Estimated air costs do not include any costs for air controls that may have been incurred in past upgrades.

The benefits categories estimated in the case study rely primarily on reductions in color, odor, foaming, and a perceived health risk from contact with mill effluent. Although the conversion to 100 percent substitution provided valuable reductions in toxicity and contributed to reductions in color, the extent to which these additional improvements would affect benefits is unknown. However, visitor use at the Samoa Dunes Recreation Area increased from approximately 41,000 in 1988 to 175,000 in 1993, and has not increased notably since that time (HSU, 1988; BLM, unpublished). Therefore, any water quality improvements associated with the conversion to TCF processing and closed cycle bleaching have not yet translated into increases in visitor use. It is unknown if these process changes will generate increased visitor use (or user day values) in the future. Consequently, the water quality-based benefits estimated for the retrospective case study are a reasonable estimate of the benefits attributable to Option B.

Benefits and Costs for Option A. After the 1989 upgrade, the mill exceeded Option A in that oxygen delignification was installed. Consequently, the benefits (and costs) estimated above and associated with oxygen delignification cannot be attributed to Option A. EPA estimated that to upgrade from the pre-1990 status to Option A the mill would have incurred capital costs of approximately $15.6 million and the operating costs at the mill would have increased by approximately $2.2 million per year for an annualized cost of $3.9 million dollars (W. Grome, ERG, personal communication, 1996).

Color was a major contributor to the realized surfing and beach use benefits, and EPA used color to estimate the differences in water quality-based benefits between Option A and Option B at the Samoa Peninsula. For kraft mills, the estimated reductions in color under Option A are 8 percent of the reductions in color under Option B (ERG, 1996b). EPA assumed that there was a linear relationship between color and recreational use. This is clearly likely to overestimate the differences in benefits between Option A and Option B, since fear of exposure to toxins before changes at the Louisiana-Pacific mill and closure of the Simpson mill clearly inhibited the use of the Samoa Peninsula waters. For all practical purposes, Option A eliminates toxic discharges to water, as does Option B. Applying the 8 percent figure, estimated surfing and beach use benefits under Option A would be $0.03 million to $0.17 million. Using this value to recalculate the low-end estimate for passive use benefits (the upper-end estimate cannot be recalculated to distinguish between levels of water quality improvements) results in estimated passive use benefits under Option A of $0.02 million to $1.19 million. Estimated total benefits attributable to Option A, therefore, are between $0.1 million and $1.4 million per year. EPA notes that this likely underestimates benefits for the reasons noted above.

9.4.7 Conclusions

In the early 1990s, the Louisiana-Pacific mill installed an oxygen delignification system and began implementing totally chlorine free (TCF) technology. Recently, the mill began taking steps to recycle 100 percent of bleach plant wastewater. The process changes implemented at the mill exceed what would be required under either Option A or Option B. Therefore, the portion of water-related benefits comparable to the rulemaking are less than the benefits already achieved. EPA estimates that the water-related benefits comparable to Option A are at least $0.1 million to $1.4 million per year. With the implementation of the selected regulatory options (Option A, final MACT I, and proposed MACT II Alternative A), EPA estimates that the annual benefits will range from a disbenefit of $4.9 million to a benefit of $11.5 million. The annualized costs for the selected regulatory options are estimated to be $5.0 million.

9.5 PENOBSCOT RIVER CASE STUDY

The case study of the Penobscot River in Maine assesses the benefits and costs of the regulation for two bleached kraft mills located on the river between Lincoln and the river's mouth. For the RIA at proposal, potential water-related benefits were estimated for the human health, recreational angling, subsistence use, and ecological/passive use categories of benefits. This section presents revised human health benefits estimates and an assessment of health risks and risk reductions to the Penobscot Tribe (not included in the analysis of the proposed regulation). The sections below also respond to public comments on the case study.

9.5.1 Human Health Benefits

Table 9-36 summarizes the results of the Agency's analysis of carcinogenic effects in the case study area (the estimated reductions in statistical cancer cases come from the national risk assessment in described in Chapter 8). Based on an estimated value of a statistical life of $2.5 million to $9.0 million (American Lung Association, 1995) and assuming all cancers are fatal, potential human health benefits from reduced dioxin contamination in the case study area are between $6,000 and $72,000 per year.

9.5.1.1 Risk Assessment for Native Americans

The potential human health effects described above are based on evaluation of fish consumption by licensed anglers. The above assessment does not include the Penobscot Indian Tribe because Native Americans are not required to purchase fishing licenses to fish within their treaty-protected fishing grounds. The Penobscot Nation's reservation includes 146 islands in the Penobscot River north of Old Town. The tribe has treaty-protected rights to the Penobscot River fishery, and has traditionally relied heavily on subsistence fishing. This section provides an assessment of risks to tribal members from the consumption of dioxin-contaminated fish from the Penobscot River, and the potential health benefits from the regulation.

Exposed Population. Tribal enrollment figures and a 1991 Penobscot Nation Survey provide an estimate of the Native American population that is consuming fish from the Penobscot River. Estimated tribal enrollment, including members residing both on and off the reservation, is 2,089. The tribal population

TABLE 9-36

POTENTIAL HUMAN HEALTH BENEFITS OF OPTION A TO LICENSED ANGLERS IN THE PENOBSCOT RIVER AREA[1]

Angler Group	Annual Reduction in Cancer Cases[2]	Annual Monetized Benefits (1995 dollars)
Recreational Anglers	0.002-0.006	$5,000-$54,000
Subsistence Anglers[2]	0.001-0.002	$2,000-$18,000
Total	0.002-0.008	$6,000-$72,000

[1]Benefits reflect reductions in cancer risk resulting from reduced levels of 2,3,7,8-TCDD and 2,3,7,8-TCDF in fish tissue.
[2]Range is based on low and high estimates of exposed population (10% to 33% of licensed anglers in counties adjacent to the receiving stream).
[3]Does not include Penobscot Tribe members (they have treaty-ceded fishing rights to the Penobscot River, are not required to purchase a fishing license and, therefore, are not in this analysis).

residing on the reservation is 410, and the tribal population residing in Maine is 1,167 (1996 enrollment; J. Banks, Department of Natural Resources, Penobscot Nation, personal communication, 1996). The in-state population accounts for many tribe members who live in nearby communities such as Old Town or Bangor and who continue to regularly use the Penobscot River (J. Banks, Department of Natural Resources, Penobscot Nation, personal communication, 1996).

A 1991 survey of tribal use of the Penobscot River found that 24 percent of respondents eat fish from the Penobscot River (Penobscot Nation Department of Natural Resources, 1991). The survey, which was mailed to all tribal members over the age of 18 residing in Maine, received only a 25 percent response rate. However, no other source of information on tribal practices is available. The survey probably underestimates actual exposure since individuals who practice a "traditional" lifestyle (i.e., members who spend substantial time on the reservation fishing and hunting) generally do not respond well to written surveys and thus are probably underrepresented in the survey results (Banks, 1992). Multiplying the in-state enrollment (1,167) by 24 percent results in an estimate of the exposed adult population of 280.

Consumption. Consuming anglers responding to the 1991 Penobscot Nation Survey reported an average consumption of 11 gpd, and a number of assumptions must be made to interpret this portion of the survey (Penobscot Nation Department of Natural Resources, 1991; CRITFC, 1994). This estimate is supported by the results for the 95th percentile of Maine anglers using freshwater rivers and streams in the state (12 gpd) (ChemRisk, 1992). The Penobscot Nation, which traditionally relies on the Penobscot River for sustenance, can be expected to be among the highest fish consuming populations in Maine. However, as described above, the Penobscot Nation Survey may underestimate mean consumption since tribal members that practice a traditional lifestyle may be underrepresented in the survey. The 90th percentile of fish consumption from the Penobscot Nation Survey was 48 gpd (CRITFC, 1994).

This analysis uses 11 gpd as a central estimate of consumption for the Penobscot Tribe, and provides results for an upper bound estimate of 48 gpd. Note that these values are much lower than the estimated fish consumption used for the nationwide risk assessment for licensed anglers. Nationally, for this EA, EPA estimates that recreational anglers consume an average of 21 gpd and subsistence anglers consume 48 gpd. However, on-site data are presumed to be most accurate, so EPA uses the survey consumption information. The survey consumption information may reflect "suppressed" fish consumption due to fear of contamination. However, EPA had no way to correct for that outcome other than to also consider the upper bound estimate.

Fish Tissue Concentrations. EPA modeled the baseline and post-regulation concentrations of dioxin in fish tissue for each mill using the DRE model (U.S. EPA, 1997). Because of the location of the tribe's fishing grounds, only the Lincoln mill is relevant for this analysis. Observations of fishing habits suggest that the majority of tribal fishing occurs below the Lincoln mill between Old Town and the West Enfield Dam (a map of the case study area was provided in the 1993 RIA). Tribe members using canoes to fish would have to use a vehicle or portage in order to fish the reach above the dam (J. Banks, Department of Natural Resources, Penobscot Nation, personal communication, 1996). Based on this observation, 90 percent of the total catch of tribal members is assumed to come from waters affected by effluent from the Lincoln mill.

The Penobscot most frequently consume smallmouth bass, brook trout, Atlantic salmon, landlocked salmon, pickerel, and perch (Penobscot Nation Department of Natural Resources, 1991). The DRE model provides concentrations for an average or "generic" fish.

Central Estimate Risk Level and Benefits. Cancer risk is assessed using standard EPA assumptions regarding body weight and exposure (see appendix), and cancer slope factors and oral RFDS for TCDD and TCDF consistent with those used previously in this EA. Penobscot River Native American anglers face a somewhat elevated baseline cancer risk from the consumption of dioxin-contaminated fish. Assuming consumption of 11 gpd, baseline cancer risk for the Penobscot is 3.25×10^{-5}. The selected option (Option A) reduces the baseline risk by an order of magnitude to 3.09×10^{-6}. Lifetime cancer cases are reduced by 0.009, yielding annualized benefits of $300 to $1,000, based on a 70 year life and a value of a statistical life of between $2.5 million and $9.0 million (American Lung Association, 1995).

Upper Bound Risk Level and Benefits. Assuming fish consumption of 48 gpd, Penobscot River Native American anglers face an elevated baseline cancer risk from the consumption of dioxin-contaminated fish. Baseline cancer risk for the Penobscot is 1.42×10^{-4}. Under the selected option (Option A), baseline risk is reduced to 1.35×10^{-5}. Lifetime cancer cases are reduced by 0.04, yielding annualized benefits of $1,300 to $4,600, based on a 70 year life and a value of a statistical life of between $2.5 million and $9.0 million (American Lung Association, 1995).

Uncertainties in the Estimation of Risk. There are numerous sources of uncertainties in the estimate of baseline risks to the Penobscot Tribe, and in the estimated reduction in risks from implementation of the regulation. Variations in health risks may occur, depending upon the factors described in Section 9.1.6. Additional uncertainties specific to this risk assessment include:

- ***Accuracy of Exposure Assumptions Used in Risk Calculations.*** There is no comprehensive source of information on the fish consumption habits of the Penobscot Tribe. The low and high consumption estimates used above are based on a tribal survey; however, the results are thought to underestimate consumption (Banks, 1992). Based on fish consumption levels observed elsewhere in the U.S. by tribal and other subsistence or sport anglers, the potentially low consumption rates may underestimate health risks.

- ***Accuracy of Fish Tissue Contaminant Concentrations Used to Determine Risks.*** The fish tissue concentrations used to assess risks are estimates derived from EPA's DRE model and, as such, may not represent site conditions.

- ***Accuracy of Estimates of Reductions in Contamination.*** The estimated reduction in fish tissue contamination may not represent immediate outcomes. It might take years for fish tissue contaminant reductions to occur.

9.5.2 Recreational Angling Benefits

For the proposal, EPA estimated recreational angling benefits in the Penobscot case study for the Atlantic salmon fishery and for other river fisheries. For the Atlantic salmon fishery, benefits were based on the increased value of the fishery to anglers from a lifting of FCAs on the river (value of a contaminant-free fishery). Comments on the case study asserted that the value of a contaminant-free fishery may not be realistic for the Penobscot River because it is based on a study of the Wisconsin Great Lakes trout and salmon fishery (Lyke, 1993).

Great Lakes sport fishing differs significantly from current fishing conditions on the Penobscot River, but both are popular salmon fisheries with contamination problems. Using the relationship between the value of a fishery and the increased value of a contaminant-free fishery found in the Lyke study to estimate benefits to anglers of other (non-Atlantic salmon) fisheries may be less appropriate. However, because there are no other applicable studies of the value to anglers of reducing toxic contamination in fish, the Lyke results (which are a range) are transferred for this case study.

Commenters also asserted that EPA's use of salmon angling days as an estimate of other, nonsalmon angling days could overestimate the size of the non-Atlantic salmon fishery. Although the level of activity associated with other Penobscot River fisheries is not known, state sources indicate that bass are the third most popular game fish in Maine, and that the bass fishery on the Penobscot River is very good (RCG/Hagler, Bailly, 1989). Additionally, most of the Atlantic salmon fishing on the Penobscot occurs above Bangor and below the dam in Veazie (Gordon Research Service, 1991, as cited in Boyle et al., 1992), which leaves a large portion of the study site (from the Lincoln mill to Veazie) that may be dominated by other types of fisheries. Therefore, the assumption that the angling days for all other fisheries combined is as high as the number of Atlantic salmon angling days appears to be a reasonable upper bound estimate. Angling benefits are not revised for analysis of the final rulemaking.

9.5.3 Subsistence Use Benefits

For the proposal, EPA estimated the traditional use benefits to the Penobscot Tribe from reducing dioxin contamination to levels allowing FCAs to be rescinded. EPA estimated the value of the Tribe's resources based on previous settlements and negotiations that have involved compensation to U.S. tribes for loss or partial loss of natural resource use. Commenters asserted that these values were transferred to an inappropriate population. They claimed that tribal enrollment is not the correct population estimate to use for this approach because not all members live in the area that will actually benefit from the regulation.

Information provided by John Banks of the Penobscot Nation supports the assertion that only about one third of enrolled tribal members live in the immediate vicinity, and that a significant percentage of members live outside Maine. Nevertheless, the 2,033 tribal members maintain the rights to use the Penobscot fishery and other services of the Penobscot River for traditional purposes. The benefits analysis used a range of values for annualized per capita settlements. These per capita settlement values were calculated using lump-sum settlements and tribal enrollment (including members who do not live locally). Therefore, assuming that the proportion of local tribal members in the previous settlements is comparable to the proportion of Penobscot members living in the immediate vicinity of the Penobscot River, the tribal enrollment is the appropriate number to use in developing the benefits estimate. These benefits are not revised for analysis of the final rulemaking.

EPA also notes that the recreational angling benefits estimated above are based on licensed anglers and, therefore, do not include benefits associated with recreational angling by Penobscot Tribe members.

9.5.4 Passive Use Benefits

For the proposal, EPA estimated passive use values using two different approaches to provide a plausible range of values that did not rely on a single study or methodological approach. One approach used Fisher and Raucher's (1984) rule of thumb in which passive use values were estimated to be at least as great as 50 percent of recreational angling values. Commenters study noted that this method is questionable because of the uncertainties present in the estimation of recreational benefits. However, EPA's use of the "50 percent of recreation value" rule of thumb is consistent with a conservative interpretation of empirical evidence provided by a large body of research (Fisher and Raucher, 1984). Studies in the literature have found the ratio of passive use values to use values to be approximately two or more (Sutherland and Walsh, 1985; Sanders et al., 1990).

The second approach transferred the results of a 1981 national survey of willingness to pay for water quality improvements in one's own state to the households in the case study area (Mitchell and Carson, 1984; 1986). The comments claimed that this method assumes that Penobscot River households do not value any improvements to water bodies in the state other than the Penobscot River. Although this approach may overstate the values held by local residents for the Penobscot River, the potential overstatement is likely to be more than outweighed by the fact that the analysis does not include values held by other residents of the state, and of the nation as a whole, for preserving and enhancing the quality of the Penobscot River. Given the national prominence of the Penobscot as habitat for Atlantic salmon, it is highly likely that many individuals other than local residents hold passive use values for the river. Therefore, EPA did not revise the estimate of passive use benefits for analysis of the final rule.

9.5.5 Summary of Water-Related Benefits

Table 9-37 provides a summary of the revised benefits of the regulation for the Penobscot River case study potential benefits total between \$0.7 million and \$2.3 million per year in 1995 dollars. These estimates

TABLE 9-37

POTENTIAL ANNUAL WATER-RELATED BENEFITS OF THE PULP AND PAPER REGULATION FOR THE PENOBSCOT RIVER CASE STUDY (1995 Dollars)

Benefit Category	Millions of Dollars
Human Health	
Licensed Anglers	$0.0-$0.1
Penobscot Tribe	$0.0-$0.0
Angling	
Recreational[1]	$0.3-$1.0
Tribal	+
Restoration of Subsistence Use to Penobscot Nation	$0.2-$0.6
Passive Use	$0.2-$0.7
Total Monetized Benefits	**$0.7- >$2.3**

+ Positive benefits expected but not estimated.
[1]Upperbound estimate based on assumption of other river fishing days equal to Atlantic salmon fishing days.

are comparable to the water-related case study benefits estimated in the RIA for the proposed rule ($0.6 million to $2.5 million in 1992 dollars).

9.5.6 Air Benefits

Table 9-38 presents revised estimates of emission reductions and air-related benefits of the selected options at the bleached kraft mills located on the Penobscot River. EPA estimates that the benefits associated with reductions in emissions resulting from MACT I controls range from a disbenefit of $9.5 million to a benefit of $7.7 million per year under Option A. Emission reductions resulting from MACT II controls are valued at approximately $0.1 million.

9.5.7 Comparison of Benefits and Costs

Table 9-39 presents a comparison of the monetized benefits and annualized costs of the regulation. EPA estimates that the annual benefits of implementing the selected regulatory options (Option A, final MACT I, and proposed MACT II, Alternative A) range from a disbenefit of $8.7 million to a benefit of $10.1 million. The monetized benefits do not reflect all benefits categories. Confidentiality agreements preclude disclosure of total costs for this site. However, for comparison the average annualized water-related cost for bleached papergrade kraft mills is $3.0 million. So a rough approximation of annualized costs for the two mills is $6.0 million.

TABLE 9-38

POTENTIAL ANNUAL AIR-RELATED BENEFITS OF THE SELECTED OPTIONS FOR THE MILLS ON THE PENOBSCOT RIVER

Regulatory Option	Emission Reductions (Mg/yr)	Annual Value (Millions of $1995)
Option A and MACT I		
VOC	0-2,985	$0-$7.7
Particulate Matter	(0.14)[1]	($0.0)[2]
SO_2	(760)[1]-0	($9.5)-$0
TOTAL Monetized Benefits	NA	($9.5)-$7.7
Option A and MACT II	9	$0.1

[1] Numbers in parentheses represent emissions increases and related increased social costs.
[2] Disbenefits of $1,767 per year.

TABLE 9-39

ANNUAL MONETIZED BENEFITS AND COSTS OF OPTION A FOR THE FINAL PULP AND PAPER REGULATION: PENOBSCOT RIVER CASE STUDY

Benefits and Costs	Millions of 1995 Dollars
Annual Monetized Benefits[1]	
Water	$0.7-$2.3
Air (MACT I)	($9.5)-$7.7
Air (MACT II)	$0.1
Water and MACT I	($8.8)-$10.0
Water, MACT I, and MACT II	($8.7)-$10.1
Annualized Costs	
Water and MACT I	A
Water, MACT I, and MACT II	A

[1]Steady state benefit levels omitting nonmonetizable benefits.
A. Confidentiality agreements preclude disclosure of total costs for this site. For a comparison, the estimated average annualized water-related cost for bleached papergrade kraft mills is $3.0 million.

9.6 WISCONSIN RIVER CASE STUDY

The Wisconsin River case study assesses the benefits and costs of the regulation for five bleached kraft mills located on the Wisconsin River. For the proposal, potential water-related benefits were estimated for human health, recreational angling, and ecologic/passive use benefits categories. This section presents revised estimates of costs, human health benefits, and a comparison of benefits to costs.

9.6.1 Revised Costs

EPA estimated that the combined cost for the case study mills to comply with Option A will be $21.0 million in capital and $2.8 million in annual operating costs (ERG, 1996a).

9.6.2 Human Health Benefits

The Agency's revised estimates of reductions in pollutant loadings and fish tissue contaminant concentrations translate into revised human health benefits in the case study area. Table 9-40 shows the reductions in excess cancer cases (the estimated reductions in statistical cancer cases come from the national risk assessment described in Chapter 8. Based on an estimated value of a statistical life of $2.5 million to $9.0 million (American Lung Association, 1995) and assuming all cancers are fatal, potential human health benefits from reduced dioxin contamination in the case study area are between $100 and $1,000 per year.

The estimated risks and reductions in risk due to the regulation may be underestimated in the case study area. EPA's methodology for estimating fish tissue contaminant concentrations considers each mill in isolation and thus ignores the cumulative impact of effluent from more than one mill. As mentioned above, there are five mills in the case study area.

TABLE 9-40

POTENTIAL HUMAN HEALTH BENEFITS OF OPTION A TO LICENSED ANGLERS IN THE WISCONSIN RIVER CASE STUDY AREA[1]

Angler Group	Annual Reduction in Cancer Cases[2]	Annual Monetized Benefits (1995 Dollars)
Recreational Anglers	< 0.001	$0-$700
Subsistence Anglers	< 0.001	$0-$400
Total[3]	< 0.001	$100-$1,000

[1]Benefits reflect reductions in cancer risk resulting from reduced levels of 2,3,7,8-TCDD and 2,3,7,8-TCDF in fish tissue. Results are expected to underestimate benefits for the case study site because the methodology for estimating risks does not reflect the cumulative effect of effluent from more than one mill on dioxin concentrations in fish tissue.
[2]Based on low and high estimates of exposed population (10% to 33% of licensed anglers in counties adjacent to the receiving stream).
[3]Detail does not add due to rounding.

9.6.3 Summary of Water-Related Benefits

Table 9-41 provides a summary of the revised water-related benefits of the regulation for the Wisconsin River case study. Potential monetized benefits total between $0.1 million and $1.5 million per year in 1995 dollars. The benefits estimates reflect a downward revision from the case study benefits estimated in the RIA for the proposed rule due to a reduction in baseline toxin loadings ($0.5 million to $3.4 million per year in 1992 dollars).

9.6.4 Air Benefits

Table 9-42 presents revised estimates of emission reductions and air-related benefits from implementation of air controls at the bleached kraft mills located on the Wisconsin River. EPA estimates that the annual benefits from implementing MACT I range from a disbenefit of $16.9 million to a benefit of $15.6 million under Option A . Emission reductions in particulate matter resulting from MACT II controls are valued at $2.1 million per year under Option A.

9.6.5 Comparison of Benefits and Costs

Table 9-43 presents a comparison of the annual monetized benefits and annualized costs of the regulation. EPA estimates that the annual benefits of implementing the selected regulatory options (Option A, final MACT I, and proposed MACT II, Alternative A) range from a disbenefit of $14.7 million to a benefit of $19.2 million and annualized costs are $9.3 million. The monetized benefits do not reflect all benefits categories.

TABLE 9-41

POTENTIAL ANNUAL MONETIZED WATER-RELATED BENEFITS OF THE PULP AND PAPER REGULATION FOR THE WISCONSIN RIVER CASE STUDY (1995 Dollars)

Benefit Category	Millions of Dollars
Human Health [1] Licensed Anglers	 $0.0-$0.0
Recreational Angling	$0.1-$0.1
Ecologic/Passive Use	$0.0-$1.4
Other Benefits	+
Total Monetized Benefits	**$0.1-$1.5**

+ Positive Benefits expected but not monetized.
[1]Results are expected to underestimate benefits because the methodology for estimating risks does not reflect the cumulative effect of effluent from more than one mill on dioxin concentrations in fish tissue.

TABLE 9-42

POTENTIAL ANNUAL AIR-RELATED BENEFITS OF THE SELECTED OPTIONS FOR BLEACHED KRAFT PULP AND PAPER MILLS ON THE WISCONSIN RIVER

Regulatory Option	Emission Reductions (Mg/yr)	Annual Value (Millions of $1995)
Option A and MACT I		
VOC	0-6,036	$0-$15.6
Particulate Matter	(0.01)[1]	$0[2]
SO_2	(1,349)[1]-0	($16.9)-$0
TOTAL Monetized Benefits	NA	($16.9)-$15.6
Option A and MACT II		
Particulate Matter	164	$2.1

[1] Numbers in parentheses represent emissions increases and related increased social costs.
[2] Disbenefits of $1,262 per year.
NA = Not applicable.

TABLE 9-43

ANNUAL CASE STUDY MONETIZED BENEFITS AND COSTS OF OPTION A FOR THE FINAL PULP AND PAPER REGULATION: WISCONSIN RIVER CASE STUDY

	Millions of 1995 Dollars
Annual Monetized Benefits [1]	
Water	$0.1-$1.5
Air (MACT I)	($16.9)-$15.6
Air (MACT II)	$2.1
Water and MACT I	($16.8)-$17.1
Water, MACT I, and MACT II	($14.7)-$19.2
Annualized Costs [2]	
Water and MACT I	$8.0
Water, MACT I, and MACT II	$9.3

[1]Steady state benefit levels omitting nonmonetizable benefits.
[2]Based on annuatized pretax compliance costs, reflecting a 7% real discount rate and a 16 year accounting period.

9.7 LOWER COLUMBIA RIVER CASE STUDY

The case study of the Lower Columbia River in Washington and Oregon assesses the benefits from the regulation for four bleached kraft mills located in the Lower Columbia River basin. For the RIA at proposal, potential water-related benefits were estimated for the human health, recreational fishing, nonconsumptive, and ecologic/passive use benefits categories. This section presents revised costs, revised human health benefits, an assessment of risks to Native American populations in the Columbia River Basin (not included in the analysis of the proposed regulation) and a comparison of benefits to costs.

9.7.1 Revised Costs

EPA estimates that the combined cost for the case study mills to comply with Option A will be $58.6 million in capital and a savings of $1.6 million in annual operating costs (ERG, 1996a).

9.7.2 Human Health Benefits

Table 9-44 summarizes the results of the Agency's revised analysis of carcinogenic effects in the case study area (the estimated reductions in statistical cancer cases come from the national risk assessment described in Chapter 8. Based on an estimated value of a statistical life of $2.5 million to $9.0 million (American Lung Association, 1995) and assuming all cancers are fatal, potential human health benefits from reduced dioxin contamination in the case study area are between $60,000 and $710,000 per year.

The estimated risks and reductions in risk due to the regulation may be underestimated in the case study area. EPA's methodology for estimating fish tissue contaminant concentrations considers each mill in isolation and thus ignores the cumulative impact of effluent from more than one mill. As stated above, there are five mills in the case study area.

TABLE 9-44

POTENTIAL HUMAN HEALTH BENEFITS OF OPTION A TO LICENSED ANGLERS IN THE LOWER COLUMBIA RIVER CASE STUDY AREA[1]

Angler Group	Annual Reduction in Cancer Cases[2]	Annual Monetized Benefits (Millions of 1995 Dollars)
Recreational Anglers	0.019-0.062	$0.05-$0.56
Subsistence Anglers[3]	0.005-0.017	$0.01-$0.15
Total	0.024-0.079	$0.06-$0.71

[1]Benefits reflect reductions in cancer risk resulting from reduced levels of 2,3,7,8-TCDD and 2,3,7,8-TCDF in fish tissue. Results are expected to underestimate benefits for the case study site because the methodology for estimating risks does not reflect the cumulative effect of effluent from more than one mill on dioxin concentrations in fish tissue.
[2]Range is based on low and high estimates of exposed population (10% to 33% of licensed anglers in counties adjacent to the receiving stream).
[3]Does not include Columbia River Inter-Tribal Fish Commission members tribes (they have treaty-ceded fishing rights in the Columbia River Basin, are not required to purchase a fishing license and, therefore, are not in this analysis).

9.7.2.1 Risk Assessment for Native Americans

The assessment of risk to anglers from the consumption of fish was based on licensed anglers, and their household members, who reside in counties bordering affected river reaches. Because Native Americans are not required to purchase fishing licenses to fish within their treaty-ceded fishing grounds, the above estimates do not capture human health benefits to Native American populations. This section provides an assessment of risks to Native American populations from the consumption of dioxin contaminated fish from the Columbia River, and the potential health benefits from the regulation.

