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Final Report:
Pulp, Paper, and Paperboard Detailed Study

U.S. Environmental Protection Agency
Engineering and Analysis Division
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ACRONYMS

2,3,7,8-TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
2,3,7,8-TCDF	2,3,7,8-tetrachlorodibenzofuran
AET	Alliance for Environmental Technology
AF&PA	American Forest and Paper Association
AOX	Adsorbable Organic Halides.
BAT	Best Available Technology Economically Achievable
BCT	Best Conventional Pollutant Control Technology
BOD5	Five-day Biochemical Oxygen Demand
BPK	Bleached Papergrade Kraft
BPT	Best Practicable Control Technology
CDD	Chlorinated Dibenzo-p-Dioxins
CDF	Chlorinated Dibenzofurans
CFR	Code of Federal Regulations
COD	Chemical Oxygen Demand
CMP	Chemimechanical Pulping
CTMP	Chemi-Thermo-Mechanical Pulp
CWA	Clean Water Act
DCN	Document Control Number
DMR	Discharge Monitoring Reports
ECF	Elemental Chlorine-Free
EDS	Effluent Data Statistics
ELGs	Effluent Limitations Guidelines and Standards
EPA	U.S. Environmental Protection Agency
FR	Federal Register
ML	Minimum Level
NAICS	North American Industry Classification System
NCASI	National Council for Air and Stream Improvement, Inc.
NESHAP	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
NSPS	New Source Performance Standards
PAC	Polycyclic Aromatic Compounds
PAH	Polycyclic Aromatic Hydrocarbons
PCS	Permit Compliance System
pH	Negative logarithm of the effective hydrogen-ion concentration in moles per liter, a measure of acidity
POTW	Publicly Owned Treatment Works
PS	Papergrade Sulfite
PSES	Pretreatment Standards for Existing Sources
PSNS	Pretreatment Standards for New Sources
SIC	Standard Industrial Classification
TCF	Totally Chlorine-Free
TEQ	Toxic Equivalents
TMP	Thermo-Mechanical Pulp
TRI	Toxics Release Inventory

ACRONYMS (Continued)

TWPE	Toxic-Weighted Pound Equivalents
TWFs	Toxic Weighting Factors
VATIP	Voluntary Advanced Technology Incentives Program

GLOSSARY

2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) and 2,3,7,8-tetrachlorodibenzofuran (2,3,7,8-TCDF) - Two CDD and CDF congeners with chlorine substitution of hydrogen atoms at the 2, 3, 7, and 8 positions on the benzene rings. The 1998 Cluster Rules promulgated by EPA included ELGs for these two congeners. Because of the ELGs, most pulp and paper mills are typically required to monitor for 2,3,7,8-TCDD and 2,3,7,8-TCDF, and these monitoring results are compiled in EPA's Permit Compliance System.

Alliance for Environmental Technology (AET) - An international association of chemical manufacturers created to establish a clearing house of educational and technical resources relating to chlorine dioxide and it's use in papermaking.

Adsorbable Organic Halides (AOX) - A bulk parameter that measures the total mass of chlorinated organic matter in water and wastewater.

American Forest and Paper Association (AF&PA) - The national trade association of the forest, pulp, paper, paperboard and wood products industry. AF&PA represent member companies engaged in growing, harvesting and processing wood and wood fiber, manufacturing pulp, paper and paperboard products from both virgin and recycled fiber, and producing engineered and traditional wood products.

Best Available Technology Economically Achievable (BAT) - Effluent limitations guidelines based on the Best Available Technology Economically Achievable (BAT). The factors considered in assessing BAT include the cost of achieving BAT effluent reductions, the age of equipment and facilities involved, the process employed, potential process changes, non water quality environmental impacts, including energy requirements, and other such factors as the EPA Administrator deems appropriate. The technology must also be economically achievable.

Best Conventional Pollutant Control Technology (BCT) - Effluent reduction levels for conventional pollutants that go beyond the requirements for BPT, as required by the 1977 amendments to the Clean Water Act. These more stringent requirements must meet a two part cost-reasonableness test.

Best Practicable Control Technology Currently Available (BPT) - EPA defines Best Practicable Control Technology Currently Available (BPT) effluent limitations for conventional, toxic, and non-conventional pollutants. Traditionally, EPA establishes BPT effluent limitations based on the average of the best performances of facilities within the industry of various ages, sizes, processes, or other common characteristics. Where existing performance is uniformly inadequate, BPT may reflect higher levels of control than currently in place in an industrial category if the Agency determines that the technology can be practically applied.

Bleach plant - All process equipment used for bleaching beginning with the first application of bleaching agents (e.g., chlorine, chlorine dioxide, ozone, sodium or calcium hypochlorite, or peroxide), each subsequent extraction stage, and each subsequent stage where bleaching agents are applied to the pulp. For mills in Subpart E producing specialty grades of pulp, the bleach plant includes process equipment used for the hydrolysis or extraction stages prior to the first application of bleaching agents. Process equipment used for oxygen delignification prior to the application of bleaching agents is not part of the bleach plant.

Bleach plant effluent - The total discharge of process wastewaters from the bleach plant from each physical bleach line operated at the mill, comprising separate acid and alkaline filtrates or the combination thereof.

Bleached pulp - Pulp that has been purified or whitened by chemical treatment to alter or remove coloring matter and has taken on a higher brightness characteristic.

Bleaching - The process of further delignifying and whitening pulp by chemically treating it to alter the coloring matter and to impart a higher brightness.

Bleaching chemicals - A variety of chemicals used in the bleaching of pulp such as chlorine (Cl_2), sodium hypochlorite (NaOCl), calcium hypochlorite ($Ca(OCl)_2$), chlorine dioxide (ClO_2), peroxide (H_2O_2), oxygen (O_2), ozone (O_3), and others. Also referred to as bleaching chemical.

Congener – A term of chemistry referring to one of many variants or configurations of a common chemical structure. See dioxin and dioxin-like compounds.

Conventional pollutants - The pollutants identified in Section 304(a)(4) of the Clean Water Act and the regulations there under (biochemical oxygen demand (BOD_5), total suspended solids (TSS), oil and grease, fecal coliform, and pH).

Chlorinated Phenolic Compounds - Chlorinated phenolic compounds include phenols, guaiacols, catechols, and vanillins substituted with from one to five chlorine atoms per molecule. Typically, bleaching processes that result in the formation of 2,3,7,8-TCDD and 2,3,7,8-TCDF also generate the higher substituted tri-, tetra-, and penta-chlorinated compounds. EPA established effluent limitations guidelines and pretreatment standards for 12 chlorinated phenolic compounds in 1998.

Cluster Rules - The Cluster Rules apply to mills with operations subject to 40 CFR Part 430 Subpart B, Bleached Papergrade Kraft and Soda, and Subpart E, Papergrade Sulfite. The Cluster Rules regulate toxic and nonconventional pollutants that are characteristic of mills that bleach chemical pulp with chlorine-containing compounds. These pollutants include adsorbable organic halides (AOX), chloroform, TCDD, TCDF, and 12 chlorinated phenolic compounds.

Deinked Pulp - Fiber reclaimed from wastepaper by removing ink, coloring materials, and fillers.

Dioxin and Dioxin-like Compounds - The 17 CDDs and CDFs compounds (called congeners), which include chlorine substitution of hydrogen atoms at the 2, 3, 7, and 8 positions on the benzene rings. The 17 congeners are referred to as 'dioxin-like,' because of the similar chemical structure, similar physical-chemical properties, and invoke a common battery of toxic responses, though the toxicity of the congeners varies greatly. The TRI method of reporting requires that facilities report the total mass of all 17 congeners.

Direct discharger - A facility that discharges or may discharge treated or untreated process wastewaters, noncontact cooling waters, or nonprocess wastewaters (including stormwater runoff) into waters of the United States.

Discharge Monitoring Reports (DMRs) - Compliance reports required by NPDES permits. Facilities with major discharges are required to monitor their discharges and submit monitoring reports to their permitting authority at a frequency specified by the permit.

Effluent Data Statistics (EDS) - An EPA mainframe computer program than calculates facility annual pollutant loads (kg/year) using compliance monitoring data reported in PCS.

Effluent limitation - Any restriction, including schedules of compliance, established by a state or the Administrator on quantities, rates, and concentrations of chemical, physical, biological, and other constituents which are discharged from point sources into navigable waters, the waters of the contiguous zone, or the ocean.

Effluent limitations guidelines and standards (ELGs) - Categorical regulations developed by EPA as required by the Clean Water Act.

Elemental chlorine-free (ECF) - Any process for bleaching pulps in the absence of elemental chlorine and hypochlorite that uses chlorine dioxide as the only chlorine-containing bleaching agent.

Fiber line - A series of operations employed to convert wood or other fibrous raw material into pulp. If the final product is bleached pulp, the fiber line encompasses pulping, de-knotting, brownstock washing, pulp screening, centrifugal cleaning, and multiple bleaching and washing stages.

Final effluent - Pulp or paper mill wastewater discharges to receiving waters including streams, lakes, and other waters of the United States.

Furnish - Raw materials (hardwood or softwood) used to manufacture market pulp, paper, or paperboard.

Indirect discharger - A facility that discharges or may discharge wastewaters into a publicly owned treatment works or a treatment works not owned by the discharging facility.

Integrated mill - A mill that produces pulp and may use none, some, or all of that pulp (often in combination with purchased pulp) to produce paper or paperboard products.

Kraft process - Sulfate chemical pulping process.

Mechanical pulp - Pulp produced by reducing pulpwood logs and chips into their fiber components by the use of mechanical energy (at CMP or CTMP mills, also with the use of chemicals or heat), via grinding stones or refiners.

Minimum level (ML) - The level at which the analytical system gives recognizable signals and an acceptable calibration point. The MLs for pollutants regulated by the Cluster Rules are specified in 40 CFR 430.01(i).

North American Industry Classification System (NAICS) - A system for classifying economic activity developed jointly by the United States, Canada, and Mexico.

National Council of the Paper Industry for Air and Stream Improvement, Inc (NCASI) - An independent, nonprofit research institute that focuses on environmental topics of interest to the forest products industry. NCASI is a source of data on environmental issues affecting this industry, and has more than 75 member companies throughout the United States and Canada.

Nonconventional pollutants - Pollutants that are neither conventional pollutants nor priority pollutants (see 40 CFR Section 401.15 and Part 423, Appendix A).

National Pollutant Discharge Elimination System (NPDES) - The NPDES program is authorized by the Clean Water Act and requires permits for the discharge of pollutants from any point source into waters of the United States.

Outfall - The mouth of conduit drains and other conduits from which a mill effluent discharges into receiving waters.

Paperboard - Thick, heavyweight paper product. Nominally, sheets above 0.3 mm are classed as paperboard. May be referred to simply as "board."

Picograms (pg) - one trillionth (10^{-12}) of a gram. One pg/liter is equivalent to one part per quadrillion (ppq).

Polycyclic Aromatic Compounds (PAC) - Sometimes known as polycyclic aromatic hydrocarbons (PAHs), these are a class of organic compounds consisting of two or more fused aromatic rings.

PCSLoads2002 - A Microsoft Access™ database in which EPA has compiled data taken from PCS, the calculated TWPE, and the relationship between SIC codes and regulatory categories. The data taken from PCS represent wastewater discharged in calendar year 2002.

Permit Compliance System (PCS) - An EPA mainframe database created by EPA to track permit, compliance, and enforcement status of facilities regulated by the NPDES program under the Clean Water Act.

Peroxide - A short name for hydrogen peroxide (H_2O_2) or sodium peroxide (Na_2O_2).

Polychlorinated dibenzo-p-dioxins (CDDs) and polychlorinated dibenzofurans (CDFs) - CDDs and CDFs constitute a group of persistent, bioaccumulative, and toxic chemicals. Facilities are required to report to EPA's TRI the total mass of 17 of these CDDs and CDFs released to the environment every year. The 17 compounds (called congeners) are referred to as 'dioxin-like,' because they have similar chemical structure, similar physical-chemical properties, and invoke a common battery of toxic responses, though the toxicity of the congeners varies greatly.

Pretreatment standard - A regulation addressing industrial wastewater effluent quality required for discharge to a POTW.

Process wastewater - For the effluent guidelines for Subparts B and E of the Pulp, Paper, and Paperboard Point Source Category (40 CFR Part 430), process water is any water that, during manufacturing or processing, comes into direct contact with or results from the production or use of any raw material, intermediate product, finished product, by-product, or waste product. For purposes of Subparts B and E, process wastewater includes boiler blowdown; wastewaters from water treatment and other utility operations; blowdowns from high rate (e.g., greater than 98 percent) recycled noncontact cooling water systems to the extent they are mixed and cotreated with other process wastewaters; wastewater, including leachates, from landfills owned by pulp and paper mills subject to Subparts B or E if the wastewater is commingled with wastewater from the mill's manufacturing or processing facility; and stormwaters from the immediate process areas to the extent they are mixed and cotreated with other process wastewaters. Contaminated ground waters from on-site or off-site ground water remediation projects are not process wastewater.

Process water - Water used to dilute, wash, or carry raw materials, pulp, and any other materials used in the manufacturing process.

Pretreatment Standards for Existing Sources (PSES) - categorical regulations for indirect dischargers designed to prevent the discharge of pollutants that pass through, interfere with, or are otherwise incompatible with the operation of POTWs, including sludge disposal methods at POTWs.

Pulp and Paper Category, Phase I - When EPA revised 40 CFR Part 430 in 1998, it reorganized the category into 12 subcategories and promulgated new ELGs for two subcategories, Subpart B (Bleached Papergrade Kraft and Soda) and Subpart E (Papergrade Sulfite). Subparts B and E became known as Phase I; EPA promulgated revised ELGs for these subparts April 15, 1998 (63 FR 18504).

Pulp and Paper Category, Phase II - EPA planned to promulgate ELGs for the Phase II subcategories (Subparts C and F through L) after promulgating the final rules for the Phase I subcategories.

Pulp and Paper Category, Phase III - The two dissolving pulp subcategories (Subpart A, Dissolving Kraft, and Subpart D, Dissolving Sulfite).

Pulp bleaching - The process of further delignifying and whitening pulp by chemically treating it to alter the coloring matter and to impart a higher brightness.

Secondary fiber - Furnish consisting of recovered material. Secondary fiber includes recycled paper or paperboard known commonly as "post-consumer" recycled material. The term secondary fiber is used both for the raw material (wastepaper, old corrugated containers, etc.) and the pulp produced from the wastepaper and board.

Standard Industrial Classification (SIC) - A system for classifying economic activity developed by the Office of Management and Budget and used by other government agencies, including EPA, to promote data comparability. In the SIC system, each establishment is classified according to its primary economic activity, which is determined by its principal product or group of products. An establishment may have activities in more than one SIC code.

Soda process - A chemical pulping process that consists of the reduction of chips to their individual fiber components by use of cooking liquor made up of caustic soda (NaOH) solution, the recovery and preparation of this liquor, or the treatment of pulp and paper produced from it.

Sulfite process - An acid pulp manufacturing process in which chips are reduced to their component parts by cooking (digesting) in a pressurized vessel using a liquor of calcium, sodium, magnesium or ammonia salts of sulfurous acid.

Totally chlorine-free (TCF) bleaching - Pulp bleaching operations that are performed without the use of chlorine, sodium hypochlorite, calcium hypochlorite, chlorine dioxide, chlorine monoxide, or any other chlorine-containing compound.

Toxicity Equivalents (TEQ) - a calculated value that allows the comparison of toxicity of different combinations of dioxins and dioxin-like compounds. To calculate a TEQ, a toxic equivalent factor (TEF) is assigned to each member of the dioxin and dioxin-like compounds category. The TEF is the ratio of the toxicity of one of the compounds in this category to the toxicity of the most toxic compound in the category 2,3,7,8-tetrachlorodibenzo-p-dioxin, which is assigned a TEF of 1. TEFs that have been established through international agreements currently range from 1 to 0.0001.

Toxics Release Inventory (TRI) - TRI is the common name for Section 313 of the Emergency Planning and Community Right-to-Know Act (EPCRA). Each year, facilities that meet certain thresholds must report their releases and other waste management activities for listed toxic chemicals. That is, facilities must report the quantities of toxic chemicals recycled, collected and combusted for energy recovery, treated for destruction, or disposed of. A separate report must be filed for each chemical that exceeds the reporting threshold. EPA compiles the reported information into a publicly available database known as the Toxics Release Inventory.

Toxic-weighted pound equivalents (TWPE) - Multiplying the pounds of pollutants discharged by chemical-specific toxic weighting factors results in an estimate of toxic-weighted pound equivalents (TWPE).

Toxic weighting factors (TWFs) - Weighting factors that reflect both aquatic life and human health effects and were developed by EPA's Office of Water/Engineering and Analysis Division (EAD) for use in regulatory development.

TRIReleases2002 - A Microsoft Access™ database in which EPA has compiled data taken from TRI, the adjusted releases from POTWs to surface waters, the calculated TWPE, and the relationship between SIC codes and regulatory categories. The data taken from TRI represent facility-reported releases that occurred in calendar year 2002.

TRIReleases2003 - A Microsoft Access™ database similar to *TRIReleases2002*, except that it uses TRI 2003 release data.

Unbleached pulp - Pulp that has not been treated in a bleaching process.

Voluntary Advanced Technology Incentives Program (VATIP) - The program established under 40 CFR Part 430.24(b) (for existing direct dischargers) and 40 CFR Part 430.25(c) (for new direct dischargers) whereby participating mills agree to accept enforceable effluent limitations and conditions in their NPDES permits that are more stringent than the "baseline BAT limitations or NSPS" that would otherwise apply, in exchange for regulatory- and enforcement-related rewards and incentives.

Wastewater - Water carrying waste materials from a facility. It is a mixture of water, and dissolved and suspended pollutants.

1.0 INTRODUCTION

Section 304(b) of the Clean Water Act requires EPA to annually review and, if appropriate, revise its technology-based regulations, called effluent limitations guidelines and standards. These guidelines limit the discharge of pollutants to waters of the United States from various categories of industrial facilities. Section 304(m) supplements the core requirement of section 304(b) by requiring EPA to publish a plan every two years announcing its schedule for performing this annual review and its schedule for rulemaking for any effluent guideline selected for possible revision as a result of that annual review. EPA last published an Effluent Guidelines Program Plan in 2004 (69 FR 53705; September 2, 2004). EPA's Preliminary 2006 Effluent Guidelines Program Plan was published for public comment August 29, 2005 (70 FR 51042).

During its 2005 screening-level analysis of discharges from categories with existing regulations, EPA determined that the Pulp, Paper, and Paperboard Point Source Category ranked higher than any other category in discharges of toxic and nonconventional pollutants[1]. Because of these findings, EPA conducted a more detailed study of this category. The primary purpose of this detailed study is to determine whether EPA should revise the existing categorical effluent limitations guidelines and pretreatment standards (ELGs). To determine if it should revise existing ELGs, EPA investigated the sources of the toxic pollutants discharged from at pulp and paper mills. These toxic pollutants include dioxin and dioxin-like compounds, polycyclic aromatic compounds (PACs), metals, and other pollutants.

A secondary purpose of this detailed study is to determine how the revisions of the categorical ELGs that were promulgated in 1998 have been implemented, their effect on mill discharges, and whether they should be further revised to provide additional control of pollutants originating from bleaching operations.

[1] One mill accounted for more than 99 percent of 2,3,7,8-tetrachlorodibenzo-p-dioxin discharges tallied in EPA's Permit Compliance System (PCS) for this industrial category in 2002. With or without these discharges from this one mill, this category ranks higher than any other category in terms of the estimated combined 2002 toxic discharges from EPA's Toxic Release Inventory (TRI) and PCS databases. See Section 5.2 for more discussion of this mill's discharges.

Additionally, EPA considered whether there are industrial sectors not currently subject to effluent guidelines or pretreatment standards that should be considered potential new subcategories of this category. Although the primary purpose of the detailed study is to determine whether it is be appropriate for EPA to revise the existing effluent guidelines, its decision to conduct a detailed study on this category does not mean that EPA is required to revise its regulations for this category.

1.1 Industry Description

Mills that manufacture pulp, paper, or paperboard are generally classified under three Standard Industrial Classification (SIC) codes that identify their principal product or group of products. The three SIC codes used to identify facilities in the Pulp, Paper, and Paperboard Point Source Category (hereafter the Pulp and Paper Category) are:

- SIC Code 2611 - Pulp Mills: Establishments primarily engaged in manufacturing pulp from wood or from other materials, such as rags, linters, wastepaper, and straw.
- SIC Code 2621 - Paper Mills: Establishments primarily engaged in manufacturing paper from wood pulp and other fiber pulp, and which may also manufacture converted paper products.
- SIC Code 2631 - Paperboard Mills: Establishments primarily engaged in manufacturing paperboard, including paperboard coated on the paperboard machine, from wood pulp and other fiber pulp; and which may also manufacture converted paperboard products.

A mill may have activities in one or more SIC code. For example, integrated mills make pulp from wood or other raw materials (SIC code 2611). They then use this pulp to make paper (SIC code 2621) and/or paperboard (SIC code 2631). Thus, an integrated mill's primary product may be paper, but it also manufactures pulp. The pulp manufacturing operations are likely to be the major source of wastewater pollutants. A non-integrated mill does not make pulp, but purchases pulp to make paper or paperboard.

Table 1-1 lists the three SIC codes assigned to the Pulp and Paper Category and eight SIC codes for facilities that convert paper or paperboard into products such as boxes or bags. EPA is considering including operations of these eight additional SIC codes as potential new subcategories of the Pulp and Paper Category. See Section 4.1 for discussion of these potential new subcategories.

Table 1-1 also lists the North American Industrial Classification System (NAICS) codes that apply to the pulp and paper industry. The U.S. Economic Census reports data by the NAICS code. However, the wastewater discharge information in EPA's TRI and PCS databases is organized by SIC code. For this reason, to compare the number of facilities enumerated by the census to the number of facilities in the EPA databases, EPA converted the NAICS data in Table 1-1 to the equivalent SIC code. Note that SIC codes 2621, 2671, and 2679 do not correlate directly to individual NAICS codes.

As shown in Table 1-1, more facilities are identified as SIC code 2611 (pulp mills) in EPA's TRI and PCS databases than are counted in the census as establishments primarily engaged in manufacturing pulp for the following reasons. For the census, facilities are assigned to an SIC code based on the revenues from products sold. For TRI, facilities identify the SIC codes that are the source of their toxic releases. For PCS, permitting authorities identify the SIC code that is the source of wastewater discharges. Many mills manufacture pulp but use it on site to make paper instead of selling it on the market. Because pulping operations generate more pollutant loads than paper and paperboard manufacturing operations, mills will be identified as SIC code 2611 (pulp mills) in TRI and PCS but as SIC codes 2621 or 2631 (paper and paperboard mills) in the census.

As mentioned earlier, Table 1-1 also lists eight SIC codes used for facilities that convert purchased paper and paperboard into products, such as boxes, bags, and packaging papers. The existing ELGs for the Pulp and Paper Category at 40 CFR 430 do not apply to wastewaters from converting operations. Although some of these facilities report wastewater discharges to TRI, PCS contains no pollutant discharge data for facilities in these eight SIC codes because none of them are considered major dischargers.

Table 1-1. Number of Pulp and Paper Facilities

SIC Code	NAICS Code	Point Source Category	2002 U.S. Economic Census	2002 TRI[a]	2002 PCS[b]	
					Major	Minor
2611	3221-10	Pulp Mills	32	77	96	9
2621	3221-21, 3221-22	Paper Mills	329	151	144	22
2631	3221-30	Paperboard Mills	199	101	52	8
			560	**329**	**292**	**39**
Potential New Subcategories						
2653	3222-11	Corrugated and Solid Fiber Boxes	1,719	16	0	5
2655	3222-14	Fiber Cans, Tubes, Drums, and Similar Products	261	2	0	
2656	3222-15	Sanitary Food Containers, Except Folding	72	4	0	4
2657	3222-12	Folding Paperboard Boxes, Including Sanitary	490	7	0	1
2671	3222-21, 326112	Packaging Paper and Plastics Film, Coated and Laminated	391	49	0	5
2672	3222-22	Coated and Laminated Paper, Not Elsewhere Classified	541	90	0	1
2674	3222-24	Uncoated Paper and Multiwall Bags	123	1	0	
2679	3222-31, 3222-99	Converted Paper and Paperboard Products, Not Elsewhere Classified	869	11	0	3
			4,466	**180**	**0**	**19**

Source: U.S. Economic Census, 2002; *TRIReleases2002*; *PCSLoads2002*.
[a]Releases to any media.
[b]PCS is divided into major and minor dischargers.

1.2 Regulatory Background

Between 1974 and 1986, EPA promulgated ELGs for the Pulp and Paper Category. For these regulations, EPA divided the industry into 25 subcategories, based on the products made and processes used at the mills.

A 1988 legal suit obligated EPA to address discharges of polychlorinated dibenzo-(p)-dioxins and polychlorinated dibenzofurans[2] from 104 bleaching pulp mills, including nine dissolving pulp mills. While meeting that obligation, EPA also reviewed ELGs for the entire Pulp and Paper Category. As part of that review, EPA reorganized the category into 12 subcategories. Although the Pulp and Paper Category regulations apply to all facilities in SIC codes 2611, 2621, and 2631, the 12 subcategories are organized by process used and product produced and do not correspond to SIC codes.

During its response to the 1988 legal suit, EPA decided to review and revise the Pulp and Paper Category regulations in three phases. Table 1-2 presents these three phases and the subcategories EPA planned to address in each phase.

In revising the Pulp and Paper Category regulations, EPA first addressed two subcategories, Subpart B (Bleached Papergrade Kraft and Soda) and Subpart E (Papergrade Sulfite), because these subparts applied to the majority of the 104 mills identified in the 1988 suit[3]. Subparts B and E became known as Phase I; EPA promulgated revised ELGs for these subparts April 15, 1998 (63 FR 18504). EPA promulgated the Phase I ELGs at the same time it promulgated National Emissions Standards for Hazardous Air Pollutants (NESHAPs) for kraft and sulfite pulp mills. Because these water and air regulations were developed, analyzed, and promulgated jointly, they are called the Cluster Rules.

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[2] Polychlorinated dibenzo-p-dioxins (CDDs) and polychlorinated dibenzofurans (CDFs) constitute a group of persistent, bioaccumulative, and toxic chemicals. Facilities are required to report to EPA's TRI the total mass of 17 of these CDDs and CDFs released to the environment every year. In this report, EPA uses the term "dioxin and dioxin-like compounds" to refer to the total mass of the 17 CDDs and CDFs, as reported to TRI.
For discharges from certain mills in the Pulp and Paper Category, EPA promulgated ELGs for two specific dioxins: 2,3,7,8-tetrachlorodibenzo-p-dioxin and 2,3,7,8-tetrachlorodibenzofuran. In this report, these compounds are referred to as TCDD and TCDF, respectively. See Section 3.2 of this report for a discussion of dioxin and dioxin-like compounds.

[3] The remainder of the 104 mills identified in the 1988 suit were in Subpart A, Dissolving Kraft, and Subpart D, Dissolving Sulfite. These two subparts became known as Phase III.

Table 1-2. Relationship Between Pulp and Paper Regulatory Phases and Subcategories

Phase	Subpart	Subcategory
I	B	Bleached Papergrade Kraft and Soda
	E	Papergrade Sulfite
II	C	Unbleached Kraft
	F	Semi-Chemical
	G	Groundwood, Chemi-Mechanical, and Chemi-Thermo-Mechanical
	H	Non-Wood Chemical Pulp
	I	Secondary Fiber Deink
	J	Secondary Fiber Non-Deink
	K	Fine and Lightweight Papers from Purchased Pulp
	L	Tissue, Filter, Non-Woven and Paperboard from Purchased Pulp
III	A	Dissolving Kraft
	D	Dissolving Sulfite

Note: EPA promulgated revised ELGs for Phase I, known as the Cluster Rules on April 15, 1998. EPA has not promulgated revised ELGs for Phase II or Phase III.

Eight subcategories are known as Phase II and are listed in Table 1-2. EPA has not revised the ELGs for these subcategories, which were promulgated between 1974 and 1986.

Phase III affected the two dissolving pulp subcategories (Subpart A, Dissolving Kraft, and Subpart D, Dissolving Sulfite). EPA did not promulgate revised ELGs addressing TCDD and TCDF for Phase III in 1998, because the affected companies were undertaking a multiyear laboratory study and mill trial to develop alternative bleaching technologies. EPA anticipated that final ELGs would be based on different technologies than those that served as the basis for the Phase I regulations. As of August 2006, there were only three operating mills in these two subcategories. As part of its 2004 Effluent Guidelines Program Plan, EPA determined that rather than promulgate revised ELGs for Phase III mills, EPA would support NPDES permit writers individually in developing permit-specific effluent limitations to control TCDD and TCDF releases from these three mills (see 69 FR 53,716; September 2, 2004).

1.3 Detailed Study Scope

Only Phase I and Phase II mills were included in this investigation because, as noted above, EPA previously determined that it would not promulgate revised ELGs for Phase III mills. Because the Cluster Rules apply to Phase I mills, but not to Phase II mills, the regulatory implementation analysis part of this detailed study addresses only Phase I mills.

2.0 DATA SOURCES

This section describes the data sources used for the pulp and paper detailed study as well as potential data quality limitations. Specific data sources used for this investigation include readily available information from EPA's TRI and PCS databases, pulp and paper mill National Pollutant Discharge Elimination System (NPDES) permits and related fact sheets, and information provided by two industry groups, the American Forest and Paper Association (AF&PA) and the National Council for Air and Stream Improvement (NCASI). AF&PA is the national trade association of the forest, pulp, paper, paperboard, and wood products industry. NCASI is a nonprofit research institute funded by North American forest products industry, including pulp and paper companies. Many of the companies that fund NCASI are also members of AF&PA.

2.1 PCS

For its 2005 and 2006 screening-level analyses, EPA used 2002 discharge monitoring data compiled in PCS to evaluate current mill discharges. PCS was created by EPA's Office of Enforcement and Compliance Assurance to track permit, compliance, and enforcement status of facilities regulated by the NPDES program under the Clean Water Act. PCS contains only permit-required monitoring data for direct-discharging facilities. As required by their permits, mills file Discharge Monitoring Reports (DMRs) with the state once a month (or at other specified frequencies). Each mill's NPDES permit specifies the pollutants to monitor and at what frequency. Pulp and paper mills that discharge to a publicly owned treatment works (POTW) or that transfer their wastewater to a private waste treater do not submit DMRs; therefore, their data are not included in PCS. In addition, PCS typically does not include data for mills that states classify as "minor sources."

EPA estimated pollutant mass loadings for mills included in PCS and estimated the toxicity of these discharges using toxic weighting factors (TWFs) to calculate toxic-weighted pound equivalents (TWPE). EPA compiled the estimated PCS discharge loads, TWFs, and related information into a Microsoft Access™ database called *PCSLoads2002*. For additional information about the development of *PCSLoads2002*, see the *Screening-Level Analysis Report*

(U.S. EPA, 2005a) and *Technical Support Document* for the *2006 Effluent Guidelines Program Plan* (U.S. EPA, 2006c).

2.1.1 Utility and Limitations of PCS Data

The data collected in PCS are particularly useful for the pulp and paper detailed study for the following reasons:

- PCS is national in scope, including data from all 50 states and U.S. territories.
- PCS includes data for 74 of 77 Phase I mills and 118 of 175 Phase II mills.
- Discharge reports included in PCS are based on wastewater discharges measured with flow meters and chemical analyses of effluent. Additionally PCS includes information indicating when the monitored pollutants were present in concentrations above the method detection limits.

Limitations of the pulp and paper data collected in PCS include the following:

- Some states do not submit all DMR data to PCS, or do not submit the data in a timely fashion. For example, Washington State receives internal monitoring data from mills and examines the data for compliance, but does not submit the data to PCS. Only final outfall data are submitted.
- PCS does not contain sufficient information to fully identify discharge pipes. EPA could not always identify which discharge pipes carried wastewaters from mill operations as opposed to discharges from landfills, nonprocess area stormwater run-off, or other wastewaters not related to mill operations.

2.2 <u>TRI</u>

EPA used data reported to TRI to estimate the mass of pollutants discharged by industrial point source categories. Using the same methodology used with calculated PCS loads, EPA estimated the toxicity of these discharges using TWFs to calculate TWPE, and compiled the TRI data, TWFs, and related information into Microsoft Access™ databases called *TRIReleases2002* (for chemicals released in 2002) and *TRIReleases2003* (for chemicals released in 2003). For additional information about the development of the *TRIReleases* databases, see the *Screening-Level Analysis Report* (U.S. EPA, 2005a) and the *Technical Support Document for the 2006 Effluent Guidelines Plan* (U.S. EPA, 2006c).

2.2.1 Utility and Limitations of TRI Data

The data collected in TRI are particularly useful as a starting point for the detailed study for the following reasons:

- TRI includes data from all 50 states and U.S. territories;
- TRI includes data for all Phase I mills and 173 Phase II mills;
- TRI includes releases reported by both indirect and direct dischargers; and
- TRI includes releases of many pollutants, not just the pollutants with NPDES permit limits.

Limitations of the data collected in TRI include the following:

- Small establishments (less than 10 employees) are not required to report to TRI. EPA expects that pulp and paper mills in all three regulatory phases meet the facility size reporting threshold.
- TRI requires the reporting of chemical releases only when a facility manufactures, processes, or otherwise uses an amount greater than the TRI reporting threshold (e.g., more than 0.1 grams/year of dioxin and dioxin-like compounds, more than 100 pounds/year of PACs).
- Per TRI guidance, release reports may be based on estimates, not measurements. As a result, facilities may overstate releases because they can be penalized for under-reporting releases.
- Certain chemicals (PACs, dioxin and dioxin-like compounds, metal compounds) are reported as a class, not as individual chemical compounds. Because the individual compounds in the class have widely varying toxic effects, the potential toxicity of chemical releases can be inaccurately estimated.

2.3 NPDES Permits

One of the purposes of this detailed study is to evaluate the extent to which the Cluster Rules have been incorporated into permits issued after 1998. EPA collected permits for all but one currently operating Phase I mill or the POTWs treating their effluents. POTWs receiving wastewater from Phase I mills may include effluent discharge limits that are similar to mill limits. Table 2-1 shows the number of permits collected.

Table 2-1. Phase I Mill NPDES Permits Collected

	Phase I Bleached Papergrade Kraft Mills	Phase I Papergrade Sulfite Mills	POTWs Receiving Phase I Mill Wastewater
Number of Mills			
At promulgation (1998)	84	11	10
Idle or no longer in Phase I, as of 2004	12	5	5
Operational in 2004	72	6[a]	5
Number of Permits Collected			
Industry-provided	48[b]	2[c]	0
EPA-collected	22	2	4[d]
Total collected	70[e]	4[c]	4[d]

[a]Includes one papergrade sulfite mill (Wausau Mosinee Paper in Brokaw WI; NPDES: WI0003379) closed as of November 2005.
[b]Includes two permits that cover two mills: two Parsons & Whittemore mills (Alabama Pine Pulp and Alabama River Pulp) in Claiborne, AL, both bleached papergrade kraft mills, share a single permit; and two Domtar mills (Nekoosa - a bleached papergrade kraft mill and Port Edwards - a papergrade sulfite mill) share a permit. Includes one other permit shared by the Boise Cascade mill and the City of St. Helens POTW. Includes one other indirect mill (SAPPI in Muskegon MI; NPDES: MI0001210) that ceased Phase I operations in August 2005; the facility is now a Phase II mill.
[c]Excludes a permit shared by two Domtar mills (Nekoosa - a bleached papergrade kraft mill and Port Edwards - a papergrade sulfite mill).
[d]Includes one permit shared by the Boise Cascade mill and the City of St. Helens POTW.
[e]EPA identified a total of 70 permits for 72 bleached papergrade kraft mills, because the Alabama Pine Pulp and Alabama River Pulp mills in Claiborne share a single permit and the Boise Cascade mill was identified as a POTW receiving Phase I mill water.

AF&PA and its member companies provided the majority of the permits. EPA contacted state permitting authorities to obtain permits not readily available on the Internet and not provided by AF&PA. As of August, 2006, EPA had requested, but not received, a permit for one POTW, the Bay County Wastewater Treatment Plant in Panama City, Florida.

EPA also collected permits for several operating Phase II mills to investigate how permit writers had established discharge limits and monitoring requirements for metals and nutrients for these mills. EPA obtained permits for 21 of the 173 Phase II mills with discharge data in PCS.

2.4 <u>Information Provided by Industry and Trade Associations</u>

EPA met with representatives from AF&PA and NCASI three times during this detailed study. At these meetings, EPA, AF&PA and NCASI discussed EPA's screening-level review of PCS and TRI discharge data (Eastern Research Group, 2005a), how mills estimated TRI-reported releases of PACs and dioxin and dioxin-like compounds, and EPA's need for additional information, particularly about non-bleaching sources of wastewater pollutants, such as metals and nutrients. In 2005, AF&PA member companies provided EPA with copies of discharge monitoring reports (DMRs) and analytical results documenting errors in PCS-reported data (Schwartz, 2005). In 2006, AF&PA member companies and NCASI provided EPA with additional information about their basis for TRI reporting, NPDES permits and permit application data, and NCASI Technical Bulletins related to metals and nutrient discharges.

2.4.1 Information from Commenters on the 2006 Preliminary ELG Plan

EPA published its Preliminary 2006 Effluent Guidelines Plan on August 29, 2005 (70 FR 51042). The docket supporting the preliminary plan included the *Preliminary Report: Pulp, Paper, and Paperboard Detailed Study* (U.S. EPA, 2005b). Comments EPA received on the preliminary plan and preliminary detailed study report are located in EPA Docket Number OW-2004-0032. Comments from industry stakeholders consisted largely of corrections to the PCS and TRI databases and suggested revisions to report tables and text.

2.4.2 Other Industry-Supplied Data

EPA contacted selected mills based on the metal and dioxin and dioxin-like compound discharges they reported to TRI. If mills indicated that their reported releases were based on monitoring data, EPA asked them to provide any available direct measurement data they had used to estimate their releases. EPA also asked about the source of metals in mill effluents. EPA contacted representatives from 18 mills to discuss their basis for TRI reporting of metal and dioxin and dioxin-like compounds. One additional facility (Graphic Packaging International in Kalamazoo MI) was contacted regarding a large release of potassium dimethyl-dithio-carbamate.

2.5 <u>NPDES Permit Application (Form 2C) Data</u>

When mills file applications for new or revised NPDES permits, they must complete a Form 2C, which requires analyses of certain pollutants. Effluent data requirements vary depending on the types of pollutants the permitting authority expects to be present in a mill's wastewater. Facilities may also provide intake concentration data in their Form 2Cs.

EPA obtained Form 2C data representing effluents from 28 mills, including 18 Phase I mills and 10 Phase II mills. International Paper provided Form 2C data for 22 of its 23 mills, and six other mills in Pennsylvania and South Carolina also provided data. EPA used Form 2C data to evaluate the concentrations of metals and PACs in mill effluent.

2.6 <u>Information from States</u>

EPA found that PCS did not include complete data for Washington State mill discharges for the period 1998 to 2004. As of 2004, six active pulp and paper mills were located in Washington State. Typically, these mills submit discharge data to the Washington Department of Ecology, which imports the data into the state's database, examines them for compliance with permit limits, and transfers the data to PCS. Washington State does not transfer in-plant monitoring data to PCS. At EPA's request for the missing in-plant monitoring data, the Washington Department of Ecology provided TCDD and TCDF bleach plant concentration data for each of its active mills (Lange, 2005b).

The Washington Department of Ecology requires Kimberly-Clark, Everett to submit annual study reports that describe the facility's actions taken to control TCDF in bleach plant effluent. The Washington Department of Ecology provided EPA the 2004 and 2005 study reports (Kurtz, 2004; Kurtz, 2005). EPA also discussed the prevalence of sea-floated logs with Washington Department of Ecology staff because Kimberly-Clark investigations suggested combustion of waste wood from these logs may be a source of their dioxin and dioxin-like compound discharges (Lange, 2006a).

The state of Wisconsin established effluent limits for phosphorus in wastewaters discharged to surface waters. The limits are designed to control anthropogenic eutrophication of Wisconsin lakes and streams. State rules allow industrial facilities and municipalities to apply for alternative effluent limitations. Wisconsin provided EPA with requests for alternative phosphorus limits submitted by eight Wisconsin pulp and paper mills (Lange, 2006b).

2.7 Technical Literature Review

EPA searched technical literature for information concerning discharges of metals, nutrients, TCDD, and TCDF from pulp and paper mills and technologies or practices used to control those discharges. For this search, EPA used the database of abstracts and reference citations maintained by the Dialog Corporation for peer-reviewed articles published after 1989.

EPA developed a comprehensive list of key words including industry synonyms, pollutants of interest, and pollutant removal terms. The Agency collected approximately 10 articles for each of the five questions below:

- What technologies or practices do pulp and paper mills use to control metals discharges?
- What are the chemical forms of nitrogen and phosphorus discharged by pulp and paper mills?
- What are the nitrogen and phosphorus discharges from pulp and paper mills, and what kind of environmental impacts have they had?
- Even though TCDD and TCDF are not detected in mill effluents, are they still bioaccumulating in organisms exposed to effluent? What kind of environmental impacts have they had?
- How have mills changed production process to comply with the Cluster Rules? Can process improvements or additional pollution prevention programs implemented since promulgation be identified?

2.8 Dioxin Fish Consumption Advisory Data Sources

For its review of dioxin fish consumption advisories, EPA used information from EPA's *National Listing of Fish and Wildlife Advisories: Advisory Report Query* web site, fish advisory web pages on state departments of health, state departments of environmental protection web sites, reports and scientific publications on dioxin, fish advisories, and watershed planning. EPA also consulted staff at state departments of health and state departments of environmental protection.

3.0 PULP AND PAPER CATEGORY WASTEWATER POLLUTANTS

As discussed in Sections 2.1 and 2.2, EPA used its *TRIReleases2002*, *TRIReleases2003*, and *PCSLoads2002* databases to conduct a screening-level analysis of industry discharge data in 2005 and 2006 (U.S. EPA, 2005a; U.S. EPA, 2006c). As it began the 2005 screening-level analysis, EPA found that the toxic and nonconventional pollutant loadings for the Pulp and Paper Category were driven by three groups of pollutants: dioxin and dioxin-like compounds, polycyclic aromatic compounds (PACs), and metals. After discussing the terminology used to describe concentrations below chemical analysis detection limits, this section provides background on these three pollutant groups,

3.1 Chemical Analysis Detection Limits

Laboratories use a combination of chemical and physical techniques to identify specific chemicals in wastewater and to quantify how much of the chemical is present. For each analyte or chemical, laboratories use a standard analytical method to make these determinations. Laboratories express the result of the analysis either numerically or as "not detected" or "not quantitated." When the result is expressed numerically, then the pollutant was detected and quantitated in the sample. For example, for a hypothetical pollutant X, the result would be reported as "15 µg/L" when the laboratory quantitated the amount of pollutant X in the sample as being 15 µg/L.

For the nonquantitated results for each sample, the laboratories report a "sample-specific quantitation limit," though some laboratories use the term "sample-specific detection limit." For example, for the hypothetical pollutant X, the laboratory would report the result as "<10 µg/L" when it could not quantitate the amount of pollutant X in the sample. That is, the analytical result indicated a value less than the sample-specific quantitation limit of 10 µg/L, meaning the actual amount of pollutant X in that sample is between zero (i.e., the pollutant is not present) and 10 µg/L. The sample-specific quantitation limit for a particular pollutant is generally the smallest quantity in the calibration range that can be measured reliably in an individual sample. If a pollutant is reported as not quantitated (or not detected), it does not mean that the pollutant is not present in the wastewater sample, merely that analytical techniques (whether because of instrument limitations, pollutant interactions, or other reasons) could not measure the pollutant at levels below the sample-specific quantitation limit.

In common parlance, a detection limit is the lowest concentration of an analyte that can reliably distinguished from a zero concentration. Many terms have been used to express the "detection limit" concept, some of which are:

- *Quantitation Limit* – concentration at which an analyte can be quantified rather than simply identified (detected).
- *Instrument Detection Limit* – the smallest signal above background noise that an instrument can detect reliably. This concept is used for certain metals analysis methods that use atomic emission or atomic absorption spectroscopy. This limit is laboratory- and time-specific.
- *Method Detection Limit* – a measure of method sensitivity, defined at 40 CFR Part 136 Appendix B as "the minimum concentration of a substance that can be reported with 99 percent confidence that the analyte concentration is greater than zero." MDLs can be operator-, method-, laboratory-, and matrix-specific.
- *Practical Quantitation Level* – a term used in EPA's drinking water program, defined as "the lowest concentration of an analyte that can be reliably measured within specified limits of precision and accuracy during routine laboratory operating conditions."
- *Minimum Level* – a term defined in recently promulgated analytical methods as the lowest concentration at which the entire analytical system can give a recognizable signal and acceptable calibration point for the analyte.

