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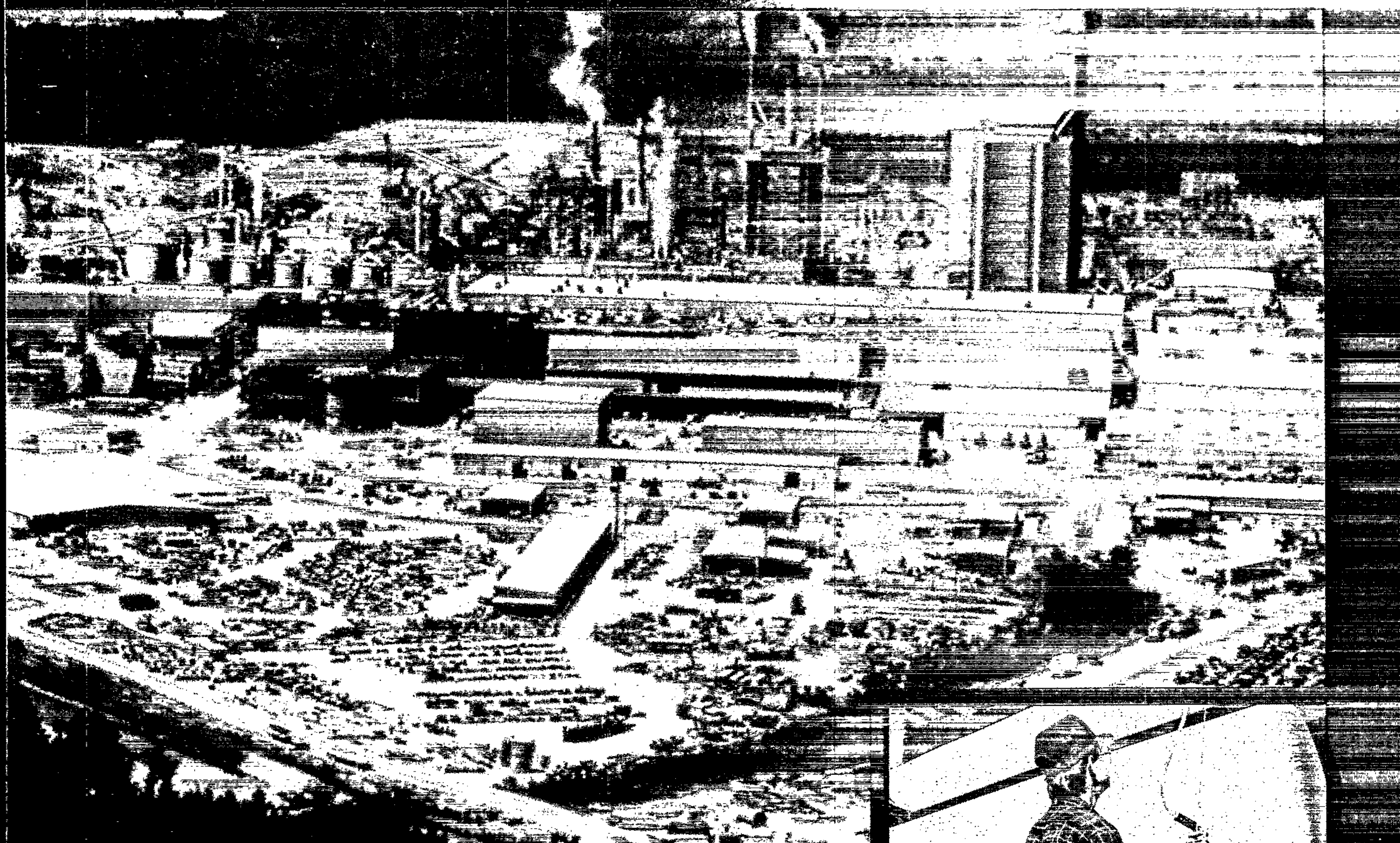
EPA

Profile Of The Pulp And Paper Industry



EPA Office Of Compliance
Sector Notebook Project

SECTOR
EPA
NOTEBOOKS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

THE ADMINISTRATOR

Message from the Administrator

Over the past 25 years, our nation has made tremendous progress in protecting public health and our environment while promoting economic prosperity. Businesses as large as iron and steel plants and businesses as small as the dry cleaner on the corner have worked with EPA to find ways to operate cleaner, cheaper, and smarter. As a result, we no longer have rivers catching on fire. Our skies are clearer. American environmental technology and expertise are in demand throughout the world.

The Clinton Administration recognizes that to continue this progress, we must move beyond the pollutant-by-pollutant approaches of the past to comprehensive, facility-wide approaches for the future. Industry by industry and community by community, we must build a new generation of environmental protection.

Within the past two years, the Environmental Protection Agency undertook its Sector Notebook Project to compile, for a number of key industries, information about environmental problems and solutions, case studies and tips about complying with regulations. We called on industry leaders, state regulators, and EPA staff with many years of experience in these industries and with their unique environmental issues. Together with notebooks for 17 other industries, the notebook you hold in your hand is the result.

These notebooks will help business managers to better understand their regulatory requirements, learn more about how others in their industry have undertaken regulatory compliance and the innovative methods some have found to prevent pollution in the first instance. These notebooks will give useful information to state regulatory agencies moving toward industry-based programs. Across EPA we will use this manual to better integrate our programs and improve our compliance assistance efforts.

I encourage you to use this notebook to evaluate and improve the way that together we achieve our important environmental protection goals. I am confident that these notebooks will help us to move forward in ensuring that -- in industry after industry, community after community -- environmental protection and economic prosperity go hand in hand.