The Umatilla, Nez Perce, Yakama, and Warm Springs tribes, collectively referred to as the Columbia River Inter-Tribal Fish Commission (CRITFC) member tribes, each possess fishing rights in the Columbia River Basin reserved by treaties, and members from each tribe fish for both ceremonial and subsistence purposes in the Columbia River Basin. The tribes harvest both the anadromous and resident fish species from the Lower Columbia River. The fishery resource is not only a major food source for tribal members; it is also “an integral part of the tribes’ cultural, economic, and spiritual well-being” (CRITFC, 1994).

Exposed Population. The U.S. Bureau of Census (1993) reports Native American populations on reservations and trust lands. According to the Census, there are 1,883 Nez Perce, 1,030 Umatilla, 6,198 Yakama, and 2,871 Warm Springs Native Americans living on reservation and trust lands.

Consumption. During the fall and winter of 1991-1992, the CRITFC conducted a survey to determine the level and nature of fish consumption among Columbia River Basin tribes (CRITFC, 1994). Based on low-end estimates of fish consumption provided by respondents, the survey showed tribal members 18 years and older consume an average of 58.7 gpd of fish. This rate reflects both consuming and nonconsuming tribal members, and includes fish from all sources. Overall, 87 percent of fish is obtained from self or family, friends, ceremonies, and tribal distributions. Nine percent of fish is obtained from stores, and 4 percent is obtained from other sources such as restaurants. The 90th percentile of consumption was between 97 gpd and 130 gpd. Tribal members 60 years of age and older consume 74.4 gpd; nursing mothers and females who had previously breast-fed their children consume an average of 59.1 gpd. For this assessment, risks were assessed for an average consumption of 58.7 gpd. The midpoint of the 90th percentile (114 gpd) provides an upper bound estimate.

Fish Tissue Concentrations.

Background Fish Tissue Concentrations. A recent survey of the portion of the Columbia River from Bonneville Dam to the mouth provided the data on fish tissue contaminant concentrations (Tetra Tech, 1996). This survey, conducted from September 1994 to February 1995, was designed specifically to collect human health risk assessment data. In addition to dioxin, the background risk assessed here includes risk from arsenic (inorganic), mercury, selenium, silver, aldrin, alpha-BHC, PCBs, beta-BHC, dieldrin, gamma-BHC, heptachlor, heptachlor epoxide, hexachlorobenzene, p,p'-DDD, p,p'-DDE, p,p'-DDT, and toxaphene. Although the regulation will result in reduced risks only from dioxin, data availability allowed the calculation of background risks for the range of contaminants present in fish tissue. This calculation provides perspective on the total background risk level from fish consumption faced by Native Americans. The contaminants listed above are a subset of the contaminants analyzed in the sampling survey that are of most concern for human health. Not all contaminants were detected in each species. When a contaminant was detected in any species, EPA used one-half the detection limit to estimate the degree of contamination in those species in which the contaminant was not detected.

The sampling survey (Tetra Tech, 1996) included filets of carp, largescale sucker, white sturgeon, steelhead trout, coho salmon, and chinook salmon. The fish consumption survey (CRITFC, 1994) provides detailed information on grams of fish consumed by species for 10 species specifically listed on the survey (salmon, trout, lamprey, smelt, whitefish, sturgeon, walleye, sucker, shad, and squawfish). Information from these two surveys was used to construct a weighted average fish tissue concentration that reflects the actual mix of species consumed. Salmon and trout are the most consumed species, and the species listed in the survey comprise 66 percent of total mean consumption. The species listed in the survey were matched as closely as possible to the available sampling data, and contaminant concentrations for the consumption of species not listed in the CRITFC survey (44 percent of total consumption) were calculated as an average of species consumed. Note that carp, among the most contaminated species sampled, was not included in the weighted concentration because it was not specifically listed in the CRITFC survey.

Post-Regulation Fish Tissue Concentrations. EPA modeled the background and post-regulation concentrations of TCDD and TCDF in fish tissue for each mill using the DRE model (U.S. EPA, 1997). The percentage reduction in TCDD and TCDF was applied to the background concentrations described above to calculate post-regulation concentrations. There are six bleached kraft mills in the Lower Columbia River basin. The average percentage reduction across these mills was used for this analysis. EPA used a conservative estimate of one-half the detection limit where dioxins and furans are not detected in pulp mill effluent of mills that use chlorine bleaching compounds. This may overestimate the remaining dioxin-related risks to Native Americans after compliance with either Option A or Option B. Both Option A and Option B virtually eliminate dioxin from pulp and paper mill discharges.

Central Estimate Risk Level and Benefits. Cancer risk is assessed using standard EPA assumptions regarding body weight and exposure (see appendix), and cancer slope factors and oral RFDS for TCDD and TCDF consistent with those used previously in this EA (U.S. EPA, 1997). The cancer slope factors and oral RFDS for contaminants other than TCDD and TCDF are from Tetra Tech (1996) unless otherwise noted in the appendix. Assuming consumption of 58.7 gpd, the background risk from all contaminants for the Columbia River Native American anglers is 1.15×10^{-4}. The selected BAT/PSES (Option A) reduces the background risk to 1.03×10^{-4}, although virtually all cancer risk from pulp and paper mills is eliminated. All of the remaining cancer risk is from sources other than pulp and paper mills. The selected BAT will reduce lifetime cancer cases by 0.15, yielding annualized benefits of $5,000 to $19,000, based on a 70 year life and a value of a statistical life of between $2.5 million and $9.0 million (American Lung Association, 1995).

Upper Bound Risk Level and Benefits. Assuming consumption of 114 gpd, Columbia River Native American anglers face a somewhat excessive background cancer risk from the consumption of dioxin-contaminated fish. Background cancer risk for the Columbia River Native American anglers is 2.23×10^{-4}. Under the selected BAT/PSES, background risk is reduced to 2.0×10^{-4}. Lifetime cancer cases are reduced by 0.28, yielding annualized benefits of $10,000 to $36,000.

Uncertainties in the Estimation of Risk. There are numerous sources of uncertainties in the estimate of background risks to Native Americans fishing the Lower Columbia River, and in the estimated reduction in risks from implementation of the regulation. Variations in health risks may occur, depending on the factors described in Section 9.1.6 (with the exception of the uncertainty associated with other contaminants in fish; this analysis considers contaminants other than dioxin). Additional uncertainties specific to this risk assessment include:

- ***Accuracy of Fish Tissue Contaminant Concentrations Used to Determine Risks.*** The fish tissue concentrations used to assess risks are estimates derived from EPA's DRE model and, as such, may not represent site conditions. Moreover, the assumption of one- half detection limits is very conservative.

- ***Accuracy of Estimates of Reductions in Contamination.*** The estimated reduction in fish tissue contamination may not represent actual conditions. It might take years for fish tissue contaminant reductions to occur, or they might occur sooner than predicted.

9.7.3 Summary of Water-Related Benefits

Table 9-45 provides a summary of the revised benefits of the regulation for the Lower Columbia River case study. Potential benefits total between $1.5 million and $8.6 million per year in 1995 dollars. These benefits reflect a downward revision from the water-related case study benefits estimated in the RIA for the proposed rule ($1.8 to $12.5 million per year in 1992 dollars).

9.7.4 Air Benefits

Table 9-46 presents revised estimates of emission reductions and air-related benefits of the selected options at four bleached kraft pulp and paper mills on the Lower Columbia River. Annual MACT I air-related benefits for the Lower Columbia River region range from a disbenefit of $26.9 million to a benefit of $56.2 million under Option A. Annual MACT II air-related benefits are estimated at $0.7 million under Option A.

TABLE 9-45

POTENTIAL ANNUAL MONETIZED WATER-RELATED BENEFITS OF THE PULP AND PAPER REGULATION FOR THE LOWER COLUMBIA RIVER CASE STUDY (1995 Dollars)

Benefit Category	Millions of Dollars
Human Health[1]	
Licensed Anglers	$0.1-$0.7
Columbia River Basin Tribes	$0.0-$0.0
Recreational Angling	$0.8-$2.4
Commercial Angling	$0.1-$0.8
Nonconsumptive Use	$0.1-$0.2
Ecologic/Passive Use	$0.4-$4.5
Other Benefits	+
Total Monetized Benefits	**$1.5-$8.6**

+ Positive Benefits expected but not monetized.
[1]Results are expected to underestimate benefits because the methodology for estimating risks does not reflect the cumulative effect of effluent from more than one mill on dioxin concentrations in fish tissue.

TABLE 9-46

POTENTIAL ANNUAL AIR-RELATED BENEFITS OF THE SELECTED OPTIONS FOR THE BLEACHED KRAFT PULP AND PAPER MILLS ON THE LOWER COLUMBIA RIVER

Regulatory Option	**Emission Reductions (Mg/yr)**	**Annual Value (millions of $1995)**
Option A and MACT I		
VOC	0-21,774	$0-$56.2
Particulate Matter	(0.56)[1]	$0[2]
SO_2	(5,500)-0	($26.9)-$0
TOTAL Monetized Benefits	NA	($26.9)-$56.2
Option A and MACT II		
Particulate Matter	57	$0.7

[1] Numbers in parentheses represent emissions increases and related increased social costs.
[2] Disbenefits of $7,067 per year.
NA = Not applicable.

9.7.5 Comparison of Benefits and Costs

Table 9-47 presents a comparison of the monetized benefits and annualized costs of the regulation. EPA estimates that the annual benefits of implementing the selected regulatory options (Option A, final MACT I, and proposed MACT II, Alternative A) range from a disbenefit of $24.7 million to a benefit of $65.5 million and estimated annualized costs are $16.6 million. The monetized benefits do not reflect all benefits categories.

9.8 CONCLUSIONS

The case studies presented in this chapter provide insight into both the types and potential magnitude of benefits expected to result from implementation of the pulp and paper rulemaking. Table 9-48 presents a summary of the monetized benefits estimates for the retrospective case studies and a comparison to costs. A large portion of the benefits for these case studies have already been realized; however, some benefits, particularly those associated with implementation of air controls, would occur after implementation of the final rule. Table 9-49 presents a summary of the revised estimated benefits and costs for the prospective case study sites at which the air or water controls that will be mandated by the regulation have not been implemented. An analysis of the representativeness of the case study sites with respect to the universe of affected sites is presented in Chapter 8.

TABLE 9-47

ANNUAL CASE STUDY BENEFITS AND COSTS OF OPTION A FOR THE FINAL PULP AND PAPER REGULATION: LOWER COLUMBIA RIVER CASE STUDY

Benefits and Costs	Millions of 1995 Dollars per Year
Annual Monetized Benefits [1]	
Water	$1.5-$8.6
Air (MACT I)	($26.9)-$56.2
Air (MACT II)	$0.7
Water and MACT I	($25.4)-$64.8
Water, MACT I, and MACT II [3]	($24.7)-$65.5
Annualized Costs [2]	
Water and MACT I	$14.0
Water, MACT I, and MACT II	$16.6

[1]Steady state benefit levels omitting nonmonetizable benefits.
[2]Based on annuatized pretax compliance costs, reflecting a 7% real discount rate and a 16 year accounting period.

TABLE 9-48

SUMMARY OF RETROSPECTIVE CASE STUDY EVALUATIONS OF ANNUAL MONETIZED BENEFITS AND COSTS OF THE SELECTED OPTION[1] FOR THE FINAL PULP AND PAPER REGULATION (Millions of 1995 Dollars)

	Case Study Site			
	Tombigbee and Mobile Rivers	**Pigeon River**	**Upper Columbia River**	**Samoa Peninsula**
Retrospective Portion				
Annual Monetized Benefits [2]				
Water	$1.1-$12.0	$2.7-$8.7	$1.5-$11.6 [3]	$0.1-$1.4
Air	?	?	?	?
Combined Water and Air	$1.1-$12.0	$2.7-$8.7	$1.5-$11.6 [3]	$0.1-$1.4
Annualized Costs [4]				
Water	savings of $1.8	$5.8	$3.0	$3.9
Air	?	?	?	?
Combined Water and Air	savings of $1.8	$5.8	$3.0	$3.9
Prospective Portion				
Annual Monetized Benefits [2]				
Water	+	$0	$0	$0
Air	($55.1)-$194.9	($3.7)-$7.8	NA	($5.0)-$10.1
Combined Water and Air	($55.1)-$194.9	($3.7)-$7.8	$0	($5.0)-$10.1
Annualized Costs [4]				
Water	$24.2	$0	$0	$0
Air	$10.1	$1.3	NA	$1.1
Combined Water and Air	$34.3	$1.3	$0	$1.1
Retrospective and Prospective Combined				
Annual Monetized Benefits [2]				
Water	$1.1-$12.0	$2.7-$8.7	$1.5-$11.6[3]	$0.1-$1.4
Air	($55.1)-$194.9	($3.7)-$7.8	NA	($5.0)-$10.1
Combined Water and Air	($54.0)-$206.9	($1.0)-$16.5	$1.5-$11.6[3]	($4.9)-$11.5
Annualized Costs [4]				
Water	$22.4	$5.8	$3.0	$3.9
Air	$10.1	$1.3	NA	$1.1
Combined Water and Air	$32.5	$7.1	$3.0	$5.0

TABLE 9-48 (continued)

? Retrospective air costs and benefits are not estimated.
\+ Potential benefits from additional upgrades to meet compliance with rule are not estimated.
NA Benefits and costs for air controls are not available for the Upper Columbia River case study because the mill is located in Canada.

[1]Option A, MACT I, and MACT II Alternative A.
[2]Steady state benefit levels omitting nonmonetizable benefits.
[3]Benefits for Option B are estimated to be $1.5 to $11.6.
[4]Based on annualized pretax compliance costs, reflecting a 7% real discount rate and a 16 year accounting period.

TABLE 9-49

SUMMARY OF REVISED PROSPECTIVE CASE STUDY EVALUATIONS OF ANNUAL MONETIZED BENEFITS AND COSTS OF THE SELECTED OPTION [1] FOR THE FINAL PULP AND PAPER REGULATION (Millions of 1995 Dollars)

	Penobscot River	Wisconsin River	Lower Columbia River
Annual Monetized Benefits [2]			
Water	$0.7-$2.3	$0.1-$1.5	$1.5-$8.6
Air (MACT I)	($9.5)-$7.7	($16.9)-$15.6	($26.9)-$56.2
Air (MACT II)	$0.1	$2.1	$0.7
Water and MACT I	($8.8)-$10.0	($16.8)-$17.1	($25.4)-$64.8
Water, MACT I, and MACT II	($8.7)-$10.1	($14.7)-$19.2	($24.7)-$65.5
Annualized Costs [3]			
Water and MACT I	A	$8.0	$14.0
Water, MACT I, and MACT II [4]	A	$9.3	$16.6

A. Confidentiality agreements preclude disclosure of total costs for this site. For comparison, the estimated average annualized water-related cost for bleached papergrade kraft mills is $3.0 million.

[1]Option A.
[2]Steady state benefit levels, omitting nonmonetizable benefits.
[3]Based on annualized pretax compliance costs, reflecting a 7% real discount rate and a 16 year accounting period.
[4]MACT II floor Option (#1).

9.9 REFERENCES

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CHAPTER 10

COMPARISON OF MONETIZED BENEFITS AND COSTS

This chapter provides a comparison of the monetized benefits and costs of the pulp and paper rulemaking (i.e., Option A, MACT I, and the selected alternative for MACT II). The comparison is presented in a variety of ways. First, we present the national estimate of annual benefits and costs based on the methodology applied in Chapter 8. These values are then examined over a 30-year period to evaluate the impact of benefits that accrue in the future. Finally, annual benefits and costs of the case studies are presented in Section 10.2.

As discussed in Chapter 8, EPA is unable to place a value on all benefit categories, including several health and welfare endpoints as well as entire pollutant categories, that will accrue as a result of the pulp and paper rulemaking. Therefore, monetized benefits are underestimated. Given this shortfall in the benefit estimates, it would be misleading to subtract benefits from the estimated costs and make conclusions about the net benefits of the regulation to society. In the final section of this chapter, conclusions are presented based only on a general comparison of benefits and costs.

10.1 SUMMARY OF NATIONAL MONETIZED BENEFITS AND COSTS

EPA monetizes national benefits and costs of the selected regulatory options based on both air- and water-related impacts. On an annual basis, EPA estimates that the combined air- and water-related national benefits, when fully realized, will range from a disbenefit of $727 million to a benefit of $1,496 million. As shown in Table 10-1, the large range in total benefits is driven by the large range in estimated air-related benefits. EPA estimates compliance costs are $420 million (Table 10-1), about the midpoint of the benefits range.

EPA also estimates the present value of these benefits and costs over a 30-year period. A 30-year period provides a reasonable estimate of cumulative benefits and costs that can be expected to result from the rule. This approach assumes that the characteristics of the industry and the affected population 30 years in

TABLE 10-1

ANNUAL BENEFITS AND COSTS OF THE SELECTED REGULATORY OPTIONS

Monetized Benefits[a] and Costs	**(Millions of 1995 dollars per year)[b]**
Water-Related Benefits	
Human health[c]	$2-$22
Recreational angling	
"Contaminant-free" fishery	$2-$19
Increased participation[d]	+
Sludge	$8-$16
Total Water-Related Benefits	**$12-$57**
Air-Related Benefits	
MACT I and Option A	($1,040)-$1,054
MACT II Alternative A	$302-$384
Total Air-Related Benefits	**($739)-$1,438**
Total Combined Benefits	**($727)-$1,496**
Water-Related Costs	$263
Air-Related Costs	
MACT I	$125
MACT II	$32
Total Air-Related Costs	**$157**
Total Combined Costs	**$420**

[a]National-level benefits are not inclusive of all categories of benefits that can be expected to result from the regulation.
[b]Totals may not add due to rounding.
[c]Does not include reduction in noncancer health effects and risk reductions (cancer and noncancer) to unlicensed anglers such as Native Americans with treaty-ceded fishing rights.
[d]For example, an increase in participation of 20% would generate benefits on the order of $5 million to $15 million annually.

the future will be similar to the characteristics that exist today. While it is likely that some characteristics will change due to population growth or the development of new technologies that alter production processes (and thus emissions) or creates substitute markets for pulp and paper, this analysis is a useful tool to compare benefits and costs over time.

The present value calculation employs both a 7 percent discount rate, in accordance with OMB guidance, as well as a 3 percent social rate of time preference to demonstrate the sensitivity of the results to the interest rate chosen. The present value calculation reflects phase-in periods for water-related benefits to account for lags in the realization of these benefits. EPA phased in recreational angling values over 2 years and human health values over 5 years (i.e., at full value in years 3 and 6, respectively). Sludge benefits and air-related benefits are not phased in. The cost calculation reflects capital costs in years 1 and 21 (including a 7 percent opportunity cost on capital), and O&M costs in years 2 through 30. Table 10-2 summarizes the annual and present value estimates for national monetized benefits and costs. EPA did not calculate net benefits because only a portion of air- or water-related benefits categories have been monetized at the national level, although annual and present value costs using either discount rate fall within the corresponding range of benefits. The case study examples provide somewhat more comprehensive estimates of water-related benefits.

10.2 SUMMARY OF CASE STUDY BENEFITS AND COSTS

The case studies provide greater insight into both the types and potential magnitude of water-related benefits expected to result from implementation of the pulp and paper rulemaking. Table 10-3 presents a summary of the monetized benefit and cost estimates for the three original case studies and the four new case studies. The original case studies evaluate water controls that will be applied as a result of the final effluent guidelines, while new case studies are based on mills that have already implemented water-related process changes similar to what will be required in the final rule. The estimation of air benefits and costs for all case studies are based on the air controls that are assumed to be applied after implementation of the rule.

A large portion of the benefits (and costs) for the new case studies have already been realized; however, some benefits (and costs), particularly those associated with implementation of air controls, would occur after implementation of the final rule. For the original case studies, the air and water controls that will

TABLE 10-2

ANNUAL AND PRESENT VALUES OF BENEFITS AND COSTS FOR THE SELECTED REGULATORY OPTIONS FOR THE FINAL PULP AND PAPER REGULATION
(Millions of 1995 Dollars)

		Present Value[a]	
	Annual Value	7% Discount Rate	3% Discount Rate
Combined Monetized Benefits	($727) - $1,496	($9,654) - $19,788	($14,675) - $30,120
Combined Costs	$420	$5,348	$7,563

[a]Present value over a 30 year period. The calculation reflects capital costs in years 1 and 21 (including a 7% escalation to reflect the opportunity cost of capital), and O&M costs in years 2 through 30.

TABLE 10-3

ANNUAL MONETIZED BENEFITS AND ANNUALIZED COSTS OF THE SELECTED REGULATORY OPTIONS FOR THE FINAL PULP AND PAPER RULE (Millions of 1995 Dollars)

Site	Water-Related Benefits	Air-Related Benefits[a]		Total Monetized Benefits	Total Compliance Costs
		MACT I	MACT II		
Original Case Studies					
Penobscot River	$0.7-$2.3	($9.5)-$7.7	$0.1	($8.7)-$10.1	[b]
Wisconsin River	$0.1-$1.5	($16.9)-$15.6	$2.1	($14.7)-$19.2	$9.3
Lower Columbia River	$1.5-$8.6	($26.9)-$56.2	$0.7	($24.7)-$65.5	$16.6
New Case Studies					
Lower Tombigbee and Mobile Rivers	$1.1-$12.0	($136.8)-$113.2	$81.7	($54.0)-$206.9	$32.5
Pigeon River	$2.7-$8.7	($5.8)-$5.7	$2.1	($1.0)-$16.5	$7.1
Samoa Peninsula	$0.1-$1.4	($5.0)-$10.1	$0.0	($4.9)-$11.5	$5.0
Upper Columbia River/Lake Roosevelt	$1.5-$11.6	NA	NA	$1.5-$11.6	$3.0

[a]Results are reported for the final MACT I standard and the proposed MACT II alternative in conjunction with the final BAT/PSES option.
[b]Confidentiality agreements preclude disclosure of total costs for this site.
NA Not applicable.

be required by the regulation have not been implemented, and consequently, the estimated benefits and costs have not yet been realized. As in the national estimates of monetized benefits, the large range in total benefits is driven by the large range in estimated air-related benefits. An analysis of the representativeness of the water components of the case study sites with respect to the universe of affected sites indicates that the benefits at the case study facilities may under-represent the aggregate potential benefits of the final rule, but may also underestimate potential costs (see Chapter 8).

Because many benefits categories are not monetized at the national level, the case studies provide a more comprehensive assessment of the water-related benefits that may be expected at individual sites. To provide a sense of the potential magnitude of water-related benefits that have not been captured in the monetized benefits at the national level, EPA extrapolated water-related benefits from the case studies to the national level based on comparability of receiving water and sociodemographic characteristics. Using this approach, EPA estimates that total national water-related benefits could range from $91 million to $451 million per year, approximately eight times the portion of water-related benefits EPA monetized at the national level ($12 million to $57 million per year). Because the same methodology to estimate air benefits and costs at the national level is applied to the case studies, air benefits from the case studies are not extrapolated to the national level.

10.3 CONCLUSIONS

Although several benefit categories are not monetized, a comparison of both annual and present value benefits and costs indicates that the costs fall within the range of monetized benefits of the final rulemaking. The case studies illustrate that the national level water quality benefits assessment is missing some potentially valuable categories of benefits, particularly those related to recreational water use. As with the national level assessment, costs fall within the estimated range of benefits for the six case studies where both costs and benefits are presented.

APPENDIX A

PRICE INCREASE METHODOLOGY

A.1 PRICE INCREASE CALCULATION

The percentage that a producer can increase his or her prices due to an increase in input costs can be calculated by the following formula for each product i:

$$\frac{dP}{P} = \left(\frac{\varepsilon_i}{\varepsilon_i - \delta_i}\right) \frac{\left(\frac{\sum_{m=1}^{N} C_i}{Q_i}\right)}{P} \qquad \text{(A.1)}$$

Where:

dP/P	=	the percentage increase in the price of product i
ε	=	the price elasticity of supply for product i
δ	=	the price elasticity of demand for product i
C_i	=	the pre-tax compliance cost for product i
Q_i	=	the equilibrium quantity of domestic production of product i given price P
P	=	the pre-pollution control equilibrium price for product i
N	=	the total number of mills which produce i
i	=	bleached papergrade kraft pulp; papergrade sulfite pulp; dissolving pulp (both kraft and sulfite); unbleached kraft pulp, or semichemical products

The term:

$$\frac{\varepsilon}{(\varepsilon - \delta)} \qquad \text{(A.2)}$$

represents the percent change in price for a given shift in the supply curve as represented by a percent change in cost. Dividing total compliance cost (ΣC_i) by total quantity (Q_i) yields the compliance cost per unit. Dividing this figure by equilibrium price:

$$\frac{\left(\frac{\Sigma C_i}{Q_i}\right)}{P_i} \qquad \text{(A.3)}$$

expresses the increase in unit costs due to compliance as a percentage of the equilibrium price; in other words, the shift in the supply curve as a percentage of the current price.

The percentage price increase at integrated mills with non-pulp products can be calculated as:

$$\left(\frac{dP}{P}\right)_m = \sum_i \left(\frac{dP}{P}\right)_i \frac{Q_{im}}{Q_m} + \sum_j \left(\frac{dP}{P}\right)_i \alpha_{ij} \left(\frac{dP}{P}\right)_j \frac{Q_{jm}}{Q_m} \qquad \text{(A.4)}$$

Where again for all mills m:

$(dP/P)_i$	=	the percentage increase in the price of product i
Q_i	=	the equilibrium level of production of product i given price P
P	=	the pre-pollution control equilibrium price for product i
N	=	the total number of mills that produce i
i	=	bleached papergrade kraft pulp; papergrade sulfite pulp; dissolving pulp (both kraft and sulfite); unbleached kraft pulp, or semichemical products
j	=	a product produced with i
α_{ij}	=	the quantity of pulp i needed to produce 1 ton of product j

The first summation operator calculates the percentage price changes for pulp products i, which are then weighted by the percentage of market shipments of pulp product i out of total shipments by mill m. The second summation operator calculates the percent increase in price for each product j sold by mill m, which uses pulp i as an input.

Table A-1 summarizes the elasticity, price, and quantity data taken from EPA, 1993. A price increase for bleached papergrade kraft, for example, is calculated as:

$$\frac{dP}{P} = \left(\frac{\varepsilon}{\varepsilon - \delta}\right) \left(\frac{\frac{\Sigma C_i}{Q}}{P}\right) = \frac{.186}{(.186 - (-.413))} \frac{\left(\frac{\Sigma C_i}{9{,}207{,}000}\right)}{646.49} \qquad \text{(A.5)}$$

where ΣC_i is the specific option's sum of annualized pre-tax compliance costs for all mills in that subcategory.

TABLE A-1
PRICE PERCENTAGE INCREASE COMPONENTS

Variable	Bleached Papergrade Kraft Pulp	Papergrade Sulfite Pulp	Dissolving Pulps	Unbleached Kraft Pulp	Semichemical
Supply Elasticity (ε)	0.186	0.232	0.201	0.267	0.276
Demand Elasticity (δ)	-0.413	-1.051	-0.750	-0.913	-0.353
Equilibrium Price ($/ton)	$646.49	$556.77	$735.33	$384.37	$361.50
Equilibrium Quantity (off-machine tons)	9,207,000	359,000	1,470,000	320,000	5,927,000
Total Annualized Pre-tax Compliance Costs ($)	depends on specific option	depends on specific option	depends on specific option	depends on specific option	depends on specific option
Subcategory Coefficient	5.21e-11	9.05e-10	1.95e-10	1.84e-09	2.05e-10

Source: EPA, 1993.

Given that the only parameter that varies for a product is the cost of the option, Equation 3.5 can be restated to calculate product-specific coefficients to be used with the option costs. This information is summarized in the last line of Table A-1. The specific percentage price increase for each option is used to adjust forecasted earnings in the closure analysis (see Chapter 3).