Three groups of pollutants drive the Pulp and Paper Category toxic and nonconventional pollutant loadings: dioxin and dioxin-like compounds, PACs, and metals. EPA has defined a minimum level (ML) for most of the analytical methods used to quantitate these pollutants. When an ML is published in a method, EPA has demonstrated that at least one well-operated laboratory can achieve the ML. Further, any laboratory using that method is required to demonstrate, through calibration of the analytical instrument or analytical system, that it can make measurements at the ML. Additional information about the analytical methods used for pollutants of concern in this study, and their MLs, is provided in the remainder of this section.

As discussed in Section 2.0, EPA used chemical concentration data from a variety of sources in this study. In some cases, the analytical method used to determine the concentrations was reported with the data. In those cases, results that were "not detected" are referred to as "less than the method ML." In other cases where the analytical method was not reported with the data, results that were "not detected" are presented as reported: "< the reported sample-specific quantitation limit, "not detected," or "0."

3.2 Dioxin and Dioxin-Like Compounds

As discussed in EPA's *Guidance for Reporting Toxic Chemicals within the Dioxin and Dioxin-like Compounds Category* (U.S. EPA, 2000c), the term 'dioxin and dioxin-like compounds' refers to polychlorinated dibenzo-p-dioxins (CDDs) and polychlorinated dibenzofurans (CDFs). The most toxic of this family of compounds is 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD), which is often referred to as 'dioxin.' However, there are 16 other CDDs and CDFs compounds (called congeners) that, like TCDD, include chlorine substitution of hydrogen atoms at the 2, 3, 7, and 8 positions on the benzene rings. The 17 compounds (TCDD and the 16 other congeners) are referred to as 'dioxin-like,' because they have similar chemical structure, similar physical-chemical properties, and invoke a common battery of toxic responses. However, the toxicity of individual congeners varies greatly. In this report, EPA uses the term "dioxin and dioxin-like compounds" to refer to all 17 of the 2,3,7,8-substituted CDDs and CDFs, as reported to TRI.

Table 3-1 lists these 17 compounds, their chemical name, common abbreviated name, the EPA Method 1613B minimum level, World Health Organization (WHO) toxic equivalent factor, and EPA's toxic weighting factor (TWF) for each compound.

Table 3-1. Dioxin and Dioxin-like Compounds: Minimum Levels, Toxic Equivalency Factors, and TWFs

CAS Number	Chemical Name	Abbreviated Name	1613BML pg/L	Toxic Equivalency Factor[a]	TWF[b]
Polychlorinated dibenzo-p-dioxins (CDDs)					
1746-01-6	2,3,7,8-tetrachlorodibenzo-p-dioxin	2,3,7,8-TCDD	10	1	703,584,000
40321-76-4	1,2,3,7,8-pentachlorodibenzo-p-dioxin	1,2,3,7,8-PeCDD	50	1	692,928,000
39227-28-6	1,2,3,4,7,8-hexachlorodibenzo-p-dioxin	1,2,3,4,7,8-HxCDD	50	0.1	23,498,240
57653-85-7	1,2,3,6,7,8-hexachlorodibenzo-p-dioxin	1,2,3,6,7,8-HxCDD	50	0.1	9,556,480
19408-74-3	1,2,3,7,8,9-hexachlorodibenzo-p-dioxin	1,2,3,7,8,9-HxCDD	50	0.1	10,595,840
35822-46-9	1,2,3,4,6,7,8-heptachlorodibenzo-p-dioxin	1,2,3,4,6,7,8-HpCDD	50	0.01	411,136
3268-87-9	1,2,3,4,6,7,8,9-octachlorodibenzo-p-dioxin	1,2,3,4,6,7,8,9-OCDD	100	0.0001	6,586
Polychlorinated Dibenzofurans (CDFs)					
51207-31-9	2,3,7,8-tetrachlorodibenzofuran	2,3,7,8-TCDF	10	0.1	43,819,554
57117-41-6	1,2,3,7,8-pentachlorodibenzofuran	1,2,3,7,8-PeCDF	50	0.05	7,632,640
57117-31-4	2,3,4,7,8-pentachlorodibenzofuran	2,3,4,7,8-PeCDF	50	0.5	557,312,000
70648-26-9	1,2,3,4,7,8-hexachlorodibenzofuran	1,2,3,4,7,8-HxCDF	50	0.1	5,760,000
57117-44-9	1,2,3,6,7,8-hexachlorodibenzofuran	1,2,3,6,7,8-HxCDF	50	0.1	14,109,440
72918-21-9	1,2,3,7,8,9-hexachlorodibenzofuran	1,2,3,7,8,9-HxCDF	50	0.1	47,308,800
60851-34-5	2,3,4,6,7,8-hexachlorodibenzofuran	2,3,4,6,7,8-HxCDF	50	0.1	51,204,160
67562-39-4	1,2,3,4,6,7,8-heptachlorodibenzofuran	1,2,3,4,6,7,8-HpCDF	50	0.01	85,760
55673-89-7	1,2,3,4,7,8,9-heptachlorodibenzofuran	1,2,3,4,7,8,9-HpCDF	50	0.01	3,033,984
39001-02-0	1,2,3,4,6,7,8,9-octachlorodibenzofuran	1,2,3,4,6,7,8,9-OCDF	100	0.0001	2,021

[a]Toxic Equivalency Factors are from van Leeuwen, 1997.
[b]TWFs are from *2005 Screening-Level Analysis Report* (U.S. EPA, 2005a).

3.2.1 Method 1613B Minimum Levels

EPA's promulgated method for water and wastewater analysis of dioxin and dioxin-like compounds is Method 1613B. This method establishes the minimum concentration at which these compounds can be reliably quantified. Table 3-1 lists the Method 1613B MLs for TCDD and the 16 dioxin-like compounds. Analytical laboratories may use internal standards to quantify concentrations below the lowest acceptable calibration point and thus report detected concentrations that are below the method ML. The accuracy of concentrations measured below the Method 1613B ML is less certain than concentrations measured at or above the method ML. EPA does not typically establish numerical discharge limits for concentrations less than the method ML.

3.2.2 Toxic Equivalency Factors

Toxic equivalency factors (TEFs) are used to simplify risk assessment and regulatory control of exposures to dioxin and dioxin-like compounds and still account for the relative toxicities of the 17 compounds. As defined by van Leeuwen (Van Leeuwen, 1997), a TEF is a relative potency value that is based on the results of several *in vivo* and *in vitro* studies. TEFs are order-of-magnitude estimates of the toxicity of a compound relative to 2,3,7,8-TCDD. TEFs along with the measured concentration of dioxin congeners are used to calculate toxic equivalent (TEQ) concentrations. EPA used WHO TEFs to calculate the grams TEQ. Table 3-1 lists the TEFs for the 17 dioxin and dioxin-like compounds.

3.2.3 TRI Reporting Requirements

TRI requires that facilities report releases if they manufacture, process, or otherwise use more than 0.1 grams/year of dioxin and dioxin-like compounds. Mills report the mass discharged to surface waters (for facilities discharging directly to a receiving stream) or transferred to a POTW (for indirect dischargers). They are not, however, required to report releases less than 0.0001 gram/year (100 micrograms/year).

Unlike NPDES permit compliance monitoring, TRI does not require facilities to measure waste stream pollutant concentrations. Instead, facilities may use emission factors, mass balances, or other engineering calculations to estimate releases. In addition to reporting the amount of dioxin and dioxin-like compounds released, facilities are required to report to TRI the method used to estimate their releases.

Facilities (including pulp and paper mills) are required to report to TRI the total mass of the 17 dioxin and dioxin-like compounds released to the environment every year. The TRI method of reporting the total mass of all congeners does not account for the relative toxicities of the 17 compounds. However, reporting facilities can report a facility-specific congener distribution. For the 2005 screening-level analysis (U.S. EPA, 2005a), EPA estimated the amount of each dioxin and dioxin-like compound present in a mill's discharge using the TRI-reported congener distribution. EPA then multiplied the estimated mass of each congener in the mill's discharge by the congener's TWF. If a mill did not report a congener distribution, EPA used an industry-average distribution to calculate the mass of each congener released. For the Pulp and Paper Category, because the congener distribution is more related to the bleaching process than to the product, EPA calculated the average dioxin and dioxin-like compounds distribution separately for Phases I, II, and III.

For the 2006 review, EPA revised the methodology used to estimate the TWPE of reported releases of dioxin and dioxin-like compounds. EPA did not use the dioxin congener distribution pulp and paper mills reported to TRI. Instead, EPA used the actual distribution of wastewater effluent measurement data provided by individual mills. If such data were not available, EPA used the dioxin congener distribution of the mill discharges used to develop the NCASI *SARA Handbook* emission factor. See Memorandum: Calculation of a Category-Specific Toxic Weighting Factor for "Dioxin and Dioxin-Like Compounds" Reported Released to EPA's Toxics Release Inventory (TRI) by Pulp, Paperboard and Paper Mills (Matuszko, 2006) for more details.

3.2.4 Effluent Guidelines Monitoring Requirements

In 1998, EPA established ELGs for two dioxin compounds, TCDD and TCDF, for two subcategories of the Pulp and Paper Category. The 1998 regulations require mills to demonstrate compliance with TCDD and TCDF limits where wastewater leaves the bleach plant. EPA refers to these in-process limits as "bleach plant effluent limits." For more detail on bleach plant monitoring requirements, see Section 5.2.2.

3.3 Polycyclic Aromatic Compounds (PACs)

PACs, sometimes known as polycyclic aromatic hydrocarbons (PAHs), are a class of organic compounds consisting of three or more fused aromatic rings. Table 3-2 lists the 21 individual compounds in the PAC category for TRI reporting, Chemical Abstract Service (CAS) number, analytical method detection limit, and EPA TWF. At the time of the 2005 screening-level analysis, EPA had developed TWFs for only 8 of the 21 PACs (ERG, 2005c). These TWFs are listed in the column "TWF (12/04)" in Table 3-2. In response to comments on these TWFs and review of other available data, EPA developed TWFs for two additional PACs and revised the TWFs for two others (U.S. EPA, 2006b). EPA used the April 2006 TWFs in its 2006 annual review.

Most of the 21 PACs are products of incomplete combustion. Twelve of the 21 PACs are reported to be found in fossil fuels. PACs and closely related compounds are major constituents of creosote, a commonly used wood preservative (U.S. EPA, 2001).

For TRI, facilities must report the combined mass of PACs released; they do not report releases of individual compounds. In the preliminary screening-level review of the 2002 TRI database, EPA assumed that all of the PACs reported released by pulp and paper mills were benzo(a)pyrene. Because benzo(a)pyrene has the highest TWF (100.66) of the PACs, this was a "worst case" assumption.

Table 3-2. Definition of PACs

PAC Compound	CAS Number	Method Detection Limit (μg/L)	Toxic Weighting Factor (12/04)[a]	Toxic Weighting Factor (4/06)[b]
Benzo(a)anthracene	56-55-3	0.13[c]	36.26	30.695
Benzo(a)phenanthrene (chrysene)	218-01-9	0.15[c]	31.01	31.01
Benzo(a)pyrene	50-32-8	10[d], 0.023[c]	100.66	100.66
Benzo(b)fluoranthene	205-99-2	10[d], 0.018[c]	30.66	30.66
Benzo(j)fluoranthene	205-82-3			
Benzo(k)fluoranthene	207-08-9	10[d], 0.017[c]	30.66	30.66
Benzo(j,k)fluorene (fluoranthene)	206-44-0	0.21[c]	0.829	1.2847
Benzo(r,s,t)pentaphene	189-55-9			
Dibenz(a,h)acridine	226-36-8			
Dibenz(a,j)acridine	224-42-0			
Dibenzo(a,h)anthracene	53-70-3	20[c], 0.030[c]	30.66	30.772
Dibenzo(a,e)fluoranthene	5385-75-1			
Dibenzo(a,e)pyrene	192-65-4			
Dibenzo(a,h)pyrene	189-64-0			
Dibenzo(a,l)pyrene	191-30-0			
7H-Dibenzo(e,g)carbazole	194-59-2			0.0303
7,12-Dimethylbenz(a)anthracene	57-97-6			
Indeno(1,2,3-cd)pyrene	193-39-5	20[c], 0.043[c]	30.66	30.66
3-Methylcholanthrene	56-49-5			
5-Methylchrysene	3697-24-3			
1-Nitropyrene	5522-43-0			0.026

[a]December 2004 TWF (ERG, 2005c) used for 2005 screening-level analysis.
[b]April 2006 TWF (U.S. EPA, 2006b) used for 2006 screening-level analysis.
[c]EPA Method 610 (High Performance Liquid Chromatography), Table 1.
[d]EPA Method 1625B, Table 3.

As discussed in Section 3.4.3 of the *2005 Screening-Level Analysis Report* (U.S. EPA, 2005a), after its preliminary analysis, EPA used a different approach to estimate the TWF of PACs discharged from the Pulp and Paper Category. NCASI's TRI-reporting guidance includes a table listing the concentrations of PAC compounds found in wastewaters for several types of pulping (kraft, bisulfite, chemi-thermo-mechanical, thermo-mechanical) (Wiegand, 2005b). This table is reproduced as Table 3-3 in this report. EPA used the data from Table 3-3 to calculate a category-specific TWF for PACs discharged by pulp and paper mills. Because there are few bisulfite, chemi-thermo- mechanical pulp, and thermo-mechanical pulp mills compared to the number of kraft mills, EPA used the kraft mill concentrations to calculate the category PAC TWF.

Table 3-3. PAC Concentrations in Pulp Mill Effluents[a]

Pulping Type	N[b]	PAC ->	1	2	3	4	5	6	Total[c]
		Concentration (ppb or μg/L)							
		MDL	0.05	0.05	0.05	0.1	0.05	0.1	
Kraft	2	Range					ND to Tr		
		Average	ND	ND	ND	ND	0.038	ND	0.213
Bisulfite	4	Range	ND to 0.07				ND to 1.6		
		Average	0.036	ND	ND	ND	0.419	ND	0.605
Chemical Thermo-mechanical Pulp	4	Range					ND to 0.055		
		Average	ND	ND	ND	ND	0.033	ND	0.208
Thermo-mechanical Pulp	2	Range		ND to 0.13	ND to 0.65		ND to 0.42	ND to 0.1	
		Average	ND	0.078	0.338	ND	0.223	0.075	0.789
Fine Paper[d]	1	Range	ND	ND	ND	ND	ND	ND	
		Average							ND (0.40)

Source: H.C. Larellee, Inc., 1990 (Wiegand, 2005b).
[a]Only for mills that use chemicals containing trace quantities of PACs; PACs are not manufactured during pulping or bleaching (Young et al., 1990).
[b]Number of mills tested.
[c]Compounds reported as less than the detection limit have been included in the total at one-half the detection limit.
[d]Non-integrated mill.
MDL - Method Detection Limit.
Tr - Trace (assumed equal to MDL).
ND - Not detected.
PACs in the Table:
1 - Benzo(a)anthracene.
2 - Benzo(a)pyrene.
3 - Benzo(b+k)fluoranthene.
4 - Dibenzo(a,h)anthracene.
5 - Fluoranthene.
6 - Indeno(1,2,3-c,d)pyrene.

NCASI calculated the wastewater emission factors for the industry based on six PACs: benzo(a)anthracene, benzo(a)pyrene, benzo(b+k) fluoranthene, dibenzo(a,h)anthracene, fluoranthene, and indeno(1,2,3-c,d)pyrene. For the kraft mills, only fluoranthene was detected above the laboratory detection limit; however, four of the other five compounds were detected in effluents from other pulping types. NCASI calculated the emission factor using one-half the detection limit for compounds that were not detected in kraft mill effluent.

3.4 Metals

Metals are chemical elements that form cations (positive ions) by losing electrons. Most metals are chemically reactive and will form metal oxides when exposed to oxygen and many other compounds in combination with other non-metals. Metals may be present in wastewater in dissolved form and in suspended particulate matter. Depending on pH, dissolved metals are typically present in their ionized form (e.g., Ag^+, silver ion).

3.4.1 Chemical Analysis and Minimum Levels for Metals

Wastewater samples may be analyzed for metals in the following forms:

- *Dissolved metals* - constituents of an unacidified sample that pass through a 0.45-µm membrane filter.
- *Suspended metals* - constituents of an unacidified sample retained on a 0.45-µm membrane filter.
- *Total metals* – the concentration of metals determined on an unfiltered sample after vigorous acid digestion. Includes all metals, inorganically and organically bound, both dissolved and particulate.

There are multiple approved analytical methods for measuring metal concentrations in wastewater. These methods establish both the equipment and techniques for measuring the metal as well as the minimum concentration at which the target analytes can be reliably quantified.

In the effluent guidelines program, EPA typically analyzes wastewater for total metals concentration, using Method 245.1 for mercury, Method 1636 for hexavalent chromium, and Method 200.7 for other metals. Table 3-4 lists metals found in pulp and paper mill wastewater, the analytical method number, ML, and toxic weighting factor.

Table 3-4. Analytical Method Minimum Levels for Metals Found in Pulp and Paper Mill Effluents (μg/L Total Metals)

Metal	Method	Minimum Level (μg/L)	TWF
Aluminum	200.7	50	0.0647
Arsenic	200.7	20	4.04
Barium	200.7	2	0.00199
Cadmium	200.7	2	23.1
Chromium, Total	200.7	10	0.0757
Cobalt	200.7	5	0.114
Copper	200.7	10	0.635
Lead	200.7	20	2.24
Manganese	200.7	2	0.0704
Mercury	245.1	0.2[a]	117
Nickel	200.7	20	0.109
Vanadium	200.7	10	0.035
Zinc	200.7	5	0.0469

[a]Lower limit of the measurement range.

Some metals may exist in more than one oxidation state. Chromium, for example, can exist in water in the trivalent and hexavalent state. Hexavalent chromium, which is quite soluble and used in electroplating solutions, is much more toxic that trivalent chromium.

3.4.2 TRI Reporting Requirements for Metals

TRI requires that facilities report releases of specified metals and metal compounds. These chemicals are listed in Table 3-5. Facilities are not required to report releases of aluminum or aluminum compounds to TRI.

Table 3-5. TRI Chemicals Identified as Metals and Metal Compounds

Pollutant	CAS Number	TRI Chemical Category Code
Antimony	7440360	-
Antimony compounds	-	N010
Arsenic	7440382	-
Arsenic compounds	-	N020
Barium	7440393	
Barium compounds	-	N040
Beryllium	7440417	-
Beryllium compounds	-	N050
Cadmium	7440439	-
Cadmium compounds	-	N078
Chromium	7440473	-
Chromium compounds	-	N090
Cobalt	7440484	-
Cobalt compounds	-	N096
Copper	7440508	-
Copper compounds	-	N100
Lead	7439921	-
Lead compounds	-	N420
Manganese	7439965	-
Manganese compounds	-	N450
Mercury	7439976	-
Mercury compounds	-	N458
Nickel	7440020	-
Nickel compounds	-	N495
Selenium	7782492	-
Selenium compounds	-	N725
Silver	7440224	-
Silver compounds	-	N740
Thallium	7440280	-
Thallium compounds	-	N760
Vanadium	7440622	-
Vanadium compounds	-	N770
Zinc	7440666	-
Zinc compounds	-	N982

When reporting releases of metal compounds, facilities do not identify the individual compounds present. Further, facilities report the releases as pounds of metal. For example, if a facility releases 5 pounds of lead oxide, it would report to TRI that it released 4.6 pounds of “lead compounds, as lead,” calculated as follows:

5 lbs of PbO × (207.2; mol. wt. Pb/223.2; mol. wt. PbO) = 4.6 lbs Pb

To calculate TWPEs for metal compounds, EPA used the TWF for the parent metal. For further analysis of category discharges, EPA then combined the discharges of the metal and metal compounds. For example, if a facility reported discharging 10 pounds of lead and 4.6 pounds of lead compounds, EPA analyzed the facility’s discharges as 14.6 pounds of “lead and lead compounds.”

3.4.3 Metals Data Reported to PCS

ELGs for the Pulp and Paper Category include guidelines for zinc discharges from one Phase II subcategory (Groundwood, Chemi-Mechanical, Chemi-Thermo-Mechanical). Mills that use zinc hydrosulfite as a bleaching agent are subject to these regulations. Most mills certify to their permitting authority that they do not use zinc hydrosulfite, and consequently are not required to have permit limits for zinc.

EPA has established national ambient water quality criteria for several metals to protect freshwater and saltwater organisms from acute and chronic toxicity. National criteria are used by states along with a state’s designated beneficial use of a water body, to formulate enforceable water quality standards for receiving waters. Thus, even though there are no ELGs for metals for the Pulp and Paper Category (with the exception of zinc regulations described above), some mill NPDES permits have metals limits to ensure the mill discharge does not violate water quality standards in the receiving stream. States may have water quality standards for both hexavalent and total chromium, so some mills may be required to analyze their wastewaters for both of these metal species.

4.0 SCREENING-LEVEL REVIEW RESULTS

EPA used its *TRIReleases2002* and *PCSLoads2002* databases to conduct screening-level analysis of industry discharge data in 2005. The results of this analysis were presented in Section 3.0 of the *Preliminary Detailed Study Report* (U.S. EPA, 2005b). In 2006, EPA revised the databases it used in 2005 and also created *TRIReleases2003.* These revisions included updates to TWFs and a change in the methodology EPA used to estimate the TWPE of dioxin and dioxin-like compound discharges the pulp and paper industry reported to TRI. The Agency used the revised databases for its 2006 screening-level analysis.

This section presents the results of the 2006 screening-level analysis of the Pulp and Paper Category, and explains why the remainder of this report focuses on dioxin and dioxin-like compounds, PACs, metals, and nutrients.

4.1 Potential New Subcategories

To conduct its screening-level analyses using data from TRI and PCS, EPA developed a crosswalk between SIC codes and existing point source categories. The crosswalk identifies SIC codes that EPA associated with the applicability of an existing guideline as well as SIC codes not associated with the applicability of any existing guideline. EPA reviewed information about facilities with discharge data in TRI and/or PCS that have SIC codes and are not clearly subject to existing ELGs to determine if, because of similarity of products produced, production operations, and wastewater characteristics, the industrial sectors represented by these SIC codes should be considered as potential new subcategories of categories subject to existing ELGs.

As a result of this review, EPA identified eight SIC codes, listed in Table 4-1, that identify facilities that convert paper or paperboard into products such as boxes or bags. EPA is considering including operations of these eight SIC codes as potential new subcategories of the Pulp and Paper Category. Some of the facilities in these SIC codes report wastewater discharges to TRI; however, PCS contains no pollutant discharge data for facilities in these eight SIC codes because none of them are considered major dischargers. As shown in Table 4-1, the TWPE discharged by facilities in these eight SIC codes that report to TRI are insignificant, less than 0.1

percent of the total Pulp and Paper Category TWPE. For this reason, EPA did not include the facilities in these potential new subcategories in its detailed study of the Pulp and Paper Category. Pollutant discharge information from facilities in these eight SIC Codes is not included in any of the other analyses presented in this report.

Table 4-1. TRI-Reported Discharges by Facilities in SIC Codes that are Potential New Subcategories of the Pulp and Paper Category

SIC Code	Point Source Category	2002 TRI No. of Mills[a]	2002 TRI TWPE[b]	2003TRI No. of Mills[a]	2003 TRI TWPE[b]
2653	Corrugated and Solid Fiber Boxes	16	25	16	25
2655	Fiber Cans, Tubes, Drums, and Similar Products	2	447	2	791
2656	Sanitary Food Containers, Except Folding	4	0.081	4	0.236
2657	Folding Paperboard Boxes, Including Sanitary	7	0.181	6	0.004
2671	Packaging Paper and Plastics Film, Coated and Laminated	49	0.001	46	0.001
2672	Coated and Laminated Paper, Not Elsewhere Classified	90	91	90	37
2674	Uncoated Paper and Multiwall Bags	1	0.002	3	0.004
2679	Converted Paper and Paperboard Products, Not Elsewhere Classified	11	0.003	13	12
Total from potential new subcategories (percentage of total TWPE for existing subcategories)			**563 (0.03%)**		**865 (0.03%)**

[a]Number of mills reporting transfers to POTWs or releases to surface water.
[b]TWPE accounting for POTW removal of releases transferred to POTWs.

4.2 *PCSLoads2002* Results

Table 4-2 lists the 10 pollutants with the highest TWPE of PCS-reported discharges for 2002, in order of descending TWPE. The data presented in Table 4-2 are from *PCSLoads2002_v4* and thus reflect EPA's April 2006 TWFs and database corrections made after the 2005 annual review[4]. The largest contributor to the category total TWPE is TCDD. The table also shows the number of mills that reported discharges to PCS and, for each pollutant, the TWF, the number of mills that reported discharges, the total pounds discharged to surface waters, and the total category TWPE. The two subcategories of Phase I, Bleached Papergrade Kraft and Soda (BPK) and Papergrade Sulfite (PS), are presented separately. Table 4-2 does not include pollutants for which EPA has not developed TWFs, such as five-day biochemical oxygen demand (BOD_5), total suspended solids, color, and adsorbable organic halides (AOX). The 1998 Cluster Rules established ELGs for AOX, a bulk parameter that measures the total mass of chlorinated organic compounds. EPA has not developed a TWF for AOX because it represents a group of diverse chemicals, not a single compound.

The final effluent discharge from one mill (Bowater, Catawba, SC) is responsible for all of the pulp and paper TCDD discharge. Based on data in PCS, EPA estimated that this mill discharged 0.88 grams of TCDD in 2002, which equates to 1.37 million TWPE, or 89 percent of the Pulp and Paper Category's 1.53 million TWPE. As discussed in Section 5.2.2, this mill changed its bleaching chemistry in August 2003 and reports that, since that date, neither TCDD nor TCDF has been measured in mill wastewaters above the Method 1613B ML. As presented in Table 5-2, data from PCS confirm that TCDD was not detected in mill final effluent above the Method 1613B ML after 2002. The mill is enrolled in Tier 1 of EPA's Voluntary Advanced Technology Incentives Program (VATIP) and as such was provided with a six-year schedule for compliance with Cluster Rules requirements. After 2002, the Bowater Catawba mill converted to 100 percent chlorine dioxide bleaching and started up an advanced fiber line. See Section 5.2.3 for a more detailed description of Bowater, Catawba SC mill operations.

[4]The data in Table 4-2 reflect final effluent discharges of TCDD and TCDF. Bleach plant effluent TCDD and TCDF monitoring data are discussed in Section 5.2.2 of this report.

Table 4-2. Top 10 Pollutants in *PCSLoads2002*, Final Effluent Discharges by Pulp and Paper Regulatory Phase

Number of PCS-Reporting Facilities		Phase I				Phase II		Total Category (Phase I and II)	
		BPK (74 mills)		PS (4 mills)		174 Mills		257 mills	
Pollutants	**TWF**	**Mills[a]**	**Discharged (lbs)**	**Mills[a]**	**Discharged (lbs)**	**Mills[a]**	**Discharged (lbs)**	**Discharged (lbs)**	**TWPE**
TCDD	703,584,000	1	0.002	NR	NR	NR	NR	0.002	1,366,677
Aluminum	0.0647	5	930,103	2	15,640	22	479,564	1,425,308	92,205
Chlorine[b]	0.509	6	6,004	NR	NR	19	41,101	47,105	23,984
Sulfide	2.80	1	2,442	NR	NR	NR	NR	2,442	6,841
Mercury	117	8	18	NR	NR	7	40	58	6,838
Copper	0.635	5	1,971	3	2,834	36	3,852	8,657	5,496
Total Kjeldahl Nitrogen (As N)	0.00228	4	684,409	2	350,830	15	952,039	1,987,278	4,531
Arsenic	4.04	2	321	NR	NR	4	771	1,091	4,410
TCDF	43,819,554	2	0.0001	NR	NR	NR	NR	0.0001	4,395
Cadmium	23.1	1	16	1	38	3	100	154	3,555
Total, all pollutants								**3.98×10^9**	**1,537,036**

Source: *PCSLoads2002_v4*.
[a]Number of mills monitoring the discharge of the parameter. Includes mills that never detected the parameter.
[b]Total Residual Chlorine.
BPK - Bleached Papergrade Kraft.
PS - Papergrade Sulfite.
NR - No mills reported discharging this parameter.

Table 4-3 shows the total *PCSLoads2002* TWPE for Phase I and Phase II. Mills with operations in the Bleached Papergrade Kraft and Soda Subcategory are responsible for the majority (95.3 percent) of the category TWPE. EPA recalculated the TWPE excluding the TCDD discharges from the Bowater Catawba mill. With this data exclusion, mills with operations in the Bleached Papergrade Kraft and Soda Subcategory are responsible for 53 percent of the category TWPE.

4.3 *TRIReleases2002* Results

Table 4-4 lists the 10 pollutants with the highest TWPE of TRI-reported discharges for 2002, in order of descending TWPE. The data presented in Table 4-4 are from *TRIReleases2002_v4*. Table 4-4 thus reflects EPA's April 2006 TWFs and EPA's revised methodology for estimating TWPE of dioxin and dioxin-like compounds (Matuszko, 2006), changes that were made after the 2005 annual review. The largest contributor to the category TWPE is dioxin and dioxin-like compounds. Table 4-4 lists the number of mills that reported pollutant discharges to TRI and, for each pollutant, the TWF, the number of mills that reported discharges, the pounds discharged, and total category TWPE. Discharges include direct discharges to surface waters and transfers to POTWs. POTW transfers are included in the total discharges after POTW removals are taken into account. The two subcategories of Phase I are presented separately.

Facilities in the Pulp and Paper Category reported discharges of 68.1 grams of dioxin and dioxin-like compounds to TRI in 2002, totaling 1.47 million TWPE. (In comparison, EPA estimated that TCDD and TCDF discharges in PCS totaled 0.93 grams.) Dioxin and dioxin-like compounds discharges account for 75 percent of the Pulp and Paper Category TWPE. The discharge of dioxin and dioxin-like compounds from one mill (Kimberly-Clark, Everett, WA) is responsible for 1.10 million TWPE (8.2 grams) or 54 percent of the Pulp and Paper Category's 1.98 million TWPE. Of the remaining 0.87 million TWPE, Phase I mills account for 80 percent, Phase II mills account for 17 percent, and Phase III mills account for 3 percent. Discharges of dioxin and dioxin-like compounds are discussed in detail in Section 5.0 of this report.

Table 4-3. *PCSLoads2002* TWPE by Phase, With and Without Bowater Catawba Mill TCDD Discharges

Number of PCS-Reporting Facilities	Phase I				Phase II		Total Category (Phases I and II)
	Bleached Papergrade Kraft (74 mills)		Papergrade Sulfite (4 mills)		174 Mills		252 Mills
	Total TWPE	% of Category	Total TWPE	% of Category	Total TWPE	% of Category	TWPE
TWPE	1,460,000	95	6,420	0.4	73,300	4.8	1,540,000
TWPE excluding Bowater Catawba TCDD	90,600	53	6,420	4	73,300	43	170,000

Source: *PCSLoads2002_v4*.

Table 4-4. Top 10 Pollutants in *TRIReleases2002*, Releases by Pulp and Paper Regulatory Phase[a]

Number of TRI-Reporting Facilities		Phase I				Phase II		Total Category[c] (Phases I and II)	
		BPK (79 mills)		PS (5 mills)		173 Mills		257 Mills	
Pollutants	**TWF**	**Mills**	**Released (lbs)**	**Mills**	**Released (lbs)**	**Mills**	**Released (lbs)**	**Released (lbs)**	**TWPE**
Dioxin and Dioxin-Like Compounds	[c]	45	0.115	1	0.018	15	0.012	0.145	1,469,101 [1.17 g TEQ/year]
Manganese and Manganese Compounds	0.070	70	3,413,990	1	22,251	41	876,066	4,312,307	303,729
Lead and Lead Compounds	2.24	65	11,879	4	549	117	17,143	29,571	66,240
PACs	33.7[b]	50	863	1	21	28	457	1,341	45,146
Chlorine	0.509	4	22,682	NR	NR	8	11,760	34,442	17,537
Zinc and Zinc Compounds	0.047	45	228,382	1	5,751	26	75,561	309,694	14,520
Potassium Dimethyldithiocarbamate	0.933	NR	NR	NR	NR	1	12,341	12,341	11,519
Mercury and Mercury Compounds	117	30	35	1	2	43	25	62	7,251
Nitrate Compounds	0.0007	37	2,660,662	4	1,566,544	32	1,943,383	6,170,589	4,607
Copper and Copper Compounds	0.635	2	418	3	2,121	5	1,424	3,963	2,516
Total for All Pollutants								**19,399,504**	**1,952,130**

Source: *TRIReleases2002_v4*.
[a]Releases reported include both direct and indirect discharges (transfers to POTWs). Indirect discharges account for POTW removals.
[b]EPA-calculated PAC TWF based on industry-submitted data (Wiegand, 2005b).
[c]Dioxin TWF calculated for each mill, based on reported congener distribution (Matuszko, 2006).
BPK - Bleached Papergrade Kraft.
PS - Papergrade Sulfite.
NR - None reported.
TEQ - Toxic equivalents.

After dioxin and dioxin-like compounds, the metals manganese and lead are the pollutants with the second and third highest contribution to the TRI TWPE. Table 4-5 presents the 11 metals with the highest TWPE of TRI-reported 2002 discharges.

Table 4-5. Comparison of Phase I and Phase II Mill Metals Discharges, from *TRIReleases2002*

	Phase I				Phase II			
	Mills	Pounds	TWPE	TWPE per Mill	Mills	Pounds	TWPE	TWPE per Mill
Manganese and Manganese Compounds	71	3,436,241	242,025	3,409	41	876,066	61,704	1,505
Lead and Lead Compounds	69	12,428	27,838	403	117	17,143	38,401	328
Zinc and Zinc Compounds	46	234,133	10,978	239	26	75,561	3,543	136
Mercury and Mercury Compounds	31	37	4,278	138	43	25	2,974	69
Copper and Copper Compounds	5	2,539	1,612	322	5	1,424	904	181
Vanadium and Vanadium Compounds	24	42,503	1,488	62	11	10,197	357	32
Arsenic and Arsenic Compounds	1	250	1,010	1,010	NR	NR	NR	NR
Barium and Barium Compounds	25	291,360	580	23	16	68,473	136	9
Nickel and Nickel Compounds	2	2,102	229	114	1	339	37	37
Chromium and Chromium Compounds	5	2,090	158	32	3	953	72	24
Cobalt and Cobalt Compounds	1	23	3	3	NR	NR	NR	NR

Source: *TRIReleases2004_v4*.
NR – Not reported.

Table 4-5 shows the releases reported by Phase I mills separately from Phase II mills. Table 4-5 shows the number of mills reporting, the pounds discharged (accounting for POTW removal of metals transferred to POTWs), and the TWPE per mill. Metals present in Phase I mill discharges are also present in Phase II mill discharges and in the same relative amounts. For example, manganese has the highest TWPE per mill both for Phase I and Phase II, followed by lead, then zinc, and so forth.

In addition to dioxin and dioxin-like compounds and metals, PACs and chlorine contributed to the TRI TWPE. Of the TRI-reported chemical discharges, PACs account for the fourth highest TWPE, comprising 2.4 percent of the total Pulp and Paper Category TWPE. Of the TRI-reported chemical discharges, chlorine accounts for 17,500 TWPE, or 0.9 percent of the category TWPE.

Twelve mills reported wastewater discharges of chlorine (Cl_2). However, as discussed in the *Preliminary Detailed Study Report* (U.S. EPA, 2005b), chlorine reacts very quickly with water to form HOCl, Cl-, and H+. This is an equilibrium reaction (at a pH above 4, the equilibrium shifts almost completely toward formation of these products). Because pulp and paper mills discharge wastewater at a pH between 7 and 9, EPA expects no releases of chlorine (Cl_2) in wastewater. In comments on the *Preliminary Detailed Study Report*, NCASI commented, "NCASI concurs with EPA. Investigation of the PCS database used by EPA suggests that most often mills reporting chlorine in routine discharge monitoring reports appear to be doing so for monitoring locations other than biologically treated process waters. Pipe descriptions include, for example, non-contact cooling water, sanitary wastewater, and stormwater." (Wiegand, 2005i)

Table 4-6 shows the total TWPE and TWPE per mill for each regulatory phase. Unlike PCS, one pollutant (dioxin and dioxin-like compounds) but no single facility dominated the Pulp and Paper Category TWPE; therefore, EPA recalculated the total TWPEs excluding dioxin and dioxin-like compounds reported by all mills. Even when dioxin and dioxin-like compounds are excluded from the totals, the Phase I TWPE per mill is significantly greater than the Phase II TWPE per mill.

Table 4-6. *TRIReleases2002_v4* TWPE by Regulatory Phase, With and Without Dioxin and Dioxin-Like Compounds

Number of TRI-reporting facilities	Phase I			Phase II			Total Category (Phases I and II)
	(84 mills)			(173 mills)			257 Mills
	Total TWPE	TWPE per Mill	% of Category	Total TWPE	TWPE per Mill	% of Category	TWPE
TWPE	1,805,315	21,492	92	146,814	849	7.5	1,952,130
TWPE excluding dioxin and dioxin-like compounds	338,602	4,031	70	144,427	835	30	483,029

Source: *TRIReleases2002_v4*.

4.4 Comparison of *TRIReleases2002* and *TRIReleases2003*

Table 4-7 compares the pollutants with highest TWPE of TRI-reported 2002 and 2003 discharges in order of descending TWPE. For most pollutants, the number of reporting mills and the reported pounds and TWPE discharged in 2002 are very similar to the 2003 discharges. The exception is dioxin and dioxin-like compounds, which increased from 1.5 million TWPE in 2002 to 2.3 million TWPE in 2003. EPA notes that because of the very high TWF of the dioxin and dioxin-like compounds and the high flow rates of pulp and paper mills (1 to 30 million gallons per day (MGD)), a small change in the concentration a mill used to estimate releases can have a very large impact on the TWPE. The increase in the category dioxin and dioxin-like compounds TWPE from 2002 to 2003 is due to an increase in the Domtar, Ashdown, AR reported releases (from 1.79 to 40.1 grams) and a coincident decrease in the Kimberly-Clark, Everett, WA releases (from 8.19 to 3.0 grams). In terms of TWPE, the Domtar dioxin and dioxin-like compounds discharges increased by 1.5 million TWPE while the Kimberly-Clark mill dioxin and dioxin-like compounds discharges decreased by 632,000 TWPE. However, as discussed in detail in Section 5.0, most reported dioxin and dioxin-like compounds for the Pulp and Paper Category are based on measurements less than the analytical method ML.

4.5 2005 and 2006 Screening-Level Review Findings for the Pulp and Paper Category

The results of EPA's screening-level review of Pulp and Paper Category discharges are summarized in Table 4-8. EPA identified three groups of pollutants that contribute more than 95 percent of the TWPE in *PCSLoads2002_v4* and *TRIReleases2002_v4*: dioxin and dioxin-like compounds, metals and metal compounds, and PACs. In addition to its discharges of TWPE, the Pulp and Paper Category ranked among the top three categories in discharges of nitrogen and phosphorus nutrients. As a result, EPA's detailed study focused on dioxin and dioxin-like compounds, metals and metal compounds, PACs, and nutrients. Other findings from EPA's 2005 and 2006 screening-level reviews are summarized below:

Table 4-7. Comparison of *TRIReleases2002_v4* and *TRIReleases2003_v2*

Pollutant	***TRIReleases2002_v4*** **Phase I + Phase II**			***TRIReleases2003_v2*** **Phase I + Phase II**		
	No. of Mills	**Pounds**	**TWPE**	**No. of Mills**	**Pounds**	**TWPE**
Dioxin and Dioxin-Like Compounds	61	0.145	1,469,101 [1.17 g TEQ/year][a]	60	0.216	2,387,924 [1.76 g TEQ/year][a]
Manganese and Manganese Compounds	112	4,312,307	303,729	113	4,317,774	304,114
Lead and Lead Compounds	186	29,571	66,240	180	25,449	57,006
PACs	79	1,341	45,146	76	1,313	44,190
Chlorine	12	34,442	17,537	11	28,555	14,539
Zinc and Zinc Compounds	72	309,694	14,520	72	320,971	15,049
Potassium Dimethyldithiocarbamate	1	12,341	11,519	NR	NR	NR
Mercury and Mercury Compounds	74	62	7,251	77	61	7,196
Nitrate Compounds	73	6,170,589	4,607	67	6,431,579	4,802
Copper and Copper Compounds	10	3,963	2,516	11	4,590	2,914

Source: *TRIReleases2002_v4*, *TRIReleases2003_v2*.
[a]TEQ – Toxic equivalent.

Table 4-8. Summary of Screening-Level Review Using PCS and TRI Data

	PCS Loads Phase I + Phase II		**TRI Loads Phase I + Phase II**	
	TWPE	**Percentage of Category (%)**	**TWPE**	**Percentage of Category (%)**
TCDD & TCDF	1,370,000	88.9	NR	NR
Dioxin and dioxin-like compounds	NR	NR	1,470,000	75.4
Metals and metal compounds	123,000[a]	8.0	398,000[b]	20.4
PACs	241[c]	0.0	45,100	2.3
Total Category TWPE	1,540,000		1,950,000	

Source: *PCSLoads2002_v4* and *TRIReleases2002_v4*.
[a]Metals and metal compounds reported to PCS include the following: manganese, aluminum, lead, zinc, mercury, copper, arsenic, cadmium, hexavalent chromium, chromium, nickel, iron, silver, titanium, barium, and thallium.
[b]Metals and metal compounds reported to TRI database include the following: manganese, lead, zinc, mercury, copper, vanadium, arsenic, barium, nickel, chromium, and cobalt.
[c]Discharges of PACs, as a category, are not reported to PCS. PCS includes data for discharges of one PAC (benzo(a)pyrene) for one mill.
NR – Pollutant not reported to this database.

- Using data available in *PCSLoads2002*, the total category discharge was 1.54 million TWPE. However, TCDD discharges from one mill accounted for 89 percent of the category TWPE. Without this discharge, the category discharge was 167,000 TWPE.

- Total discharges for *TRIRelease2002* was 1.98 million TWPE. Total discharges for *TRIRelease2003* was 2.88 million TWPE. For both reporting years, dioxin and dioxin-like compounds contributed 74 percent or more of the category TWPE. Dioxin and dioxin-like compound discharges are discussed in detail in Section 5.0.

- After TCDD, the pollutant contributing the most TWPE in *PCSLoads2002* is aluminum, 6 percent of the category TWPE. Mills in both Phase I and Phase II report discharging aluminum.

- After dioxin and dioxin-like compounds, metals (including manganese, lead, zinc, mercury, and copper) are the pollutants contributing the next greatest amount of TWPE in the *TRIReleases* databases. Although aluminum contributes 6 percent of category TWPE in *PCSLoads2002,* aluminum discharges are not reported to TRI. The metals contribute 20 percent or more of the category TWPE. Because metals in mill effluents are likely to have similar sources and the same or similar control technologies, metals are discussed as a group in Section 6.0.

- After metals, PACs contribute the next greatest amount of TWPE in the *TRIReleases* databases, 2.4 percent of category TWPE. PACs are discussed in detail in Section 7.0.

- The Pulp and Paper Category ranked among the top three categories in discharges of nitrogen and phosphorus nutrients. Nutrient discharges are discussed in Section 8.0.

5.0 DIOXIN AND DIOXIN-LIKE COMPOUNDS

Chiefly due to discharges of dioxin and dioxin-like compounds, the Pulp and Paper Category ranked higher than any other category in EPA's 2005 and 2006 screening-level reviews of discharges from industrial categories. As part of the Pulp and Paper Detailed Study, EPA investigated the data reported to PCS and TRI to determine the extent to which dioxin and dioxin-like compounds are currently discharged from Phase I and Phase II pulp and paper mills[5].

EPA conducted a review of mill discharges of dioxin and dioxin-like compounds to determine:

- If the existing ELGs for discharges of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) and 2,3,7,8-tetrachlorodibenzofuran (TCDF) from mills with operations in Subparts B and E (Phase I) should be revised; and
- If existing ELGs for the Phase II subcategories should be revised to control discharges of TCDD, TCDF, or other dioxin and dioxin-like compounds.

This section presents EPA's analysis of dioxin and dioxin-like compounds discharges from pulp and paper mills and includes reviews of NPDES permit compliance monitoring data and of data reported to TRI. For background on dioxin and dioxin-like compounds, see Section 3.2 of this report.

5.1 Background

As explained in Section 1.3, Phase I of EPA's 1998 revisions of the Pulp and Paper Category ELGs focused on mills that used chlorine and/or chlorine-containing compounds to bleach papergrade chemical pulp (pulp made by the kraft, soda, and sulfite processes). As a result of the bleaching processes they used, these mills were identified as discharging TCDD, TCDF, and other dioxin and dioxin-like compounds. To control these discharges, EPA revised the ELGs for Subpart B, Bleached Papergrade Kraft and Soda, and for Subpart E, Papergrade Sulfite.

[5] Although Phase III mills reported discharging dioxin and dioxin-like compounds, they are not included in this study because EPA determined as part of its 2004 Effluent Guidelines Program Plan that it would not promulgate revised guidelines for the three operating Phase III mills.