Carol M. Browner

EPA/310-R-95-015

EPA Office of Compliance Sector Notebook Project

Profile of the Pulp and Paper Industry

September 1995

Office of Compliance
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This report is one in a series of volumes published by the U.S. Environmental Protection Agency (EPA) to provide information of general interest regarding environmental issues associated with specific industrial sectors. The documents were developed under contract by Abt Associates Inc. (Cambridge, MA), and Booz-Allen & Hamilton, Inc. (McLean, VA). This publication may be **purchased** from the Superintendent of Documents, U.S. Government Printing Office. A listing of available Sector Notebooks and document numbers is included at the end of this document.

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Complimentary volumes are available to certain groups or subscribers, such as public and academic libraries, Federal, State, local, and foreign governments, and the media. For further information, and for answers to questions pertaining to these documents, please refer to the contact names and numbers provided within this volume.

Electronic versions of all Sector Notebooks are available on the EPA Enviroene Bulletin Board and via the Internet on the Enviroene World Wide Web. Downloading procedures are described in Appendix A of this document.

Sector Notebook Contacts

The Sector Notebooks were developed by the EPA's Office of Compliance. Particular questions regarding the Sector Notebook Project in general can be directed to:

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Questions and comments regarding the individual documents can be directed to the appropriate specialists listed below.

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EPA/310-R-95-003.	Wood Furniture and Fixtures Industry	Bob Marshall	564-7021
EPA/310-R-95-004.	Inorganic Chemical Industry	Walter DeRieux	564-7067
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EPA/310-R-95-007.	Fabricated Metal Products Industry	Scott Throwe	564-7013
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EPA/310-R-97-001.	*Air Transportation Industry	Virginia Lathrop	564-7057
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*Currently in DRAFT anticipated publication in September 1997

This page updated during June 1997 reprinting

Pulp and Paper Industry Sector Notebook Contents

Exhibits Index

List of Acronyms

AF&PA - American Forest & Paper Association
AFS - AIRS Facility Subsystem (CAA database)
AIRS - Aerometric Information Retrieval System (CAA database)
BIFs - Boilers and Industrial Furnaces (RCRA)
BOD - Biochemical Oxygen Demand
CAA - Clean Air Act
CAAA - Clean Air Act Amendments of 1990
CERCLA - Comprehensive Environmental Response, Compensation and Liability Act
CERCLIS - CERCLA Information System
CFCs - Chlorofluorocarbons
CO - Carbon Monoxide
COD - Chemical Oxygen Demand
CSI - Common Sense Initiative
CWA - Clean Water Act
D&B - Dun and Bradstreet Marketing Index
ELP - Environmental Leadership Program
EPA - United States Environmental Protection Agency
EPCRA- Emergency Planning and Community Right-to-Know Act
FIFRA - Federal Insecticide, Fungicide, and Rodenticide Act
FINDS - Facility Indexing System
HAPs - Hazardous Air Pollutants (CAA)
HSDB - Hazardous Substances Data Bank
IDEA - Integrated Data for Enforcement Analysis
LDR - Land Disposal Restrictions (RCRA)
LEPCs - Local Emergency Planning Committees
MACT - Maximum Achievable Control Technology (CAA)
MCLGs - Maximum Contaminant Level Goals
MCLs - Maximum Contaminant Levels
MEK - Methyl Ethyl Ketone
MSDSs - Material Safety Data Sheets
NAAQS - National Ambient Air Quality Standards (CAA)
NAFTA - North American Free Trade Agreement
NCDB - National Compliance Database (for TSCA, FIFRA, EPCRA)
NCP - National Oil and Hazardous Substances Pollution Contingency Plan
NEIC - National Enforcement Investigation Center
NESHAP - National Emission Standards for Hazardous Air Pollutants
NO_2 - Nitrogen Dioxide
NOV - Notice of Violation

NO_X -	Nitrogen Oxides
NPDES -	National Pollution Discharge Elimination System (CWA)
NPL -	National Priorities List
NRC -	National Response Center
NSPS -	New Source Performance Standards (CAA)
OAR -	Office of Air and Radiation
OECA -	Office of Enforcement and Compliance Assurance
OPA -	Oil Pollution Act
OPPTS -	Office of Prevention, Pesticides, and Toxic Substances
OSHA -	Occupational Safety and Health Administration
OSW -	Office of Solid Waste
OSWER -	Office of Solid Waste and Emergency Response
OW -	Office of Water
P2 -	Pollution Prevention
PCS -	Permit Compliance System (CWA Database)
POTW -	Publicly Owned Treatments Works
RCRA -	Resource Conservation and Recovery Act
RCRIS -	RCRA Information System
SARA -	Superfund Amendments and Reauthorization Act
SDWA -	Safe Drinking Water Act
SEPs -	Supplementary Environmental Projects
SERCs -	State Emergency Response Commissions
SIC -	Standard Industrial Classification
SO_2 -	Sulfur Dioxide
SO_X -	Sulfur Oxides
TOC -	Total Organic Carbon
TRI -	Toxic Release Inventory
TRIS -	Toxic Release Inventory System
TCRIS -	Toxic Chemical Release Inventory System
TSCA -	Toxic Substances Control Act
TSS -	Total Suspended Solids
UIC -	Underground Injection Control (SDWA)
UST -	Underground Storage Tanks (RCRA)
VOCs -	Volatile Organic Compounds

I. INTRODUCTION TO THE SECTOR NOTEBOOK PROJECT

I.A. Summary of the Sector Notebook Project

Environmental policies based upon comprehensive analysis of air, water and land pollution (such as economic sector, and community-based approaches) are becoming an important supplement to traditional single-media approaches to environmental protection. Environmental regulatory agencies are beginning to embrace comprehensive, multi-statute solutions to facility permitting, compliance assurance, education/outreach, research, and regulatory development issues. The central concepts driving the new policy direction are that pollutant releases to each environmental medium (air, water, and land) affect each other, and that environmental strategies must actively identify and address these inter-relationships by designing policies for the "whole" facility. One way to achieve a whole facility focus is to design environmental policies for similar industrial facilities. By doing so, environmental concerns that are common to the manufacturing of similar products can be addressed in a comprehensive manner. The desire to move forward with this "sector-based" approach within the EPA Office of Compliance led to the creation of this document.