A.2 DERIVATION OF PRICE INCREASE FORMULA

Start with a constant elasticity supply curve where the variable k represents a percentage change in production costs:

$$Q^s = c\left(\frac{P}{1+k}\right)^{\varepsilon} \qquad \text{(A.6)}$$

and a constant elasticity demand curve:

$$Q^d = bP^{\delta} \qquad \text{(A.7)}$$

In equilibrium:

$$c\left(\frac{P}{1+k}\right)^{\varepsilon} = bP^{\delta} \qquad \text{(A.8)}$$

Take the total derivative of the equilibrium condition:

$$-\varepsilon c(1+k)^{-\varepsilon-1}P^{\varepsilon}dk \;+\; \varepsilon c(1+k)^{-\varepsilon}P^{\varepsilon-1}dP \;=\; \delta bP^{\delta-1}dP \tag{A.9}$$

where for convenience the following derivatives:

$$dc \;\equiv\; db \;\equiv\; d\varepsilon \;\equiv\; d\delta \;\equiv\; 0 \tag{A.10}$$

Rearranging:

$$(\varepsilon c(1+k)^{-\varepsilon}P^{\varepsilon-1} \;-\; \delta bP^{\delta-1})dP \;=\; \varepsilon c(1+k)^{-\varepsilon-1}P^{\varepsilon}dk \tag{A.11}$$

Divide through by the coefficient for dk:

$$[\varepsilon c(1+k)^{-\varepsilon-1}]^{-1}P^{-\varepsilon}(\varepsilon c(1+k)^{-\varepsilon}P^{\varepsilon-1} \;-\; \delta bP^{\delta-1})dP \;=\; dk \tag{A.12}$$

Multiply by P to the power negative epsilon:

$$[\varepsilon c(1+k)^{-\varepsilon-1}]^{-1}(\varepsilon c(1+k)^{-\varepsilon}P^{-1} \;-\; \delta bP^{\delta-1-\varepsilon})dP \;=\; dk \tag{A.13}$$

and divide the left hand side by P:

$$[\varepsilon c(1+k)^{-\varepsilon-1}]^{-1}(\varepsilon c(1+k)^{-\varepsilon} \;-\; \delta bP^{\delta-\varepsilon})\frac{dP}{P} \;=\; dk \tag{A.14}$$

Now the equilibrium condition implies that:

$$P^{(\delta - \varepsilon)} = \frac{c}{b}(1 + k)^{-\varepsilon} \tag{A.15}$$

Substitute this term into the equation:

$$[\frac{\varepsilon c(1 + k)^{-\varepsilon}}{\varepsilon c(1 + k)^{-\varepsilon - 1}} - \frac{\delta b(c/b)(1 + k)^{-\varepsilon}}{\varepsilon c(1 + k)^{-\varepsilon - 1}}]\frac{dP}{P} = dk \tag{A.16}$$

Simplify:

$$((1 + k) - \frac{\delta}{\varepsilon}(1 + k))\frac{dP}{P} = dk \tag{A.17}$$

Rearrange the left hand side:

$$\frac{1}{\varepsilon}((\varepsilon - \delta)(1 + k))\frac{dP}{P} = dk \tag{A.18}$$

Divide through for the final result:

$$\frac{dP}{P} = \frac{\varepsilon}{(\varepsilon - \delta)}\frac{dk}{(1 + k)} \tag{A.19}$$

A.3 REFERENCES

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APPENDIX B

POLLUTANT REMOVALS

TABLE B-1

POLLUTANT REMOVALS
PAPERGRADE KRAFT SUBCATEGORY-DIRECT DISCHARGERS

	POLLUTANTS REMOVED (pounds)			POLLUTANTS REMOVED (pound equivalents)	
CHEMICAL NAME	OPTION A	OPTION B	TOXIC WEIGHTING FACTOR	OPTION A	OPTION B
CHLOROFORM	7.82E+04	7.82E+04	5.71E-03	4.46E+02	4.46E+02
2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN	2.18E-02	2.38E-02	4.24E+08	9.23E+06	1.01E+07
2,3,7,8-TETRACHLORODIBENZOFURAN	2.16E-01	2.19E-01	6.69E+06	1.45E+06	1.47E+06
TRICHLOROSYRINGOL	5.99E+03	6.36E+03	1.06E-01	6.34E+02	6.74E+02
2,4,5-TRICHLOROPHENOL	8.49E+01	2.83E+02	1.25E+00	1.06E+02	3.54E+02
2,4,6-TRICHLOROPHENOL	1.59E+04	1.63E+04	1.93E+00	3.08E+04	3.15E+04
3,4,5-TRICHLOROCATECHOL	4.08E+04	4.15E+04	3.11E-01	1.27E+04	1.29E+04
3,4,5-TRICHLOROGUIACOL	1.32E+04	1.36E+04	7.47E-01	9.88E+03	1.02E+04
3,4,6-TRICHLOROCATECHOL	1.21E+02	3.88E+02	1.47E-01	1.78E+01	5.70E+01
3,4,6-TRICHLOROGUIACOL	1.04E+03	1.28E+03	1.85E-01	1.92E+02	2.36E+02
4,5,6-TRICHLORGUIACOL	7.81E+03	8.18E+03	1.81E+00	1.41E+04	1.48E+04
TETRACHLOROCATECHOL	5.68E+03	6.37E+03	7.67E-01	4.36E+03	4.89E+03
TETRACHLOROGUAIACOL	2.23E+03	2.68E+03	1.75E+00	3.90E+03	4.70E+03
2,3,4,6-TETRACHLOROPHENOL	1.22E+01	2.46E+02	5.62E-01	6.84E+00	1.38E+02
PENTACHLOROPHENOL	2.52E+02	6.38E+02	4.99E-01	1.26E+02	3.18E+02
			TOTALS:	10,755,545	11,641,298

Conversion factor from kg to lbs. = 2.2046

TABLE B-2

POLLUTANT REMOVALS
PAPERGRADE KRAFT SUBCATEGORY-INDIRECT DISCHARGERS

	POLLUTANTS REMOVED (pounds)			POLLUTANTS REMOVED (pound equivalents)	
CHEMICAL NAME	OPTION A	OPTION B	TOXIC WEIGHTING FACTOR	OPTION A	OPTION B
CHLOROFORM	9.43E+03	9.43E+03	5.71E-03	5.38E+01	5.38E+01
2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN	2.04E-03	2.20E-03	4.24E+08	8.63E+05	9.32E+05
2,3,7,8-TETRACHLORODIBENZOFURAN	1.97E-02	1.99E-02	6.69E+06	1.32E+05	1.33E+05
TRICHLOROSYRINGOL	5.26E+02	5.56E+02	1.06E-01	5.57E+01	5.90E+01
2,4,5-TRICHLOROPHENOL	1.01E+01	2.78E+01	1.25E+00	1.26E+01	3.48E+01
2,4,6-TRICHLOROPHENOL	1.33E+03	1.36E+03	1.93E+00	2.56E+03	2.62E+03
3,4,5-TRICHLOROCATECHOL	2.20E+03	2.26E+03	3.11E-01	6.85E+02	7.04E+02
3,4,5-TRICHLOROGUIACOL	7.82E+02	8.13E+02	7.47E-01	5.84E+02	6.07E+02
3,4,6-TRICHLOROCATECHOL	8.54E+00	3.50E+01	1.47E-01	1.26E+00	5.14E+00
3,4,6-TRICHLOROGUIACOL	9.61E+01	1.20E+02	1.85E-01	1.78E+01	2.22E+01
4,5,6-TRICHLORGUIACOL	5.31E+02	5.62E+02	1.81E+00	9.62E+02	1.02E+03
TETRACHLOROCATECHOL	4.85E+02	5.37E+02	7.67E-01	3.72E+02	4.12E+02
TETRACHLOROGUAIACOL	2.14E+02	2.58E+02	1.75E+00	3.74E+02	4.52E+02
2,3,4,6-TETRACHLOROPHENOL	4.27E+00	2.85E+01	5.62E-01	2.40E+00	1.60E+01
PENTACHLOROPHENOL	8.54E+00	3.50E+01	4.99E-01	4.26E+00	1.75E+01
			TOTALS:	1,000,467	1,070,965

Conversion factor from kg to lbs. =2.2046

TABLE B-3

POLLUTANT REMOVALS
PAPERGRADE SULFITE SUBCATEGORY-DIRECT DISCHARGERS

CHEMICAL NAME	POLLUTANTS REMOVED (pounds) OPTION A	TOXIC WEIGHTING FACTOR	POLLUTANTS REMOVED (pound equivalents) OPTION A
CHLOROFORM	1.06E+04	5.71E-03	6.07E+01
2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN	1.42E-03	4.24E+08	6.01E+05
2,3,7,8-TETRACHLORODIBENZOFURAN	1.42E-02	6.69E+06	9.47E+04
TRICHLOROSYRINGOL	2.65E+02	1.06E-01	2.81E+01
2,4,5-TRICHLOROPHENOL	1.69E+01	1.25E+00	2.11E+01
2,4,6-TRICHLOROPHENOL	4.63E+02	1.93E+00	8.94E+02
3,4,5-TRICHLOROCATECHOL	1.53E+03	3.11E-01	4.77E+02
3,4,5-TRICHLOROGUIACOL	5.21E+02	7.47E-01	3.89E+02
3,4,6-TRICHLOROCATECHOL	2.32E+01	1.47E-01	3.40E+00
3,4,6-TRICHLOROGUIACOL	7.07E+01	1.85E-01	1.31E+01
4,5,6-TRICHLORGUIACOL	3.56E+02	1.81E+00	6.44E+02
TETRACHLOROCATECHOL	3.37E+02	7.67E-01	2.59E+02
TETRACHLOROGUAIACOL	1.54E+02	1.75E+00	2.69E+02
2,3,4,6-TETRACHLOROPHENOL	1.51E+01	5.62E-01	8.48E+00
PENTACHLOROPHENOL	2.32E+01	4.99E-01	1.16E+01
		TOTALS:	699,061

Conversion factor from kg to lbs. = 2.2046

TABLE B-4

POLLUTANT DISCHARGES
PULP, PAPER, AND PAPERBOARD INDUSTRY

CHEMICAL NAME	POLLUTANTS DISCHARGED (pounds) All Mills	Direct Dischargers	Indirect Dischargers	TOXIC WEIGHTING FACTOR	POLLUTANTS DISCHARGED (pound equivalents) All Mills	Direct Dischargers	Indirect Dischargers
CHLOROFORM	1.19E+05	1.07E+05	nd	5.71E-03	6.78E+02	6.12E+02	nd
2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN	3.53E-02	3.25E-02	nd	4.24E+08	1.50E+07	1.38E+07	nd
2,3,7,8-TETRACHLORODIBENZOFURAN	2.67E-01	2.47E-01	nd	6.69E+06	1.79E+06	1.65E+06	nd
TRICHLOROSYRINGOL	8.29E+03	7.63E+03	nd	1.06E-01	8.79E+02	8.09E+02	nd
2,4,5-TRICHLOROPHENOL	1.33E+03	1.22E+03	nd	1.25E+00	1.66E+03	1.53E+03	nd
2,4,6-TRICHLOROPHENOL	1.93E+04	1.78E+04	nd	1.93E+00	3.72E+04	3.43E+04	nd
3,4,5-TRICHLOROCATECHOL	4.75E+04	4.51E+04	nd	3.11E-01	1.48E+04	1.40E+04	nd
3,4,5-TRICHLOROGUIACOL	1.60E+04	1.51E+04	nd	7.47E-01	1.20E+04	1.13E+04	nd
3,4,6-TRICHLOROCATECHOL	2.46E+03	2.27E+03	nd	1.47E-01	3.62E+02	3.33E+02	nd
3,4,6-TRICHLOROGUIACOL	2.52E+03	2.32E+03	nd	1.85E-01	4.66E+02	4.29E+02	nd
4,5,6-TRICHLORGUIACOL	1.02E+04	9.55E+03	nd	1.81E+00	1.85E+04	1.73E+04	nd
TETRACHLOROCATECHOL	9.42E+03	8.72E+03	nd	7.67E-01	7.22E+03	6.69E+03	nd
TETRACHLOROGUAIACOL	5.17E+03	4.76E+03	nd	1.75E+00	9.06E+03	8.33E+03	nd
2,3,4,6-TETRACHLOROPHENOL	1.29E+03	1.22E+03	nd	5.62E-01	7.25E+02	6.86E+02	nd
PENTACHLOROPHENOL	2.75E+03	2.55E+03	nd	4.99E-01	1.37E+03	1.27E+03	nd
				TOTALS:	16,847,136	15,523,922	1,323,235

'nd' = not disclosed due to confidentiality.

Conversion factor from kg to lbs. = 2.2046

TABLE B-5

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
Centralized Waste Treatment[c]	3,372	1,261-1,267	5-7
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
Metal Products and Machinery[c]	140	70	50
Nonferrous Metals Forming	34	2	69
Nonferrous Metals Mfg I	6,653	313	4
Nonferrous Metals Mfg II	1,004	12	6
Oil and Gas: Offshore[b] Coastal—Produced Water/TWC Drilling Waste	3,809 951 BAT = Current Practice	2,328 239 BAT = Current Practice	33 35 BAT = Current Practice
Organic Chemicals	54,225	9,735	5
Pesticides	2,461	371	14
Pharmaceuticals[c] A/C B/D	897 90	47 0.5	47 96
Plastics Molding & Forming	44	41	BAT=BPT
Porcelain Enameling	1,086	63	6
Petroleum Refining	BAT=BPT	BAT=BPT	BAT=BPT
Pulp & Paper	**15,524**	**4,069**	**14**
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.
[c]Proposed.

TABLE B-6

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

Industry[b]	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
Centralized Waste Treatment[c]	689	328-330	70-110
Coal Mining	NA	NA	NA[c]
Coil Coating	2,503	10	10
Copper Forming	934	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
Metal Products and Machinery[c]	1,115	234	127
Nonferrous Metals Forming	189	5	90
Nonferrous Metals Mfg I	3,187	19	15
Nonferrous Metals Mfg II	38	0.41	12
Organic Chemicals	5,210	72	34
Pesticide Manufacturing	257	19	18
Pesticide Formulating	7,746	112	<3
Pharmaceuticals[c]	340	63	1
Plastics Molding & Forming	NA	NA	NA
Porcelain Enameling	1,565	96	14
Pulp & Paper	**1,323**	**314**	**14**

[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 for offshore oil and gas and coastal oil and gas.
[c]Proposed.

TABLE B-7

**COST-EFFECTIVENESS OF CWA POLLUTION CONTROL OPTIONS
BLEACHED PAPERGRADE KRAFT AND SODA SUBCATEGORY
DIRECT DISCHARGERS
POST-TAX COSTS**

	Total Annual		Incremental			
Option	Pound Equivalents Removed (PE)	Post-tax Annualized Cost ($000, 1981)	Pound Equivalents Removed (PE)	Post-tax Annualized Cost ($000, 1981)	Incremental Cost Effectiveness ($1981/PE)	Average Cost Effectiveness ($1981/PE)
Baseline	0	$0	N/A	N/A	N/A	N/A
A	10,755,545	$95,195	10,755,545	$95,195	$8.85	$8.85
B	11,641,298	$123,686	885,754	$28,491	$32.17	$10.62

TABLE B-8

**COST-EFFECTIVENESS OF CWA POLLUTION CONTROL OPTIONS
BLEACHED PAPERGRADE KRAFT AND SODA SUBCATEGORY
INDIRECT DISCHARGERS
POST-TAX COSTS**

	Total Annual		Incremental			
Option	Pound Equivalents Removed (PE)	Post-tax Annualized Cost ($000, 1981)	Pound Equivalents Removed (PE)	Post-tax Annualized Cost ($000, 1981)	Incremental Cost Effectiveness ($1981/PE)	Average Cost Effectiveness ($1981/PE)
Baseline	0	$0	N/A	N/A	N/A	N/A
A	1,000,467	$9,392	1,000,467	$9,392	$9.39	$9.39
B	1,070,965	$15,864	70,498	$6,472	$91.81	$14.81

TABLE B-9

COST-EFFECTIVENESS OF CWA POLLUTION CONTROL OPTIONS
PAPERGRADE SULFITE SUBCATEGORY
DIRECT DISCHARGERS
POST-TAX COSTS

	Total Annual		Incremental			
Option	Pound Equivalents Removed (PE)	Post-tax Annualized Cost ($000, 1981)	Pound Equivalents Removed (PE)	Post-tax Annualized Cost ($000, 1981)	Incremental Cost Effectiveness ($1981/PE)	Average Cost Effectiveness ($1981/PE)
Baseline	0	$0	N/A	N/A	N/A	N/A
A	699,061	$6,023	699,061	$6,023	$8.62	$8.62

TABLE B-10

COST-EFFECTIVENESS OF CWA POLLUTION CONTROL OPTIONS
PULP, PAPER, AND PAPERBOARD INDUSTRY
POST-TAX COSTS

	Total Annual		Incremental			
Subcategory	Pound Equivalents Removed (PE)	Post-tax Annualized Cost ($000, 1981)	Pound Equivalents Removed (PE)	Post-tax Annualized Cost ($000, 1981)	Incremental Cost Effectiveness ($1981/PE)	Average Cost Effectiveness ($1981/PE)
BAT						
Bleached Papergrade Kraft and Soda	10,755,545	$95,195	10,755,545	$95,195	$8.85	$8.85
Papergrade Sulfite	699,061	$6,023	699,061	$6,023	$8.62	$8.62
Industry Total	11,454,605	$101,218	11,454,605	$101,218	$8.84	$8.84
PSES						
Bleached Papergrade Kraft and Soda	1,000,467	$9,392	1,000,467	$9,392	$9.39	$9.39
Papergrade Sulfite	ND	ND	ND	ND	$31.43	$31.43
Industry Total	ND	ND	ND	ND	$9.58	$9.58

ND: not disclosed for reasons of confidentiality.
Note: Incremental costs and removals are calculated from the selected option and the preceding option in the subcategory cost-effectiveness analysis.

APPENDIX C

SUBCATEGORY POLLUTANT LOADS AND BENEFITS

Appendix C

Summary of Subcategory Loads and Benefits

	Bleach Plant Baseline Load	Final Effluent Baseline Load	Option A Discharge Load[a]	Option B Discharge Load[a]	Option A Reduction[b]	Option B Reduction[b]
AOX [kkg/year]						
All Mills		41,000	12,000	6,200	28,000	34,000
All Kraft		36,000	12,000	5,800	24,000	30,000
BAT Kraft		33,000	11,000	5,400	22,000	28,000
PSES Kraft		3,000	910	420	2,100	2,600
All Sulfite		nd	nd	nd	nd	nd
BAT Sulfite		4,000	370	370	3,600	3,600
PSES Sulfite		nd	nd	nd	nd	nd
All Direct		37,000	12,000	5,800	26,000	32,000
All Indirect		nd	nd	nd	nd	nd
COD [kkg/year]						
All Mills		1,200,000	1,100,000	860,000	130,000	370,000
All Kraft		1,200,000	1,000,000	810,000	110,000	350,000
BAT Kraft		1,100,000	960,000	740,000	100,000	320,000
PSES Kraft		97,000	88,000	65,000	9,000	32,000
All Sulfite		nd	nd	nd	nd	nd
BAT Sulfite		59,000	42,000	42,000	17,000	17,000
PSES Sulfite		nd	nd	nd	nd	nd
All Direct		1,100,000	1,000,000	780,000	120,000	330,000
All Indirect		nd	nd	nd	nd	nd

Appendix C (cont.)

Summary of Subcategory Loads and Benefits

	Bleach Plant Baseline Load	Final Effluent Baseline Load	Option A Discharge Load[a]	Option B Discharge Load[a]	Option A Reduction[b]	Option B Reduction[b]
Color [kkg/year]						
All Mills		2,200,000	2,100,000	1,700,000	55,000	510,000
All Kraft		2,100,000	2,000,000	1,600,000	41,000	490,000
BAT Kraft		1,900,000	1,800,000	1,400,000	38,000	440,000
PSES Kraft		180,000	180,000	130,000	3,400	47,000
All Sulfite		nd	nd	nd	nd	nd
BAT Sulfite		120,000	100,000	100,000	14,000	14,000
PSES Sulfite		nd	nd	nd	nd	nd
All Direct		2,000,000	1,900,000	1,500,000	50,000	460,000
All Indirect		nd	nd	nd	nd	nd
Chloroform [kg/year]						
All Mills	1,400,000	54,000	9,000	9,000	45,000	45,000
All Kraft	1,300,000	48,000	8,800	8,800	40,000	40,000
BAT Kraft	1,200,000	44,000	8,100	8,100	35,000	35,000
PSES Kraft	140,000	4,900	610	610	4,300	4,300
All Sulfite	nd	nd	nd	nd	nd	nd
BAT Sulfite	120,000	5,000	210	210	4,800	4,800
PSES Sulfite	nd	nd	nd	nd	nd	nd
All Direct	1,300,000	49,000	8,400	8,400	40,000	40,000
All Indirect	nd	nd	nd	nd	nd	nd

Appendix C (cont.)

Summary of Subcategory Loads and Benefits

	Bleach Plant Baseline Load	Final Effluent Baseline Load	Option A Discharge Load[a]	Option B Discharge Load[a]	Option A Reduction[b]	Option B Reduction[b]
2,3,7,8-TCDD [g/year]						
All Mills	16	16	4.5	3.6	11	12
All Kraft	15	15	4.4	3.4	11	12
BAT Kraft	14	14	4.1	3.2	10	11
PSES Kraft	1.2	1.2	0.33	0.25	0.92	1.0
All Sulfite	nd	nd	nd	nd	nd	nd
BAT Sulfite	0.78	0.78	0.13	0.13	0.64	0.64
PSES Sulfite	nd	nd	nd	nd	nd	nd
All Direct	15	15	4.2	3.3	11	11
All Indirect	nd	nd	nd	nd	nd	nd
2,3,7,8-TCDF [g/year]						
All Mills	120	120	7.9	6.3	110	120
All Kraft	110	110	7.6	6.0	110	110
BAT Kraft	110	110	7.1	5.6	100	100
PSES Kraft	9.5	9.5	0.54	0.43	8.9	9.0
All Sulfite	nd	nd	nd	nd	nd	nd
BAT Sulfite	6.7	6.7	0.30	0.30	6.4	6.4
PSES Sulfite	nd	nd	nd	nd	nd	nd
All Direct	110	110	7.4	5.9	100	110
All Indirect	nd	nd	nd	nd	nd	nd

Appendix C (cont.)

Summary of Subcategory Loads and Benefits

	Bleach Plant Baseline Load	Final Effluent Baseline Load	Option A Discharge Load[a]	Option B Discharge Load[a]	Option A Reduction[b]	Option B Reduction[b]
Trichlorosyringol [kg/year]						
All Mills	6,800	3,800	680	490	3,100	3,300
All Kraft	6,600	3,600	660	480	3,000	3,100
BAT Kraft	6,000	3,300	610	440	2,700	2,900
PSES Kraft	520	290	49	35	240	250
All Sulfite	nd	nd	nd	nd	nd	nd
BAT Sulfite	250	140	18	18	120	120
PSES Sulfite	nd	nd	nd	nd	nd	nd
All Direct	6,300	3,500	630	460	2,800	3,000
All Indirect	nd	nd	nd	nd	nd	nd
2,4,5-Trichlorophenol [kg/year]						
All Mills	1,100	600	550	450	52	150
All Kraft	1,100	580	540	440	43	140
BAT Kraft	980	540	500	410	39	130
PSES Kraft	86	47	43	35	4.6	13
All Sulfite	nd	nd	nd	nd	nd	nd
BAT Sulfite	31	17	10	10	7.7	7.7
PSES Sulfite	nd	nd	nd	nd	nd	nd
All Direct	1,000	550	510	420	46	140
All Indirect	nd	nd	nd	nd	nd	nd

Summary of Subcategory Loads and Benefits

	Bleach Plant Baseline Load	Final Effluent Baseline Load	Option A Discharge Load[a]	Option B Discharge Load[a]	Option A Reduction[b]	Option B Reduction[b]
2,4,6-Trichlorophenol [kg/year]						
All Mills	16,000	8,700	680	500	8,100	8,200
All Kraft	15,000	8,500	660	480	7,800	8,000
BAT Kraft	14,000	7,800	610	440	7,200	7,400
PSES Kraft	1,200	650	18	18	600	620
All Sulfite	nd	nd	nd	nd	nd	nd
BAT Sulfite	420	230	0.00	0.00	210	210
PSES Sulfite	nd	nd	nd	nd	nd	nd
All Direct	15,000	8,100	630	460	7,400	7,600
All Indirect	nd	nd	nd	nd	nd	nd
3,4,5-Trichlorocatechol [kg/year]						
All Mills	39,000	22,000	1,400	990	20,000	21,000
All Kraft	38,000	21,000	1,300	950	20,000	20,000
BAT Kraft	36,000	20,000	1,200	880	19,000	19,000
PSES Kraft	2,000	1,100	97	69	1,000	1,000
All Sulfite	nd	nd	nd	nd	nd	nd
BAT Sulfite	1,300	730	36	36	700	700
PSES Sulfite	nd	nd	nd	nd	nd	nd
All Direct	37,000	20,000	1,300	920	19,000	20,000
All Indirect	nd	nd	nd	nd	nd	nd

Appendix C (cont.)

Summary of Subcategory Loads and Benefits

	Bleach Plant Baseline Load	Final Effluent Baseline Load	Option A Discharge Load[a]	Option B Discharge Load[a]	Option A Reduction[b]	Option B Reduction[b]
3,4,5-Trichloroguaiacol [kg/year]						
All Mills	13,000	7,300	670	490	6,600	6,800
All Kraft	13,000	7,000	660	480	6,400	6,500
BAT Kraft	12,000	6,600	610	440	6,000	6,200
PSES Kraft	730	400	49	35	350	370
All Sulfite	nd	nd	nd	nd	nd	nd
BAT Sulfite	460	250	18	18	240	240
PSES Sulfite	nd	nd	nd	nd	nd	nd
All Direct	12,000	6,900	630	460	6,200	6,400
All Indirect	nd	nd	nd	nd	nd	nd
3,4,6-Trichlorocatechol [kg/year]						
All Mills	2,000	1,100	1,000	910	72	200
All Kraft	2,000	1,100	1,000	890	59	190
BAT Kraft	1,800	1,000	950	820	55	180
PSES Kraft	160	85	81	69	3.9	16
All Sulfite	nd	nd	nd	nd	nd	nd
BAT Sulfite	50	28	17	17	11	11
PSES Sulfite	nd	nd	nd	nd	nd	nd
All Direct	1,900	1,000	960	840	66	190
All Indirect	nd	nd	nd	nd	nd	nd

Appendix C (cont.)

Summary of Subcategory Loads and Benefits

	Bleach Plant Baseline Load	Final Effluent Baseline Load	Option A Discharge Load[a]	Option B Discharge Load[a]	Option A Reduction[b]	Option B Reduction[b]
3,4,6-Trichloroguaiacol [kg/year]						
All Mills	2,100	1,100	590	470	550	670
All Kraft	2,000	1,100	580	460	510	630
BAT Kraft	1,800	1,000	530	430	470	580
PSES Kraft	160	89	46	35	44	54
All Sulfite	nd	nd	nd	nd	nd	nd
BAT Sulfite	84	46	14	14	32	32
PSES Sulfite	nd	nd	nd	nd	nd	nd
All Direct	1,900	1,100	550	440	500	610
All Indirect	nd	nd	nd	nd	nd	nd
4,5,6-Trichloroguaiacol [kg/year]						
All Mills	8,400	4,600	680	490	3,900	4,100
All Kraft	8,100	4,400	660	480	3,800	4,000
BAT Kraft	7,500	4,200	610	440	3,500	3,700
PSES Kraft	530	290	49	35	240	250
All Sulfite	nd	nd	nd	nd	nd	nd
BAT Sulfite	330	180	18	18	160	160
PSES Sulfite	nd	nd	nd	nd	nd	nd
All Direct	7,900	4,300	630	460	3,700	3,900
All Indirect	nd	nd	nd	nd	nd	nd

Appendix C (cont.)

Summary of Subcategory Loads and Benefits

	Bleach Plant Baseline Load	Final Effluent Baseline Load	Option A Discharge Load[a]	Option B Discharge Load[a]	Option A Reduction[b]	Option B Reduction[b]
Tetrachlorocatechol [kg/year]						
All Mills	7,800	4,300	1,300	980	3,000	3,300
All Kraft	7,400	4,100	1,300	950	2,800	3,100
BAT Kraft	6,900	3,800	1,200	880	2,600	2,900
PSES Kraft	570	310	93	69	220	240
All Sulfite	nd	nd	nd	nd	nd	nd
BAT Sulfite	340	190	36	36	150	150
PSES Sulfite	nd	nd	nd	nd	nd	nd
All Direct	7,200	4,000	1,200	910	2,700	3,000
All Indirect	nd	nd	nd	nd	nd	nd
Tetrachloroguaiacol [kg/year]						
All Mills	4,300	2,300	1,200	940	1,200	1,400
All Kraft	4,100	2,200	1,100	910	1,100	1,300
BAT Kraft	3,700	2,100	1,000	840	1,000	1,200
PSES Kraft	340	190	90	69	97	120
All Sulfite	nd	nd	nd	nd	nd	nd
BAT Sulfite	180	100	30	30	70	70
PSES Sulfite	nd	nd	nd	nd	nd	nd
All Direct	3,900	2,200	1,100	870	1,100	1,300
All Indirect	nd	nd	nd	nd	nd	nd

Appendix C (cont.)