The technology basis for the revised best available technology economically achievable (BAT) for the Bleached Papergrade Kraft and Soda Subcategory is conventional pulping followed by complete substitution of chlorine dioxide for elemental chlorine, and nine other elements. For the Papergrade Sulfite Subcategory calcium-, magnesium- or sodium-based sulfite segment, the BAT technology basis is totally chlorine-free bleaching (bleaching with peroxide) and four other elements. For the Papergrade Sulfite Subcategory ammonium-based sulfite segment, the BAT technology basis is complete substitution of chlorine dioxide for elemental chlorine and five other elements. These technology bases are described in detail in the *Supplemental Technical Development Document* (U.S. EPA, 1997).

The revised ELGs, known as the Cluster Rules, have been used to develop NPDES permit limits for Phase I mills. To demonstrate compliance with their NPDES permits, mills monitor their bleach plant effluents for TCDD and TCDF and report the results to their permitting authority. The permitting authority is responsible for transferring mill monitoring data to PCS. Phase I mills also report releases of dioxin and dioxin-like compounds to TRI. As of 2004, EPA identified 71 mills with operations in the Bleached Papergrade Kraft and Soda Subcategory, including 68 that discharge directly and 3 that discharge to POTWs[6]. EPA also identified six mills with operations in the Papergrade Sulfite Subcategory, all that discharge directly.

Phase II of EPA's review and revision of the Pulp and Paper Category ELGs was defined to include mills that do not bleach chemical pulp. Phase II includes mills that make kraft pulp, but do not bleach it. Phase II also includes mills that produce pulp using other processes (e.g., groundwood and semi-mechanical), mills that make pulp from secondary fiber (wastepaper), and mills that make paper from purchased pulp. Because these mills do not bleach chemical pulp, they were not identified as discharging TCDD, TCDF, or other dioxin and dioxin-like compounds. Because EPA did not revise ELGs for discharges from Phase II operations, and Phase II mills do not have NPDES permit limits for dioxin and dioxin-like compounds, PCS contains no TCDD or TCDF effluent monitoring data for Phase II mills. However, as shown in Table 4-4, 15 of the 173 Phase II mills that reported to TRI reported discharging dioxin and

[6] Two mills, Boise, St. Helens, OR and New Page, Luke, MD, are copermitted with their POTWs and are counted as direct dischargers. Mill wastewater makes up more than 90 percent of the flow at these POTWs.

dioxin-like compounds in 2002. EPA identified 175 Phase II mills operating as of 2004, 118 with direct discharges and 57 that discharge to POTWs.

5.2 <u>Phase I Mill TCDD and TCDF Compliance Monitoring Data</u>

This subsection presents EPA's review of NPDES permit compliance data for TCDD and TCDF. Because there are no existing ELGs for TCDD and TCDF for Phase II mills, and no Phase II mill NPDES permits include water-quality-based limits for TCDD or TCDF, only discharges from Phase I mills are discussed in this subsection.

5.2.1 Implementation of Cluster Rules ELGs

As presented in Table 4-4, Phase I mills reported 2002 discharges of dioxin and dioxin-like compounds to TRI accounting for 1.47 million TWPE. Dioxin and dioxin-like compounds discharges of this magnitude are surprising because (after excluding discharges from Bowater, Catawba, SC) EPA estimated Phase I mill 2002 discharges of TCDD and TCDF accounted for only 97,000 TWPE. The differences between PCS and TRI discharge estimates suggest that either the 1998 Cluster Rules have not controlled discharges of dioxin and dioxin-like compounds or TRI-reported discharges are overestimated. To determine whether the 1998 Cluster Rules have not controlled discharges TCDD and TCDF and, thus, should be revised, EPA first determined whether the Cluster Rules requirements had been incorporated in to Phase I mill NPDES permits. Section 9.2 of this report discusses this determination. EPA found that the majority of permits for direct discharging mills (91 percent or 61 out of 67) reflect the ELGs. Permits for six bleached papergrade kraft mills do not yet include Cluster Rule limits because the permits are either being contested or have not been reissued since Cluster Rule promulgation. Permits for two papergrade sulfite mills allow the mills to demonstrate compliance with the AOX limit at alternate monitoring locations.

After confirming that Cluster Rules requirements had been incorporated into Phase I mill NPDES permits, EPA reviewed PCS and TRI data to determine if they accurately reflect current industry discharges of dioxin and dioxin-like compounds. EPA began this review by examining compliance monitoring data obtained from PCS and the state of Washington. EPA's review of NPDES permit compliance data first addresses bleach plant effluent monitoring data and then addresses final effluent monitoring data.

5.2.2 Bleach Plant Effluent Monitoring Data

The ELGs for TCDD and TCDF require mills to demonstrate compliance with TCDD and TCDF limits where wastewater leaves the bleach plant, a point upstream of the final mill effluent. EPA refers to these in-process limits as "bleach plant effluent limits." The ELGs for TCDD are <ML, meaning <10 pg/L. For TCDF, the limitations guideline for the Bleached Papergrade Kraft and Soda Subcategory is 31.9 pg/L while the limitations guideline for the ammonium sulfite segment of the Papergrade Sulfite Subcategory is <ML[7], again meaning <10 pg/L. Concentrations reported as detected, but below the Method 1613B ML, demonstrate compliance with the guidelines. For example, a bleach plant effluent TCDD concentration of 4 pg/L demonstrates compliance.

EPA retrieved DMR-reported concentration data from PCS for mills to which the 1998 ELGS apply. As discussed in Section 9.3, EPA received additional TCDD and TCDF bleach plant effluent monitoring data from Washington State. Table 5-1 presents bleach plant effluent concentrations for mills at which TCDF was detected at least once in the years 2002 through 2004[8]. The data are presented as reported: 0; < detection limit; or a value. TCDD was not detected in bleach plant effluent above the Method 1613B ML at the seven mills included in Table 5-1 or at any of the 51 mills for which EPA has data for the period 2002 to 2004.

[7] EPA did not establish guidelines for TCDD or TCDF for the calcium-, magnesium- or sodium-based sulfite segment of the Papergrade Sulfite Subcategory.

[8] Although TCDD and TCDF were not detected in bleach plant effluent at Bowater, Catawba, SC, the mill is included in Table 5-1 because TCDD was detected in the final mill effluent in 2002 and 2003.

Table 5-1. Bleach Plant Effluent Concentrations of TCDD and TCDF (pg/L)[a]

Mill	TCDD BAT limit is <10 pg/L						TCDF BAT limit is <31.9 pg/L					
	2002		2003		2004		2002		2003		2004	
	No. of Data Points	pg/L	No. of Data Points	pg/L	No. of Data Points	pg/L	No. of Data Points	pg/L	No. of Data Points	pg/L	No. of Data Points	pg/L
Bleached Papergrade Kraft Mills												
Bowater, Catawba[b] SC0001015	0	—	0	—	9	<10	0	—	0	—	9	<31.9
Parsons & Whittemore, Alabama River Pulp AL0025968	22	0	24	0	24	0	21	0	24	0	24	0
							1	19				
International Paper, Bastrop LA0007561	0		24	0	24	0	0	—	24	0	23	0
											1	12.8
Georgia-Pacific, Palatka FL0002763	2	<10	12	<10	11	<10	2	<31.9	12	<31.9	1	0
					1	0					1	0
											1	12
Boise, Jackson AL0002755	12	0	12	0	12	0	11	0	12	0	12	0
							1	11.3				
Weyerhaeuser, Hawesville KY0001716	0	-	1	5.3	2	1.3 to 6.6	0	-	0	-	1	7.1
	24	<10	23	<10	22	<10	24	<31.9	24	<31.9	23	<31.9
Boise, Wallula WA0003697	12	<10	12	<10	12	<10	11	<31.9	12	<31.9	10	<31.9
							1	0.6			2	1.0
Weyerhaeuser, Longview WA0000124	0	-	0	-	7	<10	0	-	0	-	4	<31.9
											3	4 to 8
Papergrade Sulfite[c]												
Kimberly-Clark, Everett WA0000621	13	<10	17	ND to 1.6	12	<10	11	3.2 to 35.3	12	0 to33	11	ND to 9.9
							avg	12.8	avg	14.6	avg.	4.7

[a]Shaded cells identify concentrations greater than Method 1613ML. Note that all bleached papergrade kraft mill TCDF concentrations are <31.9 and thus meet the BAT guideline.
[b]Although TCDD and TCDF were not detected in bleach plant effluent, TCDD was detected in Bowater, Catawba ,SC final mill effluent in 2002 and 2003. For this reason, Bowater is included on this table.
[c]The BAT limit applicable to Kimberly-Clark is <10 pg/L TCDF.
ND - Not detected.

As shown in Table 5-1, although all bleached papergrade kraft mills met the TCDF BAT limit of <31.9 pg/L, TCDF was detected above the Method 1613B ML in bleach plant effluent at four bleached papergrade kraft mills. TCDF was detected above the Method 1613B ML once at two bleached papergrade kraft mills in 2002 and once at two different bleached papergrade kraft mills in 2004. Several other mills reported concentrations as <31.9 pg/L. The actual measured concentration in these samples is unknown; it may be greater than the Method 1613B ML. However, the reported concentration meets the BAT guideline for the bleached papergrade kraft subcategory.

The Kimberly-Clark (K-C) mill in Everett, Washington repeatedly detected TCDF in its bleach plant effluent. The K-C mill uses ammonium sulfite pulping to produce market pulp and tissue paper and thus is subject to the BAT effluent guidelines for the ammonium sulfite segment of Subpart E. Effluent guidelines for the bleach plant effluent are <ML (<10 pg/L) for both TCDD and TCDF. The mill converted to 100 percent chlorine dioxide bleaching in October 2000 and has not detected TCDD in its bleach plant effluent since that time. Research work K-C conducted between May 2001 and December 2004 showed that TCDF concentrations in the bleach plant effluent followed a seasonal pattern, with higher levels in the summer months. K-C identified two principal causes of their bleach plant effluent TCDF: 1) TCDF precursors in their source water; and 2) the chlorine content of the chlorine dioxide solution manufactured on site in K-C's chlorine dioxide generator (Siddiqui, 2003; Kurtz, 2004).

Because of these findings, K-C was required to submit annual study reports to Washington State that describe actions taken to control of TCDF in bleach plant effluent. K-C submitted reports in December 2004 and December 2005 (Kurtz, 2004; 2005). The mill reported that, as of June 2004, it converted its on-site chlorine dioxide generator from a methanol-based process to a hydrogen-peroxide-based process that results in a lower chlorine content in the chlorine dioxide solution. This change resulted in reduced bleach plant effluent TCDF concentrations in May through October in 2004 and 2005 (Kurtz, 2004; 2005).

5.2.3 Final Effluent Monitoring Data

Table 5-2 presents final effluent concentrations for TCDD for Bowater, Catawba, SC, the one mill at which TCDD was detected in mill final effluent during the period 2002 to 2004 (the mill was required to monitor final effluent for TCDD but not TCDF). The data are presented as reported, 0, or a value. In addition to the Bowater Catawba mill, 35 other mills monitored the mill final effluent for TCDD. However, none of these mills detected TCDD in the mill final effluent above the Method 1613B ML.

Table 5-2. Final Effluent Concentrations of TCDD, Bowater, Catawba, SC

Mill		2002		2003		2004	
		No. Data Points	pg/L	No. Data Points	pg/L	No. Data Points	pg/L
Bowater, Catawba SC0001015[a]	No detectable TCDD reported	2	0	3	0	1 2	MIC 0
	TCDD detected	1	83.6	1	5.2	0	--

MIC - Monitoring is conditional and not required this period.
[a]Permit required quarterly monitoring. Limit was 84 pg/L daily maximum.

During 2002, the Bowater, Catawba, SC mill was not yet using 100 percent chlorine dioxide bleaching technology, the basis for BAT. At the end of August 2003, the mill converted to 100 percent chlorine dioxide bleaching. Bowater reports that, since that change, neither TCDD nor TCDF has been measured in bleach plant effluent or in mill final effluent above the Method 1613B ML (10 pg/L) (Bowling, 2005). Bowater reported a final effluent TCDD concentration of 5.2 pg/L in 2003. This concentration is less than the Method 1613B ML and demonstrates compliance with the mill's permit limit for final effluent (U.S. EPA, 2005b). Bowater did not routinely monitor its bleach plant effluent for TCDD or TCDF until 2004, and has not detected TCDD or TCDF in bleach plant effluent above the BAT effluent limitations since then.

EPA reviewed PCS data for the period 1998 to 2004 to evaluate the effect of the Cluster Rules on BPK mill discharges. Since the promulgation of the Cluster Rules, discharges of TCDD and TCDF have decreased significantly. As summarized in Table 5-3, EPA found that by 2004, TCDD and TCDF discharges for reporting BPK mills were only 6,100 TWPE, a 99 percent reduction from baseline. EPA calculated these discharges using the concentration and flow data available for two mills (Georgia-Pacific, Palatka and Weyerhaeuser, Hawesville).

Table 5-3. Trends in BPK Mill Discharges[a] of TCDD and TCDF

Regulated Pollutants	1995 TWPE[b]	2002		2004	
		TWPE	Number of Mills Monitoring	TWPE	Number of Mills Monitoring
TCDD + TCDF	17.9 million	1.3 million	47 for TCDD 38 for TCDF	6,100	52 for TCDD 49 for TCDF

Source for 2002 and 2004 discharges: Envirofacts.
[a]Discharges estimated using bleach plant effluent monitoring data.
[b]EPA estimated baseline TWPE for the mills monitoring for the pollutant in 2004.

5.2.4 Summary of NPDES TCDD and TCDF Permit Compliance Monitoring Data

In its review of NPDES permit compliance monitoring data, EPA found:

- TCDD was not detected in bleach plant effluent above the Method 1613B ML at any of the 51 mills for which EPA has data for the period 2002 to 2004.

- All bleached papergrade kraft mills met the BAT TCDF limit of <31.9 pg/L, but TCDF was detected above the Method 1613B ML in bleach plant effluent at four bleached papergrade kraft mills.

- TCDF was repeatedly detected in bleach plant effluent above the Method 1613B ML at one papergrade sulfite mill, Kimberly-Clark, Everett, WA in 2002 and 2003. The mill did not detect TCDF in its bleach plant effluent in 2004, after renovating its chlorine dioxide generator.

- According to data in PCS, TCDD has not been reported to be detected in any pulp and paper mill final effluent since August 2003.

5.3 <u>Review of Data Reported to TRI</u>

This subsection presents EPA's review of the dioxin and dioxin-like compound monitoring data reported by pulp and paper mills to TRI. It explains how pulp and paper mills report discharges of dioxin and dioxin-like compounds to TRI and describes emission factors and effluent monitoring data used to estimate TRI-reported discharges. This subsection also presents

EPA's analysis of whether the dioxin and dioxin-like compound discharges reported to TRI accurately reflect current industry discharges.

5.3.1 How Pulp and Paper Mills Report Discharges of Dioxin and Dioxin-Like Compounds to TRI

When reporting chemical releases to TRI, facilities may use emission factors, mass balances, or other engineering calculations to estimate releases. Facilities may estimate their releases using monitoring data collected prior to the year for which they are reporting discharges if they believe the data are representative of reporting-year operations. Because facilities may be fined for under-reporting releases to TRI, they tend to overestimate the magnitude of their releases.

In addition to the amount of dioxin and dioxin-like compounds released, facilities are required to report to TRI the method used to estimate their releases, using four code letters:

- M - Monitoring Data or Direct Measurement;
- E - Emission Factor;
- C - Mass Balance; or
- O - Other Approaches Such as Engineering Calculation.

Tables 5-4 and 5-5 list the Phase I and Phase II mills that reported releases of dioxin and dioxin-like compounds to TRI in 2002 and 2003, respectively, and the method the mills reported to TRI that they used to estimate their releases. In addition to the estimation methods, Tables 5-4 and 5-5 present EPA's estimated releases to the environment (in grams/year) that account for POTW removal. EPA assumed that approximately 83 percent of dioxin and dioxin-like compounds are removed in a POTW (Bartram, 2005). In addition, EPA calculated the TWPE of the discharges using the TWFs presented in Table 3-1 and a methodology for estimating dioxin congener distributions based on industry-provided congener distributions (Matuszko, 2006).

As shown in Table 5-4, 61 mills reported discharging dioxin and dioxin-like compounds in 2002 (47 Phase I and 14 Phase II mills). Of these 61 mills, 15 indicated that their reported discharges were based on monitoring data or direct measurement. In 2002, dioxin and dioxin-like compounds discharges reported by two mills, Kimberly-Clark (K-C), Everett, WA and Bowater, Catawba, SC contributed far more TWPE than any other mills. K-C's reported discharge represented 75 percent of the category TWPE while Bowater's contributed 15 percent.

As shown in Table 5-5, 59 mills reported releasing dioxin and dioxin-like compounds in 2003 (44 Phase I and 15 Phase II mills). Of these 59 mills, 15 indicated that their reported releases were based on monitoring data or direct measurement. In 2003, dioxin and dioxin-like compounds discharges reported by three mills contributed 94 percent of the total category TWPE. The TWPE of the releases reported by Domtar, Ashdown, AR represented 1.5 million TWPE, 63 percent of the total. K-C's reported 2003 releases were much less than 2002 (473,000 TWPE compared to 1.1 million) and represented 20 percent of the total. Bowater, Catawba contributed about 11 percent of the 2003 TWPE.

5.3.2 Emission Factors Used to Estimate TRI-Reported Discharges

As shown in Table 5-4, 27 of the 61 mills that reported releases of dioxin and dioxin-like compounds in 2002 and 26 of 59 mills that reported releases in 2003 indicated that they used emission factors to estimate their releases. As discussed in the Preliminary Report (U.S. EPA, 2005b), NCASI contacted 9 of the 10 mills that reported the largest (in terms of TWPE) releases of dioxin and dioxin-like compounds to TRI in 2002. They found that six of the nine mills estimated their releases based on information contained in *The SARA Handbook,* published by NCASI (Wiegand, 2005c; Wiegand, 2005d). For example, pulp mills using 100 percent chlorine dioxide bleaching used the dioxin and dioxin-like compound concentrations from *Table 14 PCDD/F Concentrations in Eight ECF Bleached Chemical Pulp Mill Treated Effluents*. The mills multiplied their annual wastewater discharge flow by the average total concentration of 88.3 pg/L from the table to calculate the annual mass discharge of dioxin and dioxin-like compounds reported to TRI. This concentration is the sum of average concentrations

Table 5-4. Mills that Reported 2002 Dioxin and Dioxin-Like Compounds Releases to TRI

Facility	City, State	Grams Released to the Environment (accounting for POTW removal)	TWPE	Basis of Estimate
Phase I Mills				
Kimberly-Clark Worldwide, Inc.	Everett, WA	8.19	1,104,866	C
Bowater Inc.	Catawba, SC	3.66	217,867	M
Georgia-Pacific Corp.	Zachary, LA	3.32	63,803	E
Georgia-Pacific Corp.	Pennington, AL	5.33	9,555	E[a]
Georgia-Pacific Corp.	Crossett, AR	4.94	8,867	E
Potlatch Corp.	Lewiston, ID	4.27	7,657	E
Georgia-Pacific Corp.	Camas, WA	3.58	6,427	E
Durango-Georgia Paper	Saint Marys, GA	3.38	6,062	O
Domtar Industries Inc.	Baileyville, ME	3.15	5,654	E
Jefferson Smurfit Corp.	Brewton, AL	2.40	4,306	E
Weyerhaeuser Paper Co.	Kingsport, TN	2.17	3,894	M
International Paper Co.	Franklin, VA	2.10	3,760	E
Boise Cascade Corp.	Jackson, AL	2.01	3,615	E
Domtar Industries Inc.	Ashdown, AR	1.79	3,203	E
Weyerhaeuser Paper Co.	Vanceboro, NC	1.63	2,924	E
Glatfelter	Spring Grove, PA	0.86	1,549	E
Bowater Inc.	Calhoun, TN	0.85	1,528	M
International Paper Co.	Cantonment, FL	0.80	1,435	E
International Paper Co.	Georgetown, SC	0.78	1,395	C
Weyerhaeuser Paper Co.	Plymouth, NC	0.74	1,334	E
Potlatch Corp.	Arkansas City, AR	0.57	1,026	O
Tembec Inc.	Saint Francisville, LA	0.49	873	E
International Paper Co.	Ticonderoga, NY	0.46	820	E
Boise Cascade Corp.	Deridder, LA	0.31	556	E
Gulf States Paper Corp.	Demopolis, AL	0.23	410	E
International Paper Co.	Bastrop, LA	0.21	380	M
GP Cellulose LLC	Brunswick, GA	0.20	360	E
S.D. Warren (SAPPI)	Skowhegan, ME	0.18	329	O
International Paper Co.	Eastover, SC	0.16	281	O
Weyerhaeuser Paper Co.	Rothschild, WI	0.15	273	M
Boise Cascade Corp.	Wallula, WA	0.13	235	O
Simpson Tacoma Kraft Co.	Tacoma, WA	0.13	232	E
International Paper Co.	Selma, AL	0.12	210	E
International Paper Co.	Queen City, TX	0.11	197	M
Glatfelter (was New Page Corp.)	Chillicothe, OH	0.10	178	M

Table 5-4 (Continued)

Facility	City, State	Grams Released to the Environment (accounting for POTW removal)	TWPE	Basis of Estimate
Boise Cascade (City of St. Helens)	Saint Helens, OR	0.69[b]	163	M[c,d]
Smurfit-Stone Container Corp.	Panama City, FL	0.08[b]	140	E[d]
International Paper Co.	Courtland, AL	0.07	130	E
Great Northern Paper Co.	Millinocket, ME	0.04	66	O
International Paper Co.	Riegelwood, NC	0.03	54	E
SAPPI Fine Paper North America	Muskegon, MI	0.03[b]	54	E[d]
International Paper Co.	Jay, ME	0.02	38	M
Weyerhaeuser Paper Co.	Longview, WA	0.02	36	O
International Paper Co.	Pine Bluff, AR	0.02	32	E
Weyerhaeuser Paper Co.	Columbus, MS	0.00	3	M
Weyerhaeuser (Flint River Mill)	Oglethorpe, GA	0.00	1	O
SAPPI Fine Paper North America	Cloquet, MN	0.04[b]	0	E[d]
Phase II Mills				
Nippon Paper (was Daishowa)	Port Angeles, WA	1.82	290	M
Schweitzer Mauduit Intl. Inc.	Lee, MA	0.15	269	O
Buckeye Lumberton Inc.	Lumberton, NC	0.10	180	M
Blandin Paper	Grand Rapids, MN	3.20[b]	86	M[d]
Schweitzer-Mauduit Intl. Inc.	Ancram, NY	0.02	36	O
Procter & Gamble	Mehoopany, PA	0.02	35	O
Grays Harbor Paper	Hoquiam, WA	0.02	29	C
Marcal Paper Mills Inc.	Elmwood Park, NJ	0.01[b]	22	M[d]
Procter & Gamble	Jackson, MO	0.01	11	O
Procter & Gamble	Albany, GA	0.00[b]	7	O[d]
Procter & Gamble	Green Bay, WI	0.00[b]	3	C, C[d]
West Linn Paper	West Linn, OR	0.00	1	C
Procter & Gamble	Oxnard, CA	0.00[b]	0	O[d]
Smart Papers LLC	Hamilton, OH	0.00[b]	0	M[d]

M - Monitoring Data or Direct Measurement; E - Emission Factor; C - Mass Balance; O – Other Approaches.
[a]The Georgia-Pacific mill in Pennington, AL indicated a direct measurement as the basis for its discharge estimates. When EPA contacted the mill, it indicated it used emission factors to estimate the discharge.
[b]Accounts for POTW removal.
[c]Boise Cascade in St Helens, OR indicated it used an emission factor to estimate discharges. When EPA contacted the mill, it indicated it used actual concentrations data to calculate the discharge.
[d]Basis of estimated transfer to POTW.

Table 5-5. Mills that Reported 2003 Dioxin and Dioxin-Like Compounds Release to TRI

Facility	City, State	Grams Released to the Environment (accounting for POTW removal)	TWPE	Basis of Estimate
Phase I Mills				
Domtar Industries Inc.	Ashdown, AR	40.12	1,511,611	M
Kimberly-Clark Worldwide Inc.	Everett, WA	3.00	472,778	C
Bowater Inc.	Catawba, SC	5.58	261,826	M
Georgia-Pacific Corp.	Zachary, LA	3.32	63,803	E
Georgia-Pacific Corp.	Crossett, AR	5.49	9,850	E
Georgia-Pacific Corp.	Pennington, AL	5.32	9,551	M
Potlatch Corp.	Lewiston, ID	4.18	7,505	E
Weyerhaeuser Paper Co.	Kingsport, TN	2.50	4,486	M
International Paper Co.	Queen City, TX	2.36	4,235	M
International Paper Co.	Franklin, VA	2.27	4,066	E
Jefferson Smurfit Corp.	Brewton, AL	2.20	3,947	E
Boise Cascade Corp.	Jackson, AL	1.98	3,553	E
Weyerhaeuser Paper Co.	Vanceboro, NC	1.82	3,257	E
Georgia-Pacific Corp.	Camas, WA	1.06	1,902	E
International Paper Co.	Cantonment, FL	0.93	1,669	E
Glatfelter	Spring Grove, PA	0.92	1,653	E
Potlatch Corp.	Arkansas City, AR	0.92	1,646	O
Bowater Inc.	Calhoun, TN	0.91	1,626	M
Weyerhaeuser Paper Co.	Plymouth, NC	0.82	1,470	E
International Paper Co.	Georgetown, SC	0.77	1,380	C
Weyerhaeuser Paper Co.	Port Wentworth, GA	0.72	1,284	E
Tembec Inc.	Saint Francisville, LA	0.50	899	E
International Paper Co.	Ticonderoga, NY	0.46	817	E
Boise Cascade Corp.	Deridder, LA	0.26	467	E
Gulf States Paper Corp.	Demopolis, AL	0.23	416	E
International Paper Co.	Bastrop, LA	0.22	399	M
S.D. Warren (SAPPI)	Skowhegan, ME	0.18	323	O
International Paper Co.	Eastover, SC	0.16	290	O
Boise Cascade Corp.	Wallula, WA	0.14	242	O
Simpson Tacoma Kraft Co.	Tacoma, WA	0.13	240	E
International Paper Co.	Selma, AL	0.12	208	E
Weyerhaeuser Paper Co.	Rothschild, WI	0.12	206	M
Boise Cascade (City of St. Helens)	Saint Helens, OR	0.71[a]	167	E[b]
International Paper Co.	Courtland, AL	0.09	158	E
Glatfelter (was NewPage Corp.)	Chillicothe, OH	0.09	154	M

Table 5-5 (Continued)

Facility	City, State	Grams Released to the Environment (accounting for POTW removal)	TWPE	Basis of Estimate
Smurfit-Stone Container Corp.	Panama City, FL	0.07[a]	119	E[b]
SAPPI Fine Paper North America	Muskegon, MI	0.05[a]	90	E[b]
International Paper Co.	Riegelwood, NC	0.03	55	E
Weyerhaeuser Paper Co.	Longview, WA	0.03	45	O
International Paper Co.	Jay, ME	0.02	36	M
International Paper Co.	Pine Bluff, AR	0.02	32	E
Weyerhaeuser (Flint River Mill)	Oglethorpe, GA	0.00	1	O
Weyerhaeuser Paper Co.	Columbus, MS	0.00	3	M
SAPPI Fine Paper North America	Cloquet, MN	0.04[a]	0	E[b]
Phase II Mills				
Weyerhaeuser Paper Co.	Pine Hill, AL	2.34	4,197	E
West Linn Paper	West Linn, OR	0.35	623	C
Nippon Paper(was Daishowa)	Port Angeles, WA	1.77	282	M
Schweitzer Mauduit International Inc.	Lee, MA	0.15	275	O
Blandin Paper	Grand Rapids, MN	2.21[a]	60	M[b]
Schweitzer-Mauduit International Inc.	Ancram, NY	0.02	36	O
Procter & Gamble	Mehoopany, PA	0.02	33	O
Marcal Paper Mills Inc.	Elmwood Park, NJ	0.01[a]	26	M[b]
Fox River Paper Corp (Rising Paper Div)	Housatonic, MA	0.01[a]	22	O[b]
Grays Harbor Paper LP	Hoquiam, WA	0.01	21	C
Smart Papers LLC	Hamilton, OH	0.01[a]	20	M[b]
Procter & Gamble	Jackson, MO	0.00	8	O
Procter & Gamble	Albany, GA	0.00[a]	6	O[b]
Procter & Gamble	Green Bay, WI	0.00[a]	2	C, C[b]
Procter & Gamble	Oxnard, CA	0.00[a]	0	C[b]

M - Monitoring Data or Direct Measurement; E - Emission Factor; C - Mass Balance; O - Engineering Calculation.
[a]Accounts for POTW removal.
[b]Basis of estimated transfer to POTW.

from four bleached papergrade kraft mills whose effluent is treated in aerated stabilization basins[9]. The average concentrations were calculated using zero for congeners not detected (Wiegand, 2005i).

Table 5-6 presents the average mill effluent concentrations of the 17 dioxin and dioxin-like compounds NCASI used to calculate its emission factor. At four of the eight mills, no dioxin and dioxin-like compounds were detected. NCASI calculated the average congener concentrations for the four mills at which at least one compound was detected. Because results from the four mills at which no dioxin and dioxin-like compounds were detected are not included in the average, NCASI's wastewater emission factor may be biased high. Furthermore, all average congener concentrations are less than the Method 1613B ML. Of the concentration data for individual mills provided by NCASI, (Wiegand, 2005i) only two measurements were above the Method 1613 ML. Both were measurements of octachlorodibenzo-p-dioxin (OCDD), which has lower toxicity than all but one of the 17 dioxin and dioxin-like compounds. The OCDD TWF is more than 100,000 times less than the TWF for TCDD and is the second lowest of the dioxin and dioxin-like compounds. NCASI notes that they consider values below Method 1613B ML to be "estimated concentrations" and that loads and TWPE calculated with estimated concentrations should be considered "upper bound" (Wiegand, 2005i).

5.3.3 Phase I Mill Discharges of Dioxin and Dioxin-Like Compounds Reported to TRI

This subsection describes monitoring data Phase I mills used to estimate their TRI releases and the specific congeners detected in Phase I mill effluents.

[9] In calculating this average effluent concentration, NCASI did not include results from effluent from four bleached papergrade kraft mills in which no dioxin congeners were detected.

Table 5-6. Concentrations of Dioxin and Dioxin-Like Compounds Used for NCASI's Emission Factor (pg/L)

Dioxin Congener	1613B ML (pg/L)	NCASI Average Mill Effluent Concentration (pg/L)
Polychlorinated dibenzofurans (CDFs)		
2,3,7,8-TCDF	10	1.0
1,2,3,7,8-PeCDF	50	0
2,3,4,7,8-PeCDF	50	0
1,2,3,4,7,8-HxCDF	50	0
1,2,3,6,7,8-HxCDF	50	0
2,3,4,6,7,8-HxCDF	50	0
1,2,3,7,8,9-HxCDF	50	0
1,2,3,4,6,7,8-HpCDF	50	1.9
1,2,3,4,7,8,9-HpCDF	50	0.5
1,2,3,4,6,7,8,9-OCDF	100	2.0
Polychlorinated dibenzo-p-dioxins (CDDs)		
2,3,7,8-TCDD	10	0
1,2,3,7,8-PeCDD	50	0
1,2,3,4,7,8-HxCDD	50	0
1,2,3,6,7,8-HxCDD	50	1.3
1,2,3,7,8,9-HxCDD	50	0.9
1,2,3,4,6,7,8-HpCDD	50	7.0
1,2,3,4,6,7,8,9-OCDD	100	73.7
Total dioxin and dioxin-like compound concentration		**88.3**

Source: (Wiegand, 2005c).

5.3.3.1 Phase I Mills for Which EPA has Monitoring Data

Table 5-7 lists the Phase I mills that reported to TRI that they used monitoring data or direct measurements to estimate their discharges of dioxin and dioxin-like compounds. One mill, Domtar, Ashdown, AR, reported that its estimated 2002 discharge was based on an emission factor while its estimated 2003 discharge was based on monitoring data. Another mill, Boise, St. Helens, OR reported that it used measurement data to estimate its 2002 discharge but emission factors for 2003. All of the other mills listed in Table 5-7 reported using measurement data to estimate both 2002 and 2003 discharges.

Table 5-7. Phase I Mills that Reported Using Monitoring or Direct Measurements to Estimate TRI-Reported Releases

Facility	City, State	Phase	Grams Released (after POTW removal)	TWPE	Monitoring Data Provided to EPA
2002					
Bowater Inc.	Catawba, SC	I	3.66	217,867	Bowater provided mill final effluent data.
Weyerhaeuser	Kingsport, TN	I	2.17	3,894	Weyerhaeuser provided mill final effluent data.
Bowater Inc.	Calhoun, TN	I	0.85	1,528	Bowater provided mill final effluent data.
International Paper	Bastrop, LA	I	0.21	380	
Weyerhaeuser	Rothschild, WI	I	0.15	273	
International Paper	Queen City, TX	I	0.11	197	
New Page (was MW Custom Papers)	Chillicothe, OH	I	0.10	178	
Boise Cascade (City of St. Helens) [a]	Saint Helens, OR	I	0.69	163	Boise provided effluent data from copermitted POTW and mill water intake.
International Paper	Jay, ME	I	0.02	38	
Weyerhaeuser	Columbus, MS	I	0.00	3	
2003					
Domtar Industries Inc.	Ashdown, AR	I	40.12	1,511,611	Domtar based 2002 release estimate on emission factors. Provided bleach plant effluent data used to estimate 2003 final effluent discharge.

[a]Indirect discharger. Reported monitoring data or direct measurement used to estimate the mass of dioxin and dioxin-like compounds transferred to POTW.

EPA contacted the mills with the largest (in terms of TWPE) discharges of dioxin and dioxin-like compounds based on monitoring data or direct measurements (for 2002, Bowater, Catawba, SC; Weyerhaeuser, Kingsport, TN; and Bowater, Calhoun, TN; and for 2003, Domtar, Ashdown, AR). EPA also contacted Kimberly-Clark, Everett, WA, to learn more about how this mill calculated its TRI-reported discharges, which were the largest (in terms of TWPE) in the category in 2002 and the second largest in 2003.

As a result of its contacts, EPA obtained effluent monitoring data used as the basis of TRI reporting from five Phase I mills. Including Kimberly-Clark in Everett, WA, the mills EPA contacted contributed 91 percent of the 2002 TRI dioxin and dioxin-like compound TWPE for the category and 94 percent of the 2003 TRI dioxin and dioxin-like compound TWPE. Table 5-8 presents these data and the EPA Method 1613B ML for each dioxin congener. Of the concentrations presented in Table 5-8, only OCDD at Domtar's Ashdown, AR mill was measured at concentrations above the Method 1613B ML.

In addition to reported concentrations, Table 5-8 presents the calculated mass of all 17 dioxin and dioxin-like compounds discharged by each mill, the TCDD-equivalent grams discharged (grams TEQ) represented by those discharges, and the TWPE of those discharges.

EPA calculated the total mass of all 17 dioxin and dioxin-like compounds discharged by multiplying the concentrations in Table 5-8 by the mill-provided effluent flow and summing the results. EPA's calculated masses are the same as the masses mills reported to TRI. Because the 17 dioxin and dioxin-like compounds have widely varying toxicity, EPA used WHO toxic equivalency factors to calculate the grams TEQ. (See (U.S. EPA, 2004) for a discussion of toxic equivalency factors.) In addition, EPA used the TWFs presented in Table 3-1 to calculate the TWPE of the mill discharges of dioxin and dioxin-like compounds. The calculated grams TEQ and TWPE facilitate comparison of the mill discharges to each other and to other environmental sources of dioxin and dioxin-like compounds.

Table 5-8. Concentrations of Dioxin and Dioxin-Like Compounds in Phase I Mill Effluent Samples (pg/L)

Dioxin Congener 1613B ML	pg/L	2003; Domtar Ashdown, AR[a]	2002; Bowater, Catawba, SC	2002; Bowater Calhoun, TN[b]	2001; Boise, St. Helens, OR[b]	2002; Weyerhaeuser, Kingsport, TN[c]
Polychlorinated dibenzofurans (CDFs)						
2,3,7,8-TCDF	10	0	2.1	5.6	0	0
1,2,3,7,8-PeCDF	50	0	1.6	0	0	16
2,3,4,7,8-PeCDF	50	4.3	2.3	0	0	14
1,2,3,4,7,8-HxCDF	50	7.3	0	0	0	5.7
1,2,3,6,7,8-HxCDF	50	0	0	0	0	3.7
2,3,4,6,7,8-HxCDF	50	0	0	0	0	1.8
1,2,3,7,8,9-HxCDF	50	5.9	0	0	0	0
1,2,3,4,6,7,8-HpCDF	50	5.8	7.9	0	5.0	3.1
1,2,3,4,7,8,9-HpCDF	50	0	0	0	2.1	1.7
1,2,3,4,6,7,8,9-OCDF	100	0	16.5	9.3	0	6.4
Polychlorinated dibenzo-p-dioxins (CDDs)						
2,3,7,8-TCDD	10	0	2.7	0	0	0
1,2,3,7,8-PeCDD	50	8.5	0	0	0	0
1,2,3,4,7,8-HxCDD	50	0	0	0	0	0
1,2,3,6,7,8-HxCDD	50	0	0	0	0	0
1,2,3,7,8,9-HxCDD	50	6.6	0	0	0	0
1,2,3,4,6,7,8-HpCDD	50	24.1	27.1	0	10.5	6.2
1,2,3,4,6,7,8,9-OCDD	100	446[d]	61.7	0	92.5	50
Grams/year		40.11	3.66	0.85	4.08[e] (0.69)[f]	2.17
Grams TEQ/year		1.024	0.135	0.004	0.007[e] (0.001)[f]	0.010
TWPE/year		1,511,611	217,867	1,528	163[f]	3,894

[a]Bleach plant effluent.
[b]Intake water concentrations were subtracted from the reported concentrations.
[c]Weyerhaeuser also provided effluent sample analyses for 2003; no congeners in either 2002 or 2003 were measured above the EPA Method 1613B ML.
[d]Shaded cells identify concentrations greater than the Method 1613ML.
[e]Reported discharge transferred to POTW; EPA estimated that approximately 83 percent of dioxin and dioxin-like compounds are removed in a POTW. TWPE calculated after POTW removal.
[f]Pounds released to the environment accounting for POTW removal of dioxin and dioxin-like compounds transferred to POTWs.

5.3.3.2 Dioxin Congeners Measured in Effluent from Five Phase I Mills

Domtar, Ashdown, AR. Table 5-8 presents the concentrations measured in one sample of bleach plant effluent collected at Domtar, Ashdown, AR in 2003. Domtar reported releasing 1.78 grams of dioxin and dioxin-like compounds in 2002, calculated using the NCASI emission factor, and releasing 40.118 grams in 2003, based on one sample of bleach plant effluent. As shown in Table 5-8, TCDD and TCDF were not detected in the sample of bleach plant effluent, which meets the bleached papergrade kraft BAT limitations guideline. Of the congeners detected in the Domtar mill effluent, only OCDD was detected at concentrations above the EPA Method 1613B ML. Domtar's estimated release does not account for any removal of dioxin and dioxin-like compounds that may occur in the mill's biological treatment system.

Bowater, Catawba, SC. Table 5-8 presents data collected by the Bowater, Catawba, SC mill in 2002 (Wiegand, 2005g; Henrendeen, 2006a). As shown in Table 5-2 and discussed in Section 5.2.3, Bowater detected TCDD in its mill effluent at a concentration of 83.6 pg/L in one of three samples collected in 2002. EPA contacted Bowater to discuss why the concentrations presented in Table 5-8 and used as the basis for its TRI estimate are different than the concentrations used for permit compliance monitoring. Bowater explained that based on past testing for dioxin and dioxin-like compounds and engineering judgment, the mill determined that the congener profile presented in Table 5-8 best represented its 2002 annual discharges (Herendeen, 2006b). No dioxin and dioxin-like compounds were measured above the EPA Method 1613B ML.

Bowater, Calhoun, TN. The data in Table 5-8 for Bowater, Calhoun, TN are the dioxin and dioxin-like compounds measured in the final effluent minus concentrations in the intake water. Intake water data are an average of four sampling events conducted in 1995 and 1996. The effluent sample was taken at the mill effluent in 2000 after the mill converted from chlorine/chlorine dioxide bleaching to 100 percent chlorine dioxide bleaching. No dioxin and dioxin-like compounds were measured above the EPA Method 1613B ML.

Boise, St. Helens, OR. The Boise mill in St. Helens, OR discharges its wastewater to the City of Saint Helens POTW. Mill effluent accounts for approximately 95 percent of the wastewater received by the POTW. On February 9, 2004, the state issued a joint NPDES permit to the mill and POTW. Dioxin and dioxin-like compounds discharges reported to TRI for 2002 were based on sample data collected at the mill in 2001. Concentrations of dioxin and dioxin-like compounds presented in Table 5-8 for the Boise mill correspond to the concentrations it used to calculate the discharges it reported to TRI. These concentrations were measured in the effluent from the mill to the POTW, minus estimated concentrations in the intake water (Lange, 2005c). The mill was involved in NCASI data collection to estimate the dioxin emission factor in *The SARA Handbook* (NCASI, 2005) described in Section 5.3.2. No dioxin and dioxin-like compounds were measured above the EPA Method 1613B ML.

Weyerhaeuser, Kingsport, TN. Table 5-8 also presents data collected by the Weyerhaeuser, Kingsport, TN mill. The mill's NPDES permit requires that Weyerhaeuser measure and report a congener distribution in the final effluent and bleach plant. The mill provided a total of four effluent analyses for 2002 and 2003. No dioxin and dioxin-like compounds were measured above the EPA Method 1613B ML.

5.3.3.3 Percentage of TWPE Based on Measurements Above the Method 1613B ML

As discussed above, EPA obtained the monitoring data that five Phase I mills used to estimate the discharges of dioxin and dioxin-like compounds they reported to TRI. Using congener concentrations provided by the mills and NCASI and presented in Table 5-8, EPA estimates that these five mills discharge 1.8 million TWPE per year. EPA recalculated the TWPE assuming that concentrations reported less than the Method 1613B ML were equal to zero. Because there is more uncertainty in quantifying a concentration measurement when it is below the method's minimum level, the assumption that concentrations less than the ML are zero provides a lower-bounds estimate of the TWPE discharged by these mills. Both sets of calculated TWPE are presented in Table 5-9. If only concentrations that exceed the Method 1613B ML are used to calculate the TWPE, the estimated discharge for these five mills is only 582 TWPE. Thus, more than 99.9 percent of the TWPE for these five mills is based on congener concentrations measured below the Method 1613B ML.

Furthermore, as presented in Table 5-6, the average concentrations that are the basis for NCASI's emission factor for elemental chlorine-free (ECF) bleaching chemical pulp mills (i.e., Phase I mills) are all less than the Method 1613B MLs. Almost 50 percent of the mills that reported releases to TRI estimated their releases using emission factors. Consequently, EPA concludes that there is substantial uncertainty about the magnitude of the TRI-reported dioxin and dioxin-like compounds discharges from facilities in the Pulp and Paper Category. For this reason, the TRI-reported discharges may not accurately reflect current industry discharges.

Table 5-9. Mass, TEQ, and TWPE of Dioxin and Dioxin-Like Compounds for Mills Providing Individual Congener Concentrations

Mill	TRI Reporting Year	Discharges Calculated Using Lab-Reported Concentrations			Discharges Calculated Assuming Concentrations Reported Less than Method 1613B ML Equal Zero		
		grams/year	TEQ/year	TWPE	grams/year	TEQ/year	TWPE
Domtar, Ashdown, AR	2003	40.11	1.024	1,511,611	35.18	0.004	582
Bowater, Catawba, SC	2002	3.66	0.135	217,867	0	0	0
Bowater, Calhoun, TN	2002	0.85	0.004	1,528	0	0	0
Boise, St. Helens, OR	2002	4.08	0.007	163	0	0	0
Weyerhaeuser, Kingsport, TN	2002	2.17	0.010	3,894	0	0	0
Total for Five Mills				**1.8 million**			**582**

5.3.3.4 Kimberly-Clark, Everett, Washington

K-C operates a Phase I ammonium sulfite mill in Everett, Washington. The mill reported final effluent discharges of dioxin and dioxin-like compounds to TRI: 8.19 g in 2002 and 3.001 g in 2003. These discharges represent the largest (in terms of TWPE) discharges of dioxin and dioxin-like compounds in the category in 2002 and the second largest in 2003. EPA believes that K-C's discharges of dioxin and dioxin-like compounds are not representative of the category because the TWPE discharged is much larger than other mills, and the dioxin and dioxin-like compounds likely originate from atypical discharges of waste wood boiler ash[10].

[10] K-C bleach plant effluent concentrations of TCDF are discussed earlier in this section. Although K-C told EPA it believes its waste wood ash discharges are the principal source of dioxin and dioxin-like compounds released to water from the mill, the bleach plant effluent TCDF concentrations may also contribute to the final mill effluent load of dioxin and dioxin-like compounds.