The Sector Notebook Project was initiated by the Office of Compliance to provide its staff and managers with summary information for eighteen specific industrial sectors. As other EPA offices, states, the regulated community, and the public became interested in this project, the Office of Compliance expanded the scope of the original project. The ability to design comprehensive, common sense environmental protection measures for specific industries is dependent on knowledge of several inter-related topics. For the purposes of this project, the key elements chosen for inclusion are: general industry information (economic and geographic); a description of industrial processes; pollution outputs; pollution prevention opportunities; Federal statutory and regulatory framework; compliance history; and a description of partnerships that have been formed between regulatory agencies, the regulated community and the public.

For any given industry, each topic described above could alone be the subject of a lengthy volume. However, in order to produce a manageable document, this project focuses on providing summary information for each topic. This format provides the reader with a synopsis of each issue, and references where more in-depth information is desired. Text within each profile was researched from a variety of sources, and was usually condensed from more detailed sources pertaining to specific topics. This approach allows for a wide coverage of activities that can be further explored based upon the citations and references listed at the end of this profile. As a check on the information included, each notebook went through an external document review process. The Office of Compliance appreciates the efforts of all those that participated in this process and enabled us to develop more complete, accurate and up-to-date summaries. Many of those who reviewed this notebook are listed as contacts in Section IX and may be sources of additional information. The individuals and groups on this list do not necessarily concur with all statements within this notebook.

I.B. Additional Information

Providing Comments

The Office of Compliance plans to periodically review and update notebooks and will make these updates available both in hard copy and electronically. If you have any comments on the existing notebook, or if you would like to provide additional information, please send a hard copy and computer disk to the EPA Office of Compliance, Sector Notebook Project, 401 M St., SW (2223-A), Washington, DC 20460. Comments can also be uploaded to the Enviroene Bulletin Board or the Enviroene World Wide Web for general access to all users of the system. Follow instructions in Appendix A for accessing these data systems. Once you have logged in, procedures for uploading text are available from the on-line Enviroene Help System.

Adapting Notebooks to Particular Needs

The scope of the existing notebooks reflect an approximation of the relative national occurrence of facility types that occur within each sector. In many instances, industries within specific geographic regions or states may have unique characteristics that are not fully captured in these profiles. For this reason, the Office of Compliance encourages state and local environmental agencies and other groups to supplement or re-package the information included in this notebook to include more specific industrial and regulatory information that may be available. Additionally, interested states may want to supplement the "Summary of Applicable Federal Statutes and Regulations" section with state and local requirements. Compliance or technical assistance providers may also want to develop the "Pollution Prevention" section in more detail. Please contact the appropriate specialist listed on the opening page of this notebook if your office is interested in assisting us in the further development of the information or policies addressed within this volume.

If you are interested in assisting in the development of new notebooks for sectors not covered in the original eighteen, please contact the Office of Compliance at 202-564-2395.

II. INTRODUCTION TO THE PULP AND PAPER INDUSTRY

This section provides background information on the size, geographic distribution, employment, production, sales, and economic condition of the pulp and paper industry. The type of facilities described within the document are also described in terms of their Standard Industrial Classification (SIC) codes. Additionally, this section contains a list of the largest companies in terms of sales.

II.A. Introduction, Background, and Scope of the Notebook

This notebook focuses primarily on the greatest areas of environmental concerns within the pulp and paper industry: those from pulpmaking processes. Due to this focus, some components of the pulp and paper industry, as defined by SIC code 26, are not addressed in this notebook. Converting facilities are not discussed, and the papermaking stage of the pulp and paper process is de-emphasized. Data has been drawn from industry and census sources in the preparation of this document.

According to a 1990 USEPA survey of pulp and paper mills and industry statistics, there are approximately 555 facilities manufacturing pulp and paper in the U.S. Of these facilities, about half are integrated facilities manufacturing both pulp and paper products, half manufacture only paper products and approximately 50 mills produce only pulp.[a,1] In 1991, pulp and paper mills employed approximately 198,000 people and produced $54 billion in shipments. Shipments from facilities producing converted products were approximately $75 billion.[2] In comparison, the industry total value of shipments (pulp and paper mills and converting facilities) accounted for about 4 percent of the value of shipments for the entire U.S. manufacturing sector and was similar to that of the petroleum refining sector. Pulp and paper mills tend to be large and capital intensive. Almost three quarters of U.S. mills employ over 100 people. Converting facilities tend to be smaller, more numerous and more labor intensive. The geographic distribution of mills producing pulp and paper and those producing only paper products varies. Pulp and paper mills tend to be located where pulp trees are harvested: Southeast, Northwest, Northeast, and North Central regions. Paper and paper board mills are more widely distributed in the proximity of pulping operations and near converting sector markets.[3] Deinked pulp mills are often located near recovered paper sources in urban areas.

[a] Variation in facility counts occur across data sources due to many factors, including reporting and definitional differences. This notebook does not attempt to reconcile these differences, but rather reports the data as they are maintained by each source.