Summary of Subcategory Loads and Benefits

	Bleach Plant Baseline Load	Final Effluent Baseline Load	Option A Discharge Load[a]	Option B Discharge Load[a]	Option A Reduction[b]	Option B Reduction[b]
2,3,4,6-Tetrachlorophenol [kg/year]						
All Mills	1,100	600	590	470	16	130
All Kraft	1,100	590	580	460	7.5	120
BAT Kraft	980	540	530	430	5.5	110
PSES Kraft	87	48	46	35	1.9	13
All Sulfite	nd	nd	nd	nd	nd	nd
BAT Sulfite	29	16	8.8	8.8	6.8	6.8
PSES Sulfite	nd	nd	nd	nd	nd	nd
All Direct	1,000	550	540	430	12	120
All Indirect	nd	nd	nd	nd	nd	nd
Pentachlorophenol [kg/year]						
All Mills	2,300	1,200	1,100	930	130	320
All Kraft	2,200	1,200	1,100	910	120	310
BAT Kraft	2,100	1,100	1,000	840	110	290
PSES Kraft	160	85	81	69	3.9	16
All Sulfite	nd	nd	nd	nd	nd	nd
BAT Sulfite	50	28	17	17	11	11
PSES Sulfite	nd	nd	nd	nd	nd	nd
All Direct	2,100	1,200	1,000	860	120	300
All Indirect	nd	nd	nd	nd	nd	nd

Appendix C (cont.)

Summary of Subcategory Loads and Benefits

	Bleach Plant Baseline Load	Final Effluent Baseline Load	Option A Discharge Load[a]	Option B Discharge Load[a]	Option A Reduction[b]	Option B Reduction[b]
All 12 Chlorophenolics [kg/year]						
All Mills	100,000	57,000	10,000	8,100	47,000	49,000
All Kraft	100,000	55,000	10,000	7,900	45,000	47,000
BAT Kraft	94,000	52,000	9,400	7,300	42,000	44,000
PSES Kraft	6,500	3,600	770	590	2,800	3,000
All Sulfite	nd	nd	nd	nd	nd	nd
BAT Sulfite	3,600	2,000	240	240	1,700	1,700
PSES Sulfite	nd	nd	nd	nd	nd	nd
All Direct	98,000	54,000	9,700	7,500	44,000	46,000
All Indirect	nd	nd	nd	nd	nd	nd
NCASI 2,3,7,8-TCDD [g/year]						
All Mills		14	4.5	3.3	9.3	10
All Kraft		13	4.3	3.2	8.8	10
BAT Kraft		12	4.0	2.9	8.2	9.3
PSES Kraft		0.88	0.33	0.23	0.56	0.65
All Sulfite		nd	nd	nd	nd	nd
BAT Sulfite		0.59	0.13	0.13	0.46	0.46
PSES Sulfite		nd	nd	nd	nd	nd
All Direct		13	4.1	3.1	8.7	10
All Indirect		nd	nd	nd	nd	nd

Appendix C (cont.)

Summary of Subcategory Loads and Benefits

	Bleach Plant Baseline Load	Final Effluent Baseline Load	Option A Discharge Load[a]	Option B Discharge Load[a]	Option A Reduction[b]	Option B Reduction[b]
NCASI 2,3,7,8-TCDF [g/year]						
All Mills		45	8.6	6.7	36	38
All Kraft		42	8.4	6.5	33	35
BAT Kraft		41	7.8	6.0	33	35
PSES Kraft		1.0	0.60	0.44	0.44	0.61
All Sulfite		nd	nd	nd	nd	nd
BAT Sulfite		3.4	0.28	0.28	3.1	3.1
PSES Sulfite		nd	nd	nd	nd	nd
All Direct		44	8.0	6.3	36	38
All Indirect		nd	nd	nd	nd	nd

Notes: ‘nd’ = not disclosed due to confidentiality.
Columns may not add due to rounding.

[a]For Papergrade Sulfite, only one option was evaluated for each segment; Option A is equivalent to Option B.
[b]Reduction = Baseline Load minus Option Discharge Load. For Papergrade Sulfite Option A is equivalent to Option B.

APPENDIX D

BASELINE FISHERY VALUES

Table 1
Baseline Fishery Value at Sites with a Fish Consumption Advisory for Dioxin [1]
(assumes use by 10% of licensed anglers in adjacent counties)

Receiving Stream [2]	Number of Anglers with Advisory	State Average Days Fished per Angler[3]	Baseline Fishing Days	Estimated Value (1995$)[4]
Androscoggin River (ME)	2,363	14.6	34,500	$2,499,856
Androscoggin River (NH)	805	15.3	12,317	$892,454
Bayou La Foyrche, Wham Brake, and Lake Irwin (LA)	2,006	16.5	33,099	$1,045,597
Blackwater River (VA)	358	15.0	5,373	$169,727
Chowan River (TN)	428	16.1	6,893	$217,735
Houston Ship Channel (TX)	14,495	14.5	210,178	$6,639,507
Kennebec River (ME)	2,069	14.6	30,207	$2,188,828
Neches River (TX)	5,669	14.5	82,201	$2,596,714
Penobscot River (ME)	1,838	14.6	26,835	$1,944,450
Pigeon River (NC)	394	14.5	5,717	$180,606
Pigeon River (TN)	227	16.1	3,650	$115,303
Roanoke River , Abelmarle Sound, and Welch Creek (NC)	583	14.5	8,454	$267,046
Total	31,235		459,422	$18,757,823
Lower Bound Estimate of Increase in Value (11.1% of Baseline Value)				$2,082,118

[1] Used as a basis for calculation of potential benefits from increased value of fishery. Sites where advisories associated with other contaminants will still be in place are not included.
[2] Represents 14 different water bodies and 16 different advisories, because two of the water bodies have advisories in two states. Does not include the Escatawpa River in Mississippi, the Menominee River in Michigan, or the Wisconsin River in Wisconsin because advisories are expected to remain in place for contaminants other than dioxin or furan.
[3] Source: U.S. DOI, Fish and Wildlife Service, and U.S. Department of Wildlife, Bureau of Census. 1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, U.S. Government Printing Office, Washington, D.C. 1993. Data reflect freshwater fishing days.
[4] Calculated by multiplying the number of angling days by consumer surplus per day. Mean values for warmwater ($31.59), coldwater ($41.08), and anadramous ($72.46) fishing are from Walsh et al. (1990), updated to 1995 dollars.

Table 2

Baseline Fishery Value at Sites with a Fish Consumption Advisory for Dioxin [1]
(assumes use by 33% of licensed anglers in adjacent counties)

Receiving Stream [2]	Number of Anglers with Advisory	State Average Days Fished per Angler[3]	Baseline Fishing Days	Estimated Value (1995$)[4]
Androscoggin River (ME)	7,798	14.6	113,851	$8,249,629
Androscoggin River (NH)	2,655	15.3	40,622	$2,943,434
Bayou La Foyrche, Wham Brake, and Lake Irwin (LA)	6,619	16.5	109,214	$3,450,054
Blackwater River (VA)	1,182	15.0	17,730	$560,100
Chowan River (TN)	1,413	16.1	22,745	$718,526
Houston Ship Channel (TX)	47,834	14.5	693,593	$21,910,603
Kennebec River (ME)	6,829	14.6	99,703	$7,224,508
Neches River (TX)	18,709	14.5	271,281	$8,569,751
Penobscot River (ME)	6,065	14.6	88,549	$6,416,261
Pigeon River (NC)	1,301	14.5	18,867	$595,998
Pigeon River (TN)	748	16.1	12,045	$380,501
Roanoke River , Abelmarle Sound, and Welch Creek (NC)	1,924	14.5	27,898	$881,298
Total	103,077		1,516,097	$61,900,665
Upper Bound Estimate of Increase in Value (31.3% of Baseline Value)				$19,374,908

[1] Used as a basis for calculating potential benefits from increased value of fishery. Sites where advisories associated with other contaminants will still be in place are not included.
[2] Represents 14 different water bodies and 16 different advisories, because two of the water bodies have advisories in two states. Does not include the Escatawpa River in Mississippi, the Menominee River in Michigan, or the Wisconsin River in Wisconsin because advisories are expected to remain in place for contaminants other than dioxin or furan.
[3] Source: U.S. DOI, Fish and Wildlife Service, and U.S. Department of Wildlife, Bureau of Census. 1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, U.S. Government Printing Office, Washington, D.C. 1993. Data reflect freshwater fishing days.
[4] Calculated by multiplying the number of angling days by consumer surplus per day. Mean values for warmwater ($31.59), coldwater ($41.08), and anadramous ($72.46) fishing are from Walsh et al. (1990), updated to 1995 dollars.

Table 3
Potential Recreational Angling Benefits from Increased Participation [1]
(assumes use by 10% of licensed anglers in adjacent counties)

Receiving Stream[2]	Number of Anglers with Advisory	Number of Anglers without Advisory	Change in Number of Anglers	State Average Days Fished per Angler[3]	Change in Fishing Days	Estimated Value (1995$)[4]
Androscoggin River (ME)	2,363	2,954	591	14.6	8,629	$625,228
Androscoggin River (NH)	805	1,006	201	15.3	3,075	$222,836
Bayou La Foyrche, Wham Brake, and Lake Irwin (LA)	2,006	2,507	501	16.5	8,267	$261,139
Blackwater River (VA)	358	448	90	15.0	1,343	$42,432
Chowan River (TN)	428	535	107	16.1	1,723	$54,434
Houston Ship Channel (TX)	14,495	18,119	3,624	14.5	52,548	$1,659,991
Kennebec River (ME)	2,069	2,587	518	14.6	7,563	$548,000
Neches River (TX)	5,669	7,087	1,418	14.5	20,561	$649,522
Penobscot River (ME)	1,838	2,297	459	14.6	6,701	$485,583
Pigeon River (NC)	394	493	99	14.5	1,429	$45,151
Pigeon River (TN)	227	283	57	16.1	912	$28,826
Roanoke River , Abelmarle Sound, and Welch Creek (NC)	583	729	146	14.5	2,117	$66,876
Total	31,235	39,045	7,810		114,869	$4,690,020

[1] Method does not account for potential substitution between sites which would result in lower benefits.
[2] Represents 14 different water bodies and 16 different advisories, because two of the water bodies have advisories in two states. Does not include sites where advisories are expected to remain in place for contaminants other than dioxin or furan.
[3] Source: U.S. DOI, Fish and Wildlife Service, and U.S. Department of Wildlife, Bureau of Census. 1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, U.S. Government Printing Office, Washington, D.C. 1993. Data reflect freshwater fishing days.
[4] Calculated by multiplying the change in angling days by consumer surplus per day. Mean values for warmwater ($31.59), coldwater ($41.08), and anadramous ($72.46) fishing are from Walsh et al. (1990), updated to 1995 dollars.
[5] EPA estimates that after implementation of the final rule, advisories will remain in place for other contaminants and that the number of recreational anglers will not increase.

Table 4
Potential Recreational Angling Benefits from Increased Participation [1]
(assumes use by 33% of licensed anglers in adjacent counties)

Receiving Stream[2]	Number of Anglers with Advisory	Number of Anglers without Advisory	Change in Number of Anglers	State Average Days Fished per Angler[3]	Change in Fishing Days	Estimated Value (1995$)[4]
Androscoggin River (ME)	7,798	9,747	1,949	14.6	28,455	$2,061,878
Androscoggin River (NH)	2,655	3,319	664	15.3	10,159	$736,136
Bayou La Foyrche, Wham Brake, and Lake Irwin (LA)	6,619	8,274	1,655	16.5	27,308	$862,644
Blackwater River (VA)	1,182	1,478	296	15.0	4,433	$140,025
Chowan River (TN)	1,413	1,766	353	16.1	5,686	$179,632
Houston Ship Channel (TX)	47,834	59,793	11,959	14.5	173,406	$5,477,880
Kennebec River (ME)	6,829	8,537	1,708	14.6	24,937	$1,806,921
Neches River (TX)	18,709	23,386	4,677	14.5	67,817	$2,142,323
Penobscot River (ME)	6,065	7,581	1,516	14.6	22,134	$1,603,801
Pigeon River (NC)	1,301	1,626	325	14.5	4,717	$149,000
Pigeon River (TN)	748	935	187	16.1	3,011	$95,125
Roanoke River , Abelmarle Sound, and Welch Creek (NC)	1,924	2,405	481	14.5	6,975	$220,324
Total	103,077	128,847	25,770		379,036	$15,475,688

[1] Method does not account for potential substitution between sites which would result in lower benefits.
[2] Represents 14 different water bodies and 16 different advisories, because two of the water bodies have advisories in two states. Does not include sites where advisories are expected to remain in place for contaminants other than dioxin or furan.
[3] Source: U.S. DOI, Fish and Wildlife Service, and U.S. Department of Wildlife, Bureau of Census. 1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, U.S. Government Printing Office, Washington, D.C. 1993. Data reflect freshwater fishing days.
[4] Calculated by multiplying the change in angling days by consumer surplus per day. Mean values for warmwater ($31.59), coldwater ($41.08), and anadramous ($72.46) fishing are from Walsh et al. (1990), updated to 1995 dollars.

APPENDIX E

HUMAN HEALTH BENEFITS CALCULATIONS

1.0 ALABAMA CASE STUDY

2.0 UPPER COLUMBIA RIVER/LAKE ROOSEVELT CASE STUDY

3.0 PENOBSCOT RIVER CASE STUDY

4.0 LOWER COLUMBIA RIVER CASE STUDY

ALABAMA CASE STUDY

CANCER RISK TO SPORT ANGLERS FROM INGESTION OF DIOXIN CONTAMINATED FISH
ALABAMA TOMBIGBEE RIVER AND MOBILE RIVER MILLS

	Consumption 4 oz Method	
[BW]	Body Weight (kg)	70
[EF]	Exposure Frequency (days/year)	365
[ED]	Exposure Duration (years)	70
[AT]	Averaging Time (days)	25,550
[POP]	Exposed Pop=Anglers*3.9	89,660
[CSF]	*Dioxin CSF (mg/kg-day)^-1*	*1.60E+05*
[IR]	Consumption (kg/day) 4 oz Method	0.0408
[CF]	Fish Tissue Dioxin Contamination Change (ppm)	5.72E-06
[FI]	Fraction AL Trips to Tombigbee R & Mobile R BK Mills	5%
[IN]	Intake Avoided (mg/kg-day)	1.82E-10
[CR]	Cancer Risk Avoided	2.91E-05
[CL]	Lifetime Cancer Cases Avoided	2.607
[CY]	Yearly Cancer Cases Avoided	0.037
[LV]	Low Value per Case	$2,500,000
[HV]	High Value per Case	$9,000,000
[LB]	Low Annual Benefits	$93,106
[HB]	High Annual Benefits	$335,183

	Consumption Harvest Method	
[BW]	Body Weight (kg)	70
[EF]	Exposure Frequency (days/year)	365
[ED]	Exposure Duration (years)	70
[AT]	Averaging Time (days)	25,550
[POP]	Exposed Pop=Anglers*3.9	89,660
[CSF]	*Dioxin CSF (mg/kg-day)^-1*	*1.60E+05*
[IR]	Consumption (kg/day) Harvest Method	0.0451
[CF]	Fish Tissue Dioxin Contamination Change (ppm)	5.72E-06
[FI]	Fraction AL Trips to Tombigbee R & Mobile R BK Mills	5%
[IN]	Intake Avoided (mg/kg-day)	2.01E-10
[CR]	Cancer Risk Avoided	3.21E-05
[CL]	Lifetime Cancer Cases Avoided	2.881
[CY]	Yearly Cancer Cases Avoided	0.041
[LV]	Low Value per Case	$2,500,000
[HV]	High Value per Case	$9,000,000
[LB]	Low Annual Benefits	$102,893
[HB]	High Annual Benefits	$370,415

NOTES

[BW] U.S. EPA. 1989. Interim Final Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Mannual. Prepared by the Office of Emergency and Remedial Response. U.S. Environmental Protection Agency. Washington DC.

[EF] U.S. EPA. 1989. Interim Final Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Mannual. Prepared by the Office of Emergency and Remedial Response, U.S. Environmental Protection Agency. Washington DC.

[ED] U.S. EPA. 1989. Interim Final Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Mannual. Prepared by the Office of Emergency and Remedial Response, U.S. Environmental Protection Agency. Washington DC.

[AT] U.S. EPA. 1989. Interim Final Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Mannual. Prepared by the Office of Emergency and Remedial Response. Washington DC.

[POP] Alabama Department of Conservation and Natural Resources. 1994. 1993-1994 Annual License Report. License Unit, Game and Fish Division, Department of Conservation and Natural Resources, State of Alabama. Montgomery, Alabama.
FIMS and FAA (Fishery Information Management Systems, Inc. and Department of Fisheries and Allied Aquaculture). 1993. Estimation of Daily Per Capita Freshwater Fish Consumption of Alabama Anglers. Prepared for Alabama Department of Environmental Management. Montgomery, Alabama.
Tucker, W.H. 1987. Alabama Angler Survey. Department of Conservation and Natural Resources, State of Alabama. Montgomery, Alabama.

[CSF] Tetra Tech. 1996. Revised Water Quality Assessment of Proposed Effluent Guidelines for the Pulp, Paper, and Paperboard Industry. Office of Science and Technology, U.S. Environmental Protection Agency. Washington. DC.

[IR] FIMS and FAA (Fishery Information Management Systems, Inc. and Department of Fisheries and Allied Aquaculture). 1993. Estimation of Daily Per Capita Freshwater Fish Consumption of Alabama Anglers. Prepared for Alabama Department of Environmental Management. Montgomery, Alabama.

[CF] ADEM (Alabama Department of Environmental Management). 1995b. Bleached Kraft Mills Dioxin Fish Data. Montgomery, Alabama.

[FI] Tucker, W.H. 1987. Alabama Angler Survey. Department of Conservation and Natural Resources, State of Alabama. Montgomery, Alabama.

[IN] = (CF * IR * FI * EF * ED) / (BW * AT)

[CR] = IN * CSF

[CL] = CR * POP

[CY] = (CR * POP) / ED

[HV] American Lung Association. 1995. Dollars and Cents: The Economic and Health Benefits of Potential Particulate Matter Reductions in the United States. Prepared by L.G. Chestnut, Hagler Bailly Consulting, Inc., Boulder, Colorado. New York. June.

[LV] American Lung Association. 1995. Dollars and Cents: The Economic and Health Benefits of Potential Particulate Matter Reductions in the United States. Prepared by L.G. Chestnut, Hagler Bailly Consulting, Inc., Boulder, Colorado. New York. June.

[HB] HV * CY

[LB] LV * CY

UPPER COLUMBIA RIVER/LAKE ROOSEVELT CASE STUDY

CANCER RISK TO SPORT ANGLERS FROM INGESTION OF DIOXIN CONTAMINATED FISH
UPPER COLUMBIA RIVER AND LAKE ROOSEVELT; UNITED STATES

Low Consumption		
1990 Contamination Levels		
[BW]	Body Weight (kg)	70
[EF]	Exposure Frequency (days/year)	365
[ED]	Exposure Duration (years)	70
[AT]	Averaging Time (days)	25,550
[POP]	Exposed Pop	80,199
[CSF]	*Dioxin CSF (mg/kg-day)^-1*	*1.60E+05*
[IR]	Consumption (kg/day) EPA Sport Angler	0.0200
[CF]	Fish Tissue Dioxin Contamination (ppm)	7.05E-06
[IN]	Intake Avoided (mg/kg-day)	2.01E-09
[CR]	Cancer Risk	3.22E-04
[CL]	Lifetime Cancer Cases	25.849
[CY]	Yearly Cancer Cases	0.369
1994 Contamination Levels		
[BW]	Body Weight (kg)	70
[EF]	Exposure Frequency (days/year)	365
[ED]	Exposure Duration (years)	70
[AT]	Averaging Time (days)	25,550
[POP]	Exposed Pop	80,199
[CSF]	*Dioxin CSF (mg/kg-day)^-1*	*1.60E+05*
[IR]	Consumption (kg/day) EPA Sport Angler	0.0200
[CF]	Fish Tissue Dioxin Contamination (ppm)	1.07E-06
[IN]	Intake Avoided (mg/kg-day)	3.05E-10
[CR]	Cancer Risk	4.87E-05
[CL]	Lifetime Cancer Cases	3.909
[CY]	Yearly Cancer Cases	0.056
Difference 1990 to 1994		
	90 Yearly Cancer Cases - 94 Yearly Cancer Cases	0.313
[LV]	Low Value per Case	$2,500,000
[HV]	High Value per Case	$9,000,000
[LB]	Low Consumption Low Annual Benefits	$783,549
[HB]	Low Consumption High Annual Benefits	$2,820,776

High Consumption		
1990 Contamination Levels		
[BW]	Body Weight (kg)	70
[EF]	Exposure Frequency (days/year)	365
[ED]	Exposure Duration (years)	70
[AT]	Averaging Time (days)	25,550
[POP]	Exposed Pop	80,199
[CSF]	*Dioxin CSF (mg/kg-day)^-1*	*1.60E+05*
[IR]	Consumption (kg/day) CRITFC Adult	0.0587
[CF]	Fish Tissue Dioxin Contamination (ppm)	7.05E-06
[IN]	Intake Avoided (mg/kg-day)	5.91E-09
[CR]	Cancer Risk	9.46E-04
[CL]	Lifetime Cancer Cases	75.865
[CY]	Yearly Cancer Cases	1.084
1994 Contamination Levels		
[BW]	Body Weight (kg)	70
[EF]	Exposure Frequency (days/year)	365
[ED]	Exposure Duration (years)	70
[AT]	Averaging Time (days)	25,550
[POP]	Exposed Pop	80,199
[CSF]	*Dioxin CSF (mg/kg-day)^-1*	*1.60E+05*
[IR]	Consumption (kg/day) CRITFC Adult	0.0587
[CF]	Fish Tissue Dioxin Contamination (ppm)	1.07E-06
[IN]	Intake Avoided (mg/kg-day)	8.94E-10
[CR]	Cancer Risk	1.43E-04
[CL]	Lifetime Cancer Cases	11.473
[CY]	Yearly Cancer Cases	0.164
Difference 1990 to 1994		
	90 Yearly Cancer Cases - 94 Yearly Cancer Cases	0.920
[LV]	Low Value per Case	$2,500,000
[HV]	High Value per Case	$9,000,000
[LB]	High Consumption Low Annual Benefits	$2,299,716
[HB]	High Consumption High Annual Benefits	$8,278,979

CANCER RISK TO SPORT ANGLERS FROM INGESTION OF DIOXIN CONTAMINATED FISH
UPPER COLUMBIA RIVER AND LAKE ROOSEVELT; CANADA

Low Consumption

1990 Contamination Levels		
[BW]	Body Weight (kg)	70
[EF]	Exposure Frequency (days/year)	365
[ED]	Exposure Duration (years)	70
[AT]	Averaging Time (days)	25,550
[POP]	Exposed Pop	ERR
[CSF]	*Dioxin CSF (mg/kg-day)^-1*	*1.60E+05*
[IR]	Consumption (kg/day) EPA Sport Angler	0.0200
[CF]	Fish Tissue Dioxin Contamination (ppm)	ERR
[IN]	Intake Avoided (mg/kg-day)	ERR
[CR]	Cancer Risk	ERR
[CL]	Lifetime Cancer Cases	ERR
[CY]	Yearly Cancer Cases	ERR
1994 Contamination Levels		
[BW]	Body Weight (kg)	70
[EF]	Exposure Frequency (days/year)	365
[ED]	Exposure Duration (years)	70
[AT]	Averaging Time (days)	25,550
[POP]	Exposed Pop	ERR
[CSF]	*Dioxin CSF (mg/kg-day)^-1*	*1.60E+05*
[IR]	Consumption (kg/day) EPA Sport Angler	0.0200
[CF]	Fish Tissue Dioxin Contamination (ppm)	ERR
[IN]	Intake Avoided (mg/kg-day)	ERR
[CR]	Cancer Risk	ERR
[CL]	Lifetime Cancer Cases	ERR
[CY]	Yearly Cancer Cases	ERR
Difference 1990 to 1994		
	90 Yearly Cancer Cases - 94 Yearly Cancer Cases	ERR
[LV]	Low Value per Case	$2,500,000
[HV]	High Value per Case	$9,000,000
[LB]	Low Consumption Low Annual Benefits	ERR
[HB]	Low Consumption High Annual Benefits	ERR

High Consumption

1990 Contamination Levels		
[BW]	Body Weight (kg)	70
[EF]	Exposure Frequency (days/year)	365
[ED]	Exposure Duration (years)	70
[AT]	Averaging Time (days)	25,550
[POP]	Exposed Pop	ERR
[CSF]	*Dioxin CSF (mg/kg-day)^-1*	*1.60E+05*
[IR]	Consumption (kg/day) CRITFC Adult	0.0587
[CF]	Fish Tissue Dioxin Contamination (ppm)	ERR
[IN]	Intake Avoided (mg/kg-day)	ERR
[CR]	Cancer Risk	ERR
[CL]	Lifetime Cancer Cases	ERR
[CY]	Yearly Cancer Cases	ERR
1994 Contamination Levels		
[BW]	Body Weight (kg)	70
[EF]	Exposure Frequency (days/year)	365
[ED]	Exposure Duration (years)	70
[AT]	Averaging Time (days)	25,550
[POP]	Exposed Pop	ERR
[CSF]	*Dioxin CSF (mg/kg-day)^-1*	*1.60E+05*
[IR]	Consumption (kg/day) CRITFC Adult	0.0587
[CF]	Fish Tissue Dioxin Contamination (ppm)	ERR
[IN]	Intake Avoided (mg/kg-day)	ERR
[CR]	Cancer Risk	ERR
[CL]	Lifetime Cancer Cases	ERR
[CY]	Yearly Cancer Cases	ERR
Difference 1990 to 1994		
	90 Yearly Cancer Cases - 94 Yearly Cancer Cases	ERR
[LV]	Low Value per Case	$2,500,000
[HV]	High Value per Case	$9,000,000
[LB]	High Consumption Low Annual Benefits	ERR
[HB]	High Consumption High Annual Benefits	ERR

NOTES

[BW]	U.S. EPA. 1989. Interim Final Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Mannual. Prepared by the Office of Emergency and Remedial Response. U.S. Environmental Protection Agency. Washington DC.
[EF]	U.S. EPA. 1989. Interim Final Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Mannual. Prepared by the Office of Emergency and Remedial Response, U.S. Environmental Protection Agency. Washington DC.
[ED]	U.S. EPA. 1989. Interim Final Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Mannual. Prepared by the Office of Emergency and Remedial Response, U.S. Environmental Protection Agency. Washington DC.
[AT]	U.S. EPA. 1989. Interim Final Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Mannual. Prepared by the Office of Emergency and Remedial Response. Washington DC.
[POP]	Griffith, J.R. and A.T. Scholz. 1990. Lake Roosevelt Fisheries Monitoring Program Annual Report. Project No. 88-63. Contract Number DE-8179-88DP91819. Prepared by Janelle R. Griffith and Allan T. Scholz, Upper Columbia United Tribes Fisheries Center, Department of Biology, Eastern Washington University. Prepared for Fred Holm, U.S. Department of Energy, Bonneville Power Administration, Portland,OR
	Hagler Bailly Consulting, Inc. 1995. Columbia River System Operation Review Recreation Impacts: Demand Model and Simulation Results. Prepared by Hagler Bailly Consulting, Inc., Boulder, CO. Prepared for Matthew Rea, U.S. Army Corps of Engineers, Portland, OR. June 30.
	U.S. Bureau of Census. 1990. Characteristics of American Indians by Tribe and Language. Washington, DC.
[CSF]	Tetra Tech. 1996. Revised Water Quality Assessment of Proposed Effluent Guidelines for the Pulp, Paper, and Paperboard Industry. Office of Science and Technology, U.S. Environmental Protection Agency. Washington. DC.
[IR] Low	U.S. EPA. 1989. Interim Final Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Mannual. Prepared by the Office of Emergency and Remedial Response. Washington DC.
[IR] High	Columbia River Intertribal Fish Commission. 1994. A Fish Consumption Survey of the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin. Technical Report 94-3. October.
[CF]	Various Canadian Agencies as cited in Serdar, D. 1993. "Retrospective Analysis of Toxic Contaminants in Lake Roosevelt." Prepared for The Lake Roosevelt Water Quality Council.
	Axys Analytical Services, Ltd. 1994. Analysis Report: Polychlorinated Dibenzodioxins and Dibenzofurans, High Resolution GC/MS. Prepared by Axys Analytical Services, Ltd., Sidney, B.C. Prepared for Hatfield Consultants. December 16.
[IN] =	(CF *IR *EF *ED)/(BW *AT)
[CR] =	IN * CSF
[CL] =	CR * POP
[CY] =	(CR * POP) / ED
[HV]	American Lung Association. 1995. Dollars and Cents: The Economic and Health Benefits of Potential Particulate Matter Reductions in the United States. Prepared by L.G. Chestnut, Hagler Bailly Consulting, Inc., Boulder, Colorado. New York. June.
[LV]	American Lung Association. 1995. Dollars and Cents: The Economic and Health Benefits of Potential Particulate Matter Reductions in the United States. Prepared by L.G. Chestnut, Hagler Bailly Consulting, Inc., Boulder, Colorado. New York. June.
[HB]	HV * CY
[LB]	LV * CY