K-C reported that it calculated its TRI-reported releases based on a bleach plant effluent emission factor and estimates of the dioxin and dioxin-like compounds contributed by its hog fuel (waste wood) boiler's fly ash handling system. According to K-C, the hog fuel boiler's baghouse ash system is the principal source of the dioxin and dioxin-like compounds released to water. The mill reported that ash releases are primarily from fugitive baghouse ash with an additional contribution from ash clarifier overflow. K-C did not explain how dry, fugitive baghouse ash is discharged in the mill final effluent. According to K-C, the relatively low-flow ash clarifier overflow stream has been found to contain low concentrations of dioxin and dioxin-like compounds (Ketchum, 2006a; 2006b).

K-C explained that the discharge reported to TRI for 2003 was lower than the 2002 discharge due to "improved performance (uptime) of the hog fuel boiler's ash handling system," (Ketchum, 2006a). To a lesser extent, the mill also attributed the reduced estimate to a change in its estimated bleach plant emission factor. K-C did not provide the results of analysis of its bleach plant effluent or any other wastewaters. Consequently, EPA could not determine how much, if any, of K-C's estimated releases derived from measurements less than the Method 1613B ML.

K-C's investigations into its discharges of dioxin and dioxin-like compounds suggested to the mill that salt-laden hog fuel may be a key component of dioxin and dioxin-like compounds formation. Logs transported by floating in seawater have relatively high concentrations of sodium chloride and the extra chloride in the hog fuel boiler can lead to the formation of dioxin and dioxin-like compounds (Uloth, 2003).

EPA contacted Washington Department of Ecology to learn if Washington State mills typically use sea-floated logs, or if this practice is unique to K-C, Everett. Don Nelson reported that no Washington State mills directly receive sea-floated logs, but K-C in Everett has an off-site chip facility that probably receives sea-floated logs. Mr. Nelson also reported that many Washington State mills buy chips from Canada that may be made from sea-floated logs (Lange, 2006a). The practice of sea-floating logs is more common in North America's Pacific Northwest than in the rest of the United States.

Using K-C's reported congener discharges, EPA calculated the TWPE and TEQ of its TRI-reported discharges using the same methods described above. Table 5-10 summarizes the reported mass discharge, TEQ, and TWPE.

Table 5-10. Mass, TEQ, and TWPE of Dioxin and Dioxin-Like Compounds Estimated Discharges from Kimberly-Clark, Everett, Washington (as Reported to TRI)

Year	grams/year	TEQ/year	TWPE/year
2002	8.190	0.765	1,104,866
2003	3.0	0.321	472,778

5.3.4 Phase II Mill Discharges of Dioxin and Dioxin-Like Compounds

This subsection describes monitoring data that two Phase II mills used to estimate their TRI releases and the specific congeners detected in their effluents. Discharges from these two mills account for 38.8 percent of the TWPE for Phase II mill dioxin and dioxin-like compound 2002 discharges.

5.3.4.1 Phase II Mills for Which EPA has Monitoring Data

Table 5-11 lists the five Phase II mills that reported to TRI that they used monitoring data or direct measurements to estimate the discharges of dioxin and dioxin-like compounds.

NCASI contacted 9 of the 10 mills that reported the largest (in terms of TWPE) 2002 discharges of dioxin and dioxin-like compounds. This included Blandin Paper, Grand Rapids, MN and Nippon, Port Angeles, WA (U.S. EPA, 2005b; Wiegand, 2006). Table 5-12 presents the effluent monitoring data these mills used as the basis of their 2002 TRI discharge estimates. Concentrations for three congeners (1,2,3,4,6,7,8-HpCDF, OCDF, and OCDD) measured at the Blandin Paper Co. mill were measured at concentrations above the Method 1613B ML.

Table 5-11. Phase II Mills that Reported Using Monitoring or Direct Measurements to Estimate TRI-Reported Releases

Facility	City, State	Grams Released (after POTW removal)	TWPE	Monitoring Data Provided to EPA
2002				
Blandin Paper Co.[a]	Grand Rapids, MN	3.20	86	Blandin provided influent to wastewater treatment data and method for calculating estimated transfer to POTW.
Nippon (was Daishowa America)	Port Angeles, WA	1.82	290	Nippon provided mill final effluent.
Buckeye Lumberton Inc.	Lumberton, NC	0.10	180	EPA contacted mill but it could not provide the monitoring data used to calculate the 2002 discharge.
Marcal Paper Mills[a]	Elmwood Park, NJ	0.01	22	Marcal routinely monitors wastewater solids for dioxin and dioxin-like compounds but not wastewater. Estimated discharges based on effluent solids load and concentration in solids.
Smart Papers LLC[a]	Hamilton, OH	0.00	0.3	Analyzed wastewater solids, not wastewater. Dioxin and dioxin-like compounds not detected in solids, estimated discharge based on solids detection limit and effluent solids load.

[a]Indirect discharger. Reported monitoring data or direct measurement used to estimate the mass of dioxin and dioxin-like compounds transferred to POTW.

Table 5-12. Concentrations of Dioxin and Dioxin-Like Compounds in Phase II Effluent Samples (pg/L)

Dioxin Congener	1613B ML pg/L	5/15/02 Blandin, MN	12/31/02 Blandin, MN	2002; Nippon Pt Angeles, WA
Polychlorinated dibenzofurans (CDFs)				
2,3,7,8-TCDF	10	0	0	0
1,2,3,7,8-PeCDF	50	0	0	0
2,3,4,7,8-PeCDF	50	0	0	0
1,2,3,4,7,8-HxCDF	50	0	0	0
1,2,3,6,7,8-HxCDF	50	0	0	0
2,3,4,6,7,8-HxCDF	50	0	0	0
1,2,3,7,8,9-HxCDF	50	0	0	0
1,2,3,4,6,7,8-HpCDF	50	179[a]	226[a]	10.6
1,2,3,4,7,8,9-HpCDF	50	0	0	0
1,2,3,4,6,7,8,9-OCDF	100	1,050[a]	1,760[a]	27
Polychlorinated dibenzo-p-dioxins (CDDs)				
2,3,7,8-TCDD	10	0	0	0
1,2,3,7,8-PeCDD	50	0	0	0
1,2,3,4,7,8-HxCDD	50	0	0	0
1,2,3,6,7,8-HxCDD	50	0	0	0
1,2,3,7,8,9-HxCDD	50	0	0	0
1,2,3,4,6,7,8-HpCDD	50	7.25	12.5	24.1
1,2,3,4,6,7,8,9-OCDD	100	211[a]	261[a]	97.6
Grams/year		18.8[b] (3.2)[c]		1.82
Grams TEQ/year		0.023[b] (0.004)[c]		0.004
TWPE/year		86[c]		290

[a]Shaded cells identify concentrations greater than the Method 1613B ML.
[b]Reported discharge transferred to POTW; EPA estimated that approximately 83 percent of dioxin and dioxin-like compounds are removed in a POTW. TWPE calculated after POTW removal.
[c]Pounds released to the environment accounting for POTW removal of metals transferred to POTWs.

5.3.4.2 Dioxin Congeners Measured in Effluent from Two Phase II Mills

Blandin Paper Co., Grand Rapids, MN. Blandin is a groundwood pulp mill that produces lightweight coated groundwood offset and rotogravure printing papers. The mill bleaches groundwood softwood pulp with hydrogen peroxide and sodium hydrosulfite (Lockwood-Post, 2001). This process is not known to generate dioxin and dioxin-like compounds. Discharges from Blandin are covered by Phase II Subparts G (Groundwood, Chemi-Mechanical, and Chemi-Thermo-Mechanical) and K (Fine and Lightweight Paper from Purchased Pulp). The mill treats its wastewater in an on-site biological treatment plant before discharging it to a joint industrial/municipal POTW (Lockwood-Post, 2001).

In materials provided to NCASI (Wiegand, 2005h), Blandin explained that it calculated its releases of dioxin and dioxin-like compounds using concentrations measured in the influent to its wastewater treatment plant on 5/15/2002 and 12/31/2002. It averaged the two days' measurements for each congener, summed the average congener concentrations, and multiplied by a flow of 9.6 MGD (3,504 MGY). The resulting gross discharge was 24.58 g/year of dioxin and dioxin-like compounds.

From this gross discharge, Blandin subtracted mass contributions from raw water and from the solids influent to its wastewater treatment plant. The mill calculated the raw water load using NCASI *SARA Handbook* Table 17 (NCASI, 2005), raw water concentrations, and an estimated intake of 9.6 MGD. The resulting load from the raw water was 0.71 g/year of dioxin and dioxin-like compounds.

Blandin's measured concentrations represent the influent to its wastewater treatment plant. This wastewater receives further treatment, including solids removal, prior to discharge to the POTW. Therefore, to estimate the mass of dioxin and dioxin-like compounds transferred to the POTW, Blandin subtracted the amount of dioxin and dioxin-like compounds in the solids entering its wastewater treatment plant. The calculated load from solids was 5.00 grams/year. The net discharge for 2002 was 24.58 – 0.71 – 5.00 = 18.8 g/year.

Blandin reported to TRI transferring dioxin and dioxin-like compounds to their POTW in 2002 and 2003. They reported transferring 18.8 grams in 2002, more than any other facility in the category. They reported transferring 13 grams in 2003; only Domtar, Ashdown, AR reported discharging a greater mass of dioxin and dioxin-like compounds in 2003. Although the total mass of the congeners discharged is relatively high, the TWPE is low because the congeners detected in the Blandin wastewater have relatively low toxicity. Furthermore, EPA assumes that approximately 83 percent of the dioxin and dioxin-like compounds will be removed in the POTW.

The sources of the dioxin and dioxin-like compounds measured in the Blandin mill wastewater are unknown. Chlorine bleaching is not the source because the mill does not bleach with chlorine.

Nippon, Port Angeles, WA. Nippon (formerly Daishowa America Co. Ltd.) is a groundwood pulp mill that produces directory- and specialty-groundwood-grade papers. Discharges from Nippon operations are covered by Phase II Subparts G (Groundwood, Chemi-Mechanical, and Chemi-Thermo-Mechanical) and I (Secondary Fiber Deink). The mill bleaches groundwood pulp and secondary fiber with hydrosulfite, a process not known to generate dioxin and dioxin-like compounds. Nippon treats its wastewater in an activated sludge treatment system before discharge to the Strait of Juan de Fuca (Lockwood-Post, 2001). The mill based its reported 2002 discharges on the concentrations of dioxin and dioxin-like compounds measured in a single effluent sample collected on November 9, 2000. NCASI provided these data to EPA in a letter dated January 4, 2006 (Wiegand, 2006).

EPA estimated that Blandin, Grand Rapids, MN and Nippon, Port Angeles, WA discharge only 376 TWPE per year, due to the low TWF for the congeners they detected in their effluents. EPA recalculated the TWPE assuming that concentrations reported less than the Method 1613B ML were equal to zero. EPA found the recalculated discharge for these two mills is only 82 TWPE. Thus, more than 78 percent of the TWPE for these two mills is based on congener concentrations measured below the Method 1613B ML.

5.3.5 Summary of Data Reported to TRI

In its review of the dioxin and dioxin-like compound monitoring data reported by pulp and paper mills to TRI, EPA found:

- Sixty-one mills reported discharging dioxin and dioxin-like compounds in 2002 (47 Phase I and 14 Phase II mills) to TRI. Of these 61 mills, 15 indicated that their reported discharges were based on monitoring data or direct measurement. Similarly 15 of the 59 mills that reported releases in 2003 reported estimating discharges using monitoring data.

- Twenty-seven of the 61 mills that reported releases of dioxin and dioxin-like compounds in 2002 reported that they used emission factors to estimate their releases. Similarly, 26 of 59 mills that reported releases in 2003 reported they used emission factors.

- Mills contacted by NCASI reported the emission factors they used were dioxin and dioxin-like compound concentrations from *Table 14 PCDD/F Concentrations in Eight ECF Bleached Chemical Pulp Mill Treated Effluents.* However, these concentrations were based on monitoring data for which all average congener concentrations are less than the Method 1613B ML. Of the concentration data for individual mills comprising the averages, only two measurements of OCDD were above the Method 1613B ML.

- EPA obtained monitoring data used by five Phase I mills to estimate the discharges of dioxin and dioxin-like compounds they reported to TRI and estimated that these five mills discharge 1.8 million TWPE per year. EPA recalculated the TWPE assuming that concentrations reported less than the Method 1613B ML were equal to zero. EPA found the recalculated discharge for these five mills is only 582 TWPE. Thus, more than 99.9 percent of the TWPE for these five mills is based on congener concentrations measured below the Method 1613B ML.

- One mill, K-C, Everett, WA reported the largest discharges (in terms of TWPE) in 2002 and the second largest in 2003. EPA believes that K-C's discharges of dioxin and dioxin-like compounds are not representative of the category as a whole because the TWPE discharged is much larger than other mills, and the dioxin and dioxin-like compounds likely originate from atypical discharges of waste wood boiler ash.

- EPA obtained monitoring data used by two Phase II mills to estimate the discharges of dioxin and dioxin-like compounds they reported to TRI and estimated that these two mills discharge 376 TWPE per year. EPA recalculated the TWPE assuming that concentrations reported less than the Method 1613B ML were equal to zero. EPA found the recalculated discharge for these seven mills is only 82 TWPE. Thus, more than 78 percent of the TWPE for these two mills is based on congener concentrations measured below the Method 1613B ML.

With only one exception, the TRI-reported discharges for Phase I mills for which EPA obtained congener-specific measurement data are below the Method 1613B ML. The exception is the concentration of OCDD measured in one Phase I mill's bleach plant effluent. Also, the congener-specific measurement data that NCASI used to develop an emission factor for water discharges from 100 percent chlorine dioxide bleaching Phase I pulp mills are below the Method 1613B ML.

Similarly, the TRI-reported discharges for the Phase II mills for which EPA obtained congener-specific measurement data are below the Method 1613B ML, with the exception of three (1,2,3,4,6,7,8-HpCDF, OCDF, and OCDD) measured in one Phase II mill's effluent. However, due to the low TWFs for these congeners, EPA estimated that this mill discharged only 86 TWPE.

The vast majority of data underlying the estimated releases of dioxin and dioxin-like compounds reported to TRI is based on pollutant concentrations below the Method 1613B MLs. TRI-reported discharges of dioxin and dioxin-like compounds for this category do not accurately reflect current industry discharges.

5.4 Background Concentrations of Dioxin and Dioxin-Like Compounds

Dioxin and dioxin-like compounds are anthropogenic (man-made) chemicals that do not occur naturally in the environment. Even though these chemicals do not occur naturally, they are frequently found in soil, surface water, and lake and stream sediments. Sources of dioxin and dioxin-like compounds in surface water and sediments include industrial and municipal wastewater discharges and atmospheric deposition. EPA's *Dioxin Reassessment* (U.S. EPA, 2003b) includes a summary of dioxin and dioxin-like compounds concentrations in sediment. Among other studies, the *Dioxin Reassessment* presents the results of a time-trend study of dioxin-like compounds in sediment cores (Versar, 1996; Cleverly, 1996). Sediments from 11 lakes/reservoirs located throughout the United States were selected to represent background conditions (i.e., sites with no known sources of dioxin and dioxin-like compounds). Based on the most recently deposited sediments, total TEQ $–WHO_{98}$ concentrations ranged from 0.12 parts per trillion (ppt) to 16.3 ppt.

The concentrations of dioxin and dioxin-like compounds in pulp and paper mill effluents are measured as pg/L. To compare these concentrations to the sediment concentrations, EPA assumed that the effluents contain 30 mg total suspended solids (TSS)/liter and further assumed that all discharged dioxin and dioxin-like compounds are associated with the TSS. Table 5-13 compares the TEQ concentrations of the discharges from the two Phase II mills that provided effluent congener concentration data. The table shows the annual TEQ discharge from the two mills (in grams per year) and the calculated annual TSS discharge (in trillion grams per year). The table also shows the TEQ concentration of the mill discharges and background sediments (in ppt). Phase I mill effluents are not included in this comparison because EPA has no data showing that Phase I mill effluents contain dioxin and dioxin-like compounds in concentrations above the Method 1613B MLs. (The Domtar, Ashdown, AR sample in which OCDD was detected above the Method 1613B ML was a sample of bleach plant effluent.)

Table 5-13. Comparison of Mill Discharge Concentrations and Background Sediment Concentrations, Dioxin and Dioxin-Like Compounds, TEQ (ppt)

Dioxin and Dioxin-Like Compounds Source	Treated Effluent Discharge (g TEQ/year)	Estimated TSS Discharge (trillion g/year)[b]	TEQ (ppt)
Blandin, MN	0.004[a]	3.98×10^{-4}	10.0
Nippon, WA	0.004	3.43×10^{-4}	11.9
Background Sediment[c]	-	-	0.12 to 16.3

[a]As discharged to the environment, assuming 83 percent POTW removal.
[b]Assumes 30 mg TSS/L. Blandin discharge is 3,504 MGY; Nippon discharge is 3,022 MGY.
[c]Versar, 1996; Cleverly et al., 1996. As cited in U.S. EPA, 2003.

EPA's calculated mill effluent TEQ concentrations (10.0 and 11.9 ppt) fall in the range of concentrations of background sediment.

The distribution of dioxin congeners in contaminated media is characteristic of the source of the contamination. For example, chlorine bleaching of chemical pulps will generate TCDD and TCDF. EPA's dioxin reassessment describes the sediment samples taken from Siskiwit Lake, on Isle Royale, Lake Superior. The atmosphere is the only source of anthropogenic chemicals in Siskiwit Lake. Researchers (Czuczwa et al., 1984, as cited in U.S. EPA, 2003) found that in Siskiwit Lake sediment, OCDD was the most predominant congener, and HpCDD and HpCDF congeners were also abundant. Rappe et al. (1997, as cited in U.S. EPA, 2003) studied sediment samples from 15 southern Mississippi lakes not known to be impacted by industrial point sources of dioxin and dioxin-like compounds. They found that HpCDDs and OCDD were the predominant congeners in sediments from these lakes. Table 5-14 compares the relative abundance of dioxin congeners from these two studies of pristine lake sediments and the two Phase II mills that provided effluent congener concentration data.

Table 5-14. Comparison of Relative Abundance of Dioxin Congeners

Dioxin and Dioxin-Like Compounds Source	Most Predominant Congeners	Other Abundant Congeners
Siskiwit Lake Sediments[a]	OCDD	HpCDDs and HpCDFs
Mississippi Lake Sediments[b]	OCDD and HpCDDs	-
Nippon, Port Angeles, WA[c]	OCDD	HpCDD and HpCDF
Blandin, Grand Rapids, MN	OCDF	OCDD and HpCDFs

[a]Czuczwa, et al., 1984, as cited in U.S. EPA, 2003.
[b]Rappe, et al., 1997, as cited in U.S. EPA, 2003.
[c]Concentrations in Nippon effluent were less than the Method 1613B ML.

The distribution of congeners detected in the Nippon mill effluent is the same as the distribution in Siskiwit Lake sediments. This suggests that the dioxin and dioxin-like compounds in the mill effluent may have the same source as the lake sediments. The distribution of congeners detected in the Blandin mill effluent differs from the distribution in lake sediment, with OCDF rather than OCDD the most predominant congener. However, congeners detected in Blandin mill effluent are, like those in lake sediments, the lowest toxicity congeners.

5.5 Detailed Study Findings for Dioxin and Dioxin-Like Compounds

EPA conducted a detailed study of the Pulp, Paper, and Paperboard Category, in part, to determine:

- If the existing ELGs for discharges of TCDD and TCDF from mills with operations in Subparts B and E (Phase I) should be revised; and
- If existing ELGs for the Phase II subcategories should be revised to control discharges of TCDD, TCDF, or other dioxin and dioxin-like compounds.

In 1998, EPA established ELGS for TCDD and TCDF for Phase I mills and required that mills demonstrate compliance with these guidelines at mill bleach plant effluent. NPDES permit monitoring data show that as of 2004, bleach plant effluent concentrations meet the guidelines established in EPA's 1998 rulemaking.

Both Phase I and Phase II mills report estimated releases of dioxin and dioxin-like compounds, including TCDD, TCDF, and 15 other congeners, to TRI. However, the vast majority of data underlying the estimated releases of dioxin and dioxin-like compounds reported to TRI is based on pollutant concentrations below the Method 1613B MLs. For this reason, there is substantial uncertainty about the magnitude of these discharges from facilities in the Pulp and Paper Category. TRI-reported discharges of dioxin and dioxin-like compounds for this category are most likely significantly overestimated, and thus do not accurately reflect current industry discharges.

Estimates of TCDD and TCDF discharge loads based on information in PCS reflect actual measurement data and likely more accurately reflect discharges for Phase I mills. However, operations for some mills changed after 2002 such that 2004 data more accurately reflect the current industry discharges. PCS data for 2004 show:

- TCDD was not detected in bleach plant effluent or mill final effluent.
- TCDF was not detected in mill final effluent.

- TCDF was detected in concentrations greater than the Method 1613 ML in bleach plant effluent at only 2 of the 49 mills for which EPA has data. Four other mills reported their bleach plant effluent concentration as <31.9 pg/L, so EPA could not determine if TCDF was detected above the Method 1613B ML. All mills met the Cluster Rules ELGs.

For the two Phase II mills for which EPA has dioxin congener data, EPA's calculated mill effluent TEQ concentrations (10.0 and 11.9 ppt) fall in the range of concentrations of background sediment from lakes not known to be impacted by industrial point sources of dioxin and dioxin-like compounds. The distribution of congeners detected in one Phase II mill effluent is the same as the distribution in sediments from a lake for which the atmosphere is the only source of dioxin and dioxin-like compounds. The distribution of congeners detected in the other mill's effluent differs from the distribution in lake sediment, but, like the congeners in lake sediments, the only congeners detected in the mill's effluent are the lowest toxicity congeners. The dioxin and dioxin-like compounds detected in Phase II mill effluent are similar in type and concentration to the dioxin and dioxin-like compounds detected in uncontaminated surface water sediments.

6.0 METALS

The Pulp and Paper Category ranked higher than any other category in EPA's 2005 and 2006 screening-level reviews of discharges from industrial categories. The high ranking of this category is primarily due to discharges of dioxin and dioxin-like compounds, but metals rank second in their contribution to the total category toxic discharges. For this reason, EPA conducted an analysis of metals discharges from pulp and paper mills to answer the following questions:

- What quantity of metals is discharged in pulp and paper mill effluents and which metals contribute the majority of TWPE?
- How do the concentrations of metals in mill effluents compare to analytical method minimum levels and mill intake water concentrations?
- What effluent treatment technologies are used to control metals discharged from pulp and paper mills?
- What pollution prevention strategies are available to permit writers to address mill-specific metals discharge issues?

6.1 Annual Loads from the Screening-Level Analysis

Table 6-1 lists metals discharges from pulp and paper mills calculated from EPA's PCS and TRI databases. The table presents the number of mills that reported discharges of each metal, the total TWPE for each metal discharged in 2002, and the percentage of the total category TWPE contributed by discharges of the metal. The table includes metals that contributed more than 0.1 percent of the total category TWPE reported to either database. Discharge data for some metals may not be included in both databases. For example, because TRI does not require facilities to report releases of aluminum compounds, no TRI aluminum discharges are listed in Table 6-1. PCS contains permit-required monitoring data for direct-discharging facilities. Each mill's NPDES permit specifies the pollutants to monitor and at what frequency.

Table 6-1. Metals Discharge Loads in *PCSLoads2002_v4* and *TRIReleases2002_v4* from Phase I and Phase II Pulp and Paper Mills

		PCSLoads2002			TRIReleases2002		
	TWF	Number of Facilities Reporting	Category TWPE	Percent of PCS Category TWPE (%)	Number of Facilities Reporting	Category TWPE	Percent of TRI Category TWPE (%)
Manganese	0.070	4	287	0.02%	112	303,729	15.38%
Aluminum	0.065	29	92,205	5.99%	—	—	—
Lead	2.24	12	2,299	0.15%	186	66,240	3.35%
Zinc	0.047	48	2,879	0.19%	72	14,520	0.74%
Mercury	117.1	15	6,838	0.44%	74	7,251	0.37%
Copper	0.635	44	5,496	0.36%	10	2,516	0.13%
Arsenic	4.04	6	4,410	0.29%	1	1,010	0.05%
Cadmium	23.1	5	3,555	0.23%	—	—	—
Chromium, Hexavalent	0.517	1	2,059	0.13%	—	—	—
Chromium	0.076	9	1,982	0.13%	8	230	0.01%
Subtotal, Metals		90	123,047	8.12%	206	398,313	20.11%
Category Total, All Pollutants		**257**	**1,538,130**		**257**	**1,952,130**	

Source: *PCSLoads2002_v4*; *TRIReleases2002_v4*.
— No data available.

The remainder of this section focuses on the metals listed in Table 6-1. These metals represent 99.3 percent of the TWPE of metals reported released to TRI, and 99.2 percent of the TWPE of metals for which PCS includes monitoring data.

6.2 Metals Concentrations in Mill Effluent and Mill Intake

EPA collected information about the concentrations of metals in pulp and paper mill discharges. EPA then compared these discharge concentrations to analytical method minimum levels (MLs)[11] and the concentrations found in mill intake waters. This subsection identifies the data sources EPA used for this review. It also presents typical mill effluent metals concentrations and compares median mill effluent concentrations to analytical method minimum levels and to intake water metals concentrations. This section also presents a summary of the conclusions EPA reached regarding metals discharges during the development of the 1993 proposed ELGs for the Pulp and Paper Category.

[11] The minimum level (ML) is the concentration at which the analytical system gives recognizable signals and an acceptable calibration point.

6.2.1 Data Sources

EPA collected mill effluent concentration data from three sources: technical bulletins published by NCASI, a nonprofit research institute funded by North American forest products companies; NPDES Permit Renewal Application (Form 2C) data; and PCS monthly data for Phase I mills. EPA had previously collected the Phase I mill monthly data for its review of the implementation of the 1998 guidelines revisions.

6.2.1.1 NCASI Data

NCASI maintains a database of wastewater pollutant concentrations from pulp and paper mills. Effluent metals concentrations from the database are presented in NCASI Technical Bulletin 756 (NCASI, 1998) and are listed in Table 6-2. These data combine discharge information from many mills using either activated sludge or aerated stabilization basins to provide secondary treatment (NCASI, 1998). Information is not readily available on the number of mills included in the NCASI database, nor the data quality control procedures NCASI used. For example, NCASI did not report how they used values reported as “not detected” to calculate median concentrations.

6.2.1.2 NPDES Permit Application (Form 2C) Data

When mills file applications for new or revised NPDES permits, they must complete a Form 2C, which requires analyses of certain pollutants, some of which are metals. Effluent data requirements vary depending on the types of pollutants the permitting authority expects to be present in a mill’s wastewater. Mills are not required to identify the analytical method used to conduct the pollutant analyses.

EPA obtained copies of Form 2Cs from 18 of the 68 direct discharging Phase I mills and 10 of the 118 direct discharging Phase II mills. International Paper (IP) provided EPA with Form 2Cs or the associated analytical data for 22 of its 23 mills, all located east of the Rocky Mountains. In addition, EPA received Form 2Cs for another six mills in Pennsylvania and South Carolina. Seven of the mills for which EPA collected Form 2C data also reported their intake water metals concentrations. Median mill effluent concentrations are reported in

Table 6-2; only the detected values are included in the median. The mill intake concentrations obtained are reported in Table 6-3. The Form 2C data are representative of mills in the Eastern United States only (e.g., data do not represent mills from Washington or Oregon).

6.2.1.3 PCS Data

The PCS system contains permit-required monitoring data for direct dischargers. As required by their permits, mills file Discharge Monitoring Reports (DMRs) with the state once a month (or at other specified frequencies). Each mill's NPDES permit specifies the pollutants to monitor and the monitoring frequency. States are responsible for entering DMR data into EPA's PCS database. In 2005, EPA evaluated the implementation of its 1998 effluent guidelines revisions and reported the results in EPA's *Preliminary Report: Pulp, Paper, and Paperboard Detailed Study* (U.S. EPA, 2005b). As part of the evaluation, EPA retrieved monthly data for all Phase I mills reporting to PCS. EPA reviewed that data as part of the analysis presented here. Thirty-four mills reported concentration data for metals discharges out of the 72 Phase I mills for which data have been reported to PCS. Twenty-three of these mills detected concentrations of at least one of the metals EPA included in this analysis. These 23 mills are located in 15 states, including one mill located west of the Rocky Mountains.

6.2.2 Mill Effluent Concentrations

Table 6-2 summarizes the metals concentration data EPA collected from all three sources. Metals are listed in alphabetical order. Table 6-2 includes the median metal concentration for each data source. EPA calculated the median concentration for the Form 2C and PCS data, while NCASI provided the median concentration for their data. EPA included only detected values in its median calculations. Table 6-2 also lists the number of mills reporting detectable concentrations of each metal from the Form 2C and PCS data.

Table 6-2. Median Concentration of Selected Metals in Pulp and Paper Mill Effluent, μg/L Total Metals

	Method Minimum Level[a]	NCASI Effluent (Median)	Form 2C Effluent Median (Mill Count)	PCS 2002 Median (Mill Count)	PCS 2002 Reported Nondetect (Mill Count)
Aluminum	50	—	1,338 (24)	1,147 (8)	5
Arsenic	20	—	10.0 (5)	1.6 (2)	2
Cadmium	2	6	0.54 (6)	0.60 (2)	1
Chromium, Total	10	63	6.1 (12)	23 (4)	1
Copper	10	20	6.9 (13)	15 (7)	6
Lead	20	—	16.8 (6)	1.1 (4)	4
Manganese	2	—	556 (22)	256 (2)	—
Mercury	0.2	0.6	0.1 (7)	0.01 (9)	4
Zinc	5	115	41 (22)	54 (10)	3

— No data available.
[a]Mercury, Method 245.1. All other metals on the table, Method 200.7.

The concentrations of most metals reported in Form 2C are within an order of magnitude of the concentrations reported in PCS 2002. NCASI concentrations are typically 2 to 10 times higher than the Form 2C or PCS concentrations.

As explained previously, EPA collected Form 2C data representing effluent from 28 mills, including 18 Phase I mills and 10 Phase II mills. In comparison, the PCS 2002 data represent 34 Phase I mills. Because the Form 2C data represent more types of mills (i.e., both Phase I and Phase II mills), EPA used the Form 2C data for comparison to analytical method minimum levels and to the concentrations achievable by effective treatment of metal-bearing wastewaters.

6.2.3 Comparison of Median Mill Effluent Concentration and Method Minimum Levels

There are multiple approved analytical methods for measuring metals concentrations in wastewater. These methods establish both the equipment and techniques for measuring the metal as well as the minimum concentration at which the target analytes can be reliably quantified. This ML is the concentration at which the analytical system gives recognizable signals and an acceptable calibration point. In other words, the ML represents the smallest quantity of a metal that can be reliably measured.

Facilities are not required to identify the analytical method used to measure the effluent pollutant concentrations that they report on Form 2Cs. Therefore, EPA does not know which methods and MLs are applicable to their analytical results. However, in the effluent guidelines program, EPA typically analyzes wastewater for metals using Method 245.1 for mercury and Method 200.7 for the other seven metals. For this reason, Table 6-2 compares the Methods 245.1 and 200.7 MLs to the median reported metals discharge concentrations.

Comparing method MLs to median effluent metals concentrations reveals that manganese and aluminum are discharged well above their respective MLs. The other six metals are discharged at concentrations near or below their respective MLs.

6.2.4 Form 2C Intake Water Metals Concentrations

In some cases, facilities face difficulty meeting water quality criteria because of the level of pollutants in their intake water. Under these conditions, mills may provide intake concentration data on their Form 2Cs. The permitting authority may allow credit in the NPDES permit for pollutants in intake water. Seven of the mills for which EPA collected Form 2C data also provided metals intake concentrations. These mills are located in Alabama, South Carolina, Mississippi, Pennsylvania, and Minnesota. Table 6-3 presents intake and effluent data for each of these mills.

With the exception of aluminum and manganese, the intake concentrations of the metals presented in Table 6-3 are generally greater than the median effluent concentrations. At three of the six mills providing intake and effluent concentrations for aluminum and at three of the seven mills providing intake and effluent concentrations for manganese, the intake concentration was greater than the effluent concentration.

Table 6-3. Comparison of Intake and Effluent Concentrations for Seven Mills Providing Intake Concentrations (μg/L)

	Form 2C Median Effluent Conc.	Mill 1		Mill 2		Mill 3		Mill 4		Mill 5		Mill 6		Mill 7	
		Intake	**Effluent**	**Intake**	**Effluent**	**Intake**	**Effluent**	**Intake**	**Effluent**	**Intake**	**Effluent**	**Intake**	**Effluent**	**Intake**	**Effluent**
Aluminum	1,338	50	440	90	1,970	2,100	750	28,300	1,820	5,300	1,170	—	617	220	310
Arsenic	10.0	—	—	—	—	46	37	—	—	—	—	—	1	—	—
Cadmium	0.54	—	—	—	—	0.3	0.2	—	—	—	—	—	—	—	—
Chromium, Total	6.1	—	—	—	—	15	12	—	—	5	0[a]	—	—	—	—
Copper	6.9	8.3	3.5	—	—	23	11	—	—	60	10	—	—	100	13
Lead	16.8	—	—	—	—	50	52	—	—	—	—	—	—	—	—
Manganese	556	6.3	200	1,090	1,090	260	980	2,880	730	100	91	22	71	150	530
Mercury	0.1	—	—			—	—	—	—	—	—	—	—	—	—
Zinc	41	—	—	480	40	300	60	—	18	50	13	20	20	58	110

[a]Mill reported a measurement of zero on Form 2C; neither the measurement method nor the detection limit were provided.
— No data available.

6.2.5 Wastewater Sample Data Collected by EPA to Support the 1993 Proposed Pulp Mill ELGs

While developing revisions to the Pulp and Paper Category regulations proposed in 1993, EPA collected data in an extensive sampling program. The sampling program comprised a series of short- and long-term sampling episodes at 19 separate facilities. EPA analyzed wastewater for a total of 443 pollutants including priority pollutants and other metals in samples collected from chemical pulp mills that bleach (i.e., mills in the Phase I and Phase III subcategories). These data were published in the 1993 Development Document for Proposed ELGs (U.S. EPA, 1993). For its proposal, EPA determined that 24 pollutants should be subject to limitations. These 24 pollutants did not include any metals, although manganese, aluminum, zinc, and mercury were detected in sampled wastewater. EPA determined that aluminum and manganese were not pollutants of concern because they were detected at concentrations not considered treatable with end-of-pipe treatment technologies suitable for large effluent flows. Aluminum was detected at a maximum concentration of 2,480 μg/L and manganese was detected at a maximum concentration of 2,660 μg/L. EPA determined that zinc, detected at a maximum concentration of 116 μg/L, was not a pollutant of concern because it was detected at higher concentrations in mill water supplies (i.e., intake) than in treated effluents[12]. Mercury was found in effluents from two of three mills sampled at a maximum concentration of 74 μg/L. However, EPA did not propose or establish effluent limitations for mercury.

6.2.6 Summary of Issues Related to Metals Concentrations

Below is a summary of the issues EPA found in reviewing the collected information about metals concentrations in pulp and paper mill discharges:

- EPA collected metals concentration data from NCASI references, Form 2C, and PCS. The quality control standards applied to the NCASI data are unknown.

[12] Prior to the 1993 proposed revisions, EPA had promulgated ELGs for zinc discharges from one Phase II subcategory (Groundwood, Chemi-Mechanical, Chemi-Thermo-Mechanical). Mills that use zinc hydrosulfite as a bleaching agent are subject to these regulations.

- EPA reviewed the Form 2C median concentration data and determined that only aluminum and manganese were present at concentrations well above their analytical method MLs.

- EPA has a limited amount of intake concentration data. In this limited data set, metals concentrations in the intake are often greater than effluent concentrations. Approximately half of the mills reporting both intake and effluent data for aluminum and manganese had higher concentrations of these metals in their intake than in their effluent.

- During the development of the proposed 1993 ELGs for the Pulp and Paper Category, EPA determined that aluminum and manganese were not pollutants of concern because they were detected at concentrations not considered treatable with end-of-pipe treatment technologies suitable for large effluent flows.

6.3 Metals Control Technologies Applied to Pulp and Paper Mill Wastewaters

EPA sought to identify technologies that have been applied at laboratory, pilot or full scale to remove metals from pulp and paper mill wastewaters. EPA's review of metals control technologies applied to pulp and paper mill wastewaters includes a review of NPDES permit requirements for metals, a summary of NCASI evaluation and bench-scale testing of metals removal technologies, and a summary of additional literature review of metals removal technologies.

6.3.1 NPDES Permit Requirements for Metals

EPA collected 92 permits for currently operating pulp and paper mills. Of these, 18 permits were for Phase II mills and 74 permits were for Phase I mills. EPA reviewed 15 of the 18 Phase II permits for requirements specific to metals. None of the permits for the Phase II mills included any requirements for the nine metals included in this review. EPA also reviewed permits for 15 Phase I mills for which PCS includes discharge data for at least one of the metals listed in Table 6-2 to PCS. These mills were located in 12 different states. EPA also reviewed a permit for one Phase I mill (International Paper, Quinnesec MI) that included specific mercury monitoring requirements, even though PCS did not include 2002 monitoring data for the mill.

Table 6-4 presents the number of pulp and paper mills with NPDES permit requirements for any of the nine metals that are the subject of this review. Table 6-4 also presents representative permit discharge limits. Some mills have limits written in terms of concentration (e.g., μg/L), some have limits written in terms of discharge loads (pounds/day), and some have limits written both as concentration and loads. Other permits include monitoring requirements, only, but do not limit the concentration or quantity of the discharge.

A comparison of the metals concentration limits listed in Table 6-4 to the median Form 2C effluent concentrations demonstrates that most of the nine metals reviewed are discharged at concentrations below existing water quality-based permit limits; lead and mercury are two exceptions. None of the permits reviewed included manganese limits, but permits for three mills had water quality-based limits for aluminum. However, the Form 2C median effluent concentration for aluminum is below the aluminum permit limits at all three of these mills.

Although several mills have monitoring requirements and discharge limits for some of the nine metals in Table 6-2, none operate a treatment system designed to remove metals from wastewater.

6.3.2 NCASI Evaluation and Bench-Scale Testing of Metals Removal Technologies

EPA prepared guidance for water quality criteria for arsenic (III), cadmium, copper, chromium (III and VI), mercury, nickel, and zinc as a result of its Great Lakes Initiative (GLI) process. NCASI conducted a series of studies to identify treatment processes able to reduce metals concentrations in pulp and paper mill discharges to levels that would comply with discharge limits based on EPA's water quality guidance for the Great Lakes system. This subsection summarizes NCASI's three-phased study.

Table 6-4. NPDES Permit Requirements for Nine Metals Identified in EPA's Review of 33 Phase I and Phase II Permits

Metal	Total Number of Mills with Metals Monitoring Requirements or Discharge Limits	Number of Mills Required to Monitor and Report Metal Concentrations (but do not have discharge limits)	Number of Mills with Discharge Limits	Representative Permit Discharge Limits	
				Concentration	Total Loads
Aluminum	3	—	3	Mill 1: 7,580 µg/l (daily max) 4,600 µg/l (monthly avg) Mill 2: 2,766 µg/l (monthly avg) Mill 3: 3,500 µg/l (instant max) 2,800 µg/l (daily max) 1,400 µg/l (monthly avg)	Mill 1: 1,587 lb/day (daily max) 963 lb/day (monthly avg) Mill 2: 784 lbs/day (monthly avg) Mill 3: None
Arsenic	3	2	1	report conc. (monthly avg)	0.82 lb/day (monthly avg)
Cadmium	3	1	2	Mill 1: 2.9 µg/l (daily max) Mill 2: 3.46 µg/l (daily max)	Mill 1: 0.64 lbs/day (daily max) Mill 2: None
Chromium, Total	3	1	2	Mill 1: None Mill 2: 1,730 µg/l (daily avg)	Mill 1: 6.5 lbs/day Mill 2: None
Copper	6	2	4	Mill 1: None Mill 2: None Mill 3: 73 µg/l (daily max) Mill 4: 18 µg/l (daily max)	Mill 1: 16 lbs/day Mill 2: 14.9 lb/day (daily max) Mill 3: 10.8 lb/day (daily max) Mill 4: 3.9 lb/day (daily max)
Lead	2	—	2	Mill 1: 5.87 µg/l (daily max) Mill 2: 7.4 µg/l (monthly avg)	Mill 1: None Mill 2: 1.6 lb/day (monthly avg)
Manganese	1	1	None	None	None
Mercury	13	10	3	Mill 1: 0.030 µg/l (monthly max) Mill 2: 0.030 µg/l (monthly max) Mill 3: 0.560 µg/l (daily max) 0.140 µg/l (weekly avg)	Mill 1: 0.0056 lbs/day (monthly max) Mill 2: 0.013 lb/day (monthly max) Mill 3: None
Zinc	8	5	3	Mill 1: None Mill 2: 135 µg/l (daily max) Mill 3: Limit dependant on hardness	Mill 1: 17 lbs/day Mill 2: None Mill 3: Limit dependant on hardness

6.3.2.1 NCASI Evaluation of Wastewater Treatment Technologies for Metals Removal

NCASI evaluated wastewater treatment technologies to identify feasible approaches for meeting the EPA GLI water quality criteria for six metals (arsenic, cadmium, chromium, mercury, nickel, and zinc). Results were presented in Technical Bulletin 756 (NCASI, 1998). NCASI evaluated the following major metals removal mechanisms: precipitation, adsorption, ion exchange, membrane separation, electrochemical separation, and evaporation. Based on selection criteria, NCASI concluded that sulfide precipitation and electrocoagulation appeared to have the best potential to cost-effectively and reliably remove metals from pulp and paper mill wastewater streams. According to NCASI, of the approaches for sulfide precipitation, the insoluble sulfide process offers the simplest control scheme and best addresses the issue of the releases of toxic hydrogen sulfide gas, which can adversely affect worker health. In the insoluble sulfide process, ferrous sulfite (FeS) reacts with soluble metals to generate insoluble metal sulfides, which form a sludge blanket in a solids contact clarifier. This sludge blanket promotes effective separation of the precipitated metals from the wastewater. Wastewater pH is controlled to slightly alkaline to prevent the generation of hydrogen sulfide (H_2S) gas.

Electrocoagulation is a form of iron coprecipitation that uses consumable anodes that slowly dissolve when subjected to direct current. Iron and aluminum are dissolved from the anode generating corresponding metal ions, which almost immediately hydrolyze to polymeric iron or aluminum hydroxide. Coagulation occurs when these metal cations combine with the negative particles carried toward the anode by electrophoretic motion. Contaminants are either precipitated or attached to colloidal materials being generated by the electrode erosion. Floc is removed by electroflotation, or sedimentation and filtration (Mollaha, 2004).

Because there is little information about metals removal processes treating pulp and paper mill wastewaters to low metals concentrations, NCASI estimated treatment efficiencies by projecting the results of treating wastewaters from other industries to pulp and paper wastewaters. NCASI's engineering analysis showed that both sulfide precipitation and electrocoagulation processes could potentially remove high percentages of dissolved metals and achieve GLI criteria, with the exception of mercury (NCASI, 1998). NCASI's engineering analysis did not include data from any treatment of pulp and paper mill wastewaters.

6.3.2.2 NCASI Bench-Scale Testing

NCASI conducted laboratory tests of electrocoagulation and the insoluble sulfide process to further evaluate the ability of these processes to reduce treated effluent concentrations to below GLI criteria. NCASI collected process wastewater samples at a recycled newsprint mill and a bleached papergrade kraft mill. Multiple process locations were sampled at each mill, including the final effluent and a lower volume in-plant process stream with potential for higher metals concentrations. Wastewaters were spiked with target metals and shipped to treatment equipment vendor laboratories for testing. Both the electrocoagulation and insoluble sulfide processes appeared capable of reducing metal concentration from spiked wastewaters.

Table 6-5 compares the GLI metals criteria and the results of the NCASI tests. In NCASI's tests, concentrations of dissolved arsenic, chromium, copper, lead, and zinc were reduced to near or below the GLI criteria. Concentrations of dissolved mercury were reduced to between 0.0071 and 0.033 μg/L, still above the GLI criterion of 0.0013 μg/L. Because there are no GLI criteria for aluminum or manganese, NCASI did not include these metals in its tests (NCASI, 2000). NCASI's bench-scale tests measured concentrations of dissolved metals. NCASI predicted that pilot- and full-scale treatment effluent concentrations will be higher, due to inefficiencies in solids removal and the metals concentrations in the suspended solids that remain in the wastewater.

NCASI estimated the capital and operating and maintenance costs for the electrocoagulation and insoluble sulfide treatment systems, sized to treat peak flows at the two sampled mills. The cost estimates were also expressed as total or life cycle costs (present value) calculated assuming a net (interest minus inflation) 3 percent interest rate and a 20-year project life, per 1,000 gallons of water treated. The insoluble sulfide treatment costs ranged from $0.21 to $0.84 per 1,000 gallons of wastewater treated. The electrocoagulation treatment costs were greater, ranging from $0.86 to $2.04 per 1,000 gallons (NCASI, 2000).