One important characteristic of the pulp and paper industry is the interconnection of operations between pulp mills, of which there are fewer than 60 in the U.S., and downstream processing of pulp into paper, paperboard and building paper. Another important characteristic of the pulp and paper industry are the varied processes, chemical inputs, and outputs that are used in pulp manufacture. Chemical recovery systems reuse many process chemicals for some of these pulpmaking systems. On the whole, however, pulp mill processes are chemical intensive and have been the focus of past and ongoing rulemaking. In many analyses of the sector, they should be considered separately. The Bureau of the Census' two-digit SIC 26 also includes a number of SIC codes related to converting, i.e., manufacturing finished paper and paperboard products from paper and paperboard stock, not milling. These converting operations fall under the three-digit SIC 265 - Paperboard Containers and Boxes and SIC 267 - Miscellaneous Converted Paper Products. Some companies are involved in both the manufacture of primary products and converting, especially in the production of sanitary tissue products, corrugated shipping containers, folding cartons, flexible packaging, and envelopes. (These types of integrated facilities are among the largest convertors.) The following list includes pulp and paper mills (italicized) as well as converted paper products included within SIC 26.

SIC 2611 - Pulp mills
SIC 2621 - Paper mills
SIC 2631 - Paperboard mills
SIC 2652 - Setup paperboard boxes
SIC 2653 - Corrugated and solid fiber boxes
SIC 2655 - Fiber cans, drums, and similar products
SIC 2656 - Sanitary food containers
SIC 2657 - Folding paperboard boxes
SIC 2661 - Building paper and building board mills
SIC 2671 - Paper coated and laminated, packaging
SIC 2672 - Paper coated and laminated, nec
SIC 2673 - Bags: plastics, laminated, and coated
SIC 2674 - Bags: uncoated paper and multiwall
SIC 2675 - Die-cut paper and board
SIC 2676 - Sanitary paper napkins
SIC 2677 - Envelopes
SIC 2678 - Stationery products
SIC 2679 - Converted paper products, nec

II.B. Characterization of the Pulp and Paper Industry

The pulp and paper industry produces commodity grades of wood pulp, primary paper products, and paper board products such as: printing and writing papers, sanitary tissue, industrial-type papers, container board and boxboard. Pulp facilities are comprised of mills that only produce pulp which is sold on the open market or is shipped via pipe, conveyor, truck, train, or ship to another facility where it is utilized for the production of a final product. Pulp and paper facilities are comprised of mills that produce both pulp and primary paper products, and mills that produce only paper products from pulp produced elsewhere. SIC code 26 also includes facilities that "convert" primary paper and paper board products to finished paper products such as: packaging, envelopes and shipping containers. In the following analysis of the pulp and paper industry, converting facilities are treated separately from pulp and paper mills due to major differences in the industrial processes, environmental releases, facility size and number, and relevant environmental regulations.

The processes used to manufacture pulp (which is later converted into paper) are the major sources of environmental concerns for this industry. Pulpmaking processes are the sources of air and water pollutant outputs. Although a variety of processes are used nationally, the vast majority of pulp tonnage produced in the U.S. is manufactured by the kraft chemical pulping process, which may release nuisance odors and particulates to the air. Bleaching processes, primarily used to whiten and brighten pulps for paper manufacture, may produce wastewaters containing chlorinated compounds such as dioxins. Overall, the pulp and paper making process is water-intensive: the pulp and paper industry is the largest industrial process water user in the U.S.[4] In 1988, a typical pulp and paper mill used 16,000 to 17,000 gallons of water per ton of pulp produced. This roughly translates into an industry total discharge amount of 16 million m^3/day of water.[5] Pulp and paper mills usually operate wastewater treatment plants to remove biological oxygen demand (BOD), total suspended solids (TSS), and other pollutants before discharging wastewaters to a receiving waterway. Mills with indirect discharge may operate primary treatment systems designed for TSS reduction prior to discharge to a POTW.

Generally speaking, the pulp and paper industry divides itself along pulping process lines: chemical pulping (e.g., kraft chemical pulping), mechanical pulping, and semi-chemical pulping. On a tonnage basis, chemical pulping methods produced approximately 85 percent of the pulp manufactured domestically in 1991, mechanical pulp 10 percent and semi-chemical five percent.[6]

II.B.1. Industry Size and Geographic Distribution

The approximately 555 manufacturing pulp and paper mills in the U.S. can be divided into three major categories. In the pulp and paper industry, some mills produce pulp only (market pulp facilities), some only manufacture paper from pulp (non-integrated facilities), and some produce the pulp they use for paper manufacture on-site (integrated facilities). Of the estimated 555 pulp and paper facilities in the U.S., 55 are market pulp facilities, 300 are non-integrated facilities, and 200 are integrated facilities.[7]

The Bureau of the Census tracks the pulp and paper industry at the two-digit Standard Industrial Classification (SIC) code level using SIC 26 which encompasses paper and allied products. Environmental regulations frequently distinguish primary product mills (2611, 2621, 2631, 2661) from converting operations. The pulp and paper industry is a capital intensive sector with large facilities. With increases in automation and industry restructuring, the ratio of employees to value of shipments has declined since 1972 as have the number of facilities in operation (23 percent reduction since 1972). Almost three-quarters of U.S. mills in the *1992 Census of Manufactures* employ 100 people or more. Converting facilities, those that use the primary pulp, paper and paperboard products, tend to be smaller, more numerous and more labor-intensive.