PENOBSCOT RIVER CASE STUDY

CANCER RISK TO NATIVE AMERICAN ANGLERS FROM INGESTION OF DIOXIN CONTAMINATED FISH

PENOBSCOT RIVER, MAINE
High Consumption Estimate

		TCDD	TCDF	TOTAL
[BW]	Body Weight (kg)	70	70	
[EF]	Exposure Frequency (days/year)	365	365	
[ED]	Exposure Duration (years)	70	70	
[AT]	Averaging Time (days)	25,550	25,550	
[POP]	Exposed Pop	280	280	
[CSF]	*CSF (mg/kg-day)^-1*	*1.60E+05*	*1.60E+04*	
[IR]	Consumption (kg/day) Penobscot Survey	0.0480	0.0480	
[ADJ]	Percent Consumption Contaminated	90%	90%	
[CF]	Baseline Fish Tissue Contamination (ppm)	7.70E-07	6.66E-06	
[IN]	Baseline Intake (mg/kg-day)	4.75E-10	4.11E-09	
[CR]	Baseline Cancer Risk	7.60E-05	6.58E-05	1.42E-04
[CL]	Baseline Lifetime Cancer Cases	0.02129	0.01841	0.03970
[CY]	Baseline Yearly Cancer Cases	0.00030	0.00026	0.00057
[CF]	Option 1 Fish Tissue Contamination (ppm)	1.24E-07	1.24E-07	
[IN]	Option 1 Intake (mg/kg-day)	7.65E-11	7.65E-11	
[CR]	Option 1 Cancer Risk	1.22E-05	1.22E-06	1.35E-05
[CL]	Option 1 Lifetime Cancer Cases	0.00343	0.00034	0.00377
[CY]	Option 1 Yearly Cancer Cases	0.00005	0.00000	0.00005
[CF]	Option 2 Fish Tissue Contamination (ppm)	8.35E-08	8.35E-08	
[IN]	Option 2 Intake Avoided (mg/kg-day)	5.15E-11	5.15E-11	
[CR]	Option 2 Cancer Risk	8.25E-06	8.25E-07	9.07E-06
[CL]	Option 2 Lifetime Cancer Cases	0.00231	0.00023	0.00254
[CY]	Option 2 Yearly Cancer Cases	0.00003	0.00000	0.00004
[CL]	Option 1 Lifetime Cases Reduction	0.01786	0.01807	0.03593
[CY]	Option 1 Yearly Cases Reduction	0.00026	0.00026	0.00051
[CL]	Option 2 Lifetime Cases Reduction	0.01898	0.01818	0.03716
[CY]	Option 2 Yearly Cases Reduction	0.00027	0.00026	0.00053
[VAL]	Value of a Cancer Case - Low			$2,500,000
[BEN]	Option 1 Annual Benefits			$1,283
[BEN]	Option 2 Annual Benefits			$1,327
[VAL]	Value of a Cancer Case - High			$9,000,000
[BEN]	Option 1 Annual Benefits			$4,620
[BEN]	Option 2 Annual Benefits			$4,778

SYSTEMIC RISK TO NATIVE AMERICAN ANGLERS FROM INGESTION OF DIOXIN CONTAMINATED FISH

PENOBSCOT RIVER, MAINE
High Consumption Estimate

		TCDD	TCDF	TOTAL
[BW]	Body Weight (kg)	70	70	
[EF]	Exposure Frequency (days/year)	365	365	
[ED]	Exposure Duration (years)	70	70	
[AT]	Averaging Time (days)	25,550	25,550	
[RfD]	*RfD (mg/kg-day)*	*1.00E-08*	*1.00E-07*	
[IR]	Consumption (kg/day) Penobscot Survey	0.0480	0.0480	
[ADJ]	Percent Consumption Contaminated	90%	90%	
[CF]	Baseline Fish Tissue Contamination (ppm)	7.70E-07	6.66E-06	
[IN]	Baseline Intake (mg/kg-day)	4.75E-10	4.11E-09	
[HI]	Baseline Hazard Index	0.05	0.04	0.09
[CF]	Option 1 Fish Tissue Contamination (ppm)	1.24E-07	1.24E-07	
[IN]	Option 1 Intake (mg/kg-day)	7.65E-11	7.65E-11	
[HI]	Option 1 Hazard Index	0.01	0.00	0.01
[CF]	Option 2 Fish Tissue Contamination (ppm)	8.35E-08	8.35E-08	
[IN]	Option 2 Intake (mg/kg-day)	5.15E-11	5.15E-11	
[HI]	Option 2 Hazard Index	0.01	0.00	0.01
[HI]	Option 1 HI Reduction	0.04	0.04	0.08
[HI]	Option 2 HI Reduction	0.04	0.04	0.08

CANCER RISK TO NATIVE AMERICAN ANGLERS FROM INGESTION OF DIOXIN CONTAMINATED FISH

PENOBSCOT RIVER, MAINE
Low Consumption Estimate

		TCDD	TCDF	TOTAL
[BW]	Body Weight (kg)	70	70	
[EF]	Exposure Frequency (days/year)	365	365	
[ED]	Exposure Duration (years)	70	70	
[AT]	Averaging Time (days)	25,550	25,550	
[POP]	Exposed Pop	280	280	
[CSF]	*CSF (mg/kg-day)^-1*	*1.60E+05*	*1.60E+04*	
[IR]	Consumption (kg/day) Penobscot Survey	0.0110	0.0110	
[ADJ]	Percent Consumption Contaminated	90%	90%	
[CF]	Baseline Fish Tissue Contamination (ppm)	7.70E-07	6.66E-06	
[IN]	Baseline Intake (mg/kg-day)	1.09E-10	9.42E-10	
[CR]	Baseline Cancer Risk	1.74E-05	1.51E-05	3.25E-05
[CL]	Baseline Lifetime Cancer Cases	0.00488	0.00422	0.00910
[CY]	Baseline Yearly Cancer Cases	0.00007	0.00006	0.00013
[CF]	Option 1 Fish Tissue Contamination (ppm)	1.24E-07	1.24E-07	
[IN]	Option 1 Intake (mg/kg-day)	1.75E-11	1.75E-11	
[CR]	Option 1 Cancer Risk	2.81E-06	2.81E-07	3.09E-06
[CL]	Option 1 Lifetime Cancer Cases	0.00079	0.00008	0.00086
[CY]	Option 1 Yearly Cancer Cases	0.00001	0.00000	0.00001
[CF]	Option 2 Fish Tissue Contamination (ppm)	8.35E-08	8.35E-08	
[IN]	Option 2 Intake Avoided (mg/kg-day)	1.18E-11	1.18E-11	
[CR]	Option 2 Cancer Risk	1.89E-06	1.89E-07	2.08E-06
[CL]	Option 2 Lifetime Cancer Cases	0.00053	0.00005	0.00058
[CY]	Option 2 Yearly Cancer Cases	0.00001	0.00000	0.00001
[CL]	Option 1 Lifetime Cases Reduction	0.00409	0.00414	0.00823
[CY]	Option 1 Yearly Cases Reduction	0.00006	0.00006	0.00012
[CL]	Option 2 Lifetime Cases Reduction	0.00435	0.00417	0.00852
[CY]	Option 2 Yearly Cases Reduction	0.00006	0.00006	0.00012
[VAL]	Value of a Cancer Case - Low			$2,500,000
[BEN]	Option 1 Annual Benefits			$294
[BEN]	Option 2 Annual Benefits			$304
[VAL]	Value of a Cancer Case - High			$9,000,000
[BEN]	Option 1 Annual Benefits			$1,059
[BEN]	Option 2 Annual Benefits			$1,095

SYSTEMIC RISK TO NATIVE AMERICAN ANGLERS FROM INGESTION OF DIOXIN CONTAMINATED FISH

PENOBSCOT RIVER, MAINE
Low Consumption Estimate

		TCDD	TCDF	TOTAL
[BW]	Body Weight (kg)	70	70	
[EF]	Exposure Frequency (days/year)	365	365	
[ED]	Exposure Duration (years)	70	70	
[AT]	Averaging Time (days)	25,550	25,550	
[RfD]	*RfD (mg/kg-day)*	*1.00E-08*	*1.00E-07*	
[IR]	Consumption (kg/day) Penobscot Survey	0.0110	0.0110	
[ADJ]	Percent Consumption Contaminated	90%	90%	
[CF]	Baseline Fish Tissue Contamination (ppm)	7.70E-07	6.66E-06	
[IN]	Baseline Intake (mg/kg-day)	1.09E-10	9.42E-10	
[HI]	Baseline Hazard Index	0.01	0.01	0.02
[CF]	Option 1 Fish Tissue Contamination (ppm)	1.24E-07	1.24E-07	
[IN]	Option 1 Intake (mg/kg-day)	1.75E-11	1.75E-11	
[HI]	Option 1 Hazard Index	0.00	0.00	0.00
[CF]	Option 2 Fish Tissue Contamination (ppm)	8.35E-08	8.35E-08	
[IN]	Option 2 Intake (mg/kg-day)	1.18E-11	1.18E-11	
[HI]	Option 2 Hazard Index	0.00	0.00	0.00
[HI]	Option 1 HI Reduction	0.01	0.01	0.02
[HI]	Option 2 HI Reduction	0.01	0.01	0.02

NOTES

[BW]	U.S. EPA. 1989. Interim Final Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Mannual. Prepared by the Office of Emergency and Remedial Response. U.S. Environmental Protection Agency. Washington DC.
[EF]	U.S. EPA. 1989. Interim Final Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Mannual. Prepared by the Office of Emergency and Remedial Response, U.S. Environmental Protection Agency. Washington DC.
[ED]	U.S. EPA. 1989. Interim Final Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Mannual. Prepared by the Office of Emergency and Remedial Response, U.S. Environmental Protection Agency. Washington DC.
[AT]	U.S. EPA. 1989. Interim Final Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Mannual. Prepared by the Office of Emergency and Remedial Response. Washington DC.
[POP]	Penobscot Nation Department of Natural Resources. 1991. Results of the 1991 Penobscot River Users Survey Conducted by the Department of Natural Resources.
[CSF]	Tetra Tech. 1996. Revised Water Quality Assessment of Proposed Effluent Guidelines for the Pulp, Paper, and Paperboard Industry. Office of Science and Technology, U.S. Environmental Protection Agency. Washington. DC.
[RfD]	Tetra Tech. 1996. Revised Water Quality Assessment of Proposed Effluent Guidelines for the Pulp, Paper, and Paperboard Industry. Office of Science and Technology, U.S. Environmental Protection Agency. Washington. DC.
[IR]	Penobscot Nation Department of Natural Resources. 1991. Results of the 1991 Penobscot River Users Survey Conducted by the Department of Natural Resources.
[ADJ]	Percentage fish from below mill, J. Banks pers. comm.
[CF]	Analysis for this RIA
[IN] =	(CF * ADJ * IR * EF * ED) / (BW * AT)
[CR] =	IN * CSF
[HI] =	IN / RfD
[CL] =	CR * POP
[CY] =	(CR * POP) / ED
[VAL] =	American Lung Association. 1995. Dollars and Cents: The Economic and Health Benefits of Potential Particulate Matter Reductions in the United States. Prepared by L.G. Chestnut, Hagler Bailly Consulting, Inc., Boulder, Colorado. New York. June.
[BEN] =	[CY] * [VAL]

LOWER COLUMBIA RIVER CASE STUDY

CANCER RISK TO NATIVE AMERICAN ANGLERS FROM INGESTION OF CONTAMINATED FISH
COLUMBIA RIVER
High Consumption Estimate

[BW]	Body Weight (kg)	70	
[EF]	Exposure Frequency (days/year)	365	
[ED]	Exposure Duration (years)	70	
[AT]	Averaging Time (days)	25,550	
[IR]	Consumption (kg/day)	0.1140	
[CR]	Baseline Cancer Risk by Contaminant		Percent
	2,3,7,8-TCDD	4.69E-05	20.98%
	2,3,7,8-TCDF	2.95E-05	13.23%
	Total Dioxin (w/o TCDD/TCDF)	5.48E-05	24.54%
	Arsenic (Inorganic)	3.21E-05	14.39%
	Aldrin	4.24E-07	0.19%
	alpha-BHC	2.85E-07	0.13%
	alpha-Chlordane	0.00E+00	0.00%
	Total PCB	4.27E-05	19.09%
	beta-BHC	4.20E-08	0.02%
	delta-BHC	0.00E+00	0.00%
	Dieldrin	8.34E-07	0.37%
	gamma-BHC	5.80E-08	0.03%
	gamma-Chlordane	0.00E+00	0.00%
	Heptachlor	1.05E-07	0.05%
	Heptachlor Epoxide	0.00E+00	0.00%
	Hexachlorobenzene	6.81E-07	0.31%
	p,p'-DDD	1.33E-06	0.60%
	p,p'-DDE	5.87E-06	2.63%
	p,p'-DDT	8.91E-07	0.40%
	Toxaphene	6.85E-06	3.06%
	Total Cancer Risk	2.23E-04	100.00%
[POP]	Exposed Pop Nez Perce	1,883	
	Exposed Pop Umatilla	1,030	
	Exposed Pop Yakama	6,198	
	Exposed Pop Warm Springs	2,871	
[CL]	Baseline Lifetime Cancer Cases TOTAL	2.67705	
[CY]	Baseline Yearly Cancer Cases TOTAL	0.03824	
[CR]	Option A Cancer Risk	2.00E-04	
[CL]	Option A Lifetime Cancer Cases TOTAL	2.39525	
[CY]	Option A Yearly Cancer Cases TOTAL	0.03422	
[CR]	Option B Cancer Risk	1.94E-04	
[CL]	Option B Lifetime Cancer Cases TOTAL	2.32322	
[CY]	Option B Yearly Cancer Cases TOTAL	0.03319	
[CL]	Option A Lifetime Cases Reduction	0.28180	
[CY]	Option A Yearly Cases Reduction	0.00403	
[CL]	Option B Lifetime Cases Reduction	0.35383	
[CY]	Option B Yearly Cases Reduction	0.00505	
[VAL]	Value of a Cancer Case - Low	$2,500,000	
[BEN]	Option A Annual Benefits	$10,064	
[BEN]	Option B Annual Benefits	$12,637	
[VAL]	Value of a Cancer Case - High	$9,000,000	
[BEN]	Option A Annual Benefits	$36,232	
[BEN]	Option B Annual Benefits	$45,492	

NOTES

[BW]	U.S. EPA. 1989. Interim Final Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Mannual. Prepared by the Office of Emergency and Remedial Response. U.S. Environmental Protection Agency. Washington DC.
[EF]	U.S. EPA. 1989. Interim Final Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Mannual. Prepared by the Office of Emergency and Remedial Response, U.S. Environmental Protection Agency. Washington DC.
[ED]	U.S. EPA. 1989. Interim Final Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Mannual. Prepared by the Office of Emergency and Remedial Response, U.S. Environmental Protection Agency. Washington DC.
[AT]	U.S. EPA. 1989. Interim Final Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Mannual. Prepared by the Office of Emergency and Remedial Response. Washington DC.
[POP]	U.S. Bureau of Census. 1993. 1990 Census of Population and Housing. Summary Tape File 3C. Washington, DC.
[CSF]	Tetra Tech. 1996. Final Report: Lower Columbia River Bi-State Program, Assessing Human Health Risks from Chemically Contaminated Fish in the Lower Columbia River, Risk Assessment. Redmond, Washington. (Unless otherwise noted).
[CSF] Dioxins	Tetra Tech. 1996. Revised Water Quality Assessment of Proposed Effluent Guidelines for the Pulp, Paper, and Paperboard Industry. Office of Science and Technology, U.S. Environmental Protection Agency. Washington. DC.
[CSF] Toxaphene	U.S. EPA. 1994. "Integrated Risk Information System On-Line Database of Chemical-Specific Toxicity Factors: Toxaphene." Prepared by Office of Research and Development, Washington D.C.
[IR]	CRITFC (Columbia River Inter-Tribal Fish Commission). 1994. A Fish Consumption Survey of the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin. Report No. 94-3. Portland, Oregon.
[CF]	Analysis for this RIA
[IN] =	(CF * ADJ * IR * EF * ED) / (BW * AT)
[CR] =	IN * CSF
[HI] =	IN / RfD
[CL] =	CR * POP
[CY] =	(CR * POP) / ED
[VAL] =	American Lung Association. 1995. Dollars and Cents: The Economic and Health Benefits of Potential Particulate Matter Reductions in the United States. Prepared by L.G. Chestnut, Hagler Bailly Consulting, Inc., Boulder, Colorado. New York. June.
[BEN] =	[CY] * [VAL]

Assumptions:

Body Weight (BW)	70	kg
Exposure Frequency (EF)	365	days/year
Exposure Duration (ED)	70	years
Averaging Time	25,500	days
Consumption (IR)	0.114	kg/day

Contaminant	Slope Factor (CSF) (kg-day/mg)	Concentrations (ppb) (percents below indicate species mix) Chinook Salmon 20.0%	Coho Salmon 20.0%	Largescale Sucker 0.3%	Steelhead Trout 11.0%	White Sturgeon 1.0%	Other 47.7%	Total 100.0%	Baseline Concentration (CF) (mg/kg=ppm)	Baseline Intake (IN) (mg/kg-day)	Baseline Cancer Risk (CR)
Dioxin/Furan											
Dioxin											
1,2,3,4,6,7,8-HpCDD	1.60E+03	2.40E-04	1.97E-04	3.40E-04	9.50E-05	1.72E-04	2.09E-04	2.00E-04	2.00E-07	3.27E-10	5.23E-07
1,2,3,4,6,7,8-HpCDF	1.60E+03	6.17E-05 *	1.43E-04	6.00E-04	8.33E-05 *	2.93E-04	1.69E-04	1.35E-04	1.35E-07	2.21E-10	3.53E-07
1,2,3,4,7,8,9-HpCDF	1.60E+03	8.17E-05	3.17E-05 *	1.69E-04 *	1.15E-04 *	1.02E-04 *	6.24E-05	6.66E-05	6.66E-08	1.09E-10	1.74E-07
1,2,3,4,7,8-HxCDD	1.60E+04	8.67E-05	2.83E-05 *	1.79E-04	6.33E-05	9.25E-05 *	7.50E-05	6.72E-05	6.72E-08	1.10E-10	1.75E-06
1,2,3,4,7,8-HxCDF	1.60E+04	6.17E-05	5.50E-05	3.40E-04 *	9.67E-05 *	1.08E-04 *	9.45E-05	8.11E-05	8.11E-08	1.32E-10	2.12E-06
1,2,3,6,7,8-HxCDD	1.60E+04	1.40E-04	2.10E-04	1.99E-04	7.17E-05 *	9.33E-05 *	1.19E-04	1.36E-04	1.36E-07	2.22E-10	3.56E-06
1,2,3,6,7,8-HxCDF	1.60E+04	5.00E-05	2.27E-04	5.31E-04	9.83E-05 *	4.05E-04 *	2.19E-04	1.76E-04	1.76E-07	2.87E-10	4.60E-06
1,2,3,7,8,9-HxCDD	1.60E+04	1.10E-04	3.83E-05	1.93E-04 *	7.50E-05 *	1.11E-04 *	7.53E-05	7.55E-05	7.55E-08	1.23E-10	1.97E-06
1,2,3,7,8,9-HxCDF	1.60E+04	9.33E-05	3.67E-05 *	6.24E-04	1.13E-04 *	3.06E-04	1.68E-04	1.23E-04	1.23E-07	2.01E-10	3.22E-06
1,2,3,7,8-PeCDD	8.00E+04	1.62E-04	2.33E-04 *	2.81E-04 *	9.17E-05 *	1.10E-04 *	1.10E-04	1.43E-04	1.43E-07	2.34E-10	1.87E-05
1,2,3,7,8-PeCDF	8.00E+03	1.07E-04	4.07E-04	8.76E-04	1.40E-04	2.28E-04	3.52E-04	2.91E-04	2.91E-07	4.75E-10	3.80E-06
2,3,4,6,7,8-HxCDF	1.60E+04	7.00E-05 *	6.67E-05	3.28E-04	8.83E-05 *	1.01E-04	9.34E-05	8.36E-05	8.36E-08	1.36E-10	2.18E-06
2,3,4,7,8-PeCDF	8.00E+04	1.38E-04	7.50E-05	1.74E-04 *	8.00E-05 *	7.08E-05	7.68E-05	8.93E-05	8.93E-08	1.46E-10	1.17E-05
OCDD	1.60E+02	1.23E-03	2.58E-04 *	1.11E-03	1.77E-04 *	5.96E-04	4.82E-04	5.56E-04	5.56E-07	9.07E-10	1.45E-07
OCDF	1.60E+02	2.55E-04	2.15E-04	1.04E-03	6.67E-05 *	6.51E-04	3.71E-04	2.88E-04	2.88E-07	4.70E-10	7.52E-08
2,3,7,8-TCDD	1.60E+05	2.35E-04	3.23E-04	1.91E-04 *	4.67E-05 *	1.02E-04 *	1.28E-04	1.80E-04	1.80E-07	2.93E-10	4.69E-05
2,3,7,8-TCDF	1.60E+04	1.61E-03	6.77E-04	1.26E-03	2.37E-04	2.69E-03	1.29E-03	1.13E-03	1.13E-06	1.85E-09	2.95E-05
Total Dioxin (w/o TCDD/TCDF)											5.48E-05
Metal											
Arsenic (Inorganic)	1.75E+00	1.28E+01	2.67E+00	1.25E+01	6.50E+00	3.91E+01	1.47E+01	1.13E+01	1.13E-02	1.84E-05	3.21E-05
Cadmium	NC	2.17E+00 *	3.00E+00	2.83E+00	5.67E+00 *	4.50E+00 *	2.60E+00	2.95E+00	2.95E-03	4.81E-06	0.00E+00
Lead	NC	7.00E+00	4.17E+00	1.28E+01	1.53E+01 *	1.15E+01 *	8.46E+00	8.11E+00	8.11E-03	1.32E-05	0.00E+00
Mercury	NC	9.97E+01	4.40E+01	1.53E+02	6.37E+01	6.33E+01	8.47E+01	7.73E+01	7.73E-02	1.26E-04	0.00E+00
Selenium	NC	2.80E+02	1.68E+02	1.69E+02	4.30E+02	3.99E+02	2.89E+02	2.79E+02	2.79E-01	4.56E-04	0.00E+00
Silver	NC	1.33E+00	6.67E-01	5.00E-01 *	1.00E+00 *	7.92E-01 *	6.13E-01	8.11E-01	8.11E-04	1.32E-06	0.00E+00
Pesticide/PCB											
Aldrin	1.70E+01	2.00E-02 *	2.00E-02 *	8.33E-03 *	2.00E-02 *	2.29E-02	1.01E-02	1.53E-02	1.53E-05	2.49E-08	4.24E-07
alpha-BHC	6.30E+00	2.00E-02 *	2.00E-02 *	8.33E-03 *	8.67E-02	3.08E-02	2.07E-02	2.78E-02	2.78E-05	4.53E-08	2.85E-07
alpha-Chlordane	NA	2.00E-02 *	2.00E-02 *	8.33E-03 *	2.00E-02 *	7.08E-03 *	8.38E-03	1.43E-02	1.43E-05	2.33E-08	0.00E+00
PCB											
Aroclor 1260	2.00E+00	9.97E+00	3.05E+00	3.35E+01	5.06E+00	4.64E+01	1.96E+01	1.31E+01	1.31E-02	2.13E-05	4.27E-05
Total PCB											4.27E-05
beta-BHC	1.80E+00	2.00E-02 *	2.00E-02 *	8.33E-03 *	2.00E-02 *	7.08E-03 *	8.38E-03	1.43E-02	1.43E-05	2.33E-08	4.20E-08
delta-BHC	NA	2.00E-02 *	2.00E-02 *	8.33E-03 *	2.00E-02 *	7.08E-03 *	8.38E-03	1.43E-02	1.43E-05	2.33E-08	0.00E+00
Dieldrin	1.60E+01	4.50E-02 *	4.50E-02 *	1.67E-02 *	4.50E-02 *	1.42E-02 *	1.84E-02	3.19E-02	3.19E-05	5.21E-08	8.34E-07
gamma-BHC	1.30E+00	2.00E-02 *	2.00E-02 *	8.33E-03 *	2.00E-02 *	2.14E-01	3.14E-02	2.73E-02	2.73E-05	4.46E-08	5.80E-08
gamma-Chlordane	NA	2.00E-02 *	2.00E-02 *	8.33E-03 *	2.00E-02 *	7.08E-03 *	8.38E-03	1.43E-02	1.43E-05	2.33E-08	0.00E+00
Heptachlor	4.50E+00	2.00E-02 *	2.00E-02 *	8.33E-03 *	2.00E-02 *	7.08E-03 *	8.38E-03	1.43E-02	1.43E-05	2.33E-08	1.05E-07
Heptachlor Epoxide	NA	2.00E-02 *	2.00E-02 *	8.33E-03 *	2.00E-02 *	7.08E-03 *	8.38E-03	1.43E-02	1.43E-05	2.33E-08	0.00E+00
Hexachlorobenzene	1.60E+00	1.00E-02 *	1.00E-02 *	5.00E-01	1.07E+00	3.77E-01	2.81E-01	2.61E-01	2.61E-04	4.26E-07	6.81E-07
p,p'-DDD	2.40E-01	3.71E+00	9.92E-01	8.77E+00	2.43E+00	6.23E+00	4.43E+00	3.41E+00	3.41E-03	5.56E-06	1.33E-06
p,p'-DDE	3.40E-01	8.52E+00	3.03E+00	2.32E+01	2.26E+00	4.19E+01	1.58E+01	1.06E+01	1.06E-02	1.73E-05	5.87E-06
p,p'-DDT	3.40E-01	1.47E+00	8.13E-01	1.70E+00	3.17E+00	1.07E+00	1.64E+00	1.61E+00	1.61E-03	2.62E-06	8.91E-07
Toxaphene	1.10E+00	2.96E+00 *	2.96E+00 *	4.63E+00 *	1.11E+01 *	3.94E+00 *	2.84E+00	3.81E+00	3.81E-03	6.22E-06	6.85E-06
Semi-Volatile											
4-Nitrophenol	NC	6.67E+00 *	5.00E+00 *	2.96E+01	2.53E+01	4.61E+01	1.61E+01	1.33E+01	1.33E-02	2.18E-05	0.00E+00
Phenol	NC	7.90E+01	3.57E+01	1.21E+01	1.75E+01 *	7.25E+00	2.53E+01	3.70E+01	3.70E-02	6.04E-05	0.00E+00

*: 100% non-detect. Concentration is one-half of detection limit.

NC: Not a known carcinogen.

NA: Cancer Slope Factor not available.

Sources of Contaminant Concentrations : Tetra Tech. 1996. Final Report: Lower Columbia River Bi-State Program, Assessing Human Health Risks from Chemically Contaminated Fish in the Lower Columbia River, Risk Assessment. Redmond, Washington.

CSF for PCBs based on US EPA. 1996. "PCBs: Cancer Dose-Response Assessment and Application to Environmental Mixtures." EPA/600/P-96/001F. September 1996.

Source of All Other Factors Cited on Summary Sheet.