Table 6-5. Results of NCASI Bench-Scale Tests

	Great Lakes Initiative Water Quality Criteria (µg/L) [a,b]	Electrocoagulation Iron Coprecipitation (Average Dissolved Metals Concentrations, µg/L)		Insoluble Sulfide Process (Average Dissolved Metals Concentrations, µg/L)	
		Mill 1	Mill 2	Mill 1	Mill 2
Aluminum	None	—	—	—	—
Arsenic	147.9 (as As III)	<1.5	<1.4	2	1
Cadmium	1.43	0.53	1.44	0.25	.043
Chromium	10.98 (as CrVI)	<4	<8	<2	—
Copper	5	4.8	4.4	5.6	4.8
Lead	2.7	2.66	0.63	1.4	0.49
Manganese	None	—	—	—	—
Mercury	0.0013	0.026	0.033	0.0093	0.0071
Zinc	66.6	7	7	<4	<17

Source: NCASI Technical Bulletin 807 (NCASI, 2000), Table 6.6.
[a]GLI water quality criteria are written for one arsenic oxidation state, As(III). Total arsenic includes As(III) and all other oxidation states. If the concentration of total arsenic is less than a target, because As(III) is part of the total arsenic, As(III) will also be below the target concentration. Similar logic applies to Cr(VI) and total chromium.
[b]Total recoverable metals.
Mill 1: recycled newsprint (Phase 2). Mill 2: bleached papergrade kraft (Phase 1)
— No data available.

6.3.2.3 NCASI Bench-Scale Testing of Low-Level Mercury Removal

As described in Section 6.3.2.2, the electrocoagulation and insoluble sulfide processes NCASI tested in 1999 were not able to reduce the mercury spiked into the tested pulp and paper effluent to the low concentrations mandated by the GLI. Because of this, NCASI investigated five other technologies with potential for removing mercury. These tests were conducted using biological treatment plant effluent from an integrated bleached papergrade kraft mill. This wastewater contained 5 to 10 nanograms/L of mercury and detectable concentrations of aluminum, manganese and other metals. Because aluminum and manganese were not the focus of NCASI's study, their removals were measured only in the first-stage tests of ion exchange (because aluminum and manganese can compete with mercury for ion exchange sites) and in tests of reverse osmosis. Table 6-6 lists the technologies tested and a summarizes NCASI's findings.

Table 6-6. Results of NCASI's Investigation of Techniques to Remove Low Levels of Mercury

Treatment Technology	NCASI Findings
Granulated Active Carbon (GAC)	NCASI tested GAC as a potential treatment to remove organic material prior to IX and RO to prevent fouling. GAC treatment reduced mercury concentrations to below GLI criterion for dissolved metals. Long-term feasibility unknown. Removal of aluminum and manganese not tested.
Ion Exchange (IX)	NCASI tested three IX resins, selected because of their affinity to mercury and found good mercury removals. Resins also effectively removed aluminum and manganese in short-term tests; however, these removals may be misleading. During further treatment, mercury may displace the aluminum and manganese from resin exchange sites (chromatographic effect).
Reverse Osmosis (RO)	Bench-scale RO treatment reduced mercury and other metals to below GLI criterion for dissolved metals. Aluminum concentration was reduced from 450 to 18 μg/L. Manganese concentration was reduced from 472 to 1.1 μg/L. NCASI noted that RO treatment is extremely expensive but produces high purity water that can be reused in mill operations.
Nanofiltration (NF)	NCASI tested three NF membranes, with differing molecular weight cut-offs. The "medium-tight" NF membrane reduced mercury to below the GLI criterion for dissolved metals with lower removal of non-targeted species. Removal of aluminum and manganese were not tested.
Iron Co-Precipitation (ICOP)	ICOP was effective at reducing mercury to below GLI criterion for dissolved metals. Because of the relatively high organic load of the tested mill effluent (COD 285 mg/L), a high ferric chloride dose (500 mg/L) was required for effective treatment. Although ICOP costs are lower than RO or IX, they are higher than the insoluble sulfide process tested in an earlier NCASI study.

Source: NCASI Technical Bulletin 807 (NCASI, 2000).

6.3.3 Additional Literature Review of Metals Removal Technology

EPA searched technical literature and found only three studies related to metals control technologies applied to pulp and paper mill wastewaters published since 2001. Two of these studies (Zhang, 2000; Bryant, 2004) evaluated the removal of metals in biological wastewater treatment systems. Zhang (Zhang, 2000) collected samples from three activated sludge plants. He found that activated sludge treatment considerably reduced effluent concentrations of iron, manganese, zinc, and copper, indicating rapid sorption of these metals to the biofloc. Manganese concentrations in untreated wastewaters at the three mills were 2,300, 160, and 540 μg/l. After activated sludge treatment, manganese concentrations were reduced to 160, 140, and 120 μg/l, respectively. Aluminum was not part of this investigation.

Bryant (Bryant, 2004) estimated the removal of metals at five mills: three bleached papergrade kraft mills with aerated stabilization basins (ASB), one unbleached kraft mill with an ASB, and one bleached sulfite mill with a complete-mix activated sludge treatment plant. He analyzed long-term wastewater influent and final effluent concentrations data and he also estimated the mass of accumulated sludge solids and the metal content of the sludge. Bryant found that the metals capture estimated using the analysis of the influent and effluent concentrations was reasonably similar to the metals capture estimated using the sludge-based approach. Bryant found that only copper and lead were consistently captured in biosludges for all study sites; the removal of aluminum at bleached papergrade kraft mills varied widely between sites. In contrast to Zhang's finding that manganese was removed in activated sludge treatment plants, Bryant found low manganese removal.

The third researcher (Vieira, 2001) studied treatment that could be applied to wastewaters at a Brazilian pulp and paper mill. Vieira found that he could increase metals removal with ultrafiltration by first treating the wastewater with water-soluble polymeric ligands (PVA and PEI). This treatment formed metal complexes. Bench-scale testing showed that when PVA was used, 54 percent of iron (Fe) was removed after 24 hours of contact followed by ultrafiltration. Vieira found insignificant retention of metals when ultrafiltration was used without polymer pretreatment. Vieira also measured removals of magnesium and calcium, but manganese and aluminum were not tested.

6.3.4 Summary of Issues Related to Metals Control Technologies Applied to Pulp and Paper Mill Wastewaters

Below is a summary of the issues EPA found in reviewing metals control technologies applied to pulp and paper mill wastewaters.

- Few NPDES permits include requirements for metals discharges. Some permits have monitoring requirements without discharge limits. A few mills have discharge limits for metals, but they do not use end-of-pipe treatment to control metals discharges. These mills can meet their permit limits without treatment.

- NCASI studies of metals removal technologies focused on the metals for which the GLI had published criteria (arsenic (III), cadmium, copper, chromium (III and VI), mercury, nickel, and zinc). In laboratory-scale tests of spiked pulp and paper mill wastewater, NCASI found that electrocoagulation (a type of iron coprecipitation) and the insoluble sulfide process could remove all GLI dissolved metals with the exception of mercury to below the GLI criteria. NCASI predicted, however, that pilot- and full-scale treatment effluent concentrations will be higher due to inefficiencies in solids removal and the metal concentrations in the suspended solids that remain in the wastewater. NCASI did not test these treatment options for aluminum or manganese removal. While reverse osmosis was shown to be effective in reducing aluminum and manganese as well as other GLI metals in NCASI bench-scale tests, this treatment option was considered extremely expensive.

- EPA's literature review found very few studies of metals control technologies applied to pulp and paper mill wastewaters. Two separate studies evaluating metals removal in biological treatment systems showed varying results for manganese removal. EPA has not identified other studies evaluating the removal of aluminum or manganese for pulp and paper mill wastewaters.

6.4 Evaluation of Removal Technologies for Aluminum and Manganese

Comparing aluminum and manganese effluent concentrations to the Method 200.7 ML and available intake concentrations indicates that at some mills, aluminum and manganese are present at concentrations well above the method ML and well above the concentration found in the intake water. As a result of the review described in Section 6.3 of this report, EPA found no instances that metals control technologies had been applied at full or pilot scale to remove metals from pulp and paper mill wastewaters. EPA found limited data from NCASI laboratory-scale studies. NCASI's study of electrocoagulation and the insoluble sulfide process did not include aluminum and manganese. Their laboratory-scale studies of low-level mercury removal included limited data on the removals of aluminum and manganese using ion exchange and reverse osmosis, technologies that are much more expensive to operate than the insoluble sulfide and other metals precipitation processes. For this reason, EPA reviewed metals precipitation processes that have been used to remove aluminum and manganese from wastewaters other than pulp and paper mill effluents. EPA reviewed metals removal technologies used for development of ELGs for other categories: single-stage hydroxide precipitation and two-stage precipitation. EPA found data quantifying aluminum and manganese removals by these two treatment technologies

6.4.1 Single-Stage Hydroxide Precipitation

Hydroxide precipitation is the most commonly used metals removal technology. In this process lime (calcium hydroxide) or caustic (sodium hydroxide) is added to wastewaters containing metals. These chemicals raise the wastewater pH and form low solubility metal hydroxides that then precipitate from solution. The effectiveness of this treatment depends on the final pH achieved and the solubility of the metal hydroxide at that pH. During its development of effluent limitations guidelines and pretreatment standards for the Metal Products and Machinery (MP&M) Point Source Category (40 CFR Part 438), EPA collected treatment performance data from facilities that use hydroxide precipitation and gravity clarification with pretreatment of individual waste streams (U.S. EPA, 2003a). These facilities also use in-process pollution prevention, recycling, and water conservation methods that allow for recovery and reuse of process chemicals. EPA developed long-term average treatment effectiveness concentrations for a large number of metals for one MP&M subcategory, General Metals. The subcategory includes wastewater from most manufacturing operations and heavy rebuilding operations (e.g., aircraft, aerospace, auto, bus/truck, railroad). Although EPA's collected data were not used as the basis for promulgated regulations, they provide information on the effectiveness of single-stage hydroxide precipitation treatment.

6.4.2 Two-Stage Precipitation

Effectively removing multiple metals from wastewater can sometimes require two-stage treatment, with each stage operated at a different pH and/or with a different treatment chemical to optimize the removal of metals. The minimum solubility of different metal hydroxides occurs at different pH levels. Additionally, some metals are not effectively removed by hydroxide precipitation but are more effectively removed by sulfide precipitation (that is the metal sulfide has a lower solubility than the metal hydroxide). Other less common chemical precipitants include ferric chloride and polyelectrolytes. During its development of effluent limitations guidelines and pretreatment standards for the Centralized Waste Treatment (CWT) Point Source Category (40 CFR Part 437), EPA collected treatment performance data from facilities that use two-stage precipitation (U.S. EPA, 2000b). A two-stage process is common at CWT metal subcategory facilities that treat wastewater typically contaminated with multiple metals. In the two-stage process, hydroxide precipitation is followed by sulfide precipitation, with each stage followed by a separate solids removal step.

6.4.3 Metals Treatment Effectiveness Concentrations

During the development of its ELGs, EPA collected performance data to characterize the treatment technologies described above. Using the data collected for each categorical regulation, EPA calculated long-term average (LTA) concentrations representing the performance of the treatment technologies on each category's or subcategory's wastewater. EPA's statistically-derived LTAs account for the normal variation of wastewater characteristics within each category over time. Table 6-7 presents the median Form 2C mill effluent concentrations and the LTA concentrations for metals removal technologies EPA analyzed during the development of the CWT and MP&M ELGs (U.S. EPA, 2000b; U.S. EPA, 2003a). Data are presented for aluminum and manganese.

Table 6-7. Aluminum and Manganese Treatment Effectiveness Concentrations, μg/L

	Form 2C Pulp and Paper Mill Effluent (Median)	CWT Metals Subcategory 2-Stage Precipitation (Median-LTA)	MP&M General Metals Subcategory 1-Stage Hydroxide Precipitation (Median-LTA)
Aluminum	1,338	856	—
Manganese	556	48.7	70

Source: U.S. EPA 2000b; US. EPA, 2003a)
LTA – Long-term average concentration.
— No data available from the development document. The metal was either not a pollutant of concern or data not available.

As shown in Table 6-7, the median pulp and paper mill effluent concentrations of aluminum and manganese are greater than the LTA effluent concentrations for two-stage precipitation that EPA developed for the CWT regulations. Also, the concentration of manganese is greater than the LTA effluent concentration for one-stage precipitation that EPA calculated during the development of the MP&M regulations. This suggests that removing aluminum and manganese from pulp and paper mill effluents using precipitation technologies may be feasible. However, EPA has no information that precipitation technologies have been applied on laboratory, pilot, or full scale to remove these metals from pulp and paper mill effluents. EPA notes that using precipitation may generate large amounts of wastewater treatment sludges, requiring disposal. Because of the very large wastewater flows at chemical pulp mills (10 to 30 MGD), the difficulties and cost of managing these sludges make the use of precipitation technologies infeasible.

6.5 Pollution Prevention Strategies Available to Permit Writers for Mill-Specific Discharge Issues

The metals concentrations in pulp and paper mill effluents are typically below treatable levels; however, permit writers may identify mill-specific problems that require control of metals discharges. Permit writers should use Best Professional Judgment (BPJ) to evaluate available pollution prevention and treatment technologies when establishing the NPDES permit limits that are required to address the mill-specific problems.

For those metals that are already in low concentrations or close to their respective MLs, preventing the metals from entering wastewater may be more effective than removing them from mill effluent using end-of-pipe treatment technologies. Depending on the processes at the mill and the type of products produced, metals in mill wastewaters originate from one or more sources: mill water supply; wood chips; chemicals used in the pulping, bleaching, and deinking processes; additives used in paper making; or products of corrosion. Major sources of metals in the kraft cycle are wood (calcium, potassium, manganese); make-up lime (aluminum, magnesium, iron); and mill water supply (aluminum, iron) (Johnson, 1998). Investigators have also identified sulfuric acid and sodium hydroxide used in bleaching as major sources of mercury (Kangas, 1996). Alum (aluminum sulfate) treatment of surface water used as the mill water supply and in wastewater treatment as a coagulation aid is another potential source of aluminum discharges. Some examples of mill strategies to reduce the load of metals in mill wastewaters are described in this subsection, including mercury control case studies, mercury minimization plans, control of chemical additives, and other strategies for in-plant metals control.

6.5.1 Mercury Control Case Studies

The SAPPI bleached papergrade kraft mill in Cloquet, MN reduced mercury discharges through a series of pollution prevention steps. First, SAPPI analyzed feedstock chemicals and found that products ranging from defoamers to sodium hydroxide and sulfuric acid contained mercury. The mercury content in these products was typically not disclosed on MSDS or certificates of analysis. After it identified these mercury sources, SAPPI switched to mercury-free alternatives when they were available and economical. The mill has banned the purchase of mercury-cell-grade caustic soda and lead smelter sulfuric acid. Sulfuric acid from lead smelting was shown to contain as much as 10 mg/L of mercury (Kangas, 1996). The International Paper mill in Erie, PA performed similar mercury source reduction efforts and discontinued the purchase of caustic soda made from the mercury-cell process or any acids manufactured from sulfur dioxide captured from smelters. These material substitution techniques and others are presented by NCASI (NCASI, 2004).

6.5.2 Mercury Minimization Plans

The state of Wisconsin requires that discharges of inorganic mercury compounds and metallic mercury not exceed the background level by more than 0.05 pound per 1,000,000 gallons of effluent discharged (WI Code NR 100). When industrial dischargers apply for permit reissuance, they are required to monitor and report mercury for at least two years if they have insufficient mercury discharge data. A facility that believes that a significant portion of the mercury in its effluent originates from its intake of surface water is encouraged to provide results of intake monitoring. After the monitoring data are collected, the state will accept an alternative mercury effluent limitation application. Applications must include a pollution minimization program plan and the facility’s basis for concluding that wastewater treatment technology for mercury is impractical (WI Code NR 106.145). Several mills are currently characterizing baseline mercury levels.

The permit for the NewPage (formerly Mead) mill in Escanaba, MI includes a final effluent limit for mercury and requirement for a mercury minimization plan and annual status reports. The mercury minimization plan requires that the mill annually identify mercury-containing materials used in manufacturing, measure mercury concentrations in streams, and summarize actions taken to reduce mercury discharges. As a result of the mercury minimization plan, the mill now only purchases sulfuric acid and caustic soda from prequalified suppliers. In 2003, when the mill submitted its initial mercury minimization plan, the final effluent mercury concentration was 5.5 μg/L. NewPage reports that, as of 2005, discharges have declined to 2.8 μg/L (MDEQ, 2002).

6.5.3 Mill Chemical Additives

Several of the mill permits EPA reviewed include limitations on chemical additives used at the mill, not effluent discharges. For example, the permit for Appleton Papers in Roaring Spring, PA lists approved chemicals and daily usage rates for chemical additives used to control corrosion, scaling, algae, slime, fouling, oxygen, and blow down. Chemicals permitted for use are limited to the additives that were identified in the mill's permit application. Usage rates are limited to the minimum amount necessary to accomplish the intended purposes. The controlled additives are known to include metals such as copper II sulfate.

6.5.4 Other Strategies for In-Plant Metals Control

Other strategies for in-plant metals controls include:

- *Minimizing discharges of spent chemical pulping solutions (e.g., black liquor) to the sewer.* An efficiently operated chemical pulp mill collects as much spent pulping solution as possible, routing it to the recovery cycle for reuse in the pulping processes. Spent pulping solutions may contain relatively high concentrations of metals because pulping solutions dissolve metals from the wood and pulping chemicals may also contain metal contaminants. Strategies for minimizing process losses of spent pulping solution include efficient brownstock washing; closed brownstock screening; and prevention of leaks, spills, and intentional diversions of spent pulping solutions (U.S. EPA, 1993; and 1997).

- *Minimizing paper machine losses of fiber and additives.* Common papermaking additives include aluminum sulfate (alum) used to flocculate pulp fibers and kaolin clay (hydrous aluminum silicate) used as a filler and coating; thus, white water[13] may contain high concentrations of soluble and insoluble aluminum. Strategies for minimizing paper machine white water losses include optimizing the papermaking chemistry so fiber and additives remain on the paper sheet and are not drained with the white water and efficiently operating the paper machine to capture and reuse the fiber, additives, and water (U.S. EPA, 1993).

- *Dry removal of soil (dirt) from logs prior to debarking and chipping.* Depending on the geographic region, soils may have high concentrations of aluminum and other metals (Johnson, 1998).

[13] White water is a general term for process wastewater that contains fiber fines. White water is produced during the forming and dewatering of the pulp or paper sheet on the paper machine. To make paper, pulp fiber and additives are suspended in a very dilute slurry and applied to a paper machine.

- *Using dry disposal of green liquor*[14] *dregs.* Because manganese partitions to the insoluble fraction (dregs) of the green liquor, a strategy to reduce manganese discharges is to avoid sewering the dregs (Johnson, 1998).

- *Using dry disposal of lime mud*[15]. Lime (calcium hydroxide) supplies purchased by mills can have high concentrations of aluminum and other metals. In the recausticizing cycle, the aluminum tends to partition to the insoluble lime muds. Dry disposal of the lime mud will reduce the aluminum in the mill wastewater discharges (Johnson, 1998).

6.6 Detailed Study Findings for Metals

Pulp and paper mill effluents have low concentrations of metals. EPA reviewed information available about the nine metals that account for more than 98 percent of the metals' TWPE in pulp and paper mill discharges. Conclusions are summarized below:

- The majority of the TWPE associated with metals is from aluminum, arsenic, cadmium, total chromium, copper, lead, manganese, mercury, and zinc. These metals contribute to over 8 percent of the PCS TWPE and over 20 percent of the TRI TWPE.

- EPA found that only for aluminum and manganese were the Form 2C median mill effluent concentrations well above their method minimum level concentrations. Metals concentration data available from seven mills indicate that intake concentrations are generally similar to or higher than effluent concentrations. Aluminum and manganese, however, are the exceptions, with effluent concentrations higher than intake concentrations in four of the seven mills reviewed.

- EPA did not find information on effluent treatment technologies currently in use to control metals discharges from pulp and paper mills. The NCASI bench-scale studies researching the effectiveness of different treatment technologies in removing metals from pulp and paper mill wastewaters did not focus on aluminum and manganese since these two metals are not included in the GLI water quality criteria. The reverse osmosis results, however, included effective aluminum and manganese removals, although this technology is considered very expensive.

[14] Green liquor is dissolved recovery smelt. The green liquor solute consists mainly of sodium carbonate and sodium sulfide. The insoluble portions of the smelt become the green liquor dregs that settle out during the clarification process. Green liquor dregs are washed to recover alkali. They may be thickened and disposed of in a landfill. Some mills may sewer the washed dregs.

[15] Lime mud is calcium carbonate precipitated when lime is mixed with green liquor in the causticizing reaction. Most lime mud is reburned and returned to the causticizing cycle, but some mills may sewer excess lime mud.

- At mills where discharges of aluminum and/or manganese (or other metals) are below treatable levels, preventing these metals from entering mill wastewater may reduce metals discharges. Possible pollution control strategies for aluminum and manganese include dry disposal of green liquor dregs and lime mud, dry removal of soil (dirt) from logs prior to debarking and chipping, conversion from alum precipitation water treatment to reverse osmosis treatment, minimizing paper machine losses, and minimizing spent pulping liquor losses. Pollution control strategies for mercury include managing the metal content of raw materials, particularly acids and caustic.

7.0 POLYCYCLIC AROMATIC COMPOUNDS (PACS)

This section presents EPA's analysis of PACs discharged from pulp and paper mills. As discussed in Section 3.3 of this report, PACs are a class of organic compounds consisting of three or more fused aromatic (benzene) rings. The TRI program includes 21 individual compounds listed in Table 3-2, in their "PACs" chemical category. Beginning with reporting year 2000, facilities (including pulp and paper mills) meeting certain reporting criteria that manufacture, process or otherwise use more than 100 pounds of chemicals in the PACs category during the calendar year were required to report to TRI the total mass of these 21 individual compounds released to the environment. Based on the pounds of PACs pulp and paper mills reported discharging in 2002, assumptions about the identity of the chemicals included in pulp and paper mill PACs discharges, and the TWFs EPA developed for 8 of the 21 PACs, EPA estimated in its 2005 annual screening-level review that pulp and paper mills discharged almost 50,000 TWPE of PACs in 2002. PACs discharges represented about 2.4 percent of the total category TWPE.

7.1 Annual Loads from the 2006 Screening-Level Analyses

Pulp and paper mill discharges of PACs reported to TRI and PCS are discussed in this subsection, followed by a brief discussion of possible sources of PACs in mill effluents.

7.1.1 PACs Discharges Reported to TRI and PCS

For TRI, facilities that manufacture, process, or use more than 100 pounds of PACs per year must report the combined mass of PACs released; they do not report releases of individual compounds. However, EPA has developed TWFs for individual chemical compounds, not the PAC chemical group. As discussed in Section 3.3, using information from NCASI's guidance for estimating PAC discharges (Wiegand, 2005b), EPA estimated how much of each individual PAC may be present in pulp and paper mill wastewaters. Using this estimate of wastewater PAC content and the TWFs for the individual compounds, EPA calculated a Pulp and Paper Category PAC TWF of 34.2. In its 2005 annual screening-level review, EPA used the TWFs published in the draft development document (December 2004 TWFs) (Eastern Research

Group, 2005b) and the mill-reported 2002 discharges to calculate the TWPE of pulp and paper mill PACs discharges.

EPA slightly revised the Pulp and Paper Category PAC TWF for its 2006 annual review. In response to comments on the TWFs used in EPA's 2005 screening-level analysis and review of other available data, EPA developed TWFs for two additional PACs and revised TWFs for two others (U.S. EPA, 2006b). These revisions changed the Pulp and Paper Category PAC TWF from 34.2 to 33.7. Table 7-1 shows the results of EPA's 2005 and 2006 screening-level reviews, with discharges broken out by regulatory phase.

PCS does not include data for PACs because NPDES permits do not include limits for the chemical category "PACs." Permits may have limits for individual PACs, such as benzo(a)pyrene. Only two pulp and paper mills have permit limits or other reporting requirements for any individual PACs. The discharges reported by these mills are presented in Table 7-2. PCS data for one mill, Domtar in Port Edwards, WI, included a monthly benzo(a)pyrene concentration of 50 ng/L collected on November 30, 2002. Each of the other 10 measurements for 2002 and 7 measurements for 2003 included in PCS were "not detected."

7.1.2 Sources of PACs at Pulp and Paper Mills

According to EPA's *TRI Guidance for Reporting Toxic Chemicals: Polycyclic Aromatic Compounds Category* (U.S. EPA, 2001), most of the 21 PACs are products of incomplete combustion. Twelve of the 21 compounds are reported to be found in fossil fuels. Some are also found in coal tar and coal distillates. Some PACs may be released in the air emissions from kraft pulp mill recovery furnaces and lime kilns.

Table 7-1. TWPE from PAC Discharges, 2005 and 2006 Annual Screening-Level Review

Source	PAC TWF	Phase I					Phase II			Total Phase I&II
		BPK		PS		Total Phase I				
		Mills	Released (lbs)	Mills	Released (lbs)	TWPE	Mills	Released (lbs)	TWPE	TWPE
TRIReleases2002 2005 Annual Review	34.2[a]	50	863	1	20.9	30,231	27	440	15,067	45,298
TRIReleases2002 2006 Annual Review	33.7[b]	50	863	1	20.9	29,750	28	457	15,396	45,146
TRIReleases2003 2006 Annual Review	33.7[b]	48	860	1	20.9	29,653	27	432	14,537	44,190

[a]TWF based on December 2004 TWFs (Eastern Research Group, Inc., 2005b).
[b]TWF based on April 2006 TWFs (U.S. EPA, 2006b).
BPK – Bleached papergrade kraft.
PS – Papergrade sulfite.

Table 7-2. Pulp and Paper Mill Measurement of Individual PACs in PCS

NPDES Permit Number	Mill	PAC Chemical	lb/yr
WI0003620	Domtar, Port Edwards, WI	Benzo(a)pyrene	2.4[a]
		Benzo(a)anthracene	0
		Dibenzo(a,h)anthracene	0
LA0007901	Gaylord Container Corp., Bogalusa, LA	Benzo(b)fluoranthene	0
		Benzo(k)fluoranthene	0
		Benzo(a)pyrene	0
		Benzo(a)phenanthrene (Chrysene)	0
		Benzo(j,k)fluorene (Fluoranthene)	0
		Benzo(a)anthracene	0

Source: *PCSLoads2002_v4*.
[a]Based on a detected concentration (0.050 μg/L) in 1 of 11 monitoring results for 2002. Benzo(a)pyrene was not detected in any of the seven monitoring results for 2003.

In Section 6.3 of the Preliminary Detailed Study Report (U.S. EPA, 2005b), EPA requested information about nonbleaching sources of toxic wastewater pollutants, such as pollutants derived from combustion-related activities, spent pulping liquor from unbleached kraft mills, and paper machine additives and coatings. In its comments on EPA’s preliminary 2006 plan (70 FR51042), NCASI stated:

> PACs are known to be by-products from the combustion of coal, wood, and petroleum products. To the extent that flue gases or combustion ashes come in contact with wastewaters, it is possible that some PACs could be transferred to untreated wastewaters. However, as noted in prior comments, PACs are not commonly detected in treated final effluents from pulp and paper mills.
>
> NCASI has not conducted a survey of the volumes of wastewater produced by “wet” air pollution control devices and/or ash sluicing systems used by the pulp and paper industry. We know from an engineering basis however that these volumes would represent a very small fraction of the total effluent flow from most mills (Wiegand, 2005i).

7.2 Analysis of Reported PAC Discharges

This subsection presents EPA's review of the PACs monitoring data reported by pulp and paper mills to TRI, including a review of the data reported to TRI and data provided in comments.

7.2.1 Review of Data Reported to TRI

TRI requires facilities to report releases if they manufacture, process, or otherwise use more than 100 pounds per year of PACs. Mills report the mass discharged to surface waters (for facilities discharging directly to a receiving stream) or transferred to a POTW (for indirect dischargers). TRI does not require facilities to measure waste stream pollutant concentrations. Instead, facilities may use emission factors, mass balances, or other engineering calculations to estimate releases. In addition to the amount of PACs released, facilities are required to report to TRI the method used to estimate their releases, using four code letters:

- M - Monitoring Data or Direct Measurement;
- E - Emission Factor;
- C - Mass Balance; or
- O - Other Approaches Such as Engineering Calculation.

Tables 7-3 and 7-4 list the mills that reported releases of PACs to TRI in 2002 and 2003, respectively, and the method the mills used to estimate their releases. Tables 7-3 and 7-4 reflect EPA's estimates of the releases to the environment accounting for POTW removal, as applicable, in pounds/year and TWPE per year. For facilities that discharge to POTWs, EPA estimated releases to the environment assuming that 92.64 percent of PACs are removed in a POTW (U.S.EPA, 2005e).

Table 7-3. Mills that Reported 2002 PACs Releases to TRI

Facility	City, State	Pounds Released to the Environment (accounting for POTW removal)	TWPE	Basis of Estimate
Phase I Mills				
NewPage Corp.	Luke, MD	93[a]	3,146	M
Weyerhaeuser Paper Co.	Longview, WA	45	1,501	E
Alabama River Pulp Co. Inc.	Perdue Hill, AL	39	1,313	E
Domtar Industries	Ashdown, AR	36	1,202	E
International Paper Co.	Augusta, GA	32	1,081	E
International Paper Co.	Courtland, AL	30	1,018	E
Georgia-Pacific Corp.	Pennington, AL	28	943	E
Bowater Inc.	Coosa Pines, AL	26	875	E
Boise Cascade Corp.	Deridder, LA	23	774	E
Georgia-Pacific Corp.	Camas, WA	23	774	E
Potlatch Corp.	Lewiston, ID	22	741	E
Weyerhaeuser Paper Co.	Plymouth, NC	21	714	E
NewPage Corp.	Escanaba, MI	21	707	E
Domtar Industries	Port Edwards, WI	21	704	E
Georgia-Pacific Corp.	Clatskanie, OR	21	690	E
GP Cellulose, LLC	Brunswick, GA	20	673	E
MeadWestvaco Packaging Resources	Covington, VA	19	640	
International Paper Co.	Franklin, VA	19	636	E
NewPage Corp.	Rumford, ME	19	630	E
Simpson Tacoma Kraft Co.	Tacoma, WA	19	626	E
Durango-Georgia Paper Co.	Saint Marys, GA	18	616	O
International Paper Co.	Eastover, SC	18	606	O
Jefferson Smurfit Corp.	Brewton, AL	17	572	E
S.D. Warren Co. (SAPPI)	Skowhegan, ME	17	566	E
Blue Ridge Paper Products	Canton, NC	16	539	O
Georgia-Pacific Corp.	Palatka, FL	16	529	E
Weyerhaeuser Paper Co.	Hawesville, KY	14	481	E
Bowater Inc.	Catawba, SC	14	461	E
International Paper Co.	Bastrop, LA	14	454	E
International Paper Co.	Cantonment, FL	13	451	E
Georgia-Pacific Corp.	Crossett, AR	13	438	E
GP Cellulose, LLC	New Augusta, MS	12	417	E
Smurfit-Stone Container Corp.	West Point, VA	12	404	E
Boise Cascade Corp.	Wallula, WA	12	404	O
Boise Cascade Corp.	Jackson, AL	11	360	E

Table 7-3 (Continued)

Facility	City, State	Pounds Released to the Environment (accounting for POTW removal)	TWPE	Basis of Estimate
International Paper Co.	Quinnesec, MI	10	338	O
Weyerhaeuser Paper Co.	Columbus, MS	10	337	E
Weyerhaeuser Paper Co.	Vanceboro, NC	10	330	E
Domtar Industries Inc.	Nekoosa, WI	9	313	E
Weyerhaeuser Paper Co.	Port Wentworth, GA	9	310	E
Weyerhaeuser Paper Co.	Bennettsville, SC	9	296	O
Georgia-Pacific Corp.	Old Town, ME	8	259	E
Lincoln Pulp & Paper Co. Inc.	Lincoln, ME	6	205	E
Weyerhaeuser Paper Co.	Oglethorpe, GA	6	202	O
Weyerhaeuser Paper Co.	Kingsport, TN	5	168	E
International Paper Co.	Pine Bluff, AR	4	128	E
Appleton Papers Inc.	Roaring Spring, PA	3	94	E
Boise Cascade Corp.	Saint Helens, OR	1[a]	42	E
Sappi Fine Paper North America	Cloquet, MN	1[a]	22	E
Fraser Papers Inc.	Berlin, NH	0	13	E
Smurfit-Stone Container Corp.	Panama City, FL	0[a]	6	E
Phase II Mills				
Groveton Paper Board Inc.	Groveton, NH	149	5,023	M
Monadnock Paper Mills Inc.	Bennington, NH	35	1,178	O
SP Newsprint Co. Newberg Mill	Newberg, OR	31	1,037	E
Longview Fibre Co.	Longview, WA	29	976	E
International Paper Co.	Prattville, AL	20	673	E
Daishowa America Co. Ltd.	Port Angeles, WA	20	670	E
Packaging Corp. Of America Counce Mill	Counce, TN	17	572	O
MeadWestvaco North Charleston Ops.	North Charleston, SC	17	569	
Gaylord Container Corp.	Bogalusa, LA	13	438	E
Inland Paperboard & Packaging Inc.	Orange, TX	13	438	O
International Paper Co.	Savannah, GA	12	404	O
Weyerhaeuser Paper Co.	Pine Hill, AL	11	370	E
Jefferson Smurfit Corp.	Fernandina Beach, FL	10	334	E
Inland Paperboard & Packaging Inc.	Rome, GA	10	327	O
International Paper Co.	Roanoke Rapids, NC	9	303	O
Stone Container Corp.	Florence, SC	8	273	E
Weyerhaeuser Paper Co.	Campti, LA	8	263	E
Stone Container Corp.	Missoula, MT	7	246	E
Weyerhaeuser Paper Co.	Valliant, OK	7	242	E
Packaging Corp. Of America	Clyattville, GA	7	236	E

Table 7-3 (Continued)

Facility	City, State	Pounds Released to the Environment (accounting for POTW removal)	TWPE	Basis of Estimate
Wausau-Mosinee Paper Corp.	Mosinee, WI	6	195	E
International Paper Co.	Pineville, LA	5	168	O
Stone Container Corp.	Hodge, LA	5	164	E
Packaging Corp. Of America	Tomahawk, WI	4	128	E
Wausau Papers Of New Hampshire Inc.	Groveton, NH	2	73	E
Great Southern Paper Co.	Cedar Springs, GA	2	67	O
Stone Container Corp.	Hopewell, VA	1[a]	20	E
International Paper Co.	Kaukauna, WI	0	10	E

[a] Accounts for POTW removals.

Table 7-4. Mills that Reported 2003 PACs Releases to TRI

Facility	City, State	Pounds Released to the Environment (accounting for POTW removal	TWPE	Basis of Estimate
Phase I Mills				
NewPage Corp.	Luke, MD	89[a]	2,998	M
Weyerhaeuser Paper Co	Longview, WA	47	1,576	E
Alabama River Pulp Co Inc	Perdue Hill, AL	45	1,515	E
Domtar Industries Inc	Ashdown, AR	37	1,246	E
International Paper Co.	Courtland, AL	31	1,051	E
International Paper Co.	Augusta, GA	31	1,030	E
Georgia-Pacific Corp.	Pennington, AL	28	953	E
Weyerhaeuser Paper Co.	Plymouth, NC	23	788	E
Georgia-Pacific Corp.	Camas, WA	23	774	E
Boise Cascade Corp.	Deridder, LA	23	774	E
Potlatch Corp	Lewiston, ID	22	741	E
Bowater Inc.	Catawba, SC	21	707	E
NewPage Corp.	Escanaba, MI	21	707	E
Jefferson Smurfit Corp.	Brewton, AL	21	707	E
Domtar Industries Inc.	Port Edwards, WI	21	704	E
Georgia-Pacific Corp.	Clatskanie, OR	20	680	E
MeadWestvaco Packaging Resources	Covington, VA	20	673	
International Paper Co.	Franklin, VA	20	667	E
Simpson Tacoma Kraft Co	Tacoma, WA	19	646	E
International Paper Co.	Eastover, SC	19	640	O
GP Cellulose LLC	Brunswick, GA	19	640	E
NewPage Corp	Rumford, ME	19	633	E
International Paper Co.	Georgetown, SC	17	560	E
S.D. Warren (SAPPI)	Skowhegan, ME	16	549	E
Blue Ridge Paper Products	Canton, NC	16	542	O
Bowater Inc.	Coosa Pines, AL	16	539	E
NewPage Corp.	Wickliffe, KY	16	539	O
International Paper Co	Bastrop, LA	14	475	E
Georgia-Pacific Corp.	Crossett, AR	14	471	E
Georgia-Pacific Corp.	Palatka, FL	14	471	E
GP Cellulose LLC	New Augusta, MS	13	421	E
Weyerhaeuser Paper Co	Hawesville, KY	12	407	E
Boise Cascade Corp.	Wallula, WA	12	404	O

Table 7-4 (Continued)

Facility	City, State	Pounds Released to the Environment (accounting for POTW removal	TWPE	Basis of Estimate
Smurfit-Stone Container Corp	West Point, VA	12	404	E
Boise Cascade Corp	Jackson, AL	11	370	E
Weyerhaeuser Paper Co.	Vanceboro, NC	11	367	E
Weyerhaeuser Paper Co.	Bennettsville, SC	10	337	O
Weyerhaeuser Paper Co.	Columbus, MS	10	337	E
International Paper Co.	Quinnesec, MI	10	330	O
Weyerhaeuser Co	Port Wentworth, GA	9	306	E
Fort James Operating Co	Old Town, ME	7	232	E
Weyerhaeuser Co Kingsport Paper Mill	Kingsport, TN	6	202	E
Weyerhaeuser Co.	Oglethorpe, GA	6	192	O
International Paper Co	Pine Bluff, AR	4	125	E
Appleton Papers Inc Spring Mill	Roaring Spring, PA	3	94	E
Fraser Papers Inc.	Berlin, NH	2	61	E
Boise Cascade Corp	Saint Helens, OR	1[a]	42	E
Sappi Fine Paper North America	Cloquet, MN	1[a]	22	E
Smurfit-Stone Container Corp	Panama City, FL	0[a]	6	E
Phase II Mills				
Groveton Paper Board Inc	Groveton, NH	149	5,016	M
SP Newsprint Co	Newberg, OR	31	1,040	E
Longview Fibre Co	Longview, WA	30	1,010	E
International Paper Co.	Prattville, AL	20	673	E
Nippon Paper Industries (formerly Daisohwa)	Port Angeles, WA	19	650	E
MeadWestvaco North Charleston Operations	North Charleston, SC	18	589	E
Inland Paperboard & Packaging Inc	Rome, GA	17	572	O
Packaging Corp Of America Counce Mill	Counce, TN	15	505	O
Inland Paperboard & Packaging Inc	Orange, TX	15	498	O
Gaylord Container Corp	Bogalusa, LA	12	404	E
International Paper Co	Savannah, GA	12	404	O
Weyerhaeuser Paper Co.	Pine Hill, AL	12	391	E
Jefferson Smurfit Corp	Fernandina Beach, FL	10	350	E
International Paper	Roanoke Rapids, NC	10	337	O
Weyerhaeuser Paper Co	Campti, LA	8	279	E
Stone Container Corp	Florence, SC	8	273	E
Packaging Corp Of America	Clyattville, GA	8	269	E

Table 7-4 (Continued)

Facility	City, State	Pounds Released to the Environment (accounting for POTW removal	TWPE	Basis of Estimate
Stone Container Corp	Missoula, MT	8	263	E
International Paper Co.	Mansfield, LA	8	254	E
Wausau-Mosinee Paper Corp	Mosinee, WI	6	189	E
International Paper Co.	Pineville, LA	5	168	O
Stone Container Corp.	Hodge, LA	4	146	E
Packaging Corp Of America	Tomahawk, WI	4	128	E
Great Southern Paper Co	Cedar Springs, GA	2	67	O
Weyerhaeuser Paper Co	Springfield, OR	1	30	E
Stone Container Corp	Hopewell, VA	1[a]	18	E
International Paper Co.	Kaukauna, WI	0	13	E

[a]Accounts for POTW removals.

As listed in Table 7-3, 79 mills reported to TRI discharging PACs in 2002 (51 Phase I and 28 Phase II mills). Of these 79 mills, only two indicated that their reported discharges were based on monitoring data or direct measurement. As presented in Table 7-6, these two mills did not detect any PACs in their discharges. Never the less, they estimated their releases based on a fraction of the detection limit, and these estimated releases were greater than the releases reported by any other mills in the category. The mill with the largest reported PAC release to receiving streams is the Groveton paperboard mill in Groveton, NH. It reported releasing 149 pounds in 2002, approximately 5,000 TWPE. The mill with the second largest PAC release to receiving streams is MeadWestvaco, an indirect discharging Phase I mill in Luke, MD. MeadWestvaco reported transferring 1,270 pounds of PACs to its POTW. After accounting for POTW removal, EPA estimated that the release to the receiving streams from the MeadWestvaco mill was 93 pounds, approximately 3,100 TWPE.

As shown in Table 7-4, 76 mills reported discharging PACs in 2003 (49 Phase I and 27 Phase II mills). As in 2002, only two facilities, the Groveton Paperboard, Groveton, NH and MeadWestvaco Luke, MD mills indicated that their reported releases were based on monitoring data or direct measurement. Again, even though the mills did not detect any PACs, they estimated their releases based on a fraction of the detection limit, and thus their reported releases were greater than the releases from any other mills in the category.

Table 7-5 summarizes the methods mills used to estimate their reported PAC releases. More than 75 percent of mills reported using emission factors to estimate their releases.

Table 7-5. Number of Mills Reporting PAC TRI Estimation Techniques for Reporting Years 2002 and 2003

	TRIReleases2002_v4		***TRIReleases2003_v2***	
	Number	**Percent**	**Number**	**Percent**
Engineering Calculations (O)	15	19%	14	18%
Direct Measurement (M)	2	3%	2	3%
Emission Factor (E)	60	76%	59	78%
Mass Balance (C)	-	-	-	-
No estimate provided [a]	2	3%	1	1%
Total Number of Reported Releases	**79**		**76**	

[a]Some mills did not report how they estimated their release.

To better understand pulp and paper TRI PAC estimating techniques, NCASI contacted a total of 12 Phase I and Phase II mills reporting PAC discharges to TRI. Discharges from these mills represent 40 percent of the reported 2002 PACs discharges. Table 7-6 presents the information about these mills that NCASI provided to EPA (Wiegand, 2005a). Nine of the 12 mills for which NCASI obtained information estimated their discharges based on emission factors contained in the *SARA Handbook*. The three other mills estimated releases based on results of chemical analysis of their wastewater (two, discussed earlier, reported to TRI that they used monitoring data to estimate their releases; the third, Monadnock Paper, reported to TRI that it used other approaches such as engineering calculations). For the three mills that estimated their releases based on chemical analysis (Groveton, MeadWestvaco, and Monadnock), concentrations of all PAC compounds were less than laboratory detection limits. However, following TRI guidance, the mills used a fraction of the detection limit to estimate a pollutant mass discharged for TRI.

Table 7-6. PAC Releases to Water Reported in TRI by 12 Mills for Reporting Year 2002

Facility and Location	Basis for Report	Annual Wastewater Flow (MGY)	Effluent Concentration Used for Reporting (µg/L - unless otherwise stated)	Release to Water Reported (lb/yr)
Groveton Paper Board, Inc., Groveton, NH (Phase II)	Mill believes it produces PACs in semi-chemical liquor combustion kiln that is fitted with a wet scrubber. Treated effluent analysis for 10 PACs made in conjunction with an NPDES permit application showed all PACs analyzed (10 compounds) were not detected at 5 ppb. Mill used 1 ppb for all analyzed PACs as the basis for reporting (Wiegand, 2005e).	1,788.5	10 ppb (1 ppb for each of 10 PACs)	149.2
NewPage Corp (was MeadWestvaco)., Luke, MD (Phase I)	Mill used annual priority pollutant scan for which 8 PACs were reported to be not detected at a detection limit of 5.0 ppb. Mill used ½ of detection limit for reporting (Wiegand, 2005f).	7,641.3	20 ppb (2.5 ppb for each of 8 PACs)	1,269.5 (transferred to POTW)
Alabama River Pulp Co. Inc., Perdue Hill, AL (Phase I)	Mill used NCASI factors (Wiegand, 2005a).	14,288.7 (kraft) 1,768.0 (TMP)	0.213 (kraft) 0.789 (TMP)	39
Domtar Industries, Ashdown, AR (Phase I)	Mill used NCASI factors (Wiegand, 2005a).	20,121	0.213	35.7
Monadnock Paper Mills, Inc., Bennington, NH (Phase II)	Mill used ½ of the detection limit for reporting. Mill subsequently concluded that PACs should not be present in effluent and therefore did not report release of PACs to water for the 2003 reporting year (Wiegand, 2005b).	Not provided	Not provided	35
International Paper, Augusta, GA (Phase I)	Mill used NCASI factors. Mill has since identified an error in the calculation and will be filing a correction (Wiegand, 2005a).	Not provided	Not provided	32.1
SP Newsprint Co., Newberg, OR (Phase II)	Mill used NCASI factors (Wiegand, 2005a).	4,716	0.789	30.8
International Paper Co., Courtland, AL (Phase I)	Mill used NCASI factors (Wiegand, 2005a).	17,045.9	0.213	30.24
Longview Fibre, Longview, OR (Phase II)	Mill used NCASI factors (Wiegand, 2005a).	15,900	0.213	29
International Paper Co., Prattville, AL (Phase II)	Mill used NCASI factors (Wiegand, 2005a).	11,400	0.213	20
Daishowa America (now Nippon), Port Angeles, WA (Phase II)	Mill used NCASI factors (Wiegand, 2005a).	3,022	0.789	19.89
Packaging Corporation of America, Counce, TN (Phase II)	Mill used NCASI factors (Wiegand, 2005a).	9,136	0.213	17

Source: (Wiegand, 2005a)
TMP - Thermo-mechanical pulp.