Exhibit 1: Large Facilities Dominate Industry (SICs 2611, 2621, 2631)

Employees per Facility	Percentage of Facilities (total=529)
1-19	2%
20-99	28%
100-499	44%
500-999	17%
1,000-2,499	9%

Source: *U.S. Census of Manufactures, 1992*

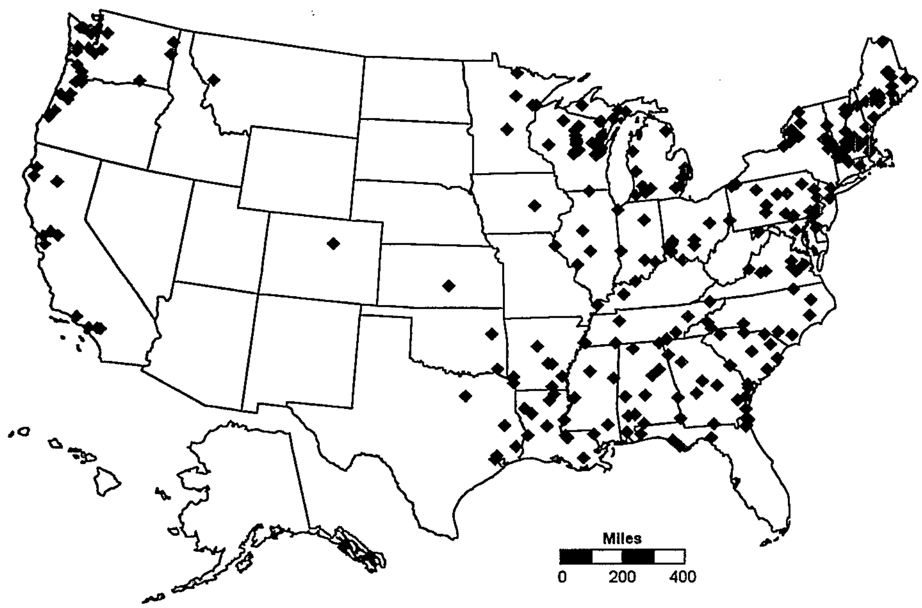
The geographic distribution of pulp and paper mills varies according to the type of mill. As there are tremendous variations in the scale of individual facilities, tallies of the number of facilities may not represent the level of economic activity (nor possible environmental consequences). Pulp mills are located primarily in regions of the country where pulp trees are harvested from natural stands or tree farms: the Southeast, Northwest, Northeast and Northern Central regions. Paper mills, however, are more widely distributed, located in proximity to pulping operations and/or near converting sector markets. The distribution of paperboard mills follows the location of manufacturing in general since such operations are the primary market for paperboards products.

Exhibit 2: Geographic Distribution of Mills Differs According to Type of Mill		
Mill Type	**Top States, descending (% of U.S. Total, by type)**	**Secondary States (% of U.S. Total, by type)**
Pulp Mills	WA, GA, WI, AL, CA, NC, TN, AK, FL, ME, MS (94%)	MI, KY (6%)
Paper Mills	WI, NY, MA, MI (42%)	PA, OH, ME, WA, NH, CA, MN, LA (39%)
Paperboard Mills	CA, OH, PA, MI, GA, NY (45%)	NJ, VA, AL, IN, IL, TN, CT, FL, LA, OR, TX (40%)

Note: States with three to five percent of the U.S. total of that mill type are listed as Secondary States. Those with six percent or more of the U.S. total are listed as Top States. Those with two percent or less are not listed.

Source: U.S. EPA, *Development Documents for Proposed Effluent Limitations Guidelines and Standards for the Pulp, Paper and Paperboard Point Source Category*. October 1993.

Exhibit 3: Pulp, Paper, and Paperboard Mills



(Source: U.S. EPA, Toxics Release Inventory Database, 1993.)

Ward's Business Directory of U.S. Private and Public Companies, produced by Gale Research Inc., compiles financial data on U.S. companies including those operating within the pulp and paper industry. Ward's ranks U.S. companies, whether they are a parent company, subsidiary or division, by sales volume within the four-digit SIC codes that they have been assigned as their primary activity. Readers should note that: 1) Companies are assigned a four-digit SIC that most closely resembles their principal industry; and 2) Sales figures include total company sales, including sales derived from subsidiaries and operations not related to pulp and paper production. Additional sources of company-specific financial information include Standard & Poor's Stock Report Services, Dun & Bradstreet's Million Dollar Directory, Moody's Manuals, Lockwood-Post's Directory, and annual reports.

Exhibit 4: Top U.S. Companies with Pulp and Paper Manufacturing Operations

Rank[a]	Company[b]	1993 Sales (millions of dollars)
1	International Paper Co.	12,703
2	Weyerhaeuser Co.	8,702
3	Kimberly-Clark Corp.	6,777
4	Georgia-Pacific Corp. Pulp and Paper Group	6,702
5	Stone Container Corp.	5,384
6	Champion International Corp.	4,786
7	Mead Corp.	4,579
8	Boise Cascade Corp.	3,951
9	Union Camp Corp.	2,967
10	Jefferson Smurfit Corp.	2,940

Note: [a] When *Ward's Business Directory* listed both a parent and subsidiary in the top ten, only the parent company is presented above to avoid double counting sales volumes. Not all sales can be attributed to the companies' pulp and paper operations.
[b] Companies shown listed SIC 2611, 2621, or 2631 as primary activity.

Source: *Ward's Business Directory of U.S. Private and Public Companies*, 1993.

II.B.2. Product Characterization

The pulp and paper industry produces primary products -- commodity grades of wood pulp, printing and writing papers, sanitary tissue, industrial-type papers, containerboard and boxboard -- using cellulose fiber from timber or purchased or recycled fibers. Paper and Allied Products are categorized by the Bureau of the Census as Standard Industrial Classification (SIC) code 26. The industry's output is "converted" to finished products such as packaging, envelopes and shipping containers by independent manufacturing facilities or at facilities located adjacent to a mill. Converting operations are included in SIC 26 but are not included in the following profiles of the pulp and paper industry unless noted.