CANCER RISK TO NATIVE AMERICAN ANGLERS FROM INGESTION OF CONTAMINATED FISH
COLUMBIA RIVER
Low Consumption Estimate

[BW]	Body Weight (kg)	70	
[EF]	Exposure Frequency (days/year)	365	
[ED]	Exposure Duration (years)	70	
[AT]	Averaging Time (days)	25,550	
[IR]	Consumption (kg/day)	0.0587	
[CR]	Baseline Cancer Risk by Contaminant		Percent
	2,3,7,8-TCDD	2.41E-05	20.98%
	2,3,7,8-TCDF	1.52E-05	13.23%
	Total Dioxin (w/o TCDD/TCDF)	2.82E-05	24.54%
	Arsenic (Inorganic)	1.66E-05	14.39%
	Aldrin	2.18E-07	0.19%
	alpha-BHC	1.47E-07	0.13%
	alpha-Chlordane	0.00E+00	0.00%
	Total PCB	2.20E-05	19.09%
	beta-BHC	2.16E-08	0.02%
	delta-BHC	0.00E+00	0.00%
	Dieldrin	4.29E-07	0.37%
	gamma-BHC	2.99E-08	0.03%
	gamma-Chlordane	0.00E+00	0.00%
	Heptachlor	5.40E-08	0.05%
	Heptachlor Epoxide	0.00E+00	0.00%
	Hexachlorobenzene	3.51E-07	0.31%
	p,p'-DDD	6.87E-07	0.60%
	p,p'-DDE	3.02E-06	2.63%
	p,p'-DDT	4.59E-07	0.40%
	Toxaphene	3.53E-06	3.06%
	Total Cancer Risk	1.15E-04	100.00%
[POP]	Exposed Pop Nez Perce	1,883	
	Exposed Pop Umatilla	1,030	
	Exposed Pop Yakama	6,198	
	Exposed Pop Warm Springs	2,871	
[CL]	Baseline Lifetime Cancer Cases TOTAL	1.37845	
[CY]	Baseline Yearly Cancer Cases TOTAL	0.01969	
[CR]	Option A Cancer Risk	1.03E-04	
[CL]	Option A Lifetime Cancer Cases TOTAL	1.23334	
[CY]	Option A Yearly Cancer Cases TOTAL	0.01762	
[CR]	Option B Cancer Risk	9.98E-05	
[CL]	Option B Lifetime Cancer Cases TOTAL	1.19625	
[CY]	Option B Yearly Cancer Cases TOTAL	0.01709	
[CL]	Option A Lifetime Cases Reduction	0.14510	
[CY]	Option A Yearly Cases Reduction	0.00207	
[CL]	Option B Lifetime Cases Reduction	0.18219	
[CY]	Option B Yearly Cases Reduction	0.00260	
[VAL]	Value of a Cancer Case - Low	$2,500,000	
[BEN]	Option A Annual Benefits	$5,182	
[BEN]	Option B Annual Benefits	$6,507	
[VAL]	Value of a Cancer Case - High	$9,000,000	
[BEN]	Option A Annual Benefits	$18,656	
[BEN]	Option B Annual Benefits	$23,425	

NOTES	
[BW]	U.S. EPA. 1989. Interim Final Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Mannual. Prepared by the Office of Emergency and Remedial Response. U.S. Environmental Protection Agency. Washington DC.
[EF]	U.S. EPA. 1989. Interim Final Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Mannual. Prepared by the Office of Emergency and Remedial Response, U.S. Environmental Protection Agency. Washington DC.
[ED]	U.S. EPA. 1989. Interim Final Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Mannual. Prepared by the Office of Emergency and Remedial Response, U.S. Environmental Protection Agency. Washington DC.
[AT]	U.S. EPA. 1989. Interim Final Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Mannual. Prepared by the Office of Emergency and Remedial Response. Washington DC.
[POP]	U.S. Bureau of Census. 1993. 1990 Census of Population and Housing. Summary Tape File 3C. Washington, DC.
[CSF]	Tetra Tech. 1996. Final Report: Lower Columbia River Bi-State Program, Assessing Human Health Risks from Chemically Contaminated Fish in the Lower Columbia River, Risk Assessment. Redmond, Washington. (Unless otherwise noted).
[CSF] Dioxins	Tetra Tech. 1996. Revised Water Quality Assessment of Proposed Effluent Guidelines for the Pulp, Paper, and Paperboard Industry. Office of Science and Technology, U.S. Environmental Protection Agency. Washington. DC.
[CSF] Toxaphene	U.S. EPA. 1994. "Integrated Risk Information System On-Line Database of Chemical-Specific Toxicity Factors: Toxaphene." Prepared by Office of Research and Development, Washington D.C.
[IR]	CRITFC (Columbia River Inter-Tribal Fish Commission). 1994. A Fish Consumption Survey of the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin. Report No. 94-3. Portland, Oregon.
[CF]	Analysis for this RIA
[IN] =	(CF * ADJ * IR * EF * ED) / (BW * AT)
[CR] =	IN * CSF
[HI] =	IN / RfD
[CL] =	CR * POP
[CY] =	(CR * POP) / ED
[VAL] =	American Lung Association. 1995. Dollars and Cents: The Economic and Health Benefits of Potential Particulate Matter Reductions in the United States. Prepared by L.G. Chestnut, Hagler Bailly Consulting, Inc., Boulder, Colorado. New York. June.
[BEN] =	[CY] * [VAL]

Assumptions:

Body Weight (BW)	70	kg
Exposure Frequency (EF)	365	days/year
Exposure Duration (ED)	70	years
Averaging Time	25,500	days
Consumption (IR)	0.0587	kg/day

Contaminant	Slope Factor (CSF) (kg-day/mg)	Concentrations (ppb) (percents below indicate species mix) Chinook Salmon 20.0%	Coho Salmon 20.0%	Largescale Sucker 0.3%	Steelhead Trout 11.0%	White Sturgeon 1.0%	Other 47.7%	Total 100.0%	Baseline Concentration (CF) (mg/kg=ppm)	Baseline Intake (IN) (mg/kg-day)	Baseline Cancer Risk (CR)
Dioxin/Furan											
Dioxin											
1,2,3,4,6,7,8-HpCDD	1.60E+03	2.40E-04	1.97E-04	3.40E-04	9.50E-05	1.72E-04	2.09E-04	2.00E-04	2.00E-07	1.68E-10	2.69E-07
1,2,3,4,6,7,8-HpCDF	1.60E+03	6.17E-05 *	1.43E-04	6.00E-04	8.33E-05 *	2.93E-04	1.69E-04	1.35E-04	1.35E-07	1.14E-10	1.82E-07
1,2,3,4,7,8,9-HpCDF	1.60E+03	8.17E-05	3.17E-05 *	1.69E-04 *	1.15E-04 *	1.02E-04 *	6.24E-05	6.66E-05	6.66E-08	5.60E-11	8.96E-08
1,2,3,4,7,8-HxCDD	1.60E+04	8.67E-05	2.83E-05 *	1.79E-04	6.33E-05	9.25E-05 *	7.50E-05	6.72E-05	6.72E-08	5.64E-11	9.03E-07
1,2,3,4,7,8-HxCDF	1.60E+04	6.17E-05	5.50E-05	3.40E-04 *	9.67E-05 *	1.08E-04 *	9.45E-05	8.11E-05	8.11E-08	6.82E-11	1.09E-06
1,2,3,6,7,8-HxCDD	1.60E+04	1.40E-04	2.10E-04	1.99E-04	7.17E-05 *	9.33E-05 *	1.19E-04	1.36E-04	1.36E-07	1.14E-10	1.83E-06
1,2,3,6,7,8-HxCDF	1.60E+04	5.00E-05	2.27E-04	5.31E-04	9.83E-05 *	4.05E-04 *	2.19E-04	1.76E-04	1.76E-07	1.48E-10	2.37E-06
1,2,3,7,8,9-HxCDD	1.60E+04	1.10E-04	3.83E-05	1.93E-04 *	7.50E-05 *	1.11E-04 *	7.53E-05	7.55E-05	7.55E-08	6.35E-11	1.02E-06
1,2,3,7,8,9-HxCDF	1.60E+04	9.33E-05	3.67E-05 *	6.24E-04	1.13E-04 *	3.06E-04	1.68E-04	1.23E-04	1.23E-07	1.04E-10	1.66E-06
1,2,3,7,8-PeCDD	8.00E+04	1.62E-04	2.33E-04 *	2.81E-04 *	9.17E-05 *	1.10E-04 *	1.10E-04	1.43E-04	1.43E-07	1.20E-10	9.64E-06
1,2,3,7,8-PeCDF	8.00E+03	1.07E-04	4.07E-04	8.76E-04	1.40E-04	2.28E-04	3.52E-04	2.91E-04	2.91E-07	2.44E-10	1.95E-06
2,3,4,6,7,8-HxCDF	1.60E+04	7.00E-05 *	6.67E-05	3.28E-04	8.83E-05 *	1.01E-04	9.34E-05	8.36E-05	8.36E-08	7.03E-11	1.12E-06
2,3,4,7,8-PeCDF	8.00E+04	1.38E-04	7.50E-05	1.74E-04 *	8.00E-05 *	7.08E-05	7.68E-05	8.93E-05	8.93E-08	7.50E-11	6.00E-06
OCDD	1.60E+02	1.23E-03	2.58E-04 *	1.11E-03	1.77E-04 *	5.96E-04	4.82E-04	5.56E-04	5.56E-07	4.67E-10	7.48E-08
OCDF	1.60E+02	2.55E-04	2.15E-04	1.04E-03	6.67E-05 *	6.51E-04	3.71E-04	2.88E-04	2.88E-07	2.42E-10	3.87E-08
2,3,7,8-TCDD	1.60E+05	2.35E-04	3.23E-04	1.91E-04 *	4.67E-05 *	1.02E-04 *	1.28E-04	1.80E-04	1.80E-07	1.51E-10	2.41E-05
2,3,7,8-TCDF	1.60E+04	1.61E-03	6.77E-04	1.26E-03	2.37E-04	2.69E-03	1.29E-03	1.13E-03	1.13E-06	9.51E-10	1.52E-05
Total Dioxin (w/o TCDD/TCDF)											2.82E-05
Metal											
Arsenic (Inorganic)	1.75E+00	1.28E+01	2.67E+00	1.25E+01	6.50E+00	3.91E+01	1.47E+01	1.13E+01	1.13E-02	9.46E-06	1.66E-05
Cadmium	NC	2.17E+00 *	3.00E+00	2.83E+00	5.67E+00 *	4.50E+00 *	2.60E+00	2.95E+00	2.95E-03	2.48E-06	0.00E+00
Lead	NC	7.00E+00	4.17E+00	1.28E+01	1.53E+01 *	1.15E+01 *	8.46E+00	8.11E+00	8.11E-03	6.81E-06	0.00E+00
Mercury	NC	9.97E+01	4.40E+01	1.53E+02	6.37E+01	6.33E+01	8.47E+01	7.73E+01	7.73E-02	6.49E-05	0.00E+00
Selenium	NC	2.80E+02	1.68E+02	1.69E+02	4.30E+02	3.99E+02	2.89E+02	2.79E+02	2.79E-01	2.35E-04	0.00E+00
Silver	NC	1.33E+00	6.67E-01	5.00E-01 *	1.00E+00 *	7.92E-01 *	6.13E-01	8.11E-01	8.11E-04	6.81E-07	0.00E+00
Pesticide/PCB											
Aldrin	1.70E+01	2.00E-02 *	2.00E-02 *	8.33E-03 *	2.00E-02 *	2.29E-02	1.01E-02	1.53E-02	1.53E-05	1.28E-08	2.18E-07
alpha-BHC	6.30E+00	2.00E-02 *	2.00E-02 *	8.33E-03 *	8.67E-02	3.08E-02	2.07E-02	2.78E-02	2.78E-05	2.33E-08	1.47E-07
alpha-Chlordane	NA	2.00E-02 *	2.00E-02 *	8.33E-03 *	2.00E-02 *	7.08E-03 *	8.38E-03	1.43E-02	1.43E-05	1.20E-08	0.00E+00
PCB											
Aroclor 1260	2.00E+00	9.97E+00	3.05E+00	3.35E+01	5.06E+00	4.64E+01	1.96E+01	1.31E+01	1.31E-02	1.10E-05	2.20E-05
Total PCB											2.20E-05
beta-BHC	1.80E+00	2.00E-02 *	2.00E-02 *	8.33E-03 *	2.00E-02 *	7.08E-03 *	8.38E-03	1.43E-02	1.43E-05	1.20E-08	2.16E-08
delta-BHC	NA	2.00E-02 *	2.00E-02 *	8.33E-03 *	2.00E-02 *	7.08E-03 *	8.38E-03	1.43E-02	1.43E-05	1.20E-08	0.00E+00
Dieldrin	1.60E+01	4.50E-02 *	4.50E-02 *	1.67E-02 *	4.50E-02 *	1.42E-02 *	1.84E-02	3.19E-02	3.19E-05	2.68E-08	4.29E-07
gamma-BHC	1.30E+00	2.00E-02 *	2.00E-02 *	8.33E-03 *	2.00E-02 *	2.14E-01	3.14E-02	2.73E-02	2.73E-05	2.30E-08	2.99E-08
gamma-Chlordane	NA	2.00E-02 *	2.00E-02 *	8.33E-03 *	2.00E-02 *	7.08E-03 *	8.38E-03	1.43E-02	1.43E-05	1.20E-08	0.00E+00
Heptachlor	4.50E+00	2.00E-02 *	2.00E-02 *	8.33E-03 *	2.00E-02 *	7.08E-03 *	8.38E-03	1.43E-02	1.43E-05	1.20E-08	5.40E-08
Heptachlor Epoxide	NA	2.00E-02 *	2.00E-02 *	8.33E-03 *	2.00E-02 *	7.08E-03 *	8.38E-03	1.43E-02	1.43E-05	1.20E-08	0.00E+00
Hexachlorobenzene	1.60E+00	1.00E-02 *	1.00E-02 *	5.00E-01	1.07E+00	3.77E-01	2.81E-01	2.61E-01	2.61E-04	2.19E-07	3.51E-07
p,p'-DDD	2.40E-01	3.71E+00	9.92E-01	8.77E+00	2.43E+00	6.23E+00	4.43E+00	3.41E+00	3.41E-03	2.86E-06	6.87E-07
p,p'-DDE	3.40E-01	8.52E+00	3.03E+00	2.32E+01	2.26E+00	4.19E+01	1.58E+01	1.06E+01	1.06E-02	8.89E-06	3.02E-06
p,p'-DDT	3.40E-01	1.47E+00	8.13E-01	1.70E+00	3.17E+00	1.07E+00	1.64E+00	1.61E+00	1.61E-03	1.35E-06	4.59E-07
Toxaphene	1.10E+00	2.96E+00 *	2.96E+00 *	4.63E+00 *	1.11E+01 *	3.94E+00 *	2.84E+00	3.81E+00	3.81E-03	3.21E-06	3.53E-06
Semi-Volatile											
4-Nitrophenol	NC	6.67E+00 *	5.00E+00 *	2.96E+01	2.53E+01	4.61E+01	1.61E+01	1.33E+01	1.33E-02	1.12E-05	0.00E+00
Phenol	NC	7.90E+01	3.57E+01	1.21E+01	1.75E+01 *	7.25E+00	2.53E+01	3.70E+01	3.70E-02	3.11E-05	0.00E+00

*: 100% non-detect. Concentration is one-half of detection limit.
NC: Not a known carcinogen.
NA: Cancer Slope Factor not available.

Source of Contaminant Concentrations : Tetra Tech. 1996. Final Report: Lower Columbia River Bi-State Program, Assessing Human Health Risks from Chemically Contaminated Fish in the Lower Columbia River, Risk Assessment. Redmond, Washington.
CSF for PCBs based on US EPA. 1996. "PCBs: Cancer Dose-Response Assessment and Application to Environmental Mixtures." EPA/600/P-96/001F. September 1996.
Source of All Other Factors Cited on Summary Sheet.

SYSTEMIC RISK TO NATIVE AMERICAN ANGLERS FROM INGESTION OF CONTAMINATED FISH
COLUMBIA RIVER
High Consumption Estimate

[BW]	Body Weight (kg)	70
[EF]	Exposure Frequency (days/year)	365
[ED]	Exposure Duration (years)	70
[AT]	Averaging Time (days)	25,550
[IR]	Consumption (kg/day)	0.1140
[HI]	Baseline Hazard Index by Effect	
	Cardiovascular	1.46
	Developmental	0.50
	Hepatic	0.20
	Immunological	0.35
	Other	0.11
[HI]	Option A Hazard Index by Effect	
	Cardiovascular	1.46
	Developmental	0.49
	Hepatic	0.20
	Immunological	0.35
	Other	0.11
[HI]	Option B Hazard Index by Effect	
	Cardiovascular	1.46
	Developmental	0.48
	Hepatic	0.20
	Immunological	0.35
	Other	0.11

NOTES	
[BW]	U.S. EPA. 1989. Interim Final Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Mannual. Prepared by the Office of Emergency and Remedial Response. U.S. Environmental Protection Agency. Washington DC.
[EF]	U.S. EPA. 1989. Interim Final Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Mannual. Prepared by the Office of Emergency and Remedial Response, U.S. Environmental Protection Agency. Washington DC.
[ED]	U.S. EPA. 1989. Interim Final Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Mannual. Prepared by the Office of Emergency and Remedial Response, U.S. Environmental Protection Agency. Washington DC.
[AT]	U.S. EPA. 1989. Interim Final Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Mannual. Prepared by the Office of Emergency and Remedial Response. Washington DC.
[POP]	U.S. Bureau of Census. 1993. 1990 Census of Population and Housing. Summary Tape File 3C. Washington, DC.
[RFD]	Tetra Tech. 1996. Final Report: Lower Columbia River Bi-State Program, Assessing Human Health Risks from Chemically Contaminated Fish in the Lower Columbia River, Risk Assessment. Redmond, Washington. (Unless otherwise noted).
[RFD] Dioxins	Tetra Tech. 1996. Revised Water Quality Assessment of Proposed Effluent Guidelines for the Pulp, Paper, and Paperboard Industry. Office of Science and Technology, U.S. Environmental Protection Agency. Washington. DC.
[RFD] Toxaphene	U.S. EPA. 1994. "Integrated Risk Information System On-Line Database of Chemical-Specific Toxicity Factors: Toxaphene." Prepared by Office of Research and Development, Washington D.C.
[IR]	CRITFC (Columbia River Inter-Tribal Fish Commission). 1994. A Fish Consumption Survey of the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin. Report No. 94-3. Portland, Oregon.
[CF]	Analysis for this RIA
[IN] =	(CF * ADJ * IR * EF * ED) / (BW * AT)
[CR] =	IN * CSF
[HI] =	IN / RfD
[CL] =	CR * POP
[CY] =	(CR * POP) / ED
[VAL] =	American Lung Association. 1995. Dollars and Cents: The Economic and Health Benefits of Potential Particulate Matter Reductions in the United States. Prepared by L.G. Chestnut, Hagler Bailly Consulting, Inc., Boulder, Colorado. New York. June.
[BEN] =	[CY] * [VAL]

Contaminant	Reference Dose (RfD) (mg/kg-day)	Chinook Salmon 20.0%	Coho Salmon 20.0%	Largescale Sucker 0.3%	Steelhead Trout 11.0%	White Sturgeon 1.0%	Other 47.7%	Total 100.0%	Baseline Concentration (CF) (mg/kg=ppm)	Baseline Intake (IN) (mg/kg-day)	Baseline Hazard Index (HI)	Effects
		Concentrations (ppb) (percents below indicate species mix)										
Dioxin/Furan												
Dioxin												
1,2,3,4,6,7,8-HpCDD	1.00E-06	2.40E-04	1.97E-04	3.40E-04	9.50E-05	1.72E-04	2.09E-04	2.00E-04	2.00E-07	3.27E-10	0.00	
1,2,3,4,6,7,8-HpCDF	1.00E-06	6.17E-05 *	1.43E-04	6.00E-04	8.33E-05 *	2.93E-04	1.69E-04	1.35E-04	1.35E-07	2.21E-10	0.00	
1,2,3,4,7,8,9-HpCDF	1.00E-06	8.17E-05	3.17E-05 *	1.69E-04 *	1.15E-04 *	1.02E-04 *	6.24E-05	6.66E-05	6.66E-08	1.09E-10	0.00	
1,2,3,4,7,8-HxCDD	1.00E-07	8.67E-05	2.83E-05 *	1.79E-04	6.33E-05	9.25E-05 *	7.50E-05	6.72E-05	6.72E-08	1.10E-10	0.00	
1,2,3,4,7,8-HxCDF	1.00E-07	6.17E-05	5.50E-05	3.40E-04 *	9.67E-05 *	1.08E-04 *	9.45E-05	8.11E-05	8.11E-08	1.32E-10	0.00	
1,2,3,6,7,8-HxCDD	1.00E-07	1.40E-04	2.10E-04	1.99E-04	7.17E-05 *	9.33E-05 *	1.19E-04	1.36E-04	1.36E-07	2.22E-10	0.00	
1,2,3,6,7,8-HxCDF	1.00E-07	5.00E-05	2.27E-04	5.31E-04	9.83E-05 *	4.05E-04 *	2.19E-04	1.76E-04	1.76E-07	2.87E-10	0.00	
1,2,3,7,8,9-HxCDD	1.00E-07	1.10E-04	3.83E-05	1.93E-04 *	7.50E-05 *	1.11E-04 *	7.53E-05	7.55E-05	7.55E-08	1.23E-10	0.00	
1,2,3,7,8,9-HxCDF	1.00E-07	9.33E-05	3.67E-05 *	6.24E-04	1.13E-04 *	3.06E-04	1.68E-04	1.23E-04	1.23E-07	2.01E-10	0.00	
1,2,3,7,8-PeCDD	2.00E-08	1.62E-04	2.33E-04 *	2.81E-04 *	9.17E-05 *	1.10E-04 *	1.10E-04	1.43E-04	1.43E-07	2.34E-10	0.01	D
1,2,3,7,8-PeCDF	2.00E-07	1.07E-04	4.07E-04	8.76E-04	1.40E-04	2.28E-04	3.52E-04	2.91E-04	2.91E-07	4.75E-10	0.00	
2,3,4,6,7,8-HxCDF	1.00E-07	7.00E-05 *	6.67E-05	3.28E-04	8.83E-05 *	1.01E-04	9.34E-05	8.36E-05	8.36E-08	1.36E-10	0.00	
2,3,4,7,8-PeCDF	2.00E-08	1.38E-04	7.50E-05	1.74E-04 *	8.00E-05 *	7.08E-05	7.68E-05	8.93E-05	8.93E-08	1.46E-10	0.01	
2,3,7,8-TCDD	1.00E-08	2.35E-04	3.23E-04	1.91E-04 *	4.67E-05 *	1.02E-04 *	1.28E-04	1.80E-04	1.80E-07	2.93E-10	0.03	D
2,3,7,8-TCDF	1.00E-07	1.61E-03	6.77E-04	1.26E-03	2.37E-04	2.69E-03	1.29E-03	1.13E-03	1.13E-06	1.85E-09	0.02	D
OCDD	1.00E-05	1.23E-03	2.58E-04 *	1.11E-03	1.77E-04 *	5.96E-04	4.82E-04	5.56E-04	5.56E-07	9.07E-10	0.00	
OCDF	1.00E-05	2.55E-04	2.15E-04	1.04E-03	6.67E-05 *	6.51E-04	3.71E-04	2.88E-04	2.88E-07	4.70E-10	0.00	
Metal												
Arsenic (Inorganic)	3.00E-04	1.28E+01	2.67E+00	1.25E+01	6.50E+00	3.91E+01	1.47E+01	1.13E+01	1.13E-02	1.84E-05	0.06	C,H,O
Cadmium	1.00E-03	2.17E+00 *	3.00E+00	2.83E+00	5.67E+00 *	4.50E+00 *	2.60E+00	2.95E+00	2.95E-03	4.81E-06	0.00	
Lead	NA	7.00E+00	4.17E+00	1.28E+01	1.53E+01 *	1.15E+01 *	8.46E+00	8.11E+00	8.11E-03	1.32E-05	NA	
Mercury	1.00E-04	9.97E+01	4.40E+01	1.53E+02	6.37E+01	6.33E+01	8.47E+01	7.73E+01	7.73E-02	1.26E-04	1.26	C
Selenium	5.00E-03	2.80E+02	1.68E+02	1.69E+02	4.30E+02	3.99E+02	2.89E+02	2.79E+02	2.79E-01	4.56E-04	0.09	C,D,H
Silver	5.00E-03	1.33E+00	6.67E-01	5.00E-01 *	1.00E+00 *	7.92E-01 *	6.13E-01	8.11E-01	8.11E-04	1.32E-06	0.00	
Pesticide/PCB												
Aldrin	3.00E-05	2.00E-02 *	2.00E-02 *	8.33E-03 *	2.00E-02 *	2.29E-02	1.01E-02	1.53E-02	1.53E-05	2.49E-08	0.00	
alpha-BHC	NA	2.00E-02 *	2.00E-02 *	8.33E-03 *	8.67E-02	3.08E-02	2.07E-02	2.78E-02	2.78E-05	4.53E-08	NA	
alpha-Chlordane	NA	2.00E-02 *	2.00E-02 *	8.33E-03 *	2.00E-02 *	7.08E-03 *	8.38E-03	1.43E-02	1.43E-05	2.33E-08	NA	
PCB												
Aroclor 1260	7.00E-05	9.97E+00	3.05E+00	3.35E+01	5.06E+00	4.64E+01	1.96E+01	1.31E+01	1.31E-02	2.13E-05	0.30	D,I
beta-BHC	NA	2.00E-02 *	2.00E-02 *	8.33E-03 *	2.00E-02 *	7.08E-03 *	8.38E-03	1.43E-02	1.43E-05	2.33E-08	NA	
delta-BHC	NA	2.00E-02 *	2.00E-02 *	8.33E-03 *	2.00E-02 *	7.08E-03 *	8.38E-03	1.43E-02	1.43E-05	2.33E-08	NA	
Dieldrin	5.00E-05	4.50E-02 *	4.50E-02 *	1.67E-02 *	4.50E-02 *	1.42E-02 *	1.84E-02	3.19E-02	3.19E-05	5.21E-08	0.00	
gamma-BHC	3.00E-04	2.00E-02 *	2.00E-02 *	8.33E-03 *	2.00E-02 *	2.14E-01	3.14E-02	2.73E-02	2.73E-05	4.46E-08	0.00	
gamma-Chlordane	NA	2.00E-02 *	2.00E-02 *	8.33E-03 *	2.00E-02 *	7.08E-03 *	8.38E-03	1.43E-02	1.43E-05	2.33E-08	NA	
Heptachlor	5.00E-04	2.00E-02 *	2.00E-02 *	8.33E-03 *	2.00E-02 *	7.08E-03 *	8.38E-03	1.43E-02	1.43E-05	2.33E-08	0.00	
Heptachlor Epoxide	1.30E-05	2.00E-02 *	2.00E-02 *	8.33E-03 *	2.00E-02 *	7.08E-03 *	8.38E-03	1.43E-02	1.43E-05	2.33E-08	0.00	
Hexachlorobenzene	8.00E-04	1.00E-02 *	1.00E-02 *	5.00E-01	1.07E+00	3.77E-01	2.81E-01	2.61E-01	2.61E-04	4.26E-07	0.00	
p,p'-DDD	5.00E-04	3.71E+00	9.92E-01	8.77E+00	2.43E+00	6.23E+00	4.43E+00	3.41E+00	3.41E-03	5.56E-06	0.01	C,D,H,I,O
p,p'-DDE	5.00E-04	8.52E+00	3.03E+00	2.32E+01	2.26E+00	4.19E+01	1.58E+01	1.06E+01	1.06E-02	1.73E-05	0.03	C,D,H,I,O
p,p'-DDT	5.00E-04	1.47E+00	8.13E-01	1.70E+00	3.17E+00	1.07E+00	1.64E+00	1.61E+00	1.61E-03	2.62E-06	0.01	
Toxaphene	NA	2.96E+00 *	2.96E+00 *	4.63E+00 *	1.11E+01 *	3.94E+00 *	2.84E+00	3.81E+00	3.81E-03	6.22E-06	NA	
Semi-Volatile												
4-Nitrophenol	6.20E-02	6.67E+00 *	5.00E+00 *	2.96E+01	2.53E+01	4.61E+01	1.61E+01	1.33E+01	1.33E-02	2.18E-05	0.00	
Phenol	6.00E-01	7.90E+01	3.57E+01	1.21E+01	1.75E+01 *	7.25E+00	2.53E+01	3.70E+01	3.70E-02	6.04E-05	0.00	

*: 100% non-detect. Concentration is one-half of detection limit.
NA: No RfD available.

Source of Contaminant Concentrations : Tetra Tech. 1996. Final Report: Lower Columbia River Bi-State Program, Assessing Human Health Risks from Chemically Contaminated Fish in the Lower Columbia River, Risk Assessment. Redmond, Washington.

Source of All Other Factors Cited on Summary Sheet.