7.2.2 Data Provided With Comments

NCASI and International Paper included additional information about the concentrations of PACs in pulp and paper mill effluents in their comments on the 2006 Preliminary Plan. NCASI noted that it had previously provided EPA with the data that form the basis of the emission factor presented in its *SARA Handbook* (these data are reproduced as Table 3-3). NCASI further noted that those data were derived from a 1990 Canadian study and also provided data from a newer Canadian study, which compiled data generated between 1998 and 2003. NCASI provided the results of treated effluent analysis for 15 individual PACs using Quebec Ministry of Environment Method MA.400-HPA 1.0 or equivalent. Method MA.400-HPA 1.0 is a high resolution gas chromatography/mass spectrometer method for the detection of polycyclic aromatic hydrocarbons (QCEAE, 2003). These newer data, which show that no analytical result was above the method detection limit, are presented in Table 7-7.

Table 7-7. Summary of Treated Effluent PAC Data Collected at 23 Quebec Pulp and Paper Mills

PAC Compound	Number of Detects	Number of Analyses	Minimum MDL µg/L	Maximum MDL µg/L
5-Methylchrysene	0	28	0.01	0.6
Benzo(a)anthracene	0	27	0.01	2
Benzo(a)phenanthrene (chrysene)	0	27	0.01	2
Benzo(a)pyrene	0	27	0.004	0.2
Benzo(b)fluoranthene	0	81	0.03	0.3
Benzo(j)fluoranthene	0	81	0.03	0.3
Benzo(j,k)fluorene (fluoranthene)	0	28	0.02	0.3
Benzo(k)fluoranthene	0	81	0.03	0.3
Benzo(r,s,t)pentaphene	0	29	0.06	0.3
Dibenz(a,h)acridine	0	28	0.1	0.4
Dibenzo(a,e)pyrene	0	29	0.08	0.4
Dibenzo(a,h)anthracene	0	29	0.02	0.2
Dibenzo(a,h)pyrene	0	29	0.04	0.2
Dibenzo(a,l)pyrene	0	29	0.08	0.4
Indeno(1,2,3-cd)pyrene	0	29	0.01	0.2

Source: NCASI comments on Preliminary 2006 Effluent Guidelines Plan (Wiegand, 2005i).
MDL – Method detection limit.

NCASI provided the following description of the collection of the data presented in Table 7-7:

> Effluent PAC data for 23 direct discharging mills in Quebec were generated between 1998 and 2003 as part of the Industrial Waste Reduction Program (Programme de réduction des rejets industriels, or PRRI) of the Ministère du Développement durable, de l'Environnement et des Parcs du Québec (MDDEP). Mills chosen for testing were those operating a sulfate [kraft] pulping process, a liquor recovery furnace, and/or a biomass-fired boiler.
>
> Samples of final treated process effluent were collected as composites of 192 aliquots per day of ≥50 mL each collected either at a fixed or a flow-proportional frequency. The samples were analyzed for 15 individual PACs using method MA.400-HPA 1.0 or an equivalent method approved by the Quebec Environmental Analysis Centre of Expertise (Centre d'expertise en analyse environnementale du Québec). All PACs included in Table 5 of NCASI's SARA Handbook were analyzed (Wiegand, 2005i).

International Paper (IP) noted in its comments that monitoring data from NPDES permit applications (Form 2Cs) do not substantiate PACs as a significant concern in pulp and paper mill effluents. To support this assertion, IP provided specific PAC NPDES application data for 20 IP mills. For the eight specific compounds that EPA used to develop its pulp and paper PAC TWF, the analytical monitoring data were below the level of detection. Table 7-8 summarizes the data provided by IP (with the exception of data from one mill for which IP could not verify the units of measure) (Lynn, 2005b).

Table 7-8. Summary of NPDES Permit Application Data, International Paper Mills

PAC Compound	Number of Detects	Number of Analyses[a]	Minimum MDL (µg/L)	Maximum MDL (µg/L)
Benzo(a)anthracene	0	19	0.2	10
Benzo(a)phenanthrene (chrysene)	0	19	0.2	10
Benzo(a)pyrene	0	19	0.2	10
Benzo(b)fluoranthene	0	19	0.2	10
Benzo(j,k)fluorene (fluoranthene)	0	19	0.2	10
Benzo(k)fluoranthene	0	19	0.2	10
Dibenz(a,h)anthracene	0	19	0.2	20
Indeno(1,2,3-cd)pyrene	0	19	0.2	20

Source: International Paper Comment (Lynn 2005b).
[a]Six mills of the 19 mills did not provide detection limits but indicated only "ND."
MDL – Method detection limit.

7.3 Detailed Study Findings on PACs

Pulp and paper mills reported wastewater discharges containing PACs to TRI in 2002 and 2003. EPA reviewed information available about these reported pulp and paper mill PAC discharges. Conclusions are summarized below:

- Using TRI data as reported (and accounting for POTW removals), EPA estimated that Phase I and Phase II pulp and paper mills released 1,341 and 1,313 pounds of PACs to surface water in 2002 and 2003, respectively.

- EPA calculated the TWPE of PACs released from pulp and paper mills using a TWF developed for pulp and paper industry discharges. EPA developed this TWF based on data NCASI used to develop an industry PAC emission factor. EPA then used this TWF along with TRI data to estimate the TWPE associated with PAC discharges in 2002 and 2003. These equate to 45,146 TWPE of PACs in 2002 and 44,190 TWPE of PACs in 2003.

- For TRI reporting year 2002, 79 out of 257 Phase I and Phase II pulp and paper mills reported releasing PACs to POTWs or surface water. EPA determined that according to basis-of-estimate codes provided in TRI, most of the reported releases were not based on measured concentrations in mill effluents. At the three mills where effluent concentrations of PACs were measured, they were not detected; however, these mills estimated releases using a fraction of the analytical detection limit and mill effluent flow rate.

- Only two pulp and paper mills have permit limits or other reporting requirements for any individual PACs. One of the two facilities detected benzo(a)pyrene at a concentration of 50 ng/L (0.050 μg/L) in one out of eleven measurements. Each of the other 10 measurements of benzo(a)pyrene for 2002 included in PCS were reported as "not detected."

- With the exception of the one PCS benzo(a)pyrene measurement, EPA identified no monitoring data showing that PACs were measured above detection limits in the discharges of any pulp and paper mill reporting PACs releases to TRI in 2002 or 2003.

- NCASI provided data from 23 Quebec kraft mills, generated between 1998 and 2003, showing that, for 15 individual PACs, no analytical result was above the method detection limit.

- International Paper provided specific PAC NPDES permit application (Form 2C) data for 20 International Paper mills. International Paper found that, for all of the data collected, the analytical monitoring data were below the level of detection for the eight specific PACs that EPA used to develop its TWF for PACs.

Therefore, EPA concludes that there is little evidence that PACs are present in concentrations above method detection levels in pulp and paper mill wastewater discharges.

8.0 NUTRIENTS

In EPA's initial analysis of wastewater discharges of nutrients (i.e., nitrogen and phosphorus) for all point source categories conducted in 2005, the Pulp and Paper Category ranked third in total annual nitrogen load (lb/yr) and first in total annual phosphorus load (lb/yr) (Eastern Research Group, Inc., 2005c). However, the Pulp and Paper Category ELGs do not include limitations or standards for any nutrient parameters. For this reason, as part of its 2006 annual review, EPA further investigated pulp and paper mill discharges to determine whether it should, at this time, revise the category ELGs to address nutrient discharges.

This section presents a brief overview of nutrients and their impacts on receiving streams. It describes the methodology EPA used to calculate nitrogen and phosphorus loads using 2002 PCS data and possible limitations of these data. It also discusses sources of nutrients in pulp and paper mill effluents and available nutrient control strategies.

8.1 Nutrients and their Impacts on Receiving Water

Nutrients are elements that promote plant growth when added to aquatic or soil systems. Nitrogen, phosphorus, potassium, calcium, magnesium, and sulfur are the six elements that make up the macronutrient category. Of these, nitrogen, phosphorus, and potassium are typically present in the environment in lower concentrations than is necessary for optimal plant growth. For this reason, these elements are the main ingredients in agricultural and garden fertilizers. Phosphorus has been identified as the growth-limiting nutrient[16] in freshwater ecosystems, particularly lakes, and for this reason, the sale of phosphate-containing detergents was banned in many states in the 1970s. Nitrogen is the growth-limiting nutrient in other ecosystems, particularly saline systems such as estuaries, the Chesapeake Bay, and Gulf of Mexico. Excess nutrients in the aquatic environment lead to excessive, unbalanced plant growth, both of phytoplankton[17] and periphyton[18]. Although eutrophication is a natural process by which lakes age and support more plant life, excess nutrient discharges accelerate eutrophication, leading to oxygen depletion and degradation of water quality.

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[16] The growth-limiting nutrient in an ecosystem is present in low proportion relative to other required nutrients. Growth is limited by the amount of this low-concentration nutrient present in the system.
[17] Phytoplankton are free-floating microalgae.
[18] Periphyton is a complex matrix of algae and heterotrophic microbes attached to submerged substrata.

Nitrogen and phosphorus occur in organic forms (that is, as part of carbon-containing macromolecules) and inorganic forms. Although bacteria can metabolize both organic and inorganic forms of nutrients, the organic forms must first be biologically or chemically degraded to inorganic forms before they are available to plants. Thus, excessive discharges of inorganic nutrients can lead to immediate eutrophication of receiving waters while excessive discharges of organic nutrients can lead to eutrophication in downstream receiving waters. For example, discharges of organic nitrogen in the Chesapeake Bay watershed can be biodegraded during transport to the Bay (or during their residence in the Bay) and lead to excessive algae growth.

NCASI (NCASI, 2001) identified the sources and forms of nitrogen and phosphorus nutrients that could be found in pulp and paper mill treatment systems, presented in abbreviated form in Table 8-1.

Table 8-1. Some Nitrogen and Phosphorus Sources in Treatment Systems

Nitrogen (Total N)		Phosphorus (Total P)	
Organic N	**Inorganic N**	**Organic P**	**Inorganic P**
Microbial Cells	Ammonium nitrate, Ammonium hydroxide	Microbial Cells	Orthophosphates: e.g., Na_3PO_4, Na_2HPO_4
Lignin	Liquid ammonia (NH_3)	Lignin	
Process Additives	Ammonium sulfate	Process Additives	Polyphosphates: e.g., $Na_3(PO_3)_6$, $Na_5P_3O_{10}$
Urea ($CO(NH_2)_2$)	Nitrate (HNO_3)		

Source: NCASI Technical Bulletin 832. (NCASI, 2001).

8.2 Nutrients Data in *PCS*

As discussed in Section 2.1 of this report, PCS contains permit-required monitoring data for direct dischargers that are considered major sources. Each mill's NPDES permit specifies what pollutants to monitor, in what discharge pipe, and at what frequency. Depending on state requirements and factors specific to the receiving water body and discharging facility, permit writers require monitoring for various forms of nutrients. Permits may require monitoring only, or may limit the concentration and/or load discharged on a daily, monthly, or annual average basis.

Table 8-2 lists the nutrient parameters for which pulp and paper mills are required to monitor, the number of mills reporting that parameter, and the pounds discharged by all facilities in the Pulp and Paper Category. As shown in this table, mills are required to monitor for inorganic forms of nitrogen (ammonia, nitrate, nitrite), organic nitrogen, and total nitrogen. For reporting year 2002, PCS includes discharge data for 252 Phase I and Phase II mills. A similar number of mills (257) reported surface water and/or POTW discharges to TRI. In comparison, relatively few mills are required to report nutrient discharges.

Table 8-2. Nutrient Parameter Discharges Reported to PCS 2002 by Pulp and Paper Mills

PCS Parameter Code	PCS Parameter Description	Number of Mills Reporting Discharges	Total Annual Pounds Discharged
Nitrogen Compounds			
00600	Nitrogen, Total (As N)	14	3,460,000
00605	Nitrogen, Organic Total (As N)	3	318,000
00615	Nitrogen, Nitrite Total (As N)	2	452
00620	Nitrogen, Nitrate Total (As N)	7	12,100
00625	Nitrogen, Kjeldahl Total (As N)[a]	21	2,900,000
00630	Nitrite Plus Nitrate Total Det. (As N)	10	1,130,000
71850	Nitrogen, Nitrate Total (As NO_3)	2	1,080
71855	Nitrogen, Nitrite Total (As NO_2)	1	414
AMMON[b]	Ammonia As NH_3, NH_4, or Unionized Ammonia	8	184,000
N[b]	Ammonia As N	65	2,980,000
Phosphorus Compounds			
PHOSP[b]	Phosphorus	86	2,860,000
PO4[b]	Phosphate	2	6,346

[a]Total Kjeldahl nitrogen is a measure of the reduced forms of nitrogen in surface water, principally, ammonium and amino forms of organic nitrogen.
[b]Parameter code developed specifically for *PCSLoads* databases.

Permit writers require monitoring of the final process wastewater effluent discharged to the receiving stream. They may also require monitoring of internal monitoring points, such as an acid sewer or wood yard sewer that are ultimately combined with the final effluent. Permit writers may also require monitoring of stormwater flows. Some of these flows are runoff from the mill process area or raw material storage areas and others are runoff from nonprocess areas of the mill, such as a parking lot. Stormwater flows may be continuous or intermittent. Monitoring may be required periodically (e.g., once a month) or after a storm event. PCS includes a pipe number that is used in the permit (e.g., 001) and sometimes also includes a description of the pipe (e.g., discharge to river). PCS also includes a designation of discharges that are final effluent, though the use of this designator is inconsistent.

8.2.1 PCS Nutrient Monitoring Data

As discussed briefly in Section 2.1 of this report and in detail in the *Screening-Level Analysis Report* (U.S. EPA, 2005a), EPA retrieved 2002 discharge data from PCS and used the Effluent Data Statistics (EDS) mainframe computer program to estimate annual pollutant loads. EDS uses discharges from pipes designated as final effluent. EDS calculations are based on the assumption that discharges are continuous: 24 hours/day and 365 days/year, an assumption that can result in overestimating loads from periodic and intermittent discharges.

For the development of the *PCSLoads2002* database and its nutrients analysis, EPA combined several parameters into four groupings with the following codes: AMMON, N, PHOSP, and PO4. AMMON includes various forms of ammonia, ammonium, and unionized ammonia. N includes ammonia nitrogen (total as N) and unionized ammonia (total as N). PHOSP includes total phosphorus (as P), while PO4 includes total phosphate (as P) and total phosphate (as PO4). See Memorandum: Point Source Category Rankings by Nitrogen and Phosphorus Loads Calculated Using PCS Data, (Eastern Research Group, Inc., 2005c) for a complete discussion of the parameter groupings.

8.2.2 Accounting for Nutrient Discharges Reported in Multiple Forms

To compare the discharges of many facilities and categories, EPA converted the pounds of each reported nutrient, based on its molecular weight, to total nitrogen (N) or to total phosphorus (P). As shown in Table 8-2, facilities may be required to report nutrient discharges in multiple forms. For example, they may be required to report total nitrogen, total Kjeldahl nitrogen (TKN), and ammonia. Because TKN includes ammonia (and organic nitrogen) and total nitrogen includes TKN and ammonia, adding the nitrogen content of the three parameters would double- and triple-count the facility's discharge load. To avoid potential double-counting, EPA developed a hierarchy for adding the parameter loads. The methodology used to convert reported loads to elemental nutrient basis and to add the loads to avoid double- and triple-counting is presented in detail in Memorandum: Point Source Category Rankings by Nitrogen and Phosphorus Loads Calculated Using 2002 PCS Data (Eastern Research Group, Inc. 2005c).

Combining the reported discharges to elemental nutrient basis simplifies the analysis of nutrient discharges; however, because organic and inorganic forms of the nutrients are not distinguished, information about the relative "eutrophication potential" of the nutrient discharges is lost.

8.3 2005 Nutrient Annual Review

For its 2005 annual review of categories with existing ELGs, in addition to the screening-level review based on TWPE, EPA calculated total N and total P, by category, and ranked the categories. See Memorandum: Point Source Category Rankings by Nitrogen and Phosphorus Loads Calculated Using 2002 PCS Data (Eastern Research Group, Inc. 2005c) for the full list of category rankings. Table 8-3 presents the results for the Pulp and Paper Category. This category ranked third in total pounds of nitrogen discharged and first in total pounds of phosphorus discharged. However, because of the large number of facilities reporting, the Pulp and Paper Category ranked lower in discharges per facility: twelfth in pounds of nitrogen discharged per facility and seventh in pounds of phosphorus discharged per facility.

Table 8-3. 2005 Screening-Level Analysis of Nutrient Loads Discharged by the Pulp and Paper Category

	# Facilities Reporting Loads	Total Annual Load (lb/yr)	Category Rank (total lbs)	Average Load per Facility (lb/yr)	Category Rank (lb/facility)
Total Nitrogen	87	8,260,000	3	95,000	12
Total Phosphorus	87	2,860,000	1	33,000	7

Source: Eastern Research Group, Inc., 2005c.

EPA received comments on the 2005 pulp and paper nutrients annual review from NCASI (Unwin, 2006). No other commenters discussed the nutrients data. After reviewing the results of the 2005 nutrients review, NCASI examined the underlying data and reported that it:

> "…did a detailed check of the top 20 highest load mills for both N and P. We also did a detailed check for any mill where the aggregate load was calculated by adding together loads from multiple discharge points. …
>
> "We found that for several mills, nutrient loads in non-process discharges (usually stormwater) were included in the aggregate load calculation. In fact, we found that such loads were always included when they existed in the database, perhaps indicating that the inclusion was intentional….
>
> "We found double counting of loads for some mills. This occurred because some permits require reporting of the same data for individual discharge points and also for combinations of the individual discharges. Thus, the PCS contains reports for the same discharge in two different pipes. The EDS program apparently did not always recognize this situation so loadings were calculated for both reports then combined to produce the aggregate load, thereby double counting some loads."

8.4 <u>2006 Nutrient Annual Review</u>

EPA continued its review of nutrient discharges during its 2006 annual review. EPA's 2006 annual review included a quality check of the nitrogen and phosphorus pollutant loads that EPA estimated during the 2005 annual review. This section discusses the quality checks of nutrient discharges from all categories, the reviews EPA conducted of pulp and paper mill discharges, and EPA's evaluation of the limitations of the quality of the nutrient loads in *PCSLoads2002*.

8.4.1 Contacts with Nutrient Dischargers

EPA conducted "reasonableness checks" of its nutrient loads estimates. First, EPA identified facilities with anomalous discharge loads of total N and total P. For the eight categories with the highest total N or total P loads, EPA identified a facility's load as anomalous if it contributed more than 20 percent total N or total P for an entire point source category. Additionally, for these eight categories, EPA also reviewed the calculated loads for the individual parameters listed in Table 8-2, again identifying a facility's load as anomalous if it contributed more than 20 percent of the category load of the individual pollutant. In addition to reviewing data from facilities that contributed more than 20 percent of total N or total P for their category, EPA also reviewed the calculated loads for the facility with the largest discharge of the individual parameters.

For the Pulp and Paper Category, EPA reviewed the nutrient loads calculated for two facilities, Brunswick Cellulose, Brunswick, GA and Georgia-Pacific, Big Island, VA. EPA reviewed the NPDES permits for these mills and contacted corporate and mill staff to verify pipe descriptions and monitoring requirements. Table 8-4 presents the results of these reviews.

Table 8-4. Review of Nitrogen Loads Discharged by Brunswick Cellulose, Brunswick, GA and Georgia-Pacific, Big Island, VA

Mill	Reason Selected for Review	Findings from Review	Changes to *PCSLoads2002*
Brunswick Cellulose (formerly Georgia-Pacific, now GP Cellulose) Brunswick, GA GA0003654	Total N Load, 1.35 million lbs (all TKN) represented 16% of the Pulp and Paper Category.	Pipe labels and descriptions in PCS did not match current mill permit. For 2002, discharges in winter months were continuous (outfall 002). Discharges for rest of year were based on tides. PCS was missing discharge data for two months in 2002. Mill provided complete, corrected 2002 discharges. EDS incorrectly assumed each outfall was in continuous operation and estimated loads where data were unavailable.	TKN load reduced from 1.35 million lbs to 436,000 lb, 6% of the Pulp and Paper Category total N load.
Georgia-Pacific, Big Island, VA VA0003026	Nitrite + Nitrate load, 580,000 lbs represented 51% of the Pulp and Paper Category, but G-P said it did not monitor its outfall for nitrate.	Pipe labels from mill permit indicated that nitrate discharges are associated with landfill leachate and stormwater from nonprocess areas.	Nitrite + nitrate load was deleted because it did not derive from mill process operations.

Source: Wolford, 2006; VDEQ, 2005.

8.4.2 Consideration of Public Comments During Annual Review

EPA also reviewed the information NCASI provided in its March 20, 2006 memorandum (Unwin, 2006). As explained in Section 8.3, NCASI suggested that stormwater discharges should not be included in the calculated total mill nutrient discharges. However, 40 CFR 430.01(m) explicitly defines process wastewater to include, among other things "stormwaters from the immediate process areas to the extent that they are mixed and cotreated with other process wastewaters…" After reviewing the NCASI comments and information available in PCS, EPA determined that identifying which stormwater outfalls contain stormwaters from the immediate process areas is not feasible using the information contained in PCS.

Other NCASI comments indicated that some discharges included in the calculation of total N and total P were from internal monitoring points (e.g., "woodroom sewer," "pipe 098 renumbered as 002") that were also included in the mill final effluent resulting in double-counting of these loads. EPA determined that identifying which internal monitoring discharges were included in the final mill discharge is also not feasible using the information contained in PCS.

Because approximately 87 pulp and paper mills reported nutrient discharges to PCS, and PCS does not contain information to address NCASI's concerns, EPA did not complete an assessment of the NCASI comments or review of nutrient discharges during the 2006 annual review. As a result, EPA acknowledges that NCASI's concerns may be valid and may lead to overestimates of nutrient discharges for some facilities.

8.4.3 Nutrients Analysis Data Quality Review

During the 2006 annual review, EPA analyzed the methodologies it used to calculate nutrient loads from PCS discharge data and reviewed the completeness and accuracy of nutrients data reported to PCS (Bicknell, 2006). EPA reviewed nutrient loads calculated for all categories, including the Pulp and Paper Category. Although EPA found that its calculation methodologies and the quality of nutrients data reported to PCS may lead to some inaccuracies, EPA concluded it used the best available data and calculation methodologies to estimate nutrient annual discharge loads. EPA further concluded that the approach it used to calculate nutrient annual loads was reasonable for its screening-level analysis because EPA conducts a more detailed analysis of categories that rank high in nutrient discharge loads during its detailed investigations.

EPA's analysis of calculation methodologies demonstrated that its methodology may overestimate some loads while PCS data quality issues may result in underestimates of total category nutrient loads (e.g., PCS contains more limited data for nutrients than for toxic pollutants). Because of these issues, EPA intends to investigate ways to improve its review of the quality of nutrients and other pollutant discharge data in future effluent guidelines planning cycles.

8.4.4 Findings/Summary from 2006 Annual Review

EPA began an investigation of the nutrients (nitrogen and phosphorus) discharged by each point source category with existing ELGs. EPA calculated the total pounds of nitrogen (nitrate, nitrite, ammonia, total nitrogen) and phosphorus (phosphates) discharged and found that the Pulp and Paper Category ranked high in discharges of these nutrients. EPA requested additional information from industry to confirm the reported discharges of nutrients. EPA intends to pursue means for improving the data review processes for nutrients discharges in future effluent guidelines planning cycles, so EPA can better identify and correct in accuracies in estimated discharge loads.

8.5 Sources of Nutrients in Pulp and Paper Mill Effluents

NCASI reports (NCASI, 2001) that mills may discharge from 3 to 10 mg/L of total N and, on average, 1 mg/L of total P. With pulp and paper mill flows in the range of 1 to 30 MGD, nitrogen discharges may range from 4,000 to 400,000 lb/year and phosphorus discharges may range from 1,300 to 40,000 lb/year. Discharges of this magnitude may lead to violations of water quality standards that permit writers may need to address. Permit writers should use Best Professional Judgment (BPJ) to evaluate available pollution prevention and treatment technologies when establishing the NPDES permit limits that are required to address mill-specific problems. EPA reviewed technical literature to learn more about sources of nutrients and potential control strategies. Nutrient sources are discussed in this subsection and control strategies are discussed in Section 8.6.

Pulp and paper mill wastewater, as generated, typically does not contain sufficient nitrogen and phosphorus to operate a stable biological treatment system for maximum reduction of the organic load (BOD_5). For this reason, mills typically add nutrients to their treatment systems. In addition to discussing process sources of nitrogen and phosphorous, this subsection discusses how nutrients are added to and generated in wastewater treatment systems, resulting in nutrient discharges that may exceed water quality standards.

8.5.1 Process Sources of Wastewater Nitrogen Discharge

Slade, Nicol, and Grigsby (Slade, 1999) found that foul condensates[19], when they are discharged to wastewater treatment, contribute the greatest amount of total N in untreated mill wastewater. The ultimate source of the nitrogen in the foul condensates is wood. Wood contains cellulose (a polymer of glucose, $C_6H_{12}O_6$) and lignin, a complex three-dimensional polymer that includes nitrogen. Because lignin dissolves in the pulping chemical solution (liquor), spent pulping liquor is the source of nitrogen in mill wastewaters. Spent pulping liquor (called black liquor in the kraft process) is separated from the cellulose in multiple washing and bleaching stages. Process steps where the spent liquor is sewered and not sent to the recovery system are sources of nitrogen in untreated wastewater. These steps may include open screening in the pulping area, washers in early bleaching stages, and general mill leaks and spills. Most spent pulping liquor is routed to the recovery cycle where it is burned in the recovery boiler. Most of the nitrogen contained in the combusted liquor is lost through recovery boiler air emissions (as nitrogen gas or NO_x) (Slade, 1999).

NCASI evaluated process additives as possible sources of nitrogen. Additives include defoamers, water conditioners, scale inhibitors, chelants, biocides, slimicides, wet and dry strength additives, and dyes and pigments. They concluded that, with the possible exception of chelants (such as ethylene diamine tetracetic acid – EDTA) used in some peroxide-bleaching mills, process additives were unlikely to contribute significantly to process wastewater nitrogen loads (NCASI, 2001).

[19] Foul condensates are the condensed steam from pulp digesters and black liquor evaporators that contains foul-smelling components, as well as color bodies, ammonium, and substantial BOD/COD. Foul condensates are typically steam-stripped to remove methanol, reduced sulfur gases and other volatiles, which are routed to incineration in the lime kiln or power boiler. Steam stripping may also reduce ammonium and thus the total N in the condensates. The stripped condensates may be reused as pulping liquor make-up or discharged to wastewater treatment.

8.5.2 Process Sources of Wastewater Phosphorus Discharges

Slade, Nicol, and Grigsby (Slade 1999) found that bleach plant effluents, particularly acid-stage discharges, contribute the greatest amount of total P in untreated mill wastewater. They suggested that the phosphorus may be associated with the bleaching chemicals. McCubbin and Krogerus (McCubbin, 2003) suggest that phosphorus may enter the mill with the lime or lime-rock, a raw material used in the kraft recovery cycle. NCASI (NCASI, 2001) concluded that process additives were unlikely to contribute significantly to process wastewater phosphorus loads.

8.5.3 Wastewater Treatment System Sources of Wastewater Nutrient Discharges

As stated earlier, pulp and paper mill wastewater typically does not contain sufficient nitrogen and phosphorus to operate a stable biological treatment system to effectively reduce the organic load (BOD_5). Insufficient amounts of nutrients in pulp and paper mill wastewater have been linked to operational problems such as sludge bulking and poor solids separation. For this reason, mills typically add nutrients to their treatment systems. Historically, nutrient additions have been based on the BOD_5 load, in the ratio of 100:5:1 (lbs BOD_5: lbs N: lbs P). NCASI (NCASI, 2001) found that mills currently operating activated sludge treatment systems add nutrients in the ratio of 100:3.5:0.7 while mills operating aerated stabilization basis add nutrients in the ratio of 100:2.0:0.4. NCASI (NCASI, 2001) found that in practice, "…the amount of nutrients added is highly variable and is a function of the type of mill, type of treatment system and associated hydraulic residence time, number and amount of process additives containing nitrogen or phosphorous, whether [ammonia-containing] condensates are steam-stripped and burned or sent to the treatment system, and other parameters." Ammonium and phosphoric acid are commonly added as nutrients, but urea, ammonium phosphate, diammonium phosphate, and ammonium nitrate are also used (NCASI, 2001).

The nitrogen and phosphorus added to the wastewater treatment system are incorporated into the microbial cells (biomass) that remove soluble BOD_5. In an activated sludge treatment system, the biomass is removed in a clarifier prior to wastewater discharge. A portion of the biomass is returned to the aeration basin, available to remove the incoming BOD_5. Typical mean cell residence time in an activated sludge treatment system is 5 to 15 days. As the cells reach their maximum age, they lyse, releasing their cell contents so that the cell nitrogen and phosphorus are available to support the growth of other cells.

Aerated stabilization basin treatment systems require lower amounts of nutrients than activated sludge treatment systems because of increased release of nutrients from microbial cell cycling. The excess sludge in an aerated stabilization basin is not removed from the system, but forms an anaerobic layer at the bottom of the basin. Nitrogen and phosphorus are cycled to the overlying water column from this bottom (benthic) sludge layer. In addition, in certain modes of operation, aerated stabilization basins can select for a bacterial population capable of fixing atmospheric nitrogen. Consequently, aerated stabilization basins operating with nitrogen-fixing bacteria do not require the addition of any nitrogen. Resuspension of the benthic sludge layer results in discharge of total suspended solids potentially high in nitrogen and phosphorus.

8.6 Nutrient Control Strategies for Pulp and Paper Mills

To minimize the discharge of total nitrogen and phosphorus from pulp and paper mills, facilities need to optimize nutrient supplementation and effectively remove suspended solids. Very close control of nutrient supplementation requires on-line monitoring of flow and organic strength, knowledge of system nutrient requirements, and possibly also a feedback control system for effluent nutrient species (Slade, 2004). Once nutrient supplementation is well-controlled, the majority of the discharged nutrients are contained within the biomass. Effective solids separation then becomes the controlling step, and optimization of secondary clarification is crucial (Slade, 2004).

When facilities cannot meet regulatory constraints using biological treatment alone, they may need to include a tertiary treatment step. Chemical precipitation of phosphorus is the most common tertiary treatment in the pulp and paper industry. Phosphorus forms highly insoluble precipitates with calcium, magnesium, and iron, which can remove phosphorus from the soluble phase. However, tertiary treatment for phosphorus removal from high-volume wastewaters is expensive, and produces a further waste stream for disposal (Slade, 2004).

Tertiary treatment for nitrogen removal is not common in the pulp and paper industry. However, wetlands are often used to remove nitrogen from municipal wastewaters and this treatment may be adaptable to pulp and paper mill wastewaters.

To address anthropogenic eutrophication of its lakes and streams, the state of Wisconsin established nitrogen and phosphorus criteria. For municipal and industrial point sources, the nutrient criteria may require phosphorus removal below the regulatory phosphorus effluent limits threshold levels. Although it established wastewater effluent standards for phosphorus of 1 mg/L, Wisconsin's State Rule NR 217 allows alternative effluent limits if the 1-mg/L standard is not practically achievable or if dischargers have a small likelihood of contributing to existing use impairments in their receiving water body.

Eight Wisconsin pulp and paper mills have applied for alternative phosphorus limits. Most of these mills chose to demonstrate that reducing nutrient supplementation caused wastewater treatment system operational problems such as sludge bulking and poor solids separation. The mills typically reduced phosphorus addition and closely monitored their biological treatment systems for nutrient deficiency. The lowest phosphorus discharge concentrations at which the mills could operate their existing wastewater treatment systems range from 1.2 to 2.6 mg/L. Table 8-5 lists the mills that requested alternative phosphorus limits and the justification they provided for their requested limit.

8.7 Detailed Study Findings for Nutrients

Below are the results regarding nutrients from EPA's 2006 annual review:

- In the initial analysis conducted in 2005, the Pulp and Paper Category ranked third in total annual nitrogen load (lb/yr) and first in total annual phosphorus load (lb/yr). Therefore, EPA began investigating wastewater discharges of nutrients (i.e., nitrogen and phosphorus) from the Pulp and Paper Category in its 2006 annual review.

Table 8-5. Wisconsin Phosphorus Minimization Alternative Limits Justifications

Facility Name NPDES Permit Number	Requested Alternative Phosphorus Limit	Justification for Requested Alternative Phosphorus Limit
City Forest WI000320	1.8 mg/L	Phosphorus minimization study demonstrated that reduced phosphorus caused filamentous bulking. Mill requested limit equal to the lowest sustainable phosphorus residual that will not impede biological performance.
Domtar WI0003620	1.5 mg/L	Phosphorus minimization study defined the minimum phosphorus addition rate necessary to maintain healthy treatment biomass. End-of-pipe control, ferric chloride, and tertiary filtration costs were prohibitive. The mill has improved accuracy of phosphoric acid pumping and increased oxygen consumption.
Weyerhaeuser WI0026042	1.5 mg/L	Mill documented incidents of phosphorus deficiency where bulking solids were later experienced. Traditional removal technologies were evaluated: alum usage could violate the aluminum permit limit, ferric chloride could attack heat exchangers, and ferric sulfide and polymer costs were prohibitive. Historically, the daily addition of phosphoric acid has been reduced.
Smart Paper (Fraser) WI0003212	2.0 mg/L	Phosphorus minimization study demonstrated that phosphorus reduction causes sudden and severe failure in the biological treatment process. An independent report recommended a BOD/PO_4 ratio be maintained for adequate phosphorus availability.
Stora Enso (Repap) WI0000698	2.0 mg/L (1.6 mg/L)[a]	Mill has historically experienced brown foam (mixed liquor which floats up in aeration tanks) upsets. Severe brown foam outbreaks were traced to a phosphorus deficiency; controlling outbreaks requires increased phosphorus feed.
Stora Enso WI00007526	1.45 mg/l (1.2 mg/l)[a]	Phosphorus minimization study demonstrated a BOD:P ratio necessary to maintain efficient BOD and TSS removal. The mill ratio is higher than typical, but the mill's products and treatment systems are unique in North America. Use of liquid alum for tertiary phosphorus removal would increase sludge, aluminum residuals, pH suppression and impact anaerobic pretreatment. It is also costly.
Wausau Paper WI0003379	2.0 mg/L	Minimization study showed the mill operated best when phosphorus discharges were between 2-2.5 mg/l. Traditional removal technologies were evaluated: ferric chloride would increase costs and sludge, but not achieve the 1mg/l limit. Sodium aluminate and an anionic polymer were also unsuccessful at achieving discharge concentrations less than 2 mg/l.
Packaging Corp WI0002810	4.01 mg/l (2.6 mg/L)[a]	Mill performed a detailed assessment of phosphorus sources; reduction was evaluated on a case-by-case basis (e.g., mill reduced phosphoric acid from felt cleaning). Mill received funding for evaluation of two innovative treatment technologies. Conventional ferric chloride precipitation was also evaluated. The evaluated technologies were either not cost-effective or unable to achieve concentrations below 5 mg/l. The alternative limit of 4.01 mg/L was derived statistically from historical data.

Source: (Lange, 2006a)
[a]Alternative limit granted by Wisconsin.

- EPA conducted "reasonableness checks" of the nutrient loads it estimated during the 2005 annual review. For the Pulp and Paper Category, EPA reviewed the nutrient loads calculated for two facilities, Brunswick Cellulose, Brunswick, GA and Georgia-Pacific, Big Island, VA and found that the loads EPA calculated in *PCSLoads2002* did not accurately represent mill nutrient discharges.

- During the 2006 annual review, EPA found its calculation methodologies and PCS data quality may lead, in some cases, to inaccuracies in estimated nutrient discharge loads. For this reason, EPA intends to investigate ways for improving the data review processes for nutrients discharges in future effluent guidelines planning cycles, so EPA can better identify and correct inaccuracies in estimated discharge loads.

- EPA found that many mills discharge measurable concentrations of nutrients. NCASI reports (NCASI, 2001) that mills may discharge from 3 to 10 mg/L of total nitrogen and, on average, 1 mg/L of total phosphorus (NCASI, 2001). Permit writers should use BPJ to evaluate available pollution prevention and treatment technologies when establishing the NPDES permit limits that are required to address the mill-specific problems.

- Wisconsin has established wastewater effluent standards for phosphorus of 1 mg/L. Achievable phosphorus discharge concentrations range from 1.2 to 2.6 mg/L, based on optimizing nutrient additions to existing biological treatment systems.

- Minimizing the discharge of total nitrogen and phosphorus from pulp and paper mill wastewater treatment systems requires optimized nutrient supplementation and effective removal of suspended solids. EPA has not determined if these strategies are feasible for all mills. EPA found that end-of-pipe treatment technologies for nutrients removal have not been well demonstrated on mill wastewaters.

9.0 CLUSTER RULE IMPLEMENTATION AND IMPACT

One of the purposes of the detailed study of the Pulp and Paper Category is to determine how the 1998 Cluster Rules have been implemented and their effect on mill discharges. EPA evaluated the implementation of the Cluster Rules by reviewing NPDES permits from 78 of the 79 (99 percent) operating Phase I mills and selected POTWs. As of August 2006, EPA had requested, but not received, a permit for one POTW, the Bay County Wastewater Treatment Plant in Panama City, FL. EPA evaluated the effect of the Cluster Rules by analyzing Phase I mill discharge data reported to PCS for the period 1998 to 2004 and reviewing the status of dioxin-related fish consumption advisories.

9.1 Detailed Summary of 1998 ELGs Revisions (Cluster Rules)

EPA promulgated revised ELGS for two subcategories, Subpart B (Bleached Papergrade Kraft and Soda) and Subpart E (Papergrade Sulfite) April 15, 1998 (63 FR 18504). EPA promulgated the Phase I ELGs at the same time it promulgated National Emissions Standards for Hazardous Air Pollutants (NESHAPs) for kraft and sulfite pulp mills. Because these water and air regulations were developed, analyzed, and promulgated jointly, they are called the Cluster Rules. The Cluster Rules regulate wastewater discharges of toxic and nonconventional pollutants that are characteristic of mills that bleach chemical pulp with chlorine-containing compounds. These pollutants include adsorbable organo-halides (AOX), chloroform, TCDD, TCDF, and 12 chlorinated phenolic compounds[20]. Chemical pulp bleaching is the principal source of these pollutants. Permit writers issue permits that, at a minimum, limit the discharge of these pollutants, following the Cluster Rules effluent limitations guidelines.

In addition to limiting pollutant discharges, NPDES permits establish monitoring and reporting requirements. Permits specify what discharge points must be monitored, for what pollutants, at what frequency, and how frequently facilities report to their permitting authority. Facility Discharge Monitoring Reports (DMRs) provide the permitting authority with the information necessary to evaluate compliance with discharge limits. Table 9-1 summarizes the

[20] 4-trichlrosyringol; 3,4,5-trichlorocatechol; 3,4,6-trichlorocatechol; 3,4,5-trichloroguaiacol; 3,4,6-trichloroguaiacol; 4,5,6-trichloroguaiacol; 2,4,5-trichlorophenol; 2,4,6-trichlorophenol; tetrachlorocatechol; tetrachloroguaiacol; 2,3,4,6-tetrachlorophenol; and pentachlorophenol.

required compliance points for each pollutant regulated by the Cluster Rules. As noted in the table, EPA established less stringent monitoring requirements for bleached papergrade kraft mills that use totally chlorine-free (TCF) bleaching. Because TCF bleaching is the basis for its BAT limitations for Segment A of Subpart E (Papergrade Sulfite), bleach plant generation of chlorinated pollutants is eliminated and EPA determined that only monitoring for AOX is required.

Table 9-1. Compliance Points for Cluster Rule Regulated Pollutants

Pollutant[a]	Subpart B (BPK Mills)		Subpart E (PS Mills)		
	Non-TCF	TCF	Calcium-, Sodium-, Magnesium-Based (Segment A)	Ammonium-Based (Segment B)	Specialty Grade (Segment C)
2,3,7,8-TCDD	Bleach Plant	Not required	Not required	Bleach Plant	Bleach Plant
2,3,7,8-TCDF	Bleach Plant	Not required	Not required	Bleach Plant	Bleach Plant
Chloroform	Bleach Plant	Not required	Not required	Reserved	Reserved
12 chlorinated phenolic pollutants	Bleach Plant	Not required	Not required	Bleach Plant	Bleach Plant
AOX	Final Effluent (Directs) Bleach Plant (Indirects)	Final Effluent	Final Effluent (Directs) Bleach Plant (Indirects)	Reserved	Reserved
COD	Reserved	Reserved	Reserved	Reserved	Reserved

Source: Permit Guidance Document (U.S. EPA, 2000a).
[a]Table 9-1 presents monitoring locations information for Cluster Rules pollutants. All Phase I mills must also monitor and comply with BPT/BCT limits for pH, BOD_5 and TSS at the final effluent. Unless they certify that they do not use chlorophenolic-containing biocides, they must also monitor and comply with BAT limits for trichlorophenol and pentachlorophenol at the final effluent.
BPK - Bleached Papergrade Kraft. PS - Papergrade Sulfite. TCF - Totally Chlorine-Free.
Reserved – Although pollutant was identified as a pollutant of concern, EPA reserved promulgation of limitations until such time that sufficient performance data were available and no monitoring is required.

As shown above, mills are required to demonstrate compliance at the following two locations:

- The point where wastewater leaves the bleach plant, before being combined with process wastewaters or noncontact cooling water from other operations prior to treatment and discharge. Hereafter, this sample location is referred to as “bleach plant effluent.”

- The point where mills discharge their treated effluent to the receiving streams; hereafter referred to as “final effluent.”

9.1.1 Best Available Technology Limitations and Pretreatment Standards

The Cluster Rules require that mills existing as of April 15, 1998 that discharge directly to receiving streams control toxic and nonconventional pollutants at the best available technology (BAT) economically achievable level of performance. EPA established Pretreatment Standards for Existing Sources (PSES) that are based on control technologies similar to BAT for indirect dischargers. EPA identified the "best available technology" for Subpart B as conventional pulping followed by complete substitution of chlorine dioxide for elemental chlorine, elimination of hypochlorite, and eight additional elements described in detail in the *Supplemental Technical Development Document* (U.S. EPA, 1997). The technology basis of New Source Performance Standards (NSPS) is equivalent to that of BAT with the addition of extended delignification (oxygen delignification and/or extended cooking). Although EPA promulgated regulations for new sources (NSPS for direct dischargers and Pretreatment Standards for New Sources (PSNS) for indirect dischargers), no new bleached papergrade kraft or papergrade sulfite mills have been constructed since 1998.

Table 9-2 presents the Subpart B BAT limitations guidelines and PSES for bleached papergrade kraft and soda mills. Except for the monitoring location for AOX, the Subpart B BAT limitations guidelines and PSES for indirect dischargers are the same. As specified in 40 CFR 430.24(a)(2), mills with operations in Subpart B that use exclusively TCF bleaching processes have limits for AOX only and must monitor at the final effluent. The AOX limit is <ML, meaning <20 μg/L.