The products of the pulp and paper industry can also be categorized by the pulping process used in paper and paperboard production. The pulping process affects the strength, appearance, and intended use characteristics of the resultant paper product. Pulping processes are the major source of environmental impacts in the pulp and paper industry; each pulping process has its own set of process inputs, outputs, and resultant environmental concerns. Papermaking activities have not been associated with significant environmental problems and are not addressed by EPA's ongoing regulatory and nonregulatory initiatives. Industry representatives and EPA, in the Proposed Effluent Limitations Guidelines and Standards for the Pulp, Paper and Paperboard Point Source Category, have used pulpmaking techniques to categorize the majority of the industry (Exhibit 5). Since many mills operate a variety of pulping processes, the percentages in Exhibit 5 are not additive. In addition, the data indicates process prevalence at mills but does not represent the proportion of pulp manufactured by each processes. For example, many mills practice some form of deink secondary fiber pulping as shown in Exhibit 5, but the great majority of U.S. pulp is produced by the kraft chemical pulping process. (The pulp and papermaking processes contained in Exhibit 5 are explained in Section III: Industrial Process Description.)

Exhibit 5: Number of Mills in U.S. by Pulping Process

Pulp Process	*% of Mills**	*Description/Principal Products*
Dissolving Kraft	1	Highly bleached and purified kraft process wood pulp suitable for conversion into products such as rayon, viscose, acetate, and cellophane.
Bleached Papergrade Kraft and Soda	24	Bleached or unbleached kraft process wood pulp usually converted into paperboard, coarse papers, tissue papers, and fine papers such as business, writing and printing.
Unbleached Kraft	10	
Dissolving Sulfite	1	Highly bleached and purified sulfite process wood pulp suitable for conversion into products such as rayon, viscose, acetate, and cellophane.
Papergrade Sulfite	3	Sulfite process wood pulp with or without bleaching used for products such as tissue papers, fine papers, and newsprint.
Semi-chemical	6	Pulp is produced by chemical, pressure, and mechanical (sometimes) forces with or without bleaching used for corrugating medium (for cardboard), paper, and paperboard.
Mechanical pulp	<12	Pulp manufacture by stone groundwood, mechanical refiner, thermo-mechanical, chemi-mechanical, or chemi-thermo-mechanical means for newsprint, coarse papers, tissue, molded fiber products, and fine papers.

Exhibit 5: Number of Mills in U.S. by Pulping Process

Pulp Process	*% of Mills**	*Description/Principal Products*
Non-wood Chemical pulp	2	Production of pulp from textiles (e.g.,rags), cotton linters, flax, hemp, tobacco, and abaca to make cigarette wrap papers and other specialty paper products.
Secondary Fiber Deink	8	Pulps from wastepapers or paperboard using a chemical or solvent process to remove contaminants such as inks, coatings and pigments used to produce fine, tissue, and newsprint papers.
Secondary Fiber Non-deink	61	Pulp production from wastepapers or paperboard without deinking processes to produce tissue, paperboard, molded products and construction papers.
Fine and Lightweight Papers from Purchased Pulp	44	Paper production from purchased market pulp or secondary fibers to make clay coated printing, uncoated free sheet, cotton fiber writing, and lightweight electrical papers.
Tissue, Filter, Non-Woven, and Paperboard from Purchased Pulp		Paper production from purchased market pulp to make paperboard, tissue papers, filter papers, non-woven items, and any products other than fine and lightweight papers.

* Percents are not additive because many mills operate multiple fiber lines and processes.

Source: USEPA. *Development Document for Proposed Effluent Limitations Guidelines and Standards for the Pulp, Paper, and Paperboard Point Source Category.* October 1993.

II.B.3. Economic Trends

The pulp and paper industry is a capital intensive sector with large facilities in terms of number of employees and chemical use. With increases in automation and industry restructuring, the ratio of employees to value of shipments has declined since 1972 as have the number of facilities in operation (23 percent reduction since 1972). Almost three-quarters of U.S. mills in the *1992 Census of Manufactures* employ 100 people or more. Converting facilities, those that use the primary pulp, paper and paperboard products tend to be smaller, more numerous and more labor-intensive.

The Bureau of the Census estimates that in 1992, 198,000 people were employed in pulp and paper mills with a payroll of $8.25 billion. The value of shipments generated by the pulp and paper sector totaled approximately $54 billion. Industry growth is expected to average two percent per year through 1998 due in large part to expected increases in exports.

The U.S. pulp and paper industry is recognized as a high-quality, high-volume, low-cost producer that benefits from a large consumer base, a modern technical infrastructure, adequate raw materials and a highly skilled labor force. Profitability within the industry is a function both of raw material prices and labor conditions as well as worldwide inventories and demand. Reduced profitability since 1991 due to decreased demand, high inventories, and higher prices of wood products led to rebuilding and modifications of existing equipment rather than installation of new machines. In 1993, domestic mills operated at between 92 and 95 percent of capacity.[8]

Within the manufacture of primary products, paper mills (SIC 2621) account for 60 percent of the total value of shipments. The remaining shipments are attributable to paperboard mills which account for 30 percent of total value of shipments and pulp mills at 10 percent. The majority of converting operations are operate independently of a primary product mill (e.g. a paper stock mill). However, those mills that are integrated with primary product mills account for the majority of the value of shipments.

The 1992 Census of Manufactures reports a payroll of $8.25 billion for 198,000 employees in the primary products sectors, three-quarters of whom are production workers. Labor relations are critical to the success of U.S. pulp and paper operations. Employment is down slightly, caused by mergers, consolidations and phasing out of older, less-efficient operations, a trend which is expected to continue. Nonetheless, labor contracts are being signed for longer periods and strikes are less frequent (one in 1993 versus 19 in 1983).

Industry growth is driven by the performance of other manufacturing sectors that use paper products in packaging and by demand for printing and writing papers. Competitive pressures come from plastic packaging in the domestic market. As foreign paper companies in developing countries improve their product quality they are likely to become more competitive in the U.S. and international markets. Current principal world market competition comes from Canada and Scandinavia.