Effects:
- C = Cardiovascular including hyperkalemia, myocardial arhythmia or hypertension
- D = Developmental
- H = Hepatic
- I = Immunological
- O = Other

SYSTEMIC RISK TO NATIVE AMERICAN ANGLERS FROM INGESTION OF CONTAMINATED FISH
COLUMBIA RIVER
Low Consumption Estimate

[BW]	Body Weight (kg)	70
[EF]	Exposure Frequency (days/year)	365
[ED]	Exposure Duration (years)	70
[AT]	Averaging Time (days)	25,550
[IR]	Consumption (kg/day)	0.0587
[HI]	Baseline Hazard Index by Effect	
	Cardiovascular	0.75
	Developmental	0.26
	Hepatic	0.10
	Immunological	0.18
	Other	0.06
[HI]	Option A Hazard Index by Effect	
	Cardiovascular	0.75
	Developmental	0.25
	Hepatic	0.10
	Immunological	0.18
	Other	0.06
[HI]	Option B Hazard Index by Effect	
	Cardiovascular	0.75
	Developmental	0.25
	Hepatic	0.10
	Immunological	0.18
	Other	0.06

NOTES	
[BW]	U.S. EPA. 1989. Interim Final Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Mannual. Prepared by the Office of Emergency and Remedial Response. U.S. Environmental Protection Agency. Washington DC.
[EF]	U.S. EPA. 1989. Interim Final Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Mannual. Prepared by the Office of Emergency and Remedial Response, U.S. Environmental Protection Agency. Washington DC.
[ED]	U.S. EPA. 1989. Interim Final Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Mannual. Prepared by the Office of Emergency and Remedial Response, U.S. Environmental Protection Agency. Washington DC.
[AT]	U.S. EPA. 1989. Interim Final Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Mannual. Prepared by the Office of Emergency and Remedial Response. Washington DC.
[POP]	U.S. Bureau of Census. 1993. 1990 Census of Population and Housing. Summary Tape File 3C. Washington, DC.
[RFD]	Tetra Tech. 1996. Final Report: Lower Columbia River Bi-State Program, Assessing Human Health Risks from Chemically Contaminated Fish in the Lower Columbia River, Risk Assessment. Redmond, Washington. (Unless otherwise noted).
[RFD] Dioxins	Tetra Tech. 1996. Revised Water Quality Assessment of Proposed Effluent Guidelines for the Pulp, Paper, and Paperboard Industry. Office of Science and Technology, U.S. Environmental Protection Agency. Washington. DC.
[RFD] Toxaphene	U.S. EPA. 1994. "Integrated Risk Information System On-Line Database of Chemical-Specific Toxicity Factors: Toxaphene." Prepared by Office of Research and Development, Washington D.C.
[IR]	CRITFC (Columbia River Inter-Tribal Fish Commission). 1994. A Fish Consumption Survey of the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin. Report No. 94-3. Portland, Oregon.
[CF]	Analysis for this RIA
[IN] =	(CF * ADJ * IR * EF * ED) / (BW * AT)
[CR] =	IN * CSF
[HI] =	IN / RfD
[CL] =	CR * POP
[CY] =	(CR * POP) / ED
[VAL] =	American Lung Association. 1995. Dollars and Cents: The Economic and Health Benefits of Potential Particulate Matter Reductions in the United States. Prepared by L.G. Chestnut, Hagler Bailly Consulting, Inc., Boulder, Colorado. New York. June.
[BEN] =	[CY] * [VAL]

Assumptions:

Body Weight (BW)	70	kg
Exposure Frequency (EF)	365	days/year
Exposure Duration (ED)	70	years
Averaging Time	25,500	days
Consumption (IR)	0.0587	kg/day

	Reference	Concentrations (ppb) (percents below indicate species mix)							Baseline	Baseline	Baseline	
	Dose (RfD) (mg/kg-day)	Chinook Salmon 20.0%	Coho Salmon 20.0%	Largescale Sucker 0.3%	Steelhead Trout 11.0%	White Sturgeon 1.0%	Other 47.7%	Total 100.0%	Concentration (CF) (mg/kg=ppm)	Intake (IN) (mg/kg-day)	Hazard Index (HI)	Effects
Contaminant												
Dioxin/Furan												
Dioxin												
1,2,3,4,6,7,8-HpCDD	1.00E-06	2.40E-04	1.97E-04	3.40E-04	9.50E-05	1.72E-04	2.09E-04	2.00E-04	2.00E-07	1.68E-10	0.00	
1,2,3,4,6,7,8-HpCDF	1.00E-06	6.17E-05 *	1.43E-04	6.00E-04	8.33E-05 *	2.93E-04	1.69E-04	1.35E-04	1.35E-07	1.14E-10	0.00	
1,2,3,4,7,8,9-HpCDF	1.00E-06	8.17E-05	3.17E-05 *	1.69E-04 *	1.15E-04 *	1.02E-04 *	6.24E-05	6.66E-05	6.66E-08	5.60E-11	0.00	
1,2,3,4,7,8-HxCDD	1.00E-07	8.67E-05	2.83E-05 *	1.79E-04	6.33E-05	9.25E-05 *	7.50E-05	6.72E-05	6.72E-08	5.64E-11	0.00	
1,2,3,4,7,8-HxCDF	1.00E-07	6.17E-05	5.50E-05	3.40E-04 *	9.67E-05 *	1.08E-04 *	9.45E-05	8.11E-05	8.11E-08	6.82E-11	0.00	
1,2,3,6,7,8-HxCDD	1.00E-07	1.40E-04	2.10E-04	1.99E-04	7.17E-05 *	9.33E-05 *	1.19E-04	1.36E-04	1.36E-07	1.14E-10	0.00	
1,2,3,6,7,8-HxCDF	1.00E-07	5.00E-05	2.27E-04	5.31E-04	9.83E-05 *	4.05E-04 *	2.19E-04	1.76E-04	1.76E-07	1.48E-10	0.00	
1,2,3,7,8,9-HxCDD	1.00E-07	1.10E-04	3.83E-05	1.93E-04 *	7.50E-05 *	1.11E-04 *	7.53E-05	7.55E-05	7.55E-08	6.35E-11	0.00	
1,2,3,7,8,9-HxCDF	1.00E-07	9.33E-05	3.67E-05 *	6.24E-04	1.13E-04 *	3.06E-04	1.68E-04	1.23E-04	1.23E-07	1.04E-10	0.00	
1,2,3,7,8-PeCDD	2.00E-08	1.62E-04	2.33E-04 *	2.81E-04 *	9.17E-05 *	1.10E-04 *	1.10E-04	1.43E-04	1.43E-07	1.20E-10	0.01	D
1,2,3,7,8-PeCDF	2.00E-07	1.07E-04	4.07E-04	8.76E-04	1.40E-04	2.28E-04	3.52E-04	2.91E-04	2.91E-07	2.44E-10	0.00	
2,3,4,6,7,8-HxCDF	1.00E-07	7.00E-05 *	6.67E-05	3.28E-04	8.83E-05 *	1.01E-04	9.34E-05	8.36E-05	8.36E-08	7.03E-11	0.00	
2,3,4,7,8-PeCDF	2.00E-08	1.38E-04	7.50E-05	1.74E-04 *	8.00E-05 *	7.08E-05	7.68E-05	8.93E-05	8.93E-08	7.50E-11	0.00	
2,3,7,8-TCDD	1.00E-08	2.35E-04	3.23E-04	1.91E-04 *	4.67E-05 *	1.02E-04 *	1.28E-04	1.80E-04	1.80E-07	1.51E-10	0.02	D
2,3,7,8-TCDF	1.00E-07	1.61E-03	6.77E-04	1.26E-03	2.37E-04	2.69E-03	1.29E-03	1.13E-03	1.13E-06	9.51E-10	0.01	D
OCDD	1.00E-05	1.23E-03	2.58E-04 *	1.11E-03	1.77E-04 *	5.96E-04	4.82E-04	5.56E-04	5.56E-07	4.67E-10	0.00	
OCDF	1.00E-05	2.55E-04	2.15E-04	1.04E-03	6.67E-05 *	6.51E-04	3.71E-04	2.88E-04	2.88E-07	2.42E-10	0.00	
Metal												
Arsenic (Inorganic)	3.00E-04	1.28E+01	2.67E+00	1.25E+01	6.50E+00	3.91E+01	1.47E+01	1.13E+01	1.13E-02	9.46E-06	0.03	C,H,O
Cadmium	1.00E-03	2.17E+00 *	3.00E+00	2.83E+00	5.67E+00 *	4.50E+00 *	2.60E+00	2.95E+00	2.95E-03	2.48E-06	0.00	
Lead	NA	7.00E+00	4.17E+00	1.28E+01	1.53E+01 *	1.15E+01 *	8.46E+00	8.11E+00	8.11E-03	6.81E-06	NA	
Mercury	1.00E-04	9.97E+01	4.40E+01	1.53E+02	6.37E+01	6.33E+01	8.47E+01	7.73E+01	7.73E-02	6.49E-05	0.65	C
Selenium	5.00E-03	2.80E+02	1.68E+02	1.69E+02	4.30E+02	3.99E+02	2.89E+02	2.79E+02	2.79E-01	2.35E-04	0.05	C,D,H
Silver	5.00E-03	1.33E+00	6.67E-01	5.00E-01 *	1.00E+00 *	7.92E-01 *	6.13E-01	8.11E-01	8.11E-04	6.81E-07	0.00	
Pesticide/PCB												
Aldrin	3.00E-05	2.00E-02 *	2.00E-02 *	8.33E-03 *	2.00E-02 *	2.29E-02	1.01E-02	1.53E-02	1.53E-05	1.28E-08	0.00	
alpha-BHC	NA	2.00E-02 *	2.00E-02 *	8.33E-03 *	8.67E-02	3.08E-02	2.07E-02	2.78E-02	2.78E-05	2.33E-08	NA	
alpha-Chlordane	NA	2.00E-02 *	2.00E-02 *	8.33E-03 *	2.00E-02 *	7.08E-03 *	8.38E-03	1.43E-02	1.43E-05	1.20E-08	NA	
PCB												
Aroclor 1260	7.00E-05	9.97E+00	3.05E+00	3.35E+01	5.06E+00	4.64E+01	1.96E+01	1.31E+01	1.31E-02	1.10E-05	0.16	D,I
beta-BHC	NA	2.00E-02 *	2.00E-02 *	8.33E-03 *	2.00E-02 *	7.08E-03 *	8.38E-03	1.43E-02	1.43E-05	1.20E-08	NA	
delta-BHC	NA	2.00E-02 *	2.00E-02 *	8.33E-03 *	2.00E-02 *	7.08E-03 *	8.38E-03	1.43E-02	1.43E-05	1.20E-08	NA	
Dieldrin	5.00E-05	4.50E-02 *	4.50E-02 *	1.67E-02 *	4.50E-02 *	1.42E-02 *	1.84E-02	3.19E-02	3.19E-05	2.68E-08	0.00	
gamma-BHC	3.00E-04	2.00E-02 *	2.00E-02 *	8.33E-03 *	2.00E-02 *	2.14E-01	3.14E-02	2.73E-02	2.73E-05	2.30E-08	0.00	
gamma-Chlordane	NA	2.00E-02 *	2.00E-02 *	8.33E-03 *	2.00E-02 *	7.08E-03 *	8.38E-03	1.43E-02	1.43E-05	1.20E-08	NA	
Heptachlor	5.00E-04	2.00E-02 *	2.00E-02 *	8.33E-03 *	2.00E-02 *	7.08E-03 *	8.38E-03	1.43E-02	1.43E-05	1.20E-08	0.00	
Heptachlor Epoxide	1.30E-05	2.00E-02 *	2.00E-02 *	8.33E-03 *	2.00E-02 *	7.08E-03 *	8.38E-03	1.43E-02	1.43E-05	1.20E-08	0.00	
Hexachlorobenzene	8.00E-04	1.00E-02 *	1.00E-02 *	5.00E-01	1.07E+00	3.77E-01	2.81E-01	2.61E-01	2.61E-04	2.19E-07	0.00	
p,p'-DDD	5.00E-04	3.71E+00	9.92E-01	8.77E+00	2.43E+00	6.23E+00	4.43E+00	3.41E+00	3.41E-03	2.86E-06	0.01	C,D,H,I,O
p,p'-DDE	5.00E-04	8.52E+00	3.03E+00	2.32E+01	2.26E+00	4.19E+01	1.58E+01	1.06E+01	1.06E-02	8.89E-06	0.02	C,D,H,I,O
p,p'-DDT	5.00E-04	1.47E+00	8.13E-01	1.70E+00	3.17E+00	1.07E+00	1.64E+00	1.61E+00	1.61E-03	1.35E-06	0.00	
Toxaphene	NA	2.96E+00 *	2.96E+00 *	4.63E+00 *	1.11E+01 *	3.94E+00 *	2.84E+00	3.81E+00	3.81E-03	3.21E-06	NA	
Semi-Volatile												
4-Nitrophenol	6.20E-02	6.67E+00 *	5.00E+00 *	2.96E+01	2.53E+01	4.61E+01	1.61E+01	1.33E+01	1.33E-02	1.12E-05	0.00	
Phenol	6.00E-01	7.90E+01	3.57E+01	1.21E+01	1.75E+01 *	7.25E+00	2.53E+01	3.70E+01	3.70E-02	3.11E-05	0.00	

*: 100% non-detect. Concentration is one-half of detection limit.

NA: No RfD available.

Source of Contaminant Concentrations : Tetra Tech. 1996. Final Report: Lower Columbia River Bi-State Program, Assessing Human Health Risks from Chemically Contaminated Fish in the Lower Columbia River, Risk Assessment. Redmond, Washington.

Source of All Other Factors Cited on Summary Sheet.

Effects:

C = Cardiovascular including hyperkalemia, myocardial arhythmia or hypertension
D = Developmental
H = Hepatic
I = Immunological
O = Other

APPENDIX F

ENVIRONMENTAL JUSTICE ANALYSIS OF THE PULP AND PAPER INTEGRATED RULE

Executive Order 12898 directs federal agencies, including EPA, to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority and low-income populations. EPA has determined that the final pulp and paper regulations will significantly reduce the environmental health risks to potentially affected minority and low-income populations, while causing a modest increase in paper prices that low-income populations will have to bear.

EPA conducted three analyses to address environmental justice-related concerns of the final pulp and paper rule:

1. an assessment of the health effects of the rule's water-related controls on Native American subsistence anglers;

2. a comparison of race, income, and employment statistics for counties with pulp and paper mills and the state as a whole; and

3. an evaluation of the effects of pulp and paper compliance costs on paper price increases, and the resulting impacts on low-income consumers.

EPA did not conduct a specific environmental justice analysis of the effect of MACT (air) standards on minority and low-income populations because accurate modeling of the exposure of these populations was not feasible.

F.1 HEALTH EFFECTS ON NATIVE AMERICAN SUBSISTENCE ANGLERS

For the final rule, EPA estimated the cancer and noncancer health risks to Native American subsistence anglers expected under the water-related options considered for two subcategories of the industry (papergrade kraft/soda and papergrade sulfite) and compared these risks to baseline conditions. Baseline conditions are defined as the pollutant concentrations found in pulp and paper mill effluent discharges as of mid-1995. EPA considered three technology options for the papergrade kraft/soda subcategory: (1) Option A — 100 percent substitution of chlorine dioxide for chlorine (the option selected for BAT/PSES), (2) Option B — oxygen delignification and/or extended cooking followed by 100 percent substitution of chlorine dioxide for chlorine, and (3) totally chlorine free (TCF) bleaching. EPA evaluated one option for each of three segments of the papergrade sulfite subcategory (Table F-1).

TABLE F-1

PROCESS OPTIONS FOR EACH SUBCATEGORY

Subcategory	Options		
Papergrade Kraft/Soda	Option A	Option B	TCF
	100% substitution of chlorine dioxide for chlorine	Oxygen delignification and/or extended cooking followed by 100% substitution of chlorine dioxide for chlorine	TCF: Totally Chlorine-Free — oxygen- and peroxide-enhanced extraction, followed by peroxide bleaching
Papergrade Sulfite (3 segments)			
(1) Uses an acidic cooking liquor of calcium, magnesium, or sodium sulfite	TCF: Totally Chlorine-Free — oxygen- and peroxide-enhanced extraction, followed by peroxide bleaching		
(2) Uses an acidic cooking liquor of ammonium sulfite	ECF: Elemental-Chlorine-Free — 100% substitution of chlorine dioxide for chlorine, peroxide-enhanced extraction, and elimination of hypochlorite		
(3) Produces specialty grade pulp characterized by a high percentage of alpha cellulose and high brightness	ECF: Elemental-Chlorine-Free — 100% substitution of chlorine dioxide for chlorine, oxygen- and peroxide-enhanced extraction, and elimination of hypochlorite		

F.1.1 Methodology

The assessment of carcinogenic risk and noncancer hazards was conducted in accordance with available EPA guidance including *Risk Assessment Guidance for Superfund* (U.S. EPA, 1989b) and *Assessing Human Health Risk from Chemically Contaminated Fish and Shellfish: A Guidance Manual* (U.S. EPA, 1989a). Potential human health impacts on Native American subsistence anglers were evaluated by (1) estimating potential individual carcinogenic risks and noncarcinogenic hazards from the consumption of fish tissue under baseline conditions and BAT/PSES options for Native American subsistence anglers on a nationwide basis and for reservations with treaty-ceded fishing rights, and (2) estimating the annual incidence of cancer and the number of individuals exposed to noncancer hazards among the potentially exposed Native American subsistence anglers with treaty-ceded fishing rights under baseline and BAT/PSES conditions. EPA assumed that the increased cancer and noncancer risks to Native American subsistence anglers from pulp and paper mills were the result of consumption of fish tissue contaminated by dioxin (2,3,7,8-TCDD), furan (2,3,7,8-TCDF), and five other pollutants in mill discharges. Consumption of fish tissue can be an important route of human exposure for certain pollutants such as dioxins/furans, which can bioaccumulate in fish tissues to high concentrations even when water concentrations are below detection limits. Extremely low doses of 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) have been found to elicit a wide range of toxic responses in animals, including carcinogenicity, teratogenicity, fetotoxicity, reproductive dysfunction, and immunotoxicity (U.S. EPA, 1987). This compound is the most potent animal carcinogen evaluated by EPA and EPA has determined that there is sufficient evidence to conclude that 2,3,7,8-TCDD is a probable human carcinogen (U.S. EPA, 1989c). Variations in fish consumption can affect exposure to contaminants in fish tissue and, hence, health risks. Some populations, such as subsistence anglers and some ethnic groups, tend to consume more fish than the general U.S. population.

EPA based its estimates of reductions in increased cancer risks on computer modeling results that showed decreases in fish tissue concentrations of five carcinogens as a result of the rule—chloroform; pentachlorophenol; 2,3,7,8-TCDD; 2,3,7,8-TCDF; and 2,4,6-trichlorophenol. EPA based its estimates of the reductions in increased noncancer hazards on estimates of reduced fish tissue concentrations of six toxicants as a result of the rule — chloroform; pentachlorophenol, 2,3,7,8-TCDD; 2,3,7,8-TCDF; 2,3,4,6-tetrachlorophenol; and 2,4,5-trichlorophenol.

To estimate both baseline and post-compliance risk levels, EPA evaluated the effluent pollutant loadings of 92 mills, the flows of pulp and paper receiving streams, and the populations of Native Americans residing downstream of pulp and paper mills. Because site-specific information on pollutant concentrations in fish was not available for each of the 92 mills, EPA predicted fish tissue concentrations and human health benefits of the final rule based on computer model simulations. EPA used a simple dilution model to predict water column and fish tissue concentrations of all contaminants except dioxin/furan. The simple dilution modeling approach is a conservative approach that assumes all pollutants (except dioxin/furan) discharged to receiving streams are available to the biota. EPA used the Office of Research and Development's Dioxin Reassessment Evaluation (DRE) model to estimate fish tissue concentrations of dioxin/furan from pulp and paper mill discharges. The DRE model provides more reliable information regarding the partitioning of hydrophobic pollutants like dioxin/furan between sediment and the water column, and thus on their bioavailability to fish.

EPA divided the angler population into three groups — recreational anglers, subsistence anglers, and Native American subsistence anglers. Recreational anglers are those anglers who fish for enjoyment, not to survive. However, they do consume more fish than typical members of the general population. Subsistence anglers (non-Native American) are those anglers who depend on fishing for at least part of their daily intake of food. Native American subsistence anglers are those Native Americans who consume relatively more fish than members of other subsistence groups as part of their daily diet, either for survival or because of customs or religious practices and beliefs.

EPA assumed that recreational anglers consume 21 grams per day (g/day) of fish, subsistence anglers (non-Native American) consume 48 g/day, and Native American subsistence anglers consume 70 g/day. EPA based the recreational and subsistence angler fish consumption rates on the 90th and 95th percentiles, respectively, of the estimated nationwide distribution of per capita freshwater and estuarine finfish and shellfish consumption rates of persons 18 and older. These estimated fish consumption rates are based on a recently completed analysis of the U.S. Department of Agriculture combined 1989, 1990, and 1991 Continuing Survey of Food Intake by Individuals (CSFII). The analysis was conducted by the Office of Science of Technology of EPA's Office of Water (U.S. EPA, 1997).

EPA based the Native American subsistence angler consumption rate on average fish consumption rates of Native Americans determined in studies conducted by the Columbia River Inter-Tribal Fish

Commission (CRITFC, 1994) and Wolf and Walker (1987). CRITFC conducted a fish consumption survey among four Columbia River Basin tribes during the fall and winter of 1991-1992. The target population included all adult tribal members who lived on or near the Yakama, Warm Springs, Umatilla, or Nez Perce reservations. Adults in the CRITFC study had an average fish intake of 58.7 g/day. Wolf and Walker (1987) analyzed a data set from 94 Native Alaskan communities for harvests of fish, land mammals, marine mammals, and other wild resources. The analysis was performed to evaluate the distribution and productivity of subsistence harvests in Alaska during the 1980s. The median per capita individual fish intake in the 94 communities was 81 g/day. The average fish intake rates of the two studies (i.e., 58.7 g/day for CRITFC and 81 g/day for Wolf and Walker) were combined and the average of these two values (approximately 70 g/day) was used as the fish consumption rate for Native Americans for the water quality assessment.

EPA conducted two separate evaluations of the potential risk to Native American subsistence angler populations. In the first, EPA evaluated the risk to Native American subsistence anglers nationwide by assuming Native Americans fish on streams below the discharges of all of the pulp and paper mills. This assumption most likely overstates the potential risk since Native Americans might not (and probably do not) fish below all of the pulp and paper mills' receiving streams. However, records of the number of Native Americans who practice subsistence angling nationwide are not available. Thus, EPA was not able to estimate the potentially exposed population and the potential reduction in cancer cases and noncancer health effects that might result from implementation of the final rule. EPA was able to evaluate only the potential risk levels faced by Native American subsistence anglers nationwide.

For the second evaluation, EPA identified the Native American tribes participating in subsistence fishing with treaty-ceded fishing grounds potentially affected by pulp and paper mill discharges (Lenhart and Castillo, 1997). EPA then evaluated the risk to the members of these tribes and also determined the population size of these tribes. Therefore, EPA considered only members of tribes living on reservations with treaty-ceded fishing rights when estimating the number of cancer cases avoided and reductions in the number of individuals exposed to noncancer effects as a result of implementing each of the water-related technology options. For both the nationwide assessment and the assessment of members of tribes with treaty-ceded fishing rights, EPA assumed Native American subsistence anglers consume 70 g/day of fish.

EPA estimated the chronic daily intake (CDI) for each pollutant evaluated based on modeled fish tissue concentrations and a 70 g/day fish tissue consumption rate for Native American subsistence anglers.

CDIs are expressed as milligrams of pollutant contacted per kilogram of body weight per day. EPA assumed that Native American subsistence anglers are exposed to pulp and paper effluent pollutants for 70 years. The potential cancer risks associated with pulp and paper mill pollutant discharges are expressed as an increased probability of developing cancer over a lifetime, or the excess individual lifetime cancer risk (U.S. EPA, 1989b). Cancer risks are quantified by multiplying the CDI times the pollutant-specific slope factor for each pollutant evaluated:

$$Cancer\ risk_i = CDI_i * SF_i$$

where:

Cancer $risk_i$	=	potential carcinogenic risk associated with exposure to chemical *i* (unitless);
CDI_i	=	chronic daily intake for chemical *i* (mg/kg/day); and
Sf_i	=	slope factor for chemical *i* $((mg/kg/day)^{-1})$.

The slope factor is a plausible upper-bound estimate of a cancer-related response per unit intake of a chemical over a lifetime. It is used to estimate the upper-bound probability that an individual will develop cancer as a result of a lifetime of exposure to a particular level of a potential carcinogen. Chemical-specific cancer risks are summed in accordance with EPA guidance (U.S. EPA, 1989b) to quantify the combined cancer risk associated with exposure to a mixture of chemicals.

EPA evaluated noncancer hazards for four systemic human toxicants by comparing the estimated CDI dose with a reference dose (RfD). These four systemic toxicants (chloroform, pentachlorphenol, 2,3,4,6-tetrachlorophenol, and 2,4,5-trichlorophenol) are the pollutants analyzed that have EPA-approved RfDs contained in the Integrated Risk Information System, or IRIS. The RfD represents an estimate, with uncertainty spanning perhaps an order of magnitude, of the level of daily exposure that is likely to be without an appreciable risk of deleterious effects to an individual during a lifetime.

EPA did not use the RfD approach to evaluate potential noncancer effects associated with dioxin/furan because the use of an RfD for dioxin/furan presents special problems. If EPA were to establish an RfD for dioxin/furan using the standard conventions of uncertainty, the RfD value would most likely be one or two orders of magnitude below average background population exposures. This situation precludes using the RfD as a means for determining an acceptable level of dioxin/furan exposure, since at ambient background levels, effects are not discernable (William Farland, Director of the National Center for Environmental Assessment, letter to Andrew Smith, State Toxicologist, Maine Bureau of Health, January 24, 1997).

Instead, EPA evaluated the potential noncancer effects of dioxin/furan on Native American subsistence anglers by comparing the modeled incremental exposure from fish tissue consumption using the toxic equivalent (TEQ) approach, which combines dioxin/furan exposures to average national ambient background exposures as estimated by EPA (120 picograms (pg) TEQ/day; U.S. EPA, 1994). EPA (1994) estimates that adverse impacts associated with dioxin/furan exposures may occur at or within one order of magnitude of average background exposures. As exposures increase within and above this range, the probability and severity of human noncancer effects most likely increases. For this evaluation, EPA identified the number of mills associated with dioxin/furan fish tissue exposures greater than one order of magnitude above ambient background exposures.

F.1.2 Potential Reductions in Increased Cancer Risk

EPA's estimates of average increased individual lifetime cancer risks for subsistence anglers in Native American populations nationwide under baseline conditions and after implementation of Option A, Option B, and TCF are shown in Table F-2. With the implementation of either Option A or Option B at papergrade kraft/soda facilities, EPA estimates that increased dioxin/furan-related cancer risk for exposed Native American subsistence anglers nationwide would be reduced from the 10^{-4} level to the 10^{-5} level. The difference between Option A and Option B is insignificant. Under TCF, the risk goes to zero. For papergrade sulfite mills, EPA estimates that the reduction in increased risk to Native American subsistence anglers nationwide would also be from the 10^{-4} level to the 10^{-5} level. For all pollutants other than dioxin/furan, EPA estimates that increased risks to exposed Native American subsistence anglers nationally under baseline conditions are at the 10^{-7} level for papergrade kraft/soda mills and the 10^{-8} level for papergrade sulfite mills. These risks would be reduced to the 10^{-8} level for papergrade kraft/soda mills and the 10^{-9} level for papergrade sulfite mills. EPA does not consider these risk levels to be of significant concern.

EPA estimates that the increased dioxin/furan-related cancer risk for Native American subsistence anglers with treaty-ceded fishing rights would be at the 10^{-4} level under baseline conditions, and would be

TABLE F-2

AVERAGE INDIVIDUAL INCREASED LIFETIME CANCER RISKS FROM DIOXIN FOR EXPOSED NATIVE AMERICAN ANGLER POPULATIONS UNDER BASELINE CONDITIONS AND BAT/PSES OPTIONS[a]

	Dioxin[b]			All Other Pollutants		
		Options			Options	
Subcategory	Baseline	A	B	Baseline	A	B
Papergrade Kraft/Soda	$5.3x10^{-4}$	$9.9x10^{-5}$	$7.7x10^{-5}$	$2.3x10^{-7}$	$4.9x10^{-8}$	$3.9x10^{-8}$
Papergrade Sulfite	$3.0x10^{-4}$	$2.8x10^{-5}$	NA	$3.3x10^{-8}$	$6.1x10^{-9}$	NA

[a] Based on modeled fish tissue levels below 92 mills and a fish tissue consumption rate of 70 g/day.

[b] Under TCF, there would be no risk associated with dioxin/furan.