Table 9-2. Subpart B (Bleached Papergrade Kraft and Soda) BAT Effluent Limitations Guidelines and Pretreatment Standards for Existing Sources

Pollutants	1-Day Maximum[a]
Bleach Plant Effluent	
TCDD	<ML[b]
TCDF	31.9 pg/l
Chloroform	1-Day Maximum: 6.92 g/kkg
	Monthly Average: 4.14 g/kkg
Trichlorosyringol	<ML[b]
3,4,5-Trichlorocatechol	<ML[b]
3,4,6-Trichlorocatechol	<ML[b]
3,4,5-Trichloroguaiacol	<ML[b]
3,4,6-Trichloroguaiacol	<ML[b]
4,5,6-Trichloroguaiacol	<ML[b]
2,4,5-Trichlorophenol	<ML[b]
2,4,6-Trichlorophenol	<ML[b]
Tetrachlorocatechol	<ML[b]
Tetrachloroguaiacol	<ML[b]
2,3,4,6-Tetrachlorophenol	<ML[b]
Pentachlorophenol	<ML[b]
Final Effluent (for BAT) or Bleach Plant Effluent (for PSES)	
AOX	1-Day Maximum: 0.951 kg/kkg
	Monthly Average: 0.623 kg/kkg

[a]EPA established monthly average limitations guidelines only for chloroform and AOX.
[b]<ML means less than the minimum level at which the analytical system gives recognizable signals and an acceptable calibration point. The MLs for each pollutant are specified in 40 CFR 430.01(i).

EPA identified the "best available technology" for Subpart E Segment A (Calcium, Magnesium, and Sodium Sulfite) as TCF bleaching (bleaching with peroxide). For Subpart E, Segment B "best available technology" was identified as complete substitution of chlorine dioxide for elemental chlorine and elimination of hypochlorite. BAT for both segments includes four additional elements described in detail in the *Supplemental Technical Development Document* (U.S. EPA, 1997). Table 9-3 presents the Subpart E BAT limitations guidelines and PSES for papergrade sulfite mills. Regulations for Segment C (Specialty-Grade Sulfite Segment) are not presented because no mills with operations in Segment C are currently operating in the United States. As was the case for Subpart B, except for the monitoring location for AOX, the Subpart E BAT limitations guidelines and PSES for indirect dischargers are the same.

Table 9-3. Subpart E (Papergrade Sulfite) BAT Effluent Limitations Guidelines and Pretreatment Standards for Existing Sources

Pollutants	Segment A Calcium, Magnesium, and Sodium Sulfite[a]	Segment B Ammonium Sulfite
Bleach Plant Effluent		
TCDD	not regulated	<ML[b]
TCDF	not regulated	<ML[b]
Chloroform	not regulated	Reserved
Trichlorosyringol	not regulated	<ML[b]
3,4,5-Trichlorocatechol	not regulated	<ML[b]
3,4,6-Trichlorocatechol	not regulated	<ML[b]
3,4,5-Trichloroguaiacol	not regulated	<ML[b]
3,4,6-Trichloroguaiacol	not regulated	<ML[b]
4,5,6-Trichloroguaiacol	not regulated	<ML[b]
2,4,5-Trichlorophenol	not regulated	<ML[b]
2,4,6-Trichlorophenol	not regulated	<ML[b]
Tetrachlorocatechol	not regulated	<ML[b]
Tetrachloroguaiacol	not regulated	<ML[b]
2,3,4,6-Tetrachlorophenol	not regulated	<ML[b]
Pentachlorophenol	not regulated	<ML[b]
Final Effluent (for BAT) or Bleach Plant Effluent (for PSES)		
AOX	1-Day Maximum: 2.64 kg/kkg	Reserved
	Monthly Average: 1.41 kg/kkg	Reserved

[a]EPA established monthly average limitations guidelines for AOX. Only final effluent monitoring is required.
[b]<ML means less than the minimum level at which the analytical system gives recognizable signals and an acceptable calibration point. The MLs for each pollutant are specified in 40 CFR 430.01(i).
Reserved – Although pollutant was identified as a pollutant of concern, EPA reserved promulgation of limitations until such time that sufficient performance data were available. No monitoring is required.

9.1.2 "Beyond BAT": VATIP and Limits for TCF Mills

As part of the Cluster Rules promulgated in 1998, EPA established two incentives for mills to reduce their discharges beyond the BAT requirements. The Voluntary Advanced Technology Incentives Program (VATIP) encourages existing and new direct dischargers subject to Subpart B to reduce pollutant discharges by implementing advanced pollution prevention controls. No comparable program was established for mills subject to Subpart E or for indirect dischargers. By enrolling in VATIP, mills receive additional time to comply with the Cluster Rules (six or more years, depending on the selected tier), reduced monitoring requirements, and public recognition. EPA established three tiers (Tier I, II, or III) of Advanced Technology performance requirements, each with increasingly more effective levels of environmental protection. EPA's *Permit Guidance Document: Pulp, Paper and Paperboard Manufacturing*

Point Source Category (40 CFR §430) provides additional details on incentives program (U.S. EPA, 2000a).

TCF bleaching is performed without using chlorine, sodium or calcium hypochlorite, chlorine dioxide, chlorine monoxide, or any other chlorine-containing compound. As an incentive for mills to use TCF bleaching, EPA provided reduced monitoring requirements for TCF bleach lines. For each bleach line that uses exclusively TCF bleaching processes, the mill is required only to comply with final effluent AOX limitations; no bleach plant limits are required in the mill's permit.

Prior to promulgating the Cluster Rules, EPA had established Project XL, which stands for "eXcellence and Leadership." This national pilot program allowed state and local governments, businesses, and federal facilities to work with EPA to develop more cost-effective strategies for achieving environmental and public health protection. In exchange, EPA offered regulatory, program, policy, or procedural flexibility to conduct the program. One bleached papergrade kraft mill (Weyerhaeuser in Oglethorpe, GA) participates in EPA's Project XL.

Table 9-4 lists the bleached papergrade kraft mills participating in these beyond-compliance programs.

Table 9-4. Bleached Papergrade Kraft Mills Operating "Beyond Compliance"

	NPDES Permit Number	Beyond Compliance Program
VATIP Mills		
International Paper, Eastover	SC0038121	VATIP
Bowater Inc., Catawba	SC0001015	VATIP
Glatfelter, Spring Grove	PA0008869	VATIP
International Paper, Franklin	VA0004162	VATIP
XL Mill		
Weyerhaeuser/Flint River Mill, Oglethorpe	GA0049336	XL
TCF Bleaching Mill		
Evergreen Pulp Company (formerly Louisiana-Pacific), Samoa	CA0005894	TCF

VATIP - Voluntary Advanced Technology Incentives Program.
XL - eXcellence and Leadership.
TCF - Totally Chlorine Free.

9.1.3 Support Documents

The following EPA documents (which can be found at the EPA web site http://epa.gov/waterscience/pulppaper/) provide additional background on the Cluster Rules and their implementation:

- *Supplemental Technical Development Document for Effluent Limitations Guidelines and Standards for the Pulp, Paper, and Paperboard Category: Subpart B (Bleached Papergrade Kraft and Soda) and Subpart E (Papergrade Sulfite)*. EPA-821-R-97-011. October 1997.

- *Technical Support Document for the Voluntary Advanced Technology Incentives Program*, November, 1997.

- *Technical Support Document for Best Management Practices for Spent Pulping Liquor Management, Spill Prevention, and Control*. EPA 821-R-97-011. October 1997.

- *Permit Guidance Document for the Pulp, Paper, and Paperboard Manufacturing Point Source Category (40 CFR 430)*. EPA-821-B-00-003. May 2000.

9.2 Incorporation of Cluster Rules Monitoring Requirements into NPDES Permits

EPA reviewed mill NPDES permits to determine if they included the appropriate Cluster Rules monitoring requirements. Permits are issued to facilities for a specific time period (generally five years) with a requirement to reapply prior to the expiration date. Permit writers are required to use the Cluster Rules guidelines for permits issued after April 15, 1998. Thus, all permits for affected mills should have had limits and monitoring requirements based on the new guidelines by April 2003, unless permit renewal was delayed or the mill was enrolled in the VATIP.

This subsection presents EPA's review of permits issued to facilities subject to the Cluster Rules and POTWs that receive wastewater subject to the Cluster Rules.

9.2.1 Bleached Papergrade Kraft Mills

At the time the Cluster Rules were promulgated, 84 bleached papergrade kraft mills operated in the United States. As of 2004, 72 mills continued to have bleached papergrade kraft operations. These mills are listed in the appendix to this report. The 72 operating mills include one TCF mill, Evergreen Pulp Company (formerly Louisiana Pacific) in Samoa, CA (which produces a chlorine-free product using peroxide bleach), five mills operating in other beyond-compliance programs, four indirect dischargers subject to PSES, and two mills that share a permit. EPA reviewed 71 permits for these bleached papergrade kraft papergrade mills to determine if the appropriate Cluster Rules monitoring requirements were included[21].

The Cluster Rules require mills to monitor for TCDD, TCDF, chloroform, and chlorinated phenolic compounds at the bleach plant. Table 9-5 lists six permits for direct dischargers that do not yet include Cluster Rule limits because the revised permits are either being contested or have not been reissued since the Cluster Rules were promulgated. Three of these active permits specify final effluent, rather than bleach plant effluent, as the compliance monitoring point.

[21] This count does not match the tally of collected BPK permits in Section 2.0; the count in Table 2-1 (70 mills) excludes Boise Cascade in Saint Helens OR, which is copermitted with the City of St. Helens POTW.

Table 9-5. Permits for Bleached Papergrade Kraft Mills Missing Required Bleach Plant Monitoring as of June 2006

Mill	NPDES Permit Number	Active Permit Expiration Date	Pollutant Absent from Required Bleach Plant Monitoring	Pollutant Absent from Required Final Effluent Monitoring	Pollutant Limited at FE not BP
International Paper Co., Cantonment (Contested)	FL0002526	8/31/95	TCDD, TCDF, chloroform, CP	AOX	-
International Paper Co., Riegelwood (Not issued)	NC0003298	11/30/01	TCDD, TCDF, chloroform, CP	AOX	TCDD, CP
Pope & Talbot Inc., Halsey (Not issued)	OR0001074	7/1/98	CP, chloroform	None	-
Fraser Paper, Berlin (Not issued)	NH0000655	10/21/99	TCDD, TCDF, chloroform, CP	None	TCDD, TCDF
Lincoln Pulp & Paper Co, Lincoln (Contested)	ME0002003	1/23/02	Chloroform, CP	None	-
International Paper Co., Texarkana (Contested)	TX0000167	1/1/01	TCDD, TCDF, chloroform, CP	None	TCDD

CP - Chlorinated phenolic compounds.
BP - Bleach Plant.
FE - Final Effluent.

In the preliminary report of this detailed study (U.S. EPA, 2005b), EPA identified four active permits for bleached papergrade kraft mills that had no AOX monitoring requirement. Each of these permits had expired and had not been reissued following promulgation of the Cluster Rules. EPA contacted Maine, North Carolina, and Florida and determined that two permits had been reissued after publication of the preliminary report. The permits for the MeadWestvaco (NewPage) mill in Rumford, ME and the Weyerhaeuser mill in Plymouth, NC were issued after August 2005 and now require final effluent AOX monitoring. The International Paper Company mills in Cantonment, FL and Riegelwood, NC continue to operate with expired permits that are missing required final effluent AOX monitoring.

9.2.2 POTWs

Four bleached papergrade kraft mills and no papergrade sulfite mills discharge their wastewater to POTWs. These four mills can contribute up to 90 percent of the receiving POTW wastewater flow (U.S. EPA, 1993). Even so, ELGs do not apply to POTWs. Permit limits for the POTWs are determined by water quality standards and the professional judgment of the permit writer. EPA reviewed permits to understand the variety of ways permit writers have limited the discharges of pulp mill wastewaters treated by POTWs. EPA did not review any pretreatment agreements between the mills and the POTW. As summarized in Table 9-6, permit writers have addressed discharges from POTWs receiving bleached papergrade kraft mill effluents in a variety of ways.

Table 9-6. Permit Requirements for POTWs Receiving Bleached Papergrade Kraft Mill Wastewater

Mill[a]	POTW	POTW NPDES Permit Number	Comments
Boise Cascade, St. Helens, OR	City of St. Helens POTW	OR0020824	Joint permit includes bleach plant effluent limits for the mill that follow the Cluster Rule guidelines.
NewPage (was Westvaco), Luke, MD	Upper Potomac River Commission, Westernport, MD	MD0021687	Includes limits for mill bleach plant effluent. Permit expired April 30, 2006.
SAPPI (was Potlatch), Cloquet, MN	Western Lake Superior Sanitary District Duluth, MN	MN0049786	Includes TCDD and chloroform final effluent monitoring requirements.
SAPPI Fine Paper (was S.D. Warren), Muskegon, MI	Muskegon County Wastewater Management System	MI0027391	Includes TCDD final effluent monitoring requirements.

[a]EPA did not obtain a copy of the permit for Stone Container Corporation in Panama City, FL (NPDES: FL0002631).

9.2.3 Papergrade Sulfite Mills

At the time the Cluster Rules were promulgated, 11 papergrade sulfite mills operated in the United States. As of 2004, only six of these mills still had sulfite pulping operations and all were direct dischargers. Table 9-7 lists these mills, their NPDES permit number, and the segment of the Subpart E regulations that applies to their discharges. None of the operating papergrade sulfite mills produce specialty grade pulp (Segment C).

Table 9-7. Papergrade Sulfite Mills Operating in 2004

Mill Name	NPDES Permit	Segment
Wausau Mosinee Paper Mills, Brokaw	WI0003379[a]	A (Calcium, Magnesium, or Sodium Sulfite)
Weyerhaeuser Paper Co., Rothschild	WI0026042	A (Calcium, Magnesium, or Sodium Sulfite)
Fraser Paper, Park Falls	WI0003212	A (Calcium, Magnesium, or Sodium Sulfite)
Domtar, Port Edwards	WI0003620[b]	A (Calcium, Magnesium, or Sodium Sulfite)
Kimberly-Clark, Everett	WA0000621	B (Ammonium Sulfite)
Finch Pruyn & Co Inc., Great Falls	NY0005525	B (Ammonium Sulfite)

[a]Wausau Mosinee Paper Mills, Brokaw ceased operations as a papergrade sulfite mill in November 2005.
[b]Two Domtar mills (Nekoosa - BPK mill & Port Edwards - a PS mill) share an NPDES permit.
Segment A - Applies to mills that produce pulp using calcium, magnesium, or sodium sulfite acidic cooking liquors.
Segment B - Applies to mills that produce pulp using an ammonium sulfite acidic liquor.

The six operating papergrade sulfite mills in 2004 include one facility that shares a treatment system with a Subpart B mill. Wausau Mosinee Paper mill in Brokaw, WI ceased papergrade sulfite operations in November 2005. Weyerhaeuser Rothschild has been totally chlorine-free since 1998; the facility produces calcium-based sulfite pulp and printing and writing paper and is in Segment A.

The Domtar Port Edwards mill produces bleached magnesium-based sulfite pulp (Segment A) and has been totally chlorine-free since 1993. It is copermitted with the Domtar Nekoosa BPK mill. The permit for the discharge from this combined wastewater treatment system includes AOX limits, based on the BPK limits. This permit was included in the review of bleached papergrade kraft mill permits and is not included in the analysis of the papergrade sulfite mill permits.

The Cluster Rules require permits for papergrade sulfite mills with operations in Segment A (Calcium-, Magnesium-, and Sodium-Based Sulfite) to have AOX limits and monitoring at the final effluent. The Cluster Rules require permits for papergrade sulfite mills with operations in Segment B (Ammonium-Based Sulfite) to have limits for TCDD, TCDF, and 12 chlorinated phenolic pollutants and monitoring at the bleach plant effluent. Table 9-8 presents the number of permits for papergrade sulfite mills that do not include the appropriate Cluster Rules monitoring requirements. EPA’s findings are discussed below.

Table 9-8. Number of Permits for Papergrade Sulfite Mills Missing Cluster Rules Monitoring Requirements, as of 2004

Segment[a]	Permits Collected	Permit Expired	Required Monitoring Missing			
			FE-AOX	BP-TCDF	BP-TCDD	BP-CP
A - Calcium, Magnesium, or Sodium Sulfite	2	0	2[b] (Final Effluent)	0[c]	0[c]	0[c]
B - Ammonium Sulfite	2	0	0[d]	0 (Bleach Plant)	0 (Bleach Plant)	0 (Bleach Plant)
Total	**4[e]**	**0**	**0**	**0**	**0**	**0**

[a]No active PS mills are indirect dischargers or in the Specialty Grade Segment.
[b]Permitting authority has allowed monitoring at an alternative internal monitoring location, in place of final effluent monitoring.
[c]Cluster Rules do not require bleach plant monitoring for TCDD, TCDF, or chlorinated phenolic compounds for the Calcium, Magnesium, or Sodium Sulfite segment.
[d]EPA has not promulgated AOX limits for the Ammonium Sulfite Segment.
[e]Excludes a permit shared by two Domtar mills (analyzed as BPK mill) and a permit for Wausau Mosinee Paper in Brokaw, WI, which ceased PS operations as of November 2005.
BP - Bleach Plant.
FE - Final Effluent.
CP - Chlorinated Phenolic Compounds.

Both permits for the two operating Segment B mills include all Cluster Rules requirements. They also include bleach plant chloroform monitoring requirements, even though the Cluster Rules do not require them.

EPA collected permits for three Segment A mills. All three mills are located in Wisconsin. One of the three mills, Wausau Mosinee Paper in Brokaw, ceased papergrade sulfite operations as of November 2005. Information about the mill's permit is not included in Table 9-8. Permits for the other two Segment A mills do not include requirements for monitoring final effluent for AOX. Instead, Wisconsin has allowed these mills to demonstrate compliance with Cluster Rule AOX limits at an internal monitoring location, equivalent to what the rule requires.

9.2.4 Monitoring Requirements in NPDES Permits, Summary of Findings

EPA reviewed how the monitoring requirements from the Cluster Rules have been incorporated into NPDES permits for all operating mills with operations in Subparts B and E. The majority of permits for direct dischargers (91 percent or 61 out of 67) reflect the ELGs. Permits for six bleached papergrade kraft mills do not yet include Cluster Rules limits because the permits are either being contested or have not been reissued since the Cluster Rules were promulgated. Permits for two papergrade sulfite mills allow the facilities to demonstrate compliance with the AOX limit at alternate monitoring locations.

9.3 Analysis of Compliance Monitoring Data

This subsection presents EPA's evaluation of compliance monitoring data reported to PCS for bleached papergrade kraft mills and for papergrade sulfite mills. Washington State does not report internal monitoring data to PCS, but provided mill bleach plant effluent monitoring data directly to EPA for this analysis. These data are also discussed in this subsection. Finally, this subsection summarizes EPA's evaluation of the effects of the Cluster Rules on mill discharges.

To evaluate the effect of the Cluster Rules on mill discharges, EPA compared PCS pollutant discharge data to the Cluster Rules limitations. For this comparison, EPA compiled data for 1998, when the Cluster Rules were promulgated, through 2004, the most recent full year for which PCS data were available at the beginning of this study. For pollutants with concentration-based limitations (TCDD, TCDF, and the chlorinated phenolic compounds), EPA determined if the mill was meeting the limitations by examining PCS-reported concentrations. EPA could not, however, determine if mills were meeting mass-based limitations for chloroform and AOX. Mass-based limitations are production-normalized (e.g., 4.14 grams of chloroform per metric ton of pulp production and 0.623 kilograms of AOX per metric ton of pulp production). PCS does not include mill production information and thus EPA could not determine production-normalized pollutant discharges.

For chloroform and AOX, EPA evaluated the Cluster Rules' impact on each reporting mill's discharges by comparing the baseline pollutant load EPA estimated during the development of the guidelines to the discharge load calculated using PCS data. As part of the Cluster Rules development, EPA estimated baseline pollutant loads for each mill. Because EPA did not have actual discharge data from each mill subject to Subpart B or E, EPA modeled baseline discharges for each mill based on the operations in use and pulp production as of mid-

1995. Hereafter, EPA's 1995 estimated production-normalized loads are referred to as "baseline loads."

The process changes that are the basis of the BAT limitations (especially using chlorine dioxide to bleach, instead of chlorine), reduce the concentrations of TCDD, TCDF, and chlorinated phenolic compounds to below or very close to analytical method detection limits. For this reason, the measured discharges of these pollutants are not related to pulp production.

Discharges of AOX and chloroform are related to pulp production[22]. For the same bleaching conditions, the higher a mill's production, the greater the mass of AOX and chloroform it will discharge. From 1998 to 2000, production for the industry as a whole was stagnant (U.S. Department of Agriculture, 2001); therefore, changes in AOX and chloroform discharges, for the industry as a whole, are more likely related to changes in bleaching conditions than to changes in pulp production. Understanding the AOX and chloroform discharge trends at individual mills, however, requires information about the mill's bleached pulp production.

9.3.1 Bleached Papergrade Kraft

EPA collected and reviewed 67 NPDES permits for bleached papergrade kraft mills. Although most of the permits included limits based on the Cluster Rules ELGs, monitoring data for many of the regulated pollutants were missing from PCS. Table 9-9 lists, for each of the Cluster Rules pollutants, the number of bleached papergrade kraft mills with Cluster Rules permit limits and the number of mills with 2004 monitoring data in PCS. Table 9-9 also shows the number of mills without Cluster Rules permit limits for which PCS contains data.

[22] Chloroform discharges are closely correlated to the use of hypochlorite bleaching. When hypochlorite is eliminated, chloroform discharges are reduced by a factor of one hundred. Chloroform discharges are also related to, among other factors, the pH of the chorine dioxide bleaching stages, chlorine dioxide dose (pounds per thousand pounds of pulp), and production. (See 67 FR 58,990; September 19, 2002.)

Table 9-9. Comparison of Permit-Required Monitoring and Monitoring Data in PCS, for Direct Discharging Bleached Papergrade Kraft Mills

	Direct Discharging BPK Mills with Permit Limits for Cluster Rules Pollutants			Mills Without Permit Limits with Data in PCS[a]
	Total (A=B+C)	Data in PCS for 2004 (B)	No Data in PCS (as of 2004) (C)	
Bleach Plant Effluent				
TCDD	63	41	22	1
TCDF	63	42	21	1
Any Chlorinated Phenolic Compound	61	40	21	
Chloroform	61	28	33	
Final Effluent				
AOX	63	37	26	

[a]Excludes permits where pollutants are limited at monitoring locations other than those required by ELGs.

Three of the 67 permits for bleached papergrade kraft mills improperly specified final effluent rather than bleach plant effluent as the TCDD compliance monitoring point (see Table 9-5). EPA found that permits for 63 direct discharging bleached papergrade kraft mills included requirements for monitoring TCDD at the bleach plant, as required by the Cluster Rules. However, EPA identified bleach plant TCDD monitoring data in PCS for only 41 mills. Thus, PCS did not contain TCDD data for 22 mills.

EPA contacted Washington State in 2005 and additional permitting authorities in 2006 to determine why 1998 to 2004 mill monitoring data were not available in the PCS. In 2006, EPA called agencies regarding 36 mills and obtained responses regarding 27 mills. EPA did not identify a systematic reason for missing data. For over half of the mills, the permitting authority did not provide a specific reason for the missing data. However, in three instances the permitting authority was able to locate and send EPA the missing data. Below are some stated reasons for missing monitoring data:

- Monitoring not required between 1998 and 2004 – 3 mills;
- Permitting authority experienced difficulty uploading data either due to software conflicts or clerical errors – 4 mills;

- Permitting authority behind on uploading data – 1 mill;
- Unusual data or reporting frequency – 4 mills; and
- Permitting authority does not upload in-plant monitoring data to PCS – 4 mills.

EPA amended the Cluster Rules in September 2002 to allow mills the option to certify to certain bleach plant operating conditions in lieu of monitoring their bleach plant effluent for chloroform. EPA did not quantify how many mills have taken advantage of this option, but it may explain why there are fewer data in PCS for chloroform than for the other Cluster Rules pollutants.

9.3.1.1 Bleach Plant TCDD and TCDF

Too few detectable concentrations were available to conduct a trend analysis on the basis of calculated mass (grams/year) discharged. As an alternative, EPA counted the number of mills monitoring for TCDD and TCDF and the number detecting these pollutants at concentrations above analytical detection limits. Although many mills have more than one bleach plant, for this analysis EPA counted the number of mills that monitor bleach plant effluent, not the number of bleach plants.

Table 9-10 presents the number of BPK mills for which TCDD and TCDF bleach plant and/or final effluent monitoring data were available in PCS over the period 1998 to 2004[23]. Table 9-10 shows two trends with respect to TCDD bleach plant monitoring at 65 direct discharging BPK mills. Overall, PCS contains TCDD data for significantly more mills in 2004 than in 1998. While the number of facilities with TCDD data at the final effluent remained fairly constant during this period, the number of facilities with TCDD data at the bleach plant increased significantly. During that same period, 13 mills stopped final effluent monitoring; however, in all cases, the mills stopped monitoring when they were issued a new permit, suggesting that permit monitoring locations changed. Trends in mill TCDF monitoring follow a similar pattern.

[23] In addition to the facilities tabulated in Table 9-10, *PCSLoads2002_v4* contained calculated loads for two mills (International Paper in Pine Bluff, AR and Boise Cascade in St. Helens, OR), but the monthly DMR data for these mills were unavailable. As a result, data from these mills are not included in the tables in Section 8.3 and EPA's analysis of compliance monitoring data.

It is important to note that the Cluster Rules do not require final effluent monitoring for TCDD or TCDF although it may be necessary to ensure compliance with state water quality standards.

Table 9-10. Number of BPK Mills with TCDD and TCDF Monitoring Data in PCS, 1998 through 2004[a]

	1998	1999	2000	2001	2002	2003	2004	Stopped Monitoring Between 1998 and 2004
TCDD at BP	11	14	18	24	31	34	41	
TCDD at FE	33	34	34	34	30	32	30	13
TCDD at either	41	44	45	45	47	50	52	3
TCDF at BP	2	5	9	20	30	34	42	
TCDF at FE	14	15	15	15	14	13	12	6
TCDF at either	14	17	19	29	38	42	49	

[a]EPA included 65 direct discharging mills in this review.
FE - Final effluent.
BP - Bleach plant, internal monitoring location.

During the development of the Cluster Rules, EPA calculated the baseline loads for each bleached papergrade kraft mill that reflect mill operations in 1995. To evaluate the effectiveness of the Cluster Rules in reducing pollutant discharges, EPA compared the baseline pollutant load estimated during the development of the ELGs to the discharge load calculated using PCS data. For its 2005 and 2006 annual reviews of existing ELGs, EPA calculated pollutant discharges, by category, using data from PCS for 2002 (U.S. EPA, 2006c). EPA compared the 1995 TCDD loads for the 47 mills with TCDD data in PCS for 2002. EPA also compared the 1995 TCDF loads for the 38 mills with TCDF in PCS for 2002. The Agency estimated the overall 1995 baseline load associated with TCDD and TCDF for these mills was 17.9 million TWPE. According to EPA baseline load estimates, if all mills reporting TCDD and TCDF releases to PCS in 2002 operated under the conditions used to calculate the baseline loads in 1995, they would have discharged a total of 17.9 million TWPE from TCDD and TCDF. In 2002, the final effluent discharge from one mill (Bowater, Catawba, SC) was responsible for all of the pulp and paper TCDD discharge. This mill discharged 0.88 grams of TCDD, which equates to 1.37 million TWPE, a 92 percent reduction from baseline. By 2004, overall TCDD and TCDF discharge loads for reporting mills were only 6,100 TWPE, more than 99 percent reduction from the 1995 baseline (see Section 5.0 for detailed discussion of detection of TCDD and TCDF).

9.3.1.2 Bleach Plant Chlorinated Phenolic Compounds

EPA analyzed the PCS bleach plant effluent chlorinated phenolic compounds data. This analysis was similar to the analysis of TCDD and TCDF discharges. Again, too few detectable concentrations were available to analyze discharge loads (grams/year discharged). Instead, EPA counted the number of mills monitoring for chlorinated phenolic compounds and the number detecting them at concentrations above analytical detection limits.

Table 9-11 presents the number of mills for which chlorinated phenolic compounds data were available in PCS for the period 1998 to 2004. By 2004, PCS included chlorinated phenolic compounds data for approximately 40 of the 65 bleached papergrade kraft mills. Most of these mills monitor for all 12 of the regulated chlorinated phenolic compounds.

Although the Cluster Rules have ELGs for 2,4,6-trichlorophenol and 2,4,5-trichlorophenol, no parameter parametric code exists in PCS for either compound. PCS has a parameter code for total trichlorophenol, as well as total trichlorophenol data for two mills.

Table 9-11 shows that PCS includes 1998 data for trichlorophenol and pentachlorophenol for two bleached papergrade kraft mills, but no other chlorinated phenolic compounds. The number of mills monitoring for chlorinated phenolic compounds has increased steadily over time. As of 2004, PCS included data for one or more chlorinated phenolic compounds for 40 bleached papergrade kraft mills.

For the 29 mills that reported chlorinated phenolic compound discharges to PCS in 2002, EPA's estimated 1995 overall baseline load of chlorinated phenolic compounds was 4,178 TWPE. In 2002, EPA's estimated overall discharge load was zero TWPE because all of these facilities reported zero pounds of chlorinated phenolic compounds.

Table 9-11. Number of BPK Mills With Chlorinated Phenolic Compounds Data in PCS, 1998 Through 2004[a]

	Mills Reporting Chlorinated Phenolic Compounds Data[b]							Stopped Monitoring Between 1998 and 2004
	1998	1999	2000	2001	2002	2003[c]	2004	
Trichlorosyringol		3	7	18	29	33	41	
Total Trichlorophenol [d]	2	2	2	1	2	2	2	1
3,4,5-Trichlorocatechol		3	7	18	29	33	40	
3,4,5-Trichloroguaiacol		1	5	14	24	28	34	
3,4,6-Trichlorocatechol		3	7	18	29	33	40	
3,4,6-Trichloroguaiacol		3	6	17	26	30	38	
4,5,6-Trichloroguaiacol		3	7	18	29	33	41	
Tetrachlorocatechol		3	7	18	29	33	41	
Tetrachloroguaiacol		3	7	17	28	32	40	
2,3,4,6-Tetrachlorophenol		3	6	17	26	30	38	
Pentachlorophenol	2	5	9	18	29	32	40	

[a]EPA included 65 direct discharging mills in this review.
[b]Operating under a single permit, the Parsons & Whittemore mills (Alabama Pine Pulp and Alabama River Pulp) in Claiborne, AL reported data for 10 chlorinated phenolic compounds from 2002 through 2004. The identified mill counts include the two Parsons & Whittemore mills.
[c]Excludes one mill (Willamette Industries Inc. in Bennetsville, SC), which monitored for 10 chlorinated phenolic compounds in 2003 and at no other time during the 1998 through 2004 study period.
[d]Cluster Rules include limitations for 2,4,6-trichlorophenol and 2,4,5-trichlorophenol. PCS contains only a total trichlorophenol parameter.

9.3.1.3 Bleach Plant Chloroform Loads

EPA analyzed PCS bleach plant effluent data for chloroform. Table 9-12 presents the number of mills for which PCS contains bleach plant chloroform data for the period 1999 to 2004 (PCS contains no bleach plant chloroform data for 1998). The number of mills with chloroform data in PCS increased steadily from 1999 to 2004 and by 2004, PCS included chloroform data for 29 of the 67 bleached papergrade kraft mills.

After the April 15, 1998 promulgation of the Cluster Rules, EPA amended the Subpart B (bleached papergrade kraft and soda) regulations to allow new and existing, direct and indirect dischargers to demonstrate compliance with the chloroform limits using a self-certification program. The amendment was promulgated on September 19, 2002. (See 67 FR

58990-58998.) In lieu of monitoring, mills may demonstrate compliance with applicable chloroform limitations and standards by: 1) performing initial monitoring to demonstrate compliance with the applicable chloroform limitations or standards; 2) certifying that the bleach plant is not using elemental chlorine or hypochlorite as bleaching agents; and 3) maintaining records of certain process and operating conditions identified during the compliance demonstration period.

As a result of this amendment to the Cluster Rules, EPA expected that PCS would have fewer data for chloroform than for the other Cluster Rules pollutants. This expectation is confirmed by the data presented in this section. For 2004, PCS has data for TCDD, TCDF, chlorinated phenolic compounds, and AOX for approximately 40 mills. As shown in Table 9-12, PCS has chloroform data for 2004 for 29 mills.

Table 9-12. Number of BPK Mills With Chloroform Monitoring Data in PCS, 1998 Through 2004[a]

	1998	1999	2000	2001	2002	2003	2004
Total number of mills with bleach plant chloroform data in PCS	0	3	7	13	22	26	29
Number of mills discharging above EPA's estimate of their 1995 baseline load	—	-	1	2	2	2	3
Number of mills discharging below EPA's estimate of their 1995 baseline load	—	3	6	11	20	24	26
% reduction from baseline[b]	—	99%	99%	97%	98%	98%	98%

[a]EPA included 67 direct discharging mills in this review.
[b]Percent reduction is 100 × (EPA estimate of 1995 baseline - PCS load) ÷ (EPA estimate of 1995 baseline).

Unlike TCDD, TCDF, and chlorinated phenolic compounds, chloroform is typically measured at concentrations above method detection limits, as evidenced by the data in PCS. For this reason, EPA was able to calculate the load (grams/year) discharged in each mill's bleach plant effluent. In addition to estimating the annual discharge load for each mill for 1999 to 2004, EPA compared the annual load to the 1995 baseline load it had estimated for the mill, and tallied the number of mills for which the annual load was above the baseline and the number below. This information is also included in Table 9-12. This comparison shows that the majority of mills (e.g., 26 of the 29 reporting in 2004) report loads below the 1995 baseline loads.

EPA also calculated the difference between the estimated annual loads and baseline loads, and the percent reduction from baseline for the mills with chloroform data in PCS for each year. Table 9-12 also presents the percent reduction from baseline for each year (1999 to 2004). For the 29 mills with data in PCS in 2004, the total annual load was 98 percent less than EPA's estimated 1995 baseline for these mills.

During the1998-to-2004 study period, chloroform bleach plant loads at three mills (Bowater Coosa Pines, AL, Weyerhaeuser, New Bern, NC, and Weyerhaeuser, Columbus, MS) were greater than EPA's estimate of their 1995 baseline loads. EPA reviewed PCS permit compliance data for these three mills and determined that they did not violate their chloroform permit limits during the study period.

ELGs for chloroform are production-normalized (i.e., they are written in terms of grams of chloroform per air-dried metric ton (ADMT) of production). During the development of the Cluster Rules, EPA determined that mills that bleached pulp with 100 percent chlorine dioxide and did not use hypochlorite discharged 0.7 g/ADMT of chloroform in their bleach plant effluent. Mills that bleached pulp with 50 to 99 percent chlorine dioxide and did not use hypochlorite discharged 19 g/ADMT of chloroform. EPA estimated baseline chloroform loads by first determining the bleaching chemicals used on the bleach lines at each mill and determining the appropriate chloroform discharge rate for the bleach line. Then, EPA multiplied the discharge rate (g/ADMT) by the bleach line baseline production (ADMT/yr) to calculate the chloroform discharge (g/yr) (U.S. EPA, 1997).

Weyerhaeuser commented that EPA underestimated the baseline loads for its Columbus and New Bern mills. Weyerhaeuser commented that at baseline, the Columbus mill bleached with 50 to 99 percent chlorine, and thus EPA should have used the 19 g/ADMT chloroform discharge rate to estimate the baseline bleach plant effluent load for this mill. Weyerhaeuser further commented that EPA's estimated pulp production for the New Bern mill was about half of the actual production (Schaffer, 2005).

Using the updated production information provided by Weyerhaeuser and chloroform discharge loads from PCS, EPA calculated the production-normalized bleach plant effluent chloroform loads for the New Bern and Columbus mills. As shown in Table 9-13, for the period 2002 to 2004, the production-normalized chloroform discharges were less than the BAT monthly average effluent limitation guideline.

Table 9-13. Production-Normalized Bleach Plant Effluent Chloroform Loads for Two Weyerhaeuser Mills

	1998 Model Mill Baseline Discharge Rate (g/ADMT)	2000 (g/ADMT)	2001 (g/ADMT)	2002 (g/ADMT)	2003 (g/ADMT)	2004 (g/ADMT)
BAT Monthly Avg. Limit: 4.14 g/ADMT						
Chloroform Group D: 50 to 99% ClO_2, No Hypochlorite	19					
Chloroform Group E: 100% ClO_2, No Hypochlorite	0.7					
Weyerhaeuser, New Bern (NC0003191)		NR	NR	0.4	0.3	0.4
Weyerhaeuser, Columbus (MS0036412)		1.4	2.3	3.0	2.9	1.8

NR - Not reported; PCS does not contain chloroform monitoring data.
ADMT - Rate of production; air-dried metric tons.

In addition to the two Weyerhaeuser mills, EPA found that the chloroform bleach plant loads from Bowater, Coosa Pines AL were greater than EPA's estimated 1995 baseline loads. However, Bowater did not provide any information about the production or chloroform discharges from its Coosa Pines, AL mill, so EPA could not determine how this mill's discharges compare to the BAT effluent limitations.

9.3.1.4 Final Effluent AOX Loads

EPA analyzed PCS data for AOX. AOX is typically measured in final mill effluents at concentrations above method detection limits. Consequently, EPA was able to calculate discharge loads (kg/year) for each mill. Table 9-14 presents the number of BPK mills for which PCS contained monitoring data for AOX for the period 1998 to 2004. PCS included data for AOX for 17 mills in 1998, increasing to 38 mills by 2004.

Table 9-14. Number of BPK Mills With AOX Monitoring Data in PCS, by Year and Relative Baseline Loads[a]

	1998	1999	2000	2001	2002	2003	2004
AOX							
Total number of mills with AOX data in PCS	17	19	21	27	35	41	38
Number of mills discharging above EPA's estimate of their 1995 baseline load	4	4	4	3	8	8	8
Number of mills discharging below EPA's estimate of their 1995 baseline load	13	15	17	24	27	33	30
% load reduction from baseline	60%	66%	70%	74%	69%	66%	61%

[a]EPA included 67 direct discharge mills in this review.

In addition to estimating annual discharge loads of AOX, for each mill for 1998 to 2004, EPA compared the annual load to the 1995 baseline load it had estimated for the mill, and tallied the number of mills for which the annual load was above the baseline and the number below. This information is also included in Table 9-14. This comparison shows that the majority of mills (e.g., 30 of the 38 mills with data in PCS for 2004) report loads below the facility-specific 1995 baseline loads. Of the eight mills with discharge load of AOX above the 1995 baseline loads, one was in violation of its permit limits. The other mills may have increased AOX discharges as a result of increased production. EPA did not collect production information, so could not determine if this was the cause.

EPA calculated the annual AOX discharge load for the years 1998 to 2004. During the study period, based on monthly measurements reported as not detected or with other PCS "no data" indicators, the annual loads for five mills were zero (kg/yr). Zero loads are included in the trend analysis presented in Table 9-14. EPA calculated the difference between the estimated annual loads and baseline loads, and the percent reduction from baseline. Table 9-14 presents the percent reduction from baseline for all reporting mills, for each year from 1998 to 2004. The calculated annual load for most mills is below EPA's estimate of their baseline loads. For the 38 mills with AOX data in PCS for 2004, the total annual load was 61 percent less than EPA's 1995 baseline loadings for the mills.

Changes in production or bleaching activities might have occurred at each of these mills after 1995. As noted at the beginning of this section, discharges of AOX and chloroform are related to pulp production, while measured discharge concentrations of TCDD, TCDF, and chlorinated phenolic compounds are below analytical method minimum levels and thus not related to production. If mill production and bleaching changed after 1995, AOX discharge loads might no longer be comparable to 1995 estimates. For example, Weyerhaeuser Port Wentworth has recently switched from a softwood/hardwood mix to 100 percent softwood production, which may contribute to an increase in both AOX and color in the final effluent (Schaffer, 2005).

The Weyerhaeuser Flint River Mill is classified as a minor discharger by the state of Georgia; therefore, PCS does not contain discharge data for that mill. The mill provided EPA with final effluent monitoring data for AOX, color, and various other conventional pollutants that are measured at the facility (Parker, 2005). Table 9-15 shows AOX and color loads for this mill; the AOX load was significantly below EPA's estimated baseline loads.

Table 9-15. Weyerhaeuser Flint River Mill (Oglethorpe GA) Calculated Annual Load Compared to EPA Estimated Baseline Load

	Pollutant	EPA's Estimated Baseline Load (kg/yr)	Highest Measured Load (yr)	2004 Load (kg/yr)
Weyerhaeuser/Flint River Mill Oglethorpe, GA	AOX	213,629	2002	24,200
	Color	13,695,500	2004	12,470,000

9.3.1.5 Washington State Bleached Papergrade Kraft Mills

During this detailed review, EPA found that data from only two of the six Washington State mills are included in PCS from 1998 through 2004. As of 2004, six active pulp and paper mills were located in Washington State, including five bleached papergrade kraft and one Segment B papergrade sulfite mill. In 2004, each of these mills monitored mill bleach plant effluent for TCDD and TCDF. Typically, these data are submitted to the Washington Department of Ecology, imported into the state's database (the Water Quality Permit Lifecycle System), examined for compliance by the state, and transferred to EPA's PCS system. Because of an error in this transfer process, data for Washington State bleached papergrade kraft and papergrade sulfite mills were not transferred to PCS.

EPA contacted the Washington Department of Ecology about the missing data. The Department of Ecology provided bleach plant concentration data for each of its active mills, but no discharge flow data (Lange, 2005b). Table 9-16 summarizes the reported TCDD and TCDF data for Washington State bleached papergrade kraft mills. Data for the papergrade sulfite mill are discussed in the next section. Table 9-16 lists the number of times the pollutant was detected during the reporting year and the number of measurements. For example, the TCDD counts for 2001 for Boise, Wallula are shown as 0/6. This means that none of the six TCDD measurements made in 2001 were "detected."

As shown in Table 9-16, TCDF was detected in bleach plant effluent from two of the Washington State bleached papergrade kraft mills. Although the Boise, Wallula and Weyerhaeuser, Longview mills detected TCDF, the concentrations were less than the Cluster Rules daily maximum limitation (31.9 pg/L).

Table 9-16. Counts of TCDD and TCDF Detected in Washington State Phase I Mill Bleach Plant Effluent

	NPDES Permit Dates	Pollutant	Number of Detects/Number of Measurements			
			2001	2002	2003	2004
Bleached Papergrade Kraft Mills						
Boise, Wallula (WA0003697)	issued: 7/1/01 expires: 7/1/06	TCDD	0/6	0/12	0/12	0/12
		TCDF	2/6	1/12	0/12	2/12
Simpson Tacoma Kraft, Tacoma (WA0000850)	issued: 11/1/01 expires: 11/1/06	TCDD	0/1	0/12	0/12	0/12
		TCDF	0/1	0/12	0/12	0/12
Weyerhaeuser, Longview (WA0000124)	issued: 6/1/04 expires: 6/1/09	TCDD	NR	NR	NR	0/7
		TCDF	NR	NR	NR	3/7
James River[a] (Georgia-Pacific), Camas (WA0000256)	issued: 4/15/03 expires: 4/15/08	TCDD	NR	NR	K4: 0/8 K5: 0/8	K4: 0/12 K5: 0/12
		TCDF	NR	NR	K4: 0/8 K5: 0/8	K4: 0/12 K5: 0/12

[a]The James River in Camas, WA monitors TCDD and TCDF at two fiber lines (K4 and K5).
NR - The mill did not monitor for that pollutant.

9.3.1.6 Summary: Analysis of Bleached Papergrade Kraft Compliance Monitoring Data

EPA reviewed PCS data for the period 1998 to 2004 to evaluate the effect of the Cluster Rules on BPK mill discharges. Since the promulgation of the Cluster Rules, discharges of regulated pollutants have decreased significantly. EPA's findings for specific pollutants are shown in Table 9-17, and summarized below:

- TCDD and TCDF discharges for reporting BPK mills were only 6,100 TWPE, more than 99 percent reduction from baseline;
- No mills reported discharges of chlorinated phenolic compounds;
- For the 29 mills with chloroform data in PCS in 2004, the total annual load was 98 percent less than EPA's estimated 1995 baseline for these mills; and
- For the 38 mills with AOX data in PCS in 2004, the total annual load was 61 percent less than EPA's 1995 baseline for these mills.

Table 9-17. Trends in BPK Mill Discharges of Cluster Rules Regulated Pollutants

Regulated Pollutants	1995 TWPE[a]	2002		2004	
		TWPE	Number of Mills Monitoring	TWPE	Number of Mills Monitoring
TCDD + TCDF	17.9 million	1.3 million	47 for TCDD 38 for TCDF	6,100	52 for TCDD 49 for TCDF
12 chlorinated phenolic compounds	4,180	0	29	0	41
Chloroform	1,877	31	22	35	29
AOX[b]	17 million pounds	12 million pounds	35	15 million pounds	38

[a]EPA estimated baseline TWPE for the mills monitoring for the pollutant in 2004.
[b]AOX is a bulk parameter with no toxic weighting factor, so pounds (not TWPE) are presented.