Exports of pulp and paper products are increasingly important to the economic health of the industry. In 1992, exports amounted to $10.1 billion (seven percent of the total value of shipments of paper and allied products). The major export markets for U.S. printed material are Canada, Mexico, and Japan. Efforts by the U.S. paper industry to meet new European Community guidelines and product standards should strengthen its competitive position in European markets. During the same period, the U.S. imported $10.4 billion worth of pulp and paper products, principally from Canada. Even with the recent weakness in Canada's economy, exports (particularly of converted paper and paperboard packaging) are likely to grow due to the U.S.-Canada Free Trade Agreement. A large number of U.S. paper and paperboard companies that have not yet entered overseas markets will likely do so if tariff and nontariff barriers are removed or reduced. Exports of recovered paper, which are not included in the figures above, totaled $560 million in 1993; imports totaled $26 million.

Domestic demand for packaging and industrial-type paper grades and strengthening export markets drive estimates for real growth of three percent in shipments of paper and allied products in 1994. The successful conclusion of the North American Free Trade Agreement (NAFTA) and the Uruguay Round of the General Agreement on Tariffs and Trade (GATT) is also increasing exports for the industry particularly to the European Community and emerging economies in Pacific Rim countries. Industry growth is expected to average two percent per year through 1998 due in large part to expected increases in exports.

III. INDUSTRIAL PROCESS DESCRIPTION

This section describes the major industrial processes within the pulp and paper industry, including the materials and equipment used, and the processes employed. The section is designed for those interested in gaining a general understanding of the industry, and for those interested in the inter-relationship between the industrial process and the topics described in subsequent sections of this profile -- pollutant outputs, pollution prevention opportunities, and Federal regulations. This section does not attempt to replicate published engineering information that is available for this industry. Refer to Section IX for a list of reference documents that are available.

This section specifically contains a description of commonly used production processes, associated raw materials, the byproducts produced or released, and the materials either recycled or transferred off-site. This discussion, coupled with schematic drawings of the identified processes, provide a concise description of where wastes may be produced in the process. This section also describes the potential fate (via air, water, and soil pathways) of these waste products.

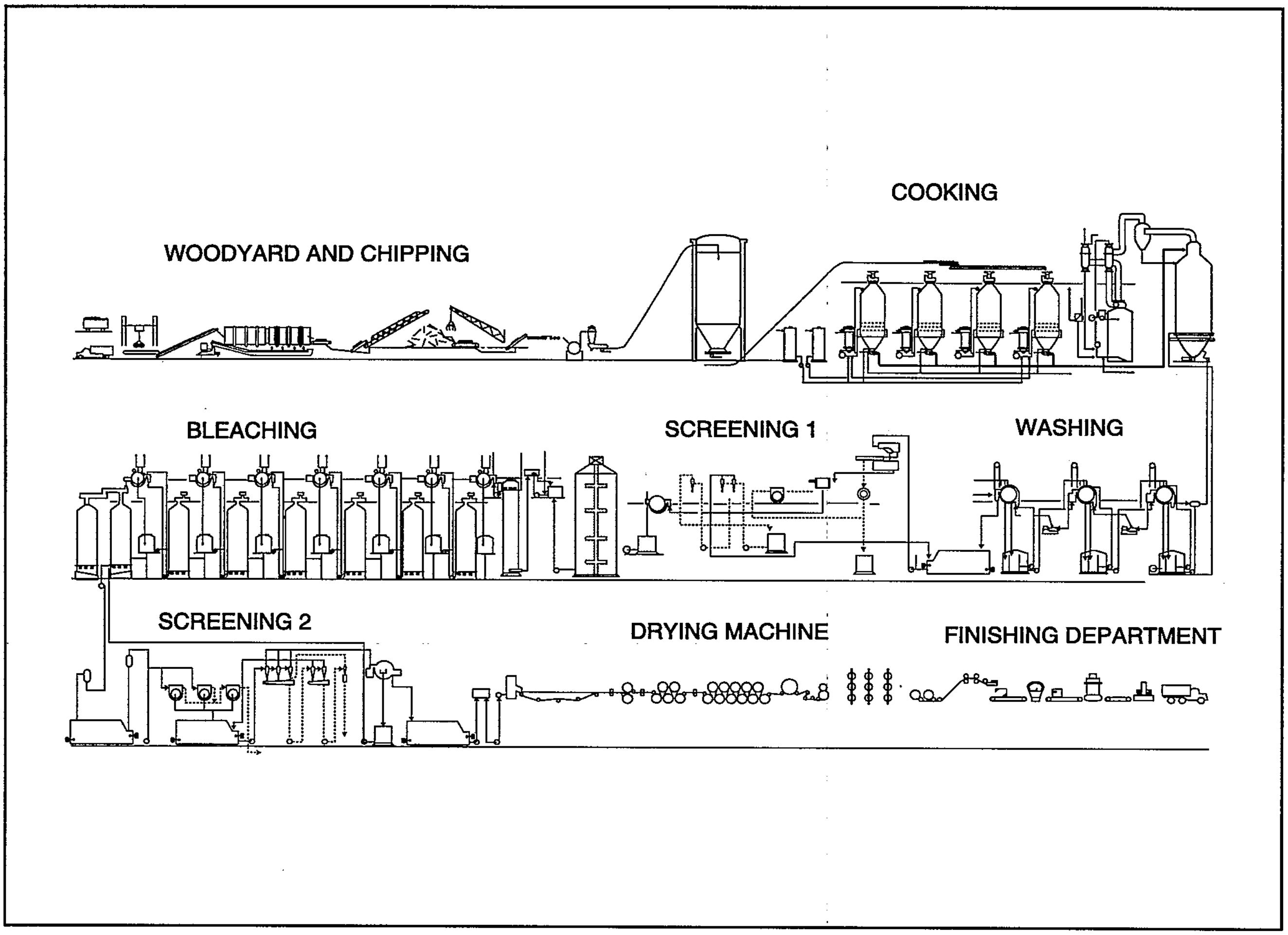
III.A. Industrial Processes in the Pulp and Paper Industry

Simply put, paper is manufactured by applying a watery suspension of cellulose fibers to a screen which allows the water to drain and leaves the fibrous particles behind in a sheet. Most modern paper products contain non-fibrous additives, but otherwise fall within this general definition. Only a few paper products for specialized uses are created without the use of water, via dry forming techniques. The watery fibrous substrate formed into paper sheets is called pulp. The production of pulp is the major source of environmental impacts in the pulp and paper industry.