Note: A 10^{-5} risk means the risk of one cancer case out of 100,000 individuals exposed to a given level, a 10^{-6} risk means the risk of one cancer case out of 1,000,000 individuals exposed, etc.

reduced to the 10^{-5} level under Options A and B and to zero under TCF (Table F-3). EPA estimates that a maximum of approximately 23,000 Native Americans would be exposed at this level. This represents an increased cancer risk of 0.14 cancer cases per year under baseline conditions, which would be reduced to 0.008 cases per year with Option A and 0.007 cases per year with Option B, a reduction of about 95 percent for either option. Under TCF, the residual number of cancer cases per year would be zero.

For all pollutants other than dioxin/furan, EPA estimates that increased cancer risks to Native American subsistence anglers with treaty-ceded fishing rights would be reduced from the 10^{-8} level under baseline conditions to the 10^{-9} level under Options A and B.

F.1.3 Noncancer Hazard Reductions

For Native American subsistence anglers nationally, EPA estimates that no mills will exceed the oral RfDs for any of the four contaminants with EPA-approved RfDs contained in IRIS (under either baseline conditions or any BAT/PSES option). EPA also estimates that potential Native American dioxin/furan exposures from consumption of contaminated fish associated with three mills (all papergrade kraft/soda mills) exceed ambient background exposures by an order of magnitude under baseline conditions. Under Option A, Option B, and TCF, no mills are associated with dioxin/furan exposures greater than an order of magnitude above background exposures.

For Native American subsistence anglers with treaty-ceded fishing rights, the maximum exposure under baseline conditions is projected to be 803 pg TEQ/day (Table F-4). Under the selected BAT/PSES options, the maximum incremental dioxin/furan exposure is reduced to 39 pg TEQ/day, which is less background exposures. EPA estimates that no Native American subsistence anglers with treaty-ceded fishing rights would receive a maximum dioxin/furan exposure greater than one order of magnitude above background under baseline conditions or the selected BAT/PSES options (i.e., exposures are less than the level of concern).

TABLE F-3

AVERAGE INDIVIDUAL INCREASED CANCER RISKS AND ANNUAL INCREASED INCIDENCE OF CANCER FROM DIOXIN/FURAN AND ALL OTHER POLLUTANTS FOR EXPOSED NATIVE AMERICAN ANGLER POPULATIONS WITH TREATY-CEDED FISHING RIGHTS UNDER BASELINE CONDITIONS AND BAT/PSES OPTIONS

	Dioxin/Furan[a]			**All Other Pollutants**		
		Options				
	Baseline	**A**	**B**	**Baseline**	**A**	**B**
Cancer Risk	$3.5x10^{-4}$	$2.3x10^{-5}$	$1.9x10^{-5}$	$5.6x10^{-8}$	$7.3x10^{-9}$	$6.3x10^{-9}$
Annual Increased Incidence of Cancer	0.14	0.008	0.007	0	0	0

[a] Under TCF, dioxin/furan-related risk and annual incidence of cancer would be zero.
NOTE: A 10^{-5} risk means the risk of one cancer case out of 100,000 individuals exposed to a given level, a 10^{-6} risk means the risk of one cancer case out of 1,000,000 individuals exposed, etc.

TABLE F-4

MILLS EXCEEDING BACKGROUND EXPOSURES OF DIOXIN/FURAN (TEQ: 120 pg/day) FROM FISH TISSUE CONSUMPTION FOR NATIVE AMERICANS WITH TREATY-CEDED FISHING RIGHTS

Option	Maximum Estimated Exposure (pg/day)	Number of Mills Exceeding Background Exposure By An Order Of Magnitude
Baseline	803	0
Option A	39	0
Option B	39	0
TCF	0	0

F.1.4 Analysis of Specific Tribes

EPA also investigated the fish habits of 48 specific Native American tribes located downstream from pulp mills in 15 states and determined that 8 of these — the Flathead (Montana), Micmac (Maine), Tulalip (Puget Sound, Washington), Nez Perce, Umatilla, Warm Springs, Yakama (the Lower Columbia River, Oregon and Washington), and Penobscot (Maine) — have treaty-ceded fishing rights and engage in subsistence fishing in waters potentially affected by pulp and paper mill effluent. The Flathead, Micmac, and Tulalip tribes have very limited information on fish consumption in mill-affected waters. The Lower Columbia River and Penobscot River tribes are considered in detail in two case studies EPA conducted for this rule. The results of the two case studies are reported below. EPA has determined that members of these tribes have elevated health risks from consuming contaminated fish because of higher consumption levels. EPA expects that the rule will reduce cancer risks by an order of magnitude (i.e., tenfold) for members of the Penobscot Nation, and by slightly less for the Lower Columbia River tribes, who consume greater quantities of fish. EPA's analysis of the Lower Columbia River tribes also indicates that the background level of risk from sources other than pulp and paper mills is significant, and that the removal of dioxin/furan by the final rule will not resolve continuing background risk levels.

F.1.5 Penobscot River and Penobscot Nation

The Penobscot Nation's reservation includes 146 islands in the Penobscot River north of Old Town, Maine. The tribe has treaty-protected rights to the Penobscot River fishery, and has traditionally relied heavily on subsistence fishing. EPA assessed the risks to tribal members from the consumption of dioxin-contaminated fish from the Penobscot River, and the potential health benefits from the regulation.

Exposed Population. To estimate the potentially exposed population, EPA used tribal enrollment figures and a 1991 survey of the Penobscot Nation. Estimated tribal enrollment, including members residing both on and off the reservation, is 2,089. The tribal population residing on the reservation is 410, and the tribal population residing in Maine is 1,167 (1996 enrollment; J. Banks, Department of Natural Resources, Penobscot Nation, personal communication, 1996). The in-state population accounts for many tribe members who live in nearby communities such as Old Town or Bangor and who continue to regularly use the

Penobscot River (J. Banks, Department of Natural Resources, Penobscot Nation, personal communication, 1996).

A 1991 survey of tribal use of the Penobscot River found that 24 percent of respondents eat fish from the Penobscot River (Penobscot Nation Department of Natural Resources, 1991). The survey, which was mailed to all tribal members over the age of 18 residing in Maine, received only a 25 percent response rate. However, no other source of information on tribal practices is available. The survey probably underestimates actual exposure since individuals who practice a "traditional" lifestyle (i.e., members who spend substantial time on the reservation fishing and hunting) generally do not respond well to written surveys and thus are probably under represented in the survey results (Banks, 1992). Multiplying the in-state enrollment (1,167) by 24 percent results in an estimate of the exposed adult population of 280.

Consumption. Consuming anglers responding to the 1991 Penobscot Nation Survey reported an average consumption of 11 g/day, although a number of assumptions must be made to interpret this portion of the survey (Penobscot Nation Department of Natural Resources, 1991; CRITFC, 1994). This estimate is supported by the results for the 95th percentile of Maine anglers using freshwater rivers and streams in the state (12 g/day) (ChemRisk, 1992). The Penobscot Nation, which traditionally relies on the Penobscot River for sustenance, can be expected to be among the highest fish consuming populations in Maine. However, as described above, the Penobscot Nation Survey may underestimate mean consumption since tribal members that practice a traditional lifestyle may be underrepresented in the survey. The 90th percentile of fish consumption from the Penobscot Nation Survey was 48 g/day (CRITFC, 1994).

For this analysis, EPA used 11 g/day as a central estimate of consumption for the Penobscot Tribe, and 48 g/day as an upper bound estimate. Note that these values are much lower than the estimated fish consumption used for the nationwide risk assessment for licensed anglers. Nationally, EPA estimates that recreational anglers consume an average of 21 g/day and subsistence anglers consume 48 g/day. However, on-site data are the most accurate, so EPA uses the survey consumption information for the Penobscot Nation. The survey consumption information may reflect "suppressed" fish consumption due to fear of contamination. However, EPA had no way to correct for that outcome other than to also consider the upper bound estimate.

Fish Tissue Contaminant Concentrations. The Penobscot Nation's treaty-ceded fishing grounds are located below the Lincoln mill, and EPA modeled the baseline and post-regulation concentrations of dioxin/furan in fish tissue for this mill using the DRE model as described above. Observations of fishing habits suggest that the majority of tribal fishing takes place below this mill. Therefore, EPA assumed that 90 percent of the total catch of tribal members comes from waters affected by effluent from the Lincoln mill. Species from the river most frequently consumed by tribal members are smallmouth bass, brook trout, Atlantic salmon, landlocked salmon, pickerel, and perch. The DRE model provides concentrations for an average or "generic" fish.

Increased Cancer Risk and Risk Reductions. EPA assessed cancer risk following the methodology described above. Under baseline conditions and assuming consumption of 11 g/day, EPA estimates that Penobscot Nation anglers face an increased cancer risk from dioxin/furan of 3.25×10^{-5} . Under EPA's selected option (Option A), this risk would be reduced by an order of magnitude to 3.09×10^{-6}. Under Option B, this risk would be reduced by slightly more than an order of magnitude to 2.08 x 10^{-6}. Assuming fish consumption of 48 g/day, Penobscot Nation anglers face an increased cancer risk of 1.42×10^{-4} under baseline conditions. The selected option would reduce this risk to 1.35×10^{-5} , while Option B would reduce this risk to 9.07 x 10^{-6}. Under the final rule for EPA's selected option (as well as Option B), increased lifetime cancer cases are reduced by 0.009 under the central estimate of consumption (11 g/day) and by 0.04 under the upper bound estimate (48 g/day). It should be noted that these estimates reflect only the risk from dioxin/furan that is expected to be reduced by the regulation and not the potential risk from other sources and contaminants that may be found in fish from the Penobscot River.

F.1.6 Lower Columbia River: Umatilla, Nez Perce, Yakama, and Warm Springs Tribes

The Umatilla, Nez Perce, Yakama, and Warm Springs tribes, which make up the CRITFC member tribes, each possess fishing rights in the Columbia River Basin reserved by treaties, and members from each tribe fish for both ceremonial and subsistence purposes in the Columbia River Basin. The tribes harvest both the anadromous and resident fish species from the Lower Columbia River. The fishery resource is not only a major food source for tribal members but also "an integral part of the tribes' cultural, economic, and spiritual well-being" (CRITFC, 1994).

Exposed Population. The U.S. Bureau of Census (1993) reports Native American populations on reservations and trust lands. According to the Census, there are 1,883 Nez Perce, 1,030 Umatilla, 6,198 Yakama, and 2,871 Warm Springs Native Americans living on reservation and trust lands. These figures may be conservative estimates of the exposed tribal population because they do not include members living near the reservation (or elsewhere along the watershed) who may also practice a traditional subsistence lifestyle.

Consumption. During the fall and winter of 1991-1992, the CRITFC conducted a survey to determine the level and nature of fish consumption among Columbia River Basin tribes (CRITFC, 1994). Based on low-end estimates of fish consumption provided by respondents, the survey showed tribal members 18 years and older consume an average of 58.7 g/day of fish. This rate reflects both consuming and nonconsuming tribal members, and includes fish from all sources. Overall, 87 percent of fish is obtained from self or family, friends, ceremonies, and tribal distributions. Nine percent of fish is obtained from stores, and 4 percent is obtained from other sources such as restaurants. The 90th percentile of consumption was between 97 g/day and 130 g/day. Tribal members 60 years of age and older consume 74.4 g/day; nursing mothers and females who had previously breast-fed their children consume an average of 59.1 g/day. For this assessment, EPA used an average consumption rate of 58.7 g/day and the midpoint of the 90th percentile (114 g/day) for an upper bound estimate.

Background Fish Tissue Concentrations. A recent survey of the portion of the Columbia River from Bonneville Dam to the mouth provided the data on fish tissue contaminant concentrations (Tetra Tech, 1996). This survey, conducted from September 1994 to February 1995, was designed specifically to collect human health risk assessment data. In addition to dioxin, the background risk assessed here includes risk from arsenic (inorganic), mercury, selenium, silver, aldrin, alpha-BHC, PCBs, beta-BHC, dieldrin, gamma-BHC, heptachlor, heptachlor epoxide, hexachlorobenzene, p,p'-DDD, p,p'-DDE, p,p'-DDT, and toxaphene. Although this analysis estimates reduced risks from only dioxin exposure, data availability allowed the calculation of background risks for the range of contaminants present in fish tissue. This calculation provides perspective on the total background risk level from fish consumption faced by Native Americans. The listed contaminants represent a subset of the contaminants analyzed in the sampling survey that are of most concern for human health. Not all contaminants were detected in each species. When a contaminant was detected in any species, EPA used one-half the detection limit for those species where the contaminant was not detected.

The sampling survey (Tetra Tech, 1996) included filets of carp, large-scale sucker, white sturgeon, steelhead trout, coho salmon, and chinook salmon. The fish consumption survey (CRITFC, 1994) provides detailed information on grams of fish consumed by species for 10 species specifically listed on the survey (salmon, trout, lamprey, smelt, whitefish, sturgeon, walleye, sucker, shad, and squawfish). Information from these two surveys was used to construct a weighted average fish tissue concentration that reflects the actual mix of species consumed. Salmon and trout are the most consumed species, and the species listed in the survey comprise 66 percent of total mean consumption. The species listed in the survey were matched as closely as possible to the available sampling data, and contaminant concentrations for the consumption of species not listed in the CRITFC survey (44 percent of total consumption) were calculated as an average of species consumed. Note that carp, among the most contaminated species sampled, was not included in the weighted concentration because it was not specifically listed in the CRITFC survey.

Post-Regulation Fish Tissue Concentrations. EPA modeled the background and post-regulation concentrations of TCDD and TCDF in fish tissue for each mill using the DRE model as described above. The percentage reduction in TCDD and TCDF were applied to the background concentrations described above to calculate post-regulation concentrations. There are six bleached kraft mills in the Lower Columbia River basin. The average percentage reduction across these mills (30 percent for TCDD and 33 percent for TCDF under Option A; 38 percent for TCDD and 40 percent for TCDF under Option B) was used for this analysis.

Increased Cancer Risk and Risk Reductions. EPA assessed cancer risk following the methodology described above. Assuming consumption of 58.7 g/day, the background risk from all contaminants for the Columbia River Native American anglers is 1.15×10^{-4}. Option A reduces the background risk to 1.03×10^{-4}, although virtually all cancer risk from pulp and paper mills is eliminated. Option B is estimated to reduce background risk to approximately 1×10^{-4}. All of the remaining cancer risk is from sources other than pulp and paper mills. The selected BAT (Option A) will reduce increased lifetime cancer cases by 0.15, while Option B will reduce increased lifetime cancer cases by 0.18.

Assuming consumption of 114 g/day, Columbia River Native American anglers face a background cancer risk of 2.23×10^{-4}. Under Option A, background risk is reduced to 2.0×10^{-4} and increased lifetime cancer cases are reduced by 0.28. Under Option B, background risk is reduced to $1.94 \text{ x } 10^{-4}$ and increased lifetime cancer cases are reduced by 0.35.

F.2 RACIAL AND INCOME CHARACTERISTICS OF AFFECTED COUNTIES AND STATES

EPA also compared the socioeconomic characteristics of counties with pulp and paper mills to the state as a whole to investigate whether low-income and minority populations are disproportionately affected by pulp and paper mills. EPA selected the county as a unit of comparison of ethnic and income difference on the assumption that health risks from pulp and paper mills on these groups would be derived principally from the consumption of fish contaminated by toxic substances in mill effluent. EPA conducted its entire analysis of risks to anglers associated with contaminated fish consumption based on records of licensed anglers in counties adjacent to receiving waters. EPA determined that within-state comparisons of ethnic and income data were the most accurate means to account for interregional demographic differences.

EPA's analysis of race and income data indicates that, of the 26 states with bleached papergrade kraft mills:

- Fifteen states had a minority (i.e., nonwhite) mill county population percentage that was *less* than the state in which they were located; 11 states had a minority mill county population that was greater than the state's;
- Sixteen states had mill counties with an African-American population percentage that was *less than or equal* to the state, and 10 states had a population percentage that was greater;
- Seven states had mill counties with an African American population percentage at least 3 percent greater than the state (in Arkansas, the African American population percentage was 22 percent greater in counties with mills compared to the state);
- Seven states had mill counties with an American Indian population percentage that was at least double the American Indian population percentage for the state;
- Fifteen states had a percent of the mill county population below the poverty line that was greater than the state. However, for all mill counties, the average percent below the poverty line was 15 percent, whereas the average for all states with mills was 14.1 percent. EPA has determined that this difference is statistically insignificant;
- Eighteen states had average unemployment rates in mill counties that were significantly higher than the state unemployment rate; and
- The average median income for all mill counties is $25,657, compared to $28,157 for the states.

Complete results are reported in Table F-5.

TABLE F-5

RACE AND INCOME CHARACTERISTICS IN STATES AND COUNTIES WITH BLEACHED KRAFT MILLS

State	% White	% Black	% American Indian	% Asian	% Other	Median Income[a]	% Below Poverty Level	% Unemployed[a]
Alabama								
Total in Counties with Mills	64.5%	33.9%	0.9%	0.6%	0.1%	$21,373	23.66%	8.99%
Total in State	73.6%	25.2%	0.5%	0.5%	0.1%	$23,597	18.34%	6.87%
Arkansas								
Total in Counties with Mills	61.0%	38.0%	0.5%	0.3%	0.2%	$20,576	24.13%	9.49%
Total in State	82.7%	15.9%	0.6%	0.5%	0.3%	$21,147	19.07%	6.76%
California								
Total in Counties with Mills	92.6%	0.7%	3.9%	1.9%	0.9%	$24,688	15.46%	8.68%
Total in State	69.1%	7.4%	0.8%	9.6%	13.1%	$35,798	12.51%	6.65%
Florida								
Total in Counties with Mills	79.9%	17.2%	0.8%	1.6%	0.5%	$24,250	16.74%	7.01%
Total in State	83.1%	13.6%	0.3%	1.2%	1.8%	$27,483	12.69%	5.78%
Georgia								
Total in Counties with Mills	63.4%	34.5%	0.3%	1.4%	0.5%	$27,551	16.15%	6.13%
Total in State	71.1%	26.9%	0.2%	1.1%	0.6%	$29,021	14.65%	5.74%
Idaho								
Total in Counties with Mills	93.9%	0.2%	4.9%	0.6%	0.5%	$25,219	12.03%	7.31%
Total in State	94.4%	0.4%	1.5%	0.9%	2.8%	$25,257	13.25%	6.15%
Kentucky								
Total in Counties with Mills	97.5%	2.3%	0.1%	0.0%	0.1%	$22,717	17.66%	11.56%
Total in State	92.1%	7.1%	0.2%	0.5%	0.2%	$22,534	19.03%	7.37%
Louisiana								
Total in Counties with Mills	65.3%	32.7%	0.3%	1.3%	0.5%	$25,037	20.64%	9.07%
Total in State	67.3%	30.8%	0.5%	0.9%	0.5%	$21,949	23.58%	9.65%
Maine								
Total in Counties with Mills	98.1%	0.4%	0.7%	0.6%	0.1%	$28,028	11.26%	6.64%
Total in State	98.4%	0.4%	0.5%	0.6%	0.1%	$27,854	10.80%	6.65%

TABLE F-5 (continued)

State	% White	% Black	% American Indian	% Asian	% Other	Median Income[a]	% Below Poverty Level	% Unemployed[a]
Maryland								
Total in Counties with Mills	97.3%	2.1%	0.0%	0.4%	0.1%	$21,546	16.50%	8.16%
Total in State	71.0%	24.9%	0.3%	2.9%	0.9%	$39,386	8.27%	4.30%
Michigan								
Total in Counties with Mills	88.2%	9.7%	1.1%	0.4%	0.6%	$25,043	14.49%	8.35%
Total in State	83.5%	13.9%	0.6%	1.1%	0.9%	$31,020	13.12%	8.24%
Minnesota								
Total in Counties with Mills	95.5%	0.2%	3.6%	0.3%	0.4%	$24,367	12.50%	7.75%
Total in State	94.5%	2.2%	1.1%	1.8%	0.5%	$30,909	10.22%	5.15%
Mississippi								
Total in Counties with Mills	73.0%	26.0%	0.2%	0.7%	0.2%	$24,739	18.83%	8.21%
Total in State	63.5%	35.6%	0.3%	0.5%	0.1%	$20,136	25.21%	8.43%
Montana								
Total in Counties with Mills	96.2%	0.2%	2.3%	1.0%	0.3%	$23,388	16.99%	7.22%
Total in State	92.8%	0.3%	6.0%	0.5%	0.5%	$22,988	16.07%	6.96%
New Hampshire								
Total in Counties with Mills	99.3%	0.1%	0.2%	0.2%	0.2%	$25,897	10.12%	8.56%
Total in State	98.0%	0.6%	0.2%	0.8%	0.3%	$36,329	6.42%	6.22%
New York								
Total in Counties with Mills	97.5%	1.4%	0.3%	0.5%	0.3%	$28,340	10.32%	7.63%
Total in State	74.5%	15.9%	0.3%	3.8%	5.5%	$32,965	13.03%	6.88%
North Carolina								
Total in Counties with Mills	75.4%	22.5%	1.2%	0.4%	0.5%	$22,727	16.59%	6.67%
Total in State	75.6%	22.0%	1.2%	0.8%	0.4%	$26,647	12.97%	4.79%
Ohio								
Total in Counties with Mills	92.6%	6.5%	0.2%	0.5%	0.1%	$24,286	17.75%	9.71%
Total in State	87.8%	10.6%	0.2%	0.8%	0.5%	$28,706	12.54%	6.60%

TABLE F-5 (continued)

State	% White	% Black	% American Indian	% Asian	% Other	Median Income[a]	% Below Poverty Level	% Unemployed[a]
Oregon								
Total in Counties with Mills	96.9%	0.2%	1.3%	0.7%	0.8%	$26,462	12.56%	7.18%
Total in State	92.8%	1.6%	1.5%	2.4%	1.8%	$27,250	12.42%	6.20%
Pennsylvania								
Total in Counties with Mills	95.6%	3.3%	0.1%	0.5%	0.5%	$28,524	10.11%	5.56%
Total in State	88.6%	9.2%	0.1%	1.1%	1.0%	$29,069	11.13%	5.97%
South Carolina								
Total in Counties with Mills	64.0%	34.4%	0.4%	0.8%	0.4%	$28,548	14.29%	5.47%
Total in State	69.1%	29.8%	0.3%	0.6%	0.3%	$26,256	15.37%	5.58%
Tennessee								
Total in Counties with Mills	97.1%	2.2%	0.3%	0.3%	0.0%	$23,898	15.09%	6.64%
Total in State	83.0%	15.9%	0.3%	0.6%	0.2%	$24,807	15.70%	6.41%
Texas								
Total in Counties with Mills	67.1%	18.5%	0.3%	3.6%	10.6%	$31,210	15.25%	6.78%
Total in State	75.3%	11.9%	0.4%	1.9%	10.6%	$27,016	18.10%	7.11%
Virginia								
Total in Counties with Mills	71.4%	27.7%	0.6%	0.2%	0.1%	$28,324	12.60%	5.87%
Total in State	77.5%	18.8%	0.3%	2.6%	0.9%	$33,328	10.25%	4.48%
Washington								
Total in Counties with Mills	90.5%	3.3%	1.5%	3.6%	1.1%	$32,069	9.92%	5.53%
Total in State	88.6%	3.0%	1.7%	4.3%	2.3%	$31,183	10.92%	5.72%
Wisconsin								
Total in Counties with Mills	98.1%	0.1%	0.4%	1.3%	0.1%	$28,263	8.90%	5.21%
Total in State	92.3%	5.0%	0.8%	1.1%	0.8%	$29,442	10.70%	5.20%

[a] For "Total in Counties with Mills," medium income is calculated as a weighted average across counties using median income and population.

Source: Census of Population and Housing. 1990. Summary Tape File 3 on CD-ROM. Prepared by the Bureau of the Census, Washington: The Bureau, 1992.

These racial and income differences vary from state to state, and as a result, it is difficult to conclude that minority and low-income populations are disproportionately affected by pulp and paper discharges and emissions and would therefore disproportionately benefit from regulations. The differences in income levels may be more highly correlated with urban versus rural distinctions, and pulp mills are often located near wood supplies in lower-wage rural locations. In 12 of 26 states, minorities may be disproportionally affected by pulp and paper discharges. Low-income populations may be disproportionally affected by pulp and paper discharges in 7 of the 26 states. However, these populations may also be the most adversely affected economically if mills close as a result of the pulp and paper integrated rules. EPA notes that the cost of rejected Option B technology (oxygen delignification + 100 percent substitution) could increase the number of individuals below the poverty line in up to five counties, whereas the cost of TCF technology could increase the number of individuals below the poverty level in up to nine counties where mills would be predicted to close.

F.3 PRICE EFFECTS ON LOW-INCOME CONSUMERS

The compliance costs associated with the various air and water pollution control options that EPA considered will have some effect on prices as a result of increasing supply costs. In Chapter 6 of the EA, EPA estimates that the price effect will benefit the regulated community, i.e., one or more mills may remain open that would otherwise close if they could not pass on some of their increased compliance costs. However, consumers must ultimately pay these increased prices, with the burden falling most heavily on those consumers who use the most paper on a per capita basis, or for whom paper products consume a disproportionate share of income. EPA used the Bureau of Labor Statistics' (U.S. Bureau of Census, 1995) 1995 Annual Consumer Expenditure Survey to evaluate the effects of regulation-induced price changes on low-income consumers by identifying: price increases associated with various combinations of MACT and BAT/PSES technology options for the bleached papergrade kraft and soda subcategory, average paper consumption for low-income populations, and the effects of price increases on low-income populations.

Based on the response of pulp and paper producers to supply shortages resulting from post-compliance mill closures, the average pulp and paper price increase associated with the final rules (BAT/PSES and MACT I) combined with the proposed MACT II rule is 1.5 percent. With Option B technology, paper prices would increase up to a maximum of 1.9 percent. Were TCF selected as BAT, EPA predicts prices would increase by 5.6 percent when combined with final MACT I and proposed MACT II rules. When the most stringent MACT II option is selected in combination with the final MACT I and TCF, EPA estimates that pulp prices would increase by an average of 6 percent.

Based on the Bureau of Labor Statistics' 1995 Consumer Expenditure Survey, EPA estimates that low-income consumers (those with incomes under $10,000) spend an average of 2.09 percent of their pretax income on paper products. The pulp and paper rule will increase this to 2.12 percent of pretax income, whereas TCF would increase this to 2.2 percent of pretax income. The aggregate effect on low-income consumers would be increased annual expenditures of up to $25.3 million for the selected rules, $32.2 million for Option B, and $90.1 million for TCF. Thus, compared to the selected BAT, EPA estimates that TCF would have a greater economic effect on low-income consumers who may be required to make tradeoffs with other necessities to sustain paper price increases.

F.4 SUMMARY

Overall, EPA's investigations into environmental justice considerations reveal:

- Individual Native Americans that engage in subsistence fishing downstream from pulp mills have elevated individual cancer risks compared to the general population or nonnative anglers. The rule will lower dioxin-related cancer risks by an order of magnitude for individuals consuming fish at average and upper end consumption rates;

- Native American tribes located on the Lower Columbia and Penobscot Rivers have treaty-ceded fishing rights and engage in subsistence fishing in waters located downstream from bleached kraft pulp and paper mills. Based on site-specific case studies of these tribes, under the selected option (Option A) EPA estimates that the rule will result in reducing individual cancer risk by an order of magnitude for the Penobscot Nation (from 1×10^{-4} to 1×10^{-5}), and somewhat less for the Lower Columbia River Tribes (from 2.23×10^{-4} to 2.0×10^{-4});

- In 19 of the 26 states with bleached kraft mills, there is no statistically significant difference between the percentage of the population below the poverty level in counties where bleached kraft mills are located and the state as a whole (in several states the percentage of the population below the poverty level is less in counties where bleached kraft mills are located);

- In 14 of the 26 states with bleached kraft mills, there is no statistically significant difference in ethnic makeup between the counties with mills and the state as a whole (in several states the percentage of minorities in counties with mills is significantly less than the percentage of minorities in the state, statistically);

- Unemployment rates in mill counties generally exceed the related state unemployment rates. Mill closures have the potential to make this worse and to increase the number of people below the poverty level in these areas; and

- Environmental groups have stated a preference for TCF technology to reduce adverse health effects on low-income and minority populations. Low-income people may also be adversely affected by paper price increases, particularly for technology options with relatively higher costs, such as TCF. Implementation of TCF would reduce cancer and noncancer risk among recreational, subsistence, and Native American anglers by a very small amount, but would increase unemployment in some counties with unemployment rates already above state and national averages, and may disproportionately adversely affect low-income consumers.

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