9.3.2 Papergrade Sulfite

As discussed in Section 9.2.3, at the time the Cluster Rules were promulgated, 11 papergrade sulfite mills operated in the United States. EPA identified six papergrade sulfite mills operating in 2004. These six mills include four mills that produce pulp using calcium, magnesium, or sodium sulfite acidic cooking liquors (Segment A) and two mills that produce pulp using an ammonium sulfite acidic liquor (Segment B). Monitoring results for one of these six mills (Domtar, Port Edwards) were analyzed with the bleached papergrade kraft mill data, because this mill shares a wastewater treatment facility and an NPDES permit with the Domtar Nekoosa bleached papergrade kraft mill.

Cluster Rules ELGs for papergrade sulfite mills differ from the ELGs for bleached papergrade kraft mills. As summarized in Table 9-3, the ELGs for direct discharging papergrade sulfite mills include:

- Segment A: Limits only for AOX in final effluent; and
- Segment B: Bleach plant limits for TCDD, TCDF, and chlorinated phenolic compounds.

Data are available in PCS for only two papergrade sulfite mills: one magnesium sulfite mill (Segment A) and one ammonium sulfite mill (Segment B). In addition to data from PCS, EPA obtained bleach plant effluent monitoring data for another ammonium sulfite mill from the state of Washington. Available compliance monitoring data for each segment is discussed below.

9.3.2.1 Calcium-, Magnesium-, or Sodium-Based Sulfite Mills (Segment A)

Although the Cluster Rules require Segment A mills to monitor AOX at the final effluent, permits for the three Segment A mills require AOX monitoring at the bleach plant effluent. However, PCS contains no AOX bleach plant monitoring data for the three mills for 1998 through 2004. For this reason, EPA cannot compare Segment A mill discharges to the Cluster Rules limitations. EPA notes, however, that the concentrations of TCDD and TCDF in final effluent reported for one Segment A mill (Weyerhaeuser, Rothschild, WI) were below the Method 1613B detection limit.

9.3.2.2 Ammonium-Based Sulfite Mills (Segment B)

For Segment B, the Cluster Rules require bleach plant monitoring for TCDD, TCDF, and chlorinated phenolic compounds. PCS includes monitoring data for all Cluster Rules pollutants for one mill (Finch Pruyn in Glens Falls, NY) and data for Kimberly-Clark (K-C), Everett, WA were provided by Washington State (Lange, 2005b). As shown in Table 9-18, for the period 2001 through 2004, neither TCDD nor TCDF was detected in samples of Finch Pruyn bleach plant effluent. Finch Pruyn experienced periods of low paper production from 2001 through 2004 due to labor and market conditions, so discharges during that period do not reflect normal mill operations. As shown in Table 5-1, K-C has not detected TCDD above the Method 1613 ML since it converted to 100 percent chlorine dioxide bleaching in October 2000. However, K-C repeatedly detected TCDF in its bleach plant effluent from 2001 to 2004. The TCDF in the K-C bleach plant effluent are discussed in more detail in Section 5.2.2.

Table 9-18. Loads for Two Papergrade Ammonium Sulfite Mills, 2001 through 2004

	Number of Detects/Number of Measurements			
	2001 (kg/y)	**2002 (kg/y)**	**2003 (kg/y)**	**2004 (kg/y)**
Kimberly-Clark, Everett, WA				
TCDD (bleach plant)	2/12	0/13	1/17	0/14
TCDF (bleach plant)	13/14	12/13	16/17	10/12
Finch Pruyn; Glens Falls, NY[a]				
TCDD (bleach plant)	0/8	0/12	0/12	0/12
TCDF (bleach plant)	0/8	0/12	0/12	0/12

[a]2001 to 2004 was a period of low production due to labor and market conditions.

9.3.2.3 Summary of Papergrade Sulfite Mill Compliance Data

EPA reviewed PCS data for the period 1998 to 2004 to evaluate the effect of the Cluster Rules on papergrade sulfite mill discharges. EPA's findings are summarized below:

- As of 2004, there were only 6 operating papergrade sulfite mills, compared to 11 in 1998. Four are subject to Segment A and two are subject to Segment B.

- AOX is the only parameter limited for Segment A papergrade sulfite mill discharges. PCS does not contain any AOX data for any Segment A facilities.
- PCS contains data for only one Segment B mill. However, these data do not reflect normal mill operations because they were collected during a low period of production.
- Therefore, EPA can not use PCS data to make any conclusions about the effect of the Cluster Rules on discharges from the papergrade sulfite mills.
- Data provided by Washington Sate show that a second Segment B mill repeatedly detected TCDF in its bleach plant effluent. However, as discussed in 5.2.2, these high concentrations were reduced when the mill upgraded its chlorine dioxide generator.

9.4 Dioxin-Related Fish Consumption Advisories

The *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*, published in October 1997, listed 19 dioxin-related fish consumption advisories on 17 water bodies in the United States that EPA predicted would be “lifted three years after dioxin discharges from pulp and paper mills are reduced as a result of implementation of the final rule.” In 2006, EPA reviewed these 19 advisories to determine whether they had been lifted after the final Cluster Rules went into effect on April 15, 1998, the reasons the advisories were rescinded or maintained, and the current status of the advisories.

EPA found that 8 of the 19 advisories listed in the *Economic Analysis* were fully rescinded and 8 were partially rescinded by 2006. Of the 16 advisories that were fully or partially rescinded, 9 were fully or partially rescinded after the Cluster Rules were promulgated while the remaining 7 were fully or partially rescinded prior to its promulgation.

Sixteen of the 17 water bodies listed in the 1997 *Economic Analysis* showed decreases in dioxin[24] concentrations in fish tissue samples by 2006. Dioxin levels in the Houston

[24] The states included in the analysis presented in this section use a variety of analytes to establish their fish consumption advisories, predominantly TEQ or TCDD and TCDF. For this reason, in this section, the term “dioxin”

Ship Channel remained relatively constant in sediment and fish tissue between 1992 and 2002, due to ongoing inputs from urban and industrial areas and resuspension of contaminated sediments (Suarez, 2005).

9.4.1 Information Sources

Sources of information include the US EPA's *National Listing of Fish and Wildlife Advisories: Advisory Report Query* web site, fish advisory web pages on state departments of health and state departments of environmental protection web sites, reports and scientific publications on dioxin, fish advisories, and watershed planning, and scientists and staff at state departments of health and state departments of environmental protection.

9.4.2 Current Status of Dioxin-related Fish Consumption Advisories Listed in the 1997 Economic Analysis

Table 9-19 presents the current status of the 19 dioxin-related fish consumption advisories listed in the 1997 *Economic Analysis*. It is important to note that the list was based on advisories in effect in December 1995, which explains why a few of the advisories included were rescinded prior to the 1998 promulgation of the Cluster Rules.

LOUISIANA

The three water bodies in Louisiana with fish consumption advisories for dioxin listed in the 1997 *Economic Analysis* are located downstream of an International Paper mill. One advisory for dioxin was rescinded and one was amended prior to the promulgation of the Cluster Rules. Since the Cluster Rules went into effect in 1998, none of the advisories have been modified or rescinded.

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is used to refer to TEQ or TCDD and TCDF.

Table 9-19. Current Status of Dioxin-Related Fish Consumption Advisories Listed in the 1997 Economic Analysis

State	Water Body	Year Advisory was Fully or Partially Rescinded	2006 Advisory
LA	Bayou LaFourche	Modified in 1996.	2 meals/month for all fish.
	Lake Irwin	Rescinded December 1996.	None.
	Wham Brake	Not rescinded.	No consumption by the general population of any fish.
ME	Androscoggin River	Modified in 1997 and 2000.	6-12 meals/year for all fish.
	Kennebec River	Modified in 1997 and 2000.	1-2 bass meals/month and 5 trout meals/year.
	Penobscot River	Modified in 1997.	1-2 meals/month for all fish.
MI	Menominee River	Rescinded January 1998.	None.
MS	Escatawpa River	Rescinded July 1996.	None.
NC	Albemarle Sound	Partially rescinded in 2001.	General population: 1 meal/month for carp and catfish. Populations potentially at greater risk: No consumption of carp and catfish.
	Chowan River	Rescinded December 2000.	None.
	Pigeon River	Rescinded 2001.	None.
	Roanoke River	Partially rescinded in 2001.	General population: 1 meal/month of carp and catfish. Populations potentially at greater risk: No consumption of carp and catfish.
	Welch Creek	Partially rescinded in 2001.	General population: 1 meal/month of carp and catfish. Populations potentially at greater risk: No consumption of carp and catfish.
NH	Androscoggin River	Not rescinded.	No consumption of all freshwater fish.
TN	Pigeon River	Partially rescinded January 2003 and fully rescinded January 2004.	None.
TX	Houston Ship Channel	Not rescinded.	General population: 1 meal/month for all fish and for shellfish-crustacean-blue crab. Populations potentially at greater risk: No consumption of fish and shellfish-crustacean-blue crab.
	Neches River	Rescinded December 1995.	None.
VA	Blackwater River	Rescinded March 1998.	None.
WI	Wisconsin River	Partially rescinded in December 2002.	From dam at Nekoosa to Petenwell Dam: No consumption of any carp or catfish-channel > 25' in length. From Petenwell Dam to Castle Rock Dam: No consumption of carp.

Bayou LaFourche

The fish consumption advisory for dioxin to avoid all consumption of black crappie and to limit consumption of all other fish to two meals per month was replaced in 1996 by an advisory to limit consumption of all fish to two meals per month (Hartley, 2001). Fish tissue sampling conducted in 2001 showed a slight decline in dioxin concentrations from 1987, but the decline was not sufficient to warrant the removal of the advisory, which requires that dioxin concentrations be below the state's action level of 2 parts per trillion (ppt) (Solieau, 2006).

Lake Irwin

The fish consumption advisory for dioxin was rescinded in December 1996 after fish tissue samples demonstrated that dioxin concentrations were below the state's action level of 2 ppt. Five fish tissue samples of two different species taken in 2001 confirmed continued low levels of dioxin in all tissue samples but one, which was considered to be an outlier (Solieau, 2006; Piehler, 2006).

Wham Brake

The fish consumption advisory for dioxin recommending no consumption by the general population of any fish has been in place since the Cluster Rules were promulgated. Fish tissue sampling documented an observable declining trend in TCDD and TCDF between 1987 and 2001, although the decline was not great enough to warrant rescinding or modifying the advisory (Hartley, 2001).

MAINE

Fish tissue sampling between 1997 and 2005 in the three rivers in Maine with fish consumption advisories for dioxin listed in the 1997 *Economic Analysis* has demonstrated declining trends in dioxin concentrations. Nevertheless, tissue samples taken from the Androscoggin and Penobscot Rivers have higher dioxin concentrations than samples taken from reference streams. These continued elevated dioxin levels may be partially attributed to the legacy of dioxin (Upgren, 2006a; MDEP, 2006). While dioxin concentrations in fish tissue samples taken from the Kennebec River are similar to those taken from reference streams, the Maine Department of Environmental Protection's *Dioxin Monitoring Report* recommends continuing sampling efforts to verify low levels of dioxin in trout, which are heavily fished in the reach below the SAPPI Somerset bleached papergrade kraft mill (MDEP, 2006).

Androscoggin River

The advisory for dioxin on the Androscoggin River was amended to limit fish consumption to 6 meals per year in 1997 and to 6 to 12 meals per year in 2000. Fish tissue samples show a declining trend in dioxin concentrations between 1997 and 2005 on three of the five reaches of the Androscoggin River sampled and a significant decrease in concentrations in 2004 and 2005 on a fourth reach. The lack of a declining trend at one reach may be due to its position in an impoundment, where settleable solids are deposited. Despite the overall declining trend, dioxin concentrations were higher in fish sampled from the Androscoggin River than from reference stations on other Maine rivers. Continued elevated levels of dioxin "are likely the legacy of the long history of discharges," according to the Maine Department of Environmental Protection's *Dioxin Monitoring Report* (MDEP, 2006). Sampling in 2003 and 2004 documented that neither the International Paper mill in Jay nor the NewPage Corporation mill in Rumford are discharging measurable amounts of dioxin, in accordance with Maine's 1997 Dioxin Law, which prohibits dioxin discharges into receiving waters (MDEP, 2006).[25]

Kennebec River

The dioxin-related advisory for the Kennebec River was revised in 1997 to limit fish consumption to one to two meals per month and in 2000 to limit consumption to one to two bass meals per month and five trout meals per year.

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[25] The Maine legislature enacted LC 1633 "An Act to Make Fish in Maine Rivers Safe to Eat and Reduce Color Pollution" in 1997. Known as the "Dioxin/Color Law," it includes three compliance dates. It prohibits bleached papergrade kraft mills from discharging dioxin into their receiving waters after December 31, 2002, requires that TCDD in bleach plant effluent be below 10 parts per quadrillion (ppq) by July 31, 1998, and requires that TCDF be below 10 ppq by December 31, 1999. It also mandates that fish tissue sampling be conducted to confirm that fish sampled downstream of a bleached papergrade kraft mill have no more dioxin than fish sampled upstream of the mill (MDEP, 2006).

Dioxin concentrations in fish tissue samples from 2002 and 2005 are significantly lower than those from the mid-1990s and 2001, and dioxin concentrations from 2005 are similar to those measured in reference stations in previous years (MDEP, 2006). Due to these decreases in dioxin levels, the Maine Center for Disease Control and Prevention is expected to relax the fish consumption advisory for dioxin on the Kennebec River in 2006 (Mowers, 2006). Fish sampling in 2003 and 2004 has shown that the SAPPI Somerset bleached papergrade kraft mill is not discharging dioxin into its receiving waters, in accordance with the 1997 Dioxin/Color Law.

Penobscot River

The advisory for dioxin for the Penobscot River was revised in 1997 to limit consumption to one to two meals per month for all fish. Fish samples taken below the Lincoln Paper and Tissue Company mill between 1997 and 2005 show declining trends in dioxin concentrations, though the decline in TCDD concentrations was marginal. These results are consistent with the decrease in concentrations of TCDD and TCDF observed in sludge and in effluent since the mill switched its bleaching process to primarily oxygen-based bleaching in 1999. However, TCDD concentrations in fish tissue samples are higher than those measured at the reference station. Below the other mill on the Penobscot River, the Georgia-Pacific mill, fish tissue samples demonstrated declining trends in TCDD concentrations between 1997 and 2005. Monitoring of bleach plant effluent from the Georgia-Pacific mill showed no discharge of dioxin from 2003 through 2005 (MDEP, 2006).

MICHIGAN

Menominee River

The fish consumption advisory on the Menominee River was rescinded in January 1998 after the state documented dioxin concentrations in fish tissue samples below the state's trigger level of 10 ppt for two different years. This occurred after the Champion International (now International Paper) mill changed its pulp bleaching technologies. The state of Michigan is currently working to revise its dioxin trigger level, which is expected to be an order of magnitude lower than the current trigger level (Upgren, 2006e).

MISSISSIPPI

Escatawpa River

The fish consumption advisory on the Escatawpa River was rescinded in July 1996. The advisory was lifted after the state recorded dioxin concentrations in fish tissue samples below the state’s action level of 5 ppt for two consecutive years, which occurred after International Paper ceased to use chlorine in its bleaching process. Sampling through the early 2000s confirmed continued low levels of dioxin (Upgren, 2006h).

NORTH CAROLINA

Three fish consumption advisories for dioxin were partially rescinded and two were fully rescinded in 2000 and 2001 after fish tissue samples taken in the mid-to-late 1990s showed decreased levels of dioxin in the five North Carolina water bodies listed in the 1997 *Economic Analysis*.

Albemarle Sound

The dioxin-related advisory to avoid consumption of all fish from the Albemarle Sound except herring, shad, and shellfish was partially rescinded in 2001. It was replaced by an advisory for the general population to limit consumption of carp and catfish to one meal per month and for populations potentially at greater risk to avoid all consumption of carp and catfish.

Weyerhaeuser Company, which discharges mill effluent approximately 7 miles upstream from Albemarle Sound, is required by North Carolina to conduct fish tissue sampling for dioxin in the Sound. Weyerhaeuser changed its bleaching process from chlorine-based bleaching in 1994. In October 2001, the advisory was lifted for game fish after dioxin concentrations in fish tissue were below the state’s action level for dioxin of 4 ppt for consecutive years (NCDENR, 2002; 2006; Upgren, 2006d).

Chowan River

The fish consumption advisory for dioxin was partially rescinded in 1998 and fully rescinded in December 2000 after dioxin concentrations in fish tissue samples showed levels below the state’s action level for dioxin of 4 ppt for two consecutive years (1998 and 1999). The advisory was enacted in 1990 as a result of dioxin contamination attributed to the Union Camp (now International Paper) mill in Franklin, VA. After the mill implemented new bleaching processes in 1990, annual tissue sampling demonstrated a declining trend in dioxin concentrations. Fish tissue sampling conducted in 2001 confirmed continued low levels of dioxin (NCDENR, 2002; 2006).

Pigeon River

The fish consumption advisory for dioxin for the Pigeon River was rescinded in August 2001. Fish tissue sampling conducted between 1989 and 1995 showed a declining trend in dioxin contamination. Between 1996 and 2001, tissue sampling demonstrated dioxin levels below the state’s action level for dioxin of 4 ppt, which prompted the removal of the consumption advisory (NCDENR, 2006; Denton, 2002).

Roanoke River

The advisory to avoid consumption of all fish except herring, shad, and shellfish due to dioxin contamination was partially rescinded in 2001. It was replaced by an advisory for the general population to limit consumption of carp and catfish to one meal per month and for populations potentially at greater risk to avoid all consumption of carp and catfish.

Weyerhaeuser Company, which discharges mill effluent near the confluence of Welch Creek and the Roanoke River, stopped using chlorine-based bleaching in 1994. In 2001, the advisory was lifted for game fish after dioxin concentrations in fish tissue were below the state’s action level for dioxin of 4 ppt. In 2006, the state recommended continuing to conduct fish tissue sampling efforts and to lift the advisory when there is no longer a risk to human health from the consumption of fish (NCDENR, 2001; 2006).

Welch Creek

The advisory to avoid consumption of all fish was rescinded in 2001 and replaced by an advisory for the general population to limit consumption of carp and catfish to one meal per month and for populations potentially at greater risk to avoid all consumption of carp and catfish.

Weyerhaeuser Company, which discharges mill effluent near the confluence of Welch Creek and the Roanoke River, is required by North Carolina to conduct fish tissue sampling for dioxin. Weyerhaeuser changed its bleaching process from chlorine-based bleaching in 1994. In 2001, the mill submitted fish tissue sampling data that showed dioxin concentrations in game fish below the state's action level of 4 ppt (NCDENR, 2006).

Elevated dioxin levels in Welch Creek have led EPA and other federal and state agencies to conduct a feasibility study to examine options to clean up dioxin contaminated solids on the streambed. Potential options include monitored natural recovery, site remediation and testing, capping, dredging, or a combination of these options. The study was scheduled to be completed by mid-2006 (NCDENR, 2001; 2006; U.S. EPA, 2006a).

NEW HAMPSHIRE

Androscoggin River

The dioxin-related advisory for the Androscoggin River has limited consumption to one to two meals per year of all fish for the general population and to no consumption for pregnant and nursing women since the Cluster Rules were promulgated. Dioxin is attributed to the Fraser Paper N.H. (formerly named Pulp and Paper of America, James River, and Crown Vantage, Inc.) mill in Berlin, NH, which implemented an elemental chlorine-free process in 1994. Following this change in bleaching technology, dioxin levels in mill effluent decreased to undetectable levels (Schnepper, 2006; MDEP, 2006).

Although the mill is required to sample fish tissue for dioxin every five years, the most recent sampling in 2004 was improperly conducted and resulted in unusable data. The state of New Hampshire is currently working with the mill to correct sampling procedures. Because the Androscoggin flows into New Hampshire from Maine and then back into Maine, New Hampshire has decided to maintain its fish consumption advisory until Maine rescinds its advisory for the Androscoggin River (Schnepper, 2006; Upgren, 2003f).

TENNESSEE

Pigeon River

The fish consumption advisory for dioxin for the Pigeon River in Tennessee was partially rescinded in January 2003 and fully rescinded in January 2004. An advisory to avoid consumption of all fish was originally issued in 1989 when dioxin levels in fish tissue samples exceeded the state's 5 ppt posting trigger. Fish tissue data collected between 1989 and 1995 demonstrated a drop in dioxin contamination after the Champion Paper Mill in Canton, NC (now Blue Ridge Paper Products) implemented enhanced pollution control practices. The decline in dioxin levels led the state to revise its advisory in 1996 to only limit the consumption of redbreast sunfish, carp, and catfish. Tissue sampling from the mid-1990s through the early 2000s demonstrated further reductions in dioxin concentrations, with levels consistently below 1 ppt for game and rough fish and below 2 ppt for catfish. As a result, the state's Division of Water Pollution Control recommended rescinding the fish consumption advisory in 2002 (Denton, 2002).

TEXAS

Houston Ship Channel

The advisory for dioxin for the Houston Ship Channel limits fish consumption by the general population to one meal per month for all fish and shellfish and recommends no consumption of fish or shellfish by populations potentially at greater risk. The Houston Ship Channel was the only water body among the 17 included in the 1997 *Economic Analysis* that did not show decreased dioxin concentrations by 2006. According to Larry Koenig of the Texas Commission on Environmental Quality (TCEQ), dioxin levels in fish tissue samples have remained flat between the early 1990s and 2005, the year of the most recent data (Upgren, 2006i). A 2002 study funded by the TCEQ and the Texas Advanced Technology Program explained that “despite regulatory controls on discharges from pulp and paper mills, there has been little change over the last 10 years in dioxin concentrations in sediment and tissue from the Houston Ship Channel” (Suarez, 2005). These continued elevated dioxin concentrations are attributed to the resuspension of contaminated sediments and ongoing inputs from urban and industrial sources (Suarez, 2005). Another source appears to be a submerged paper mill waste disposal pit that was closed in the 1970s but was recently found to have extremely elevated dioxin levels (sediment TEQ of 32,752 ng/kg-dry wt) (Koenig, 2006). This waste pit was recently sampled by EPA’s Region 6 under the Superfund Program.

Neches River

The fish consumption advisory for the Neches River was rescinded in December 1995 following a decrease in dioxin concentrations in fish tissue samples. After it ceased using chlorine bleaching processes in the early 1990s, the Temple-Inland Forest Products (now MeadWestvaco) mill noticed a decline in dioxin concentrations in its fish tissue samples. The mill alerted the state to this drop in dioxin levels, prompting the state to conduct its own sampling, which confirmed the decrease in dioxin. No sampling for dioxins has been conducted on the Neches River since the advisory was removed (Upgren, 2006g).

VIRGINIA

Blackwater River

The fish consumption advisory for dioxin on the Blackwater River was rescinded in March 1998 after fish tissue sampling showed dioxin concentrations below the state’s action level of 7 ppt for the previous five years. The International Paper (formerly Union Camp) mill began to use dioxin controls in 1990 and completely ceased using chlorine in 1996 after implementing a chlorine dioxide generation process (NCDENR, 1997).

WISCONSIN

Wisconsin River

The advisory for dioxin on the Wisconsin River recommending no consumption of white bass or common carp from the dam at Nekoosa to the Petenwell Dam and no consumption of common carp from the Petenwell Dam to the Castle Rock Dam was replaced in December 2002. The current advisory recommends avoiding consumption of all carp and channel catfish longer than 25" from the dam at Nekoosa to the Petenwell Dam and avoiding consumption of all carp from the Petenwell Dam to the Castle Rock Dam. The state began sampling for dioxin in the 1980s and suspended commercial fishing for carp from Nekoosa to the Castle Rock Dam due to dioxin in 1983. The state has observed a decrease in dioxin concentrations in fish tissue samples since the 1980s (Upgren, 2006c). Fish tissue sampling conducted by the state and the NCASI in 2004 documented low dioxin levels, and testing for the 17 congeners found no TCDD or TCDF (Upgren, 2006b).

9.4.3 Summary

Dioxin levels in fish tissue samples have declined in all but 1 of the 17 water bodies listed in the 1997 *Economic Analysis*. These declines appear to have occurred following the shift away from chlorine bleaching processes at the pulp, paper, and paperboard mills located on these rivers and lakes. However, dioxin concentrations remain above states' acceptable levels in 10 of the 17 water bodies, preventing over half of the 19 advisories from being fully rescinded. Elevated dioxin levels in these water bodies may be due to the legacy of the long history of dioxin discharges as well as to other dioxin sources such as industrial and urban runoff.

9.5 Detailed Study Findings About Cluster Rules Implementation and Impact

One of the purposes of this detailed study is to determine how the 1998 Cluster Rules have been implemented and their effect on mill discharges. EPA evaluated the implementation of the Cluster Rules by reviewing 79 permits from operating Phase I mills and selected POTWs. EPA evaluated the effect of the Cluster Rules by analyzing Phase I mill discharge data reported to PCS for the period 1998 to 2004 and reviewing the status of dioxin-related fish consumption advisories. Based on this review, EPA found:

- Cluster Rules ELGs have been incorporated into the majority (91 percent, or 61 out of 67) of active permits for direct dischargers. The remaining six permits do not yet include Cluster Rule limits because the revised permits are either being contested or have not been reissued since promulgation. In addition, permits for two mills with discharges in Subpart E allow them to demonstrate compliance with the AOX limit at alternate monitoring locations.

- EPA reviewed PCS data for the period 1998 to 2004 to evaluate the effect of the Cluster Rules on BPK mill discharges and found:

  — TCDD and TCDF discharges for reporting BPK mills were only 6,100 TWPE, more than 99 percent reduction from baseline,

  — No mills reported discharges of chlorinated phenolic compounds,

  — For the 29 mills with chloroform data in PCS in 2004, the total annual load was 98 percent less than EPA's estimated 1995 baseline for these mills, and

  — For the 38 mills with AOX data in PCS in 2004, the total annual load was 61 percent less than EPA's 1995 baseline for these mills.

- EPA reviewed PCS data for the period 1998 to 2004 to evaluate the effect of the Cluster Rules on papergrade sulfite mill discharge and found:

  — As of 2004, there were only six operating papergrade sulfite mills.

  — PCS has effluent monitoring data for two of these mills.

  — TCDD and TCDF discharges from the Kimberly-Clark mill in Everett, WA are not typical of other mills in the category. These discharges are discussed in Section 5.2.2 and 5.3.3.4.

- Dioxin levels in fish tissue samples have declined in all but 1 of the 17 water bodies listed in the 1997 *Economic Analysis*. These declines appear to have occurred following the shift away from chlorine bleaching processes at the pulp and paper mills located on these rivers and lakes. However, dioxin concentrations remain above states' acceptable levels in 10 of the 17 water bodies, preventing over half of the 19 advisories from being fully rescinded. Elevated dioxin levels in these water bodies may be due to the legacy of the long history of dioxin discharges as well as to other dioxin sources such as industrial and urban runoff.

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Appendix

CURRENT STATUS OF PHASE I MILLS

The attached table lists mills that EPA identified as Phase I mills (mills with at least some portion of their wastewater discharges that met the applicability of 40 CFR 430 Subpart B (Bleached Papergrade Kraft and Soda) and Subpart E (Papergrade Sulfite) as of April 15, 1998, when the Cluster Rules were promulgated. The table includes the following:

- **Mill Name** (updated to the 2006 ownership).
- **City**.
- **State**.
- **Phase I Subcategory** that EPA believes applies to at least a portion of mill discharges. Phase I subcategories include bleached papergrade kraft and soda (BPK) and papergrade sulfite (PS).
- **Discharge** status of the mill, either discharge directly to surface waters (i.e., direct dischargers) or to a POTW (indirect dischargers).
- **SIC code** included in PCS. If the mill is not included in PCS (for instance, if it is an indirect discharge mill) there is no SIC code. The pulp, paper, and paperboard industry corresponds to three separate SIC codes: 2611 (pulp mills), 2621 (paper mills excluding building paper mills), and 2631 (paperboard) which identify the facilities principal product or group of products. For a given mill, the SIC code in PCS may differ from the primary SIC code identified in TRI.
- **NPDES** permit number, for direct discharges.
- **TRI ID** number.
- **SID** - The site identification number given to the mill for EPA's 1990 industry-wide survey.
- **Comment** - The current operating status of the mill.

Status of Phase I Mills as of 2004

Mill Name	City	State	Phase I Sub-category [a]	Dis-charge [b]	SIC Code [c]	NPDES	TRI ID	SID [d]	Comment
Jefferson Smurfit Corp.	Brewton	AL	BPK	D	2611	AL0002682	36426-CNTNR-HIGHW	9177	
Parsons & Whittemore (Alabama River Pulp Co. Inc.)	Claiborne (Perdue Hill)	AL	BPK	D	2621	AL0025968	36470-LBMRV-OFFHI	7901	Shares NPDES and TRI with BPK - SID:5298.
(Parsons & Whittemore) Alabama Pine Pulp	Claiborne (Perdue Hill)	AL	BPK	D				5298	Shares NPDES and TRI with BPK - SID:7901.
Bowater Inc.	Coosa Pines	AL	BPK	D	2611	AL0003158	35044-SPLPN-ALABA	697	
International Paper Co.	Courtland	AL	BPK	D	2621	AL0000396	35618-CHMPN-POBOX	8040	
Gulf States Paper Corp.	Demopolis	AL	BPK	D	2631	AL0002828	36732-GLFST-HIGHW	9233	
Boise Cascade Corp.	Jackson	AL	BPK	D	2621	AL0002755	36545-BSCSC-307WE	1895	
Georgia-Pacific (Naheola Mill)	Pennington	AL	BPK	D	2631	AL0003301	36916-JMSRV-ROUTE	6515	
International Paper Co. (Riverdale)	Selma	AL	BPK	D	2611	AL0003018	36701-HMMRM-RIVER	2899	
Domtar Industries Inc.	Ashdown	AR	BPK	D	2611	AR0002968	71822-NKSPP-HIGHW	4771	
Georgia-Pacific Corp.	Crossett	AR	BPK	D	2621	AR0001210	71635-GRGPC-PAPER	9700	
Potlatch Corp.	McGehee	AR	BPK	D	2631	AR0035823	71654-PTLTC-HIGHW	335	
International Paper Co.	Pine Bluff	AR	BPK	D	2611	AR0001970	71611-NTRNT-FAIRF	2910	Phase II mill in close proximity (NPDES:AR0001601; Mid-America Packaging).
Evergreen Pulp Co.	Samoa	CA	BPK	D	2611	CA0005894	95564-LSNPC-LPDRI	5540	TCF mill (uses peroxide bleaching); operates on the edge of profitability; recently bought by Lee and Man Paper Mfg., a Chinese company.
International Paper Co.	Cantonment (Pensacola)	FL	BPK	D	2621	FL0002526	32533-CHMPN-375MU	1513	
Georgia-Pacific Corp.	Palatka	FL	BPK	D	2621	FL0002763	32078-GRGPC-STATE	7805	
Smurfit-Stone Container Corp.	Panama City	FL	BPK	I	2611	FLR05B551	32401-STNCN-1EVER	3771	Indirect; not in *PCSLoads2002* (POTW=FL0002631; Bay County Wastewater Treatment Plant).

Status of Phase I Mills as of 2004 (Continued)

Mill Name	City	State	Phase I Sub-category [a]	Dis-charge [b]	SIC Code [c]	NPDES	TRI ID	SID [d]	Comment
International Paper Co.	Augusta	GA	BPK	D	2611	GA0002801	30913-FDRLP-HIGHW	310	
GP Cellulose, LLC	Brunswick	GA	BPK	D	2611	GA0003654	31520-BRNSW-WEST9	3611	
Weyerhaeuser Paper Co. (Flint River Mill)	Oglethorpe	GA	BPK	D	2611	GA0049336	31068-BCKYC-OLDST	3114	Minor discharger; not in *PCSLoads2002*; Project XL participant.
Weyerhaeuser Paper Co.	Pt. Wentworth	GA	BPK	D	2611	GA0002798	31407-STNCN-1BONN	9982	
Potlatch Corp.	Lewiston	ID	BPK	D	2621	ID0001163	83501-PTLTC-805MI	2216	
Weyerhaeuser Paper Co.	Hawesville	KY	BPK	D	2611	KY0001716	42348-WLLMT-POBOX	8897	Recycled paperboard mill closed according to AF&PA, October 2002. Pulp and paper mill still open.
NewPage Corp.	Wickliffe	KY	BPK	D	2621	KY0000086	42087-WSTVC-HIGHW	6360	
International Paper Co.	Bastrop	LA	BPK	D	2611	LA0007561	71220-NTRNT-705CO	1907	
Boise Cascade Corp.	Deridder	LA	BPK	D	2621	LA0007927	70634-BSSTH-USHIG	9747	
Tembec Inc.	St. Francisville	LA	BPK	D	2611	LA0003468	70775-JMSRV-ENDOF	5677	
Georgia-Pacific Corp. (Port Hudson Mill)	Zachary	LA	BPK	D	2621	LA0005258	70791-GRGPC-ZACHA	181	
NewPage Corp.	Luke	MD	BPK	I	2621	MD0001422	21540-WSTVC-300PR	9926	Indirect discharger; *PCSLoads2002* contains TSS, oil & grease, and aluminum (POTW=MD0021687; Upper Potomac River Commission).
International Paper Co. (Androscoggin Mill)	Jay	ME	BPK	D	2621	ME0001937	04239-NTRNT-RILEY	6139	
S.D. Warren (SAPPI)	Hinckley (Skowhegan)	ME	BPK	D	2621	ME0021521	04976-SDWRR-RFD3U	832	
Lincoln Pulp & Paper Co.	Lincoln	ME	BPK	D	2611	ME0002003	04457-LNCLN-KATAH	7254	
Georgia-Pacific Corp.	Old Town	ME	BPK	D	2621	ME0002020	04468-JMSRV-PORTL	9195	
NewPage Corp.	Rumford	ME	BPK	D	2621	ME0002054	04276-BSCSC-ROUTE	4084	
Domtar Industries Inc.	Woodland (Baileyville)	ME	BPK	D	2411	ME0001872	04694-GRGPC-MILLA	2374	

Status of Phase I Mills as of 2004 (Continued)

Mill Name	City	State	Phase I Sub-category [a]	Dis-charge [b]	SIC Code [c]	NPDES	TRI ID	SID [d]	Comment
NewPage Corp.	Escanaba	MI	BPK	D	2611	MI0000027	49829-MDPBL-COUNT	1492	
SAPPI Fine Paper North America	Muskegon	MI	BPK	I	2621	MI0001210	49443-SDWRR-2400L	5844	Indirect discharger (Phase II as of November 2005); *PCSLoads2002* contains Chlorine (POTW=MI0027391; Muskegon County Wastewater Management System)
International Paper Co.	Quinnesec (Norway)	MI	BPK	D	2611	MI0042170	49876-CHMPN-USHIG	3042	
SAPPI Fine Paper North America	Cloquet	MN	BPK	I	2611	MN0001431	55720-PTLTC-NORTH	2212	Indirect discharger; not in *PCSLoads2002* (POTW= MN0049786; Western Lake Superior Sanitary District).
Boise Cascade Corp.	International Falls	MN	BPK	D	2611	MN0001643	56649-BSCSC-SECON	1052	
Weyerhauser Paper Co.	Columbus	MS	BPK	D	2621	MS0036412	39703-CLMBS-CARSO	8662	
GP Cellulose, LLC	New Augusta	MS	BPK	D	2611	MS0031704	39462-LFRVR-HWY29	8525	
Weyerhaeuser Paper Co.	New Bern (Vanceboro)	NC	BPK	D	2611	NC0003191	28560-WYRHS-STREE	5657	
International Paper Co.	Riegelwood	NC	BPK	D	2631	NC0003298	28456-FDRLP-RIEGE	2608	
Blue Ridge Paper Products	Canton	NC	BPK	D	2621	NC0000272	28716-CHMPN-MAINS	4572	
Weyerhaeuser Paper Co.	Plymouth	NC	BPK	D	2621	NC0000680	27962-WYRHS-TROWB	8544	
Fraser Papers Inc.	Berlin	NH	BPK	D	2611	NH0000655	03570-JMSRV-650MA	1688	Shutdown May 2006.
Finch Pruyn & Co Inc.	Glens Falls	NY	PS	D	2611	NY0005525	12801-FNCHP-1GLEN	1277	PS-B; Ammonium-based.
International Paper Co.	Ticonderoga	NY	BPK	D	2611	NY0004413	12883-NTRNT-SHORE	5123	
Glatfelter	Chillicothe	OH	BPK	D	2621	OH0004481	45601-MDCRP-401SP	4696	
Georgia-Pacific Corp.	Clatskanie	OR	BPK	D	2611	OR0000795	97016-JMSRV-WAUNA	2818	
Pope & Talbot, Inc.	Halsey	OR	BPK	D	2611	OR0001074	97348-PPTLB-30480	1811	Georgia-Pacific operates a recycle facility at Halsey that is not Phase 1.
Boise Cascade Corp. (City of St. Helens)	St. Helens	OR	BPK	D	2611	OR0020834	97051-BSCSC-1300K	644	Shares NPDES permit with POTW.

Status of Phase I Mills as of 2004 (Continued)

Mill Name	City	State	Phase I Sub-category [a]	Dis-charge [b]	SIC Code [c]	NPDES	TRI ID	SID [d]	Comment
Weyerhaeuser Paper Co.	Johnsonburg	PA	BPK	D	2621	PA0002143	15845-PNNTC-100CE	4491	
Appleton Papers Inc.	Roaring Spring	PA	BPK	D	2611	PA0008265	16673-PPLTN-100PA	5701	
Glatfelter	Spring Grove	PA	BPK	D	2621	PA0008869	17362-PHGLT-228SO	4920	VATIP-Tier 1.
Bowater Inc.	Catawba	SC	BPK	D	2611	SC0001015	29704-BWTRC-5300C	2449	VATIP-Tier 1; PCS dioxin detect in 2002 confirmed by mill (83.6pg/L).
International Paper Co.	Eastover	SC	BPK	D	2621	SC0038121	29044-NNCMP-ROUTE	1421	VATIP-Tier 1.
International Paper Co.	Georgetown	SC	BPK	D	2631	SC0000868	29442-NTRNT-KAMIN	7647	
Weyerhaeuser Paper Co.	Bennetsville	SC	BPK	D	2621	SC0042188	29512-WLLMT-HWY91	1908	
Weyerhaeuser Paper Co.	Kingsport	TN	BPK	D	2621	TN0001643	37662-MDPPR-POBOX	1146	
Bowater Inc.	Calhoun	TN	BPK	D	2621	TN0002356	37309-BWTRS-ROUTE	9523	
International Paper Co.	Texarkana (Queen City)	TX	BPK	D	2621	TX0000167	75504-NTRNT-POBOX	8135	
MeadWestvaco Texas L.P.	Evadale (Silsbee)	TX	BPK	D	2631	TX0003891	77656-PLPPP-POBOX	2647	
MeadWestvaco Packaging Resources	Covington	VA	BPK	D	2631	VA0003646	24426-WSTVC-RIVER	4318	
International Paper Co.	Franklin	VA	BPK	D	2611	VA0004162	23851-NNCMP-HIGHW	6412	VATIP-Permit does not indicate tier.
Smurfit-Stone Container Corp.	West Point	VA	BPK	D	2611	VA0003115	23181-CHSPK-19THM	5187	
Weyerhaeuser Paper Co.	Longview	WA	BPK	D	2611	WA0000124	98632-WYRHS-3401I	8668	
Boise Cascade Corp.	Wallula	WA	BPK	D	2611	WA0003697	99363-BSCSC-POBOX	732	
Georgia-Pacific Corp.	Camas	WA	BPK	D	2611	WA0000256	98607-JMSRV-NE4TH	324	
Kimberly-Clark Worldwide Inc.	Everett	WA	PS	D	2611	WA0000621	98201-SCTTP-2600F	5124	PS-B; ammonium-based.
Simpson Tacoma Kraft Co.	Tacoma	WA	BPK	D	2611	WA0000850	98421-SMPSN-801PO	3720	
SmartPapers LLC	Park Falls	WI	PS	D	2621	WI0003212	54552-FLMBP-200NO	23	PS-A; calcium-based.

Status of Phase I Mills as of 2004 (Continued)

Mill Name	City	State	Phase I Sub-category [a]	Dis-charge [b]	SIC Code [c]	NPDES	TRI ID	SID [d]	Comment
Stora Enso North America	Wisconsin Rapids	WI	BPK	D	2611	WI0037991	54494-CNSLD-950FO	7850	In 2002, mill submitted 3 separate TRI release reports (pulp mill, paper mill, and water quality center).
Weyerhaeuser Paper Co.	Rothschild	WI	PS	D	2621	WI0026042	54474-WYRHS-200GR	4139	PS-A; calcium-based.
Domtar Industries Inc.	Nekoosa	WI	BPK	D	2611	WI0003620	54457-NKSML-MARKE	4468	Shares NPDES permit with PS - SID:7163.
Domtar Industries Inc.	Port Edwards	WI	PS	D	2621		54469-PRTDW-100WI	7163	PS-A; shares NPDES permit with BPK - SID:4468.
Mill That No Longer Have Bleached Chemical Pulp Operations									
International Paper Co.	Mobile	AL	BPK	D	2621	AL0002780		6354	Idle in 2002; *PCSLoads2002* contains dioxin, TSS, iron, etc.
Kimberly-Clark Worldwide Inc.	Mobile	AL	BPK	D	2621	AL0002801	36652-SCTTP-BAYBR	4774	Idle after 2002; *PCSLoads2002* contains BOD5, oil & grease, TSS, etc.
Shasta Paper	Anderson	CA	BPK	D				8657	Idle in 2002.
Smurfit-Stone/Florida Coast	Port St. Joe	FL	BPK	I		FLR10K742		3820	Idle in 2002; not in *PCSLoads2002.*
Durango-Georgia Paper Co.	St. Marys	GA	BPK	D	2611	GA0001953	31558-GLMNP-1000O	8850	Idle after 2002; *PSCLoads2002* contains dioxin, BOD_5, and TSS. According to AF&PA, closed October 2002.
Great Northern Paper Co.	Millinocket	ME	PS	D	2621	ME0000167	04462-GRTNR-1KATA	6841	Phase II.
SAPPI Fine Paper North America	Westbrook	ME	BPK	D	2621	ME0002321	04092-SDWRR-89CUM	130	Phase II.
International Paper Co.	Moss Point	MS	BPK	I	2621	MS0002674		7115	Idle in 2002; *PCSLoads2002* contains BOD_5, TSS, dissolved oxygen.
Stone Container Corp.	Missoula	MT	BPK	D	2611	MT0000035	59806-STNCN-MULLA	3218	Phase II.
Procter & Gamble Paper	Mehoopany	PA	PS	D	2621	PA0008885	18629-PRCTR-ROUTE	7401	Phase II.
International Paper Co.	Erie	PA	BPK	I	2611	PA0000124	16533-HMMRM-1540E	3982	Phase II (POTW=PA0026301; Erie City/Erie Sew Auth). According to AF&PA mill closed June 2002.

Status of Phase I Mills as of 2004 (Continued)

Mill Name	City	State	Phase I Sub-category [a]	Dis-charge [b]	SIC Code [c]	NPDES	TRI ID	SID [d]	Comment
Abitibi-Consolidated Corp.	Houston (Sheldon)	TX	BPK	D	2621	TX0053023	77044-CHMPN-11611	4545	Idle after 2002; *PCSLoads2002* contains AOX, COD, dioxin, etc.
Abitibi-Consolidated Corp.	Lufkin	TX	BPK	D	2621	TX0001643	75902-CHMPN-HIGHW	4079	Idle after 2002; *PCSLoads2002* contains AOX, dioxin, TSS, etc. According to AF&PA idled indefinitely October 2003
Pasadena Paper Co. LP	Pasadena	TX	BPK	I	2621		77506-PSDNP-901NS	2816	Phase II (POTW=TX0005380; Gulf Coast Waste Disposal Auth.).
James River Inc.	Camas	WA	PS	D				324	Idle in 2002; now owned by Georgia-Pacific. The Camas Mill announced the permanent closure of the sulfite pulp mill and four paper machines.
Georgia-Pacific Corp.	Bellingham	WA	PS	D	2611	WA0001091	98225-GRGPC-300WL	4005	Idle after 2002; *PCSLoads2002* contains TSS, mercury, BOD5; (at promulgation, the only mill in the specialty grade mills segment).
Wausau Paper Mills Co.	Brokaw	WI	PS	D	2611	WI0003379	54417-WSPPR-2NDST	7080	Idle as of Nov 2005; facility was PS-A (magnesium-based bisulfite process).
Badger Paper Mills Inc.	Peshtigo	WI	PS	I				3764	Phase II (POTW=WI0030651; Peshtigo City WWTF).

[a]Phase I subcategories include bleached papergrade kraft (BPK) and papergrade sulfite (PS) pulping operations.
[b]Mill either discharge directly to surface waters (i.e., direct dischargers) or to a POTWs (indirect dischargers).
[c]The pulp, paper, and paperboard industry corresponds to three separate SIC codes: 2611 (pulp mills), 2621 (paper mills excluding building paper mills), and 2631 (paperboard), which identify the facilities' principal product or group of products. Table lists the SIC code listed in PCS. For a given facility, the SIC code in PCS may differ from the primary SIC code identified in TRI.
[d]EPA performed an industry-wide survey in 1990. Each mill was given a survey identification number (SID).