Processes in the manufacture of paper and paperboard can, in general terms, be split into three steps: pulp making, pulp processing, and paper/paperboard production. Paperboard sheets are thicker than paper sheets; paperboard is thicker than 0.3 mm. Generally speaking, however, paper and paperboard production processes are identical. First, a stock pulp mixture is produced by digesting a material into its fibrous constituents via chemical, mechanical, or a combination of chemical and mechanical means. In the case of wood, the most common pulping material, chemical pulping actions release cellulose fibers by selectively destroying the chemical bonds in the glue-like substance (lignin) that binds the fibers together. After the fibers are separated and impurities have been removed, the pulp may be bleached to improve brightness and processed to a form suitable for paper-making equipment. Currently one-fifth of all pulp and paper mills practice bleaching.[9] At the paper-making stage, the pulp can be combined with dyes, strength building resins, or texture adding filler materials, depending on its intended end product. Afterwards, the mixture is dewatered, leaving the fibrous constituents and pulp additives on a wire or wire-mesh conveyor. Additional additives may be applied after the sheet-making step. The fibers bond together as they are carried through a series of presses and heated rollers. The final paper product is usually spooled on large rolls for storage (see Exhibit 6).

The following discussion focuses mainly on pulping processes due to their importance in understanding industry environmental impacts and current industry regulatory classification schemes. If more information on papermaking processes is desired, the *Development Document for Proposed Effluent Limitations, Guidelines and Standards for the Pulp and Paper Industry, Point Source Category* (EPA-821-R-93-019) is recommended.

Exhibit 6: Simplified Flow Diagram: Integrated Mill (Chemical Pulping, Bleaching, and Paper Production)



(Source: Smook, GA *Handbook for Pulp & Paper Technologists*. Second Edition. Vancouver: Angus Wilde Publications, 1992.)

III.A.1. Pulp Manufacture

At the pulping stage, the processed furnish is digested into its fibrous constituents. The bonds between fibers may be broken chemically, mechanically, or by a combination of the techniques called semi-chemical pulping. The choice of pulping technique is dependent on the type of furnish and the desired qualities of the finished product, but chemical pulping is the most prevalent. Exhibit 7 presents an overview of the wood pulping types by the method of fiber separation, resultant fiber quality, and percent of 1990 U.S. pulp production. Many mills perform multiple pulping processes at the same site, most frequently non-deink secondary fiber pulping (61 percent of mills) and papergrade kraft pulping (24 percent of mills).[10] The three basic types of wood pulping processes 1) chemical pulping, 2) semi-chemical pulping, and 3) mechanical pulping are detailed below followed by a discussion of secondary fiber pulping techniques.

Exhibit 7: General Classification of Wood Pulping Processes

Process Category	*Fiber Separation Method*	*Fiber Quality*	*Examples*	*% of Total 1993 US Wood Pulp Production**
Mechanical	Mechanical energy	Short, weak, unstable, impure fibers	Stone groundwood, refiner mechanical pulp	10%
Semi-chemical	Combination of chemical and mechanical treatments	"Intermediate" pulp properties (some unique properties)	High-yield kraft, high-yield sulfite	6%
Chemical	Chemicals and heat	Long, strong, stable fibers	Kraft, sulfite, soda	84%

*American Forest and Paper Association, 1994 Statistics, Data Through 1993. Washington, D.C.:AF&PA, 1994.

Source: Smook, G.A. *Handbook for Pulp & Paper Technologists*. Second edition. Vancouver: Angus Wilde Publications, 1992.

A variety of technologies and chemicals are used to manufacture pulp, but most pulp manufacturing systems contain the following process sequence:

Exhibit 8: Pulp Manufacturing Process Sequence

Process Sequence	Description
Fiber Furnish Preparation and Handling	Debarking, slashing, chipping of wood logs and then screening of wood chips/secondary fibers (some pulp mills purchase chips and skip this step)
Pulping	Chemical, semi-chemical, or mechanical breakdown of pulping material into fibers
Pulp Processing	Removal of pulp impurities, cleaning and thickening of pulp fiber mixture
Bleaching	Addition of chemicals in a staged process of reaction and washing increases whiteness and brightness of pulp, if necessary
Stock Preparation	Mixing, refining, and addition of wet additives to add strength, gloss, texture to paper product, if necessary

Overall, most of the pollutant releases associated with pulp and paper mills occur at the pulping and bleaching stages where the majority of chemical inputs occur.

Furnish Composition

Furnish is the blend of fibrous materials used to make pulp. According to the *1990 National Census of Pulp, Paper, and Paperboard Manufacturing Facilities*, the most commonly used furnish material is wood; it is used in some form by approximately 95 percent of pulp and paper manufacturers. Overall, wood furnish averages approximately 50 percent of pulp content industry-wide.

The major source of fiber for paper products comes from the vegetative tissues of vascular plants. Although almost any vascular plant could be used for paper production, the economics of scale require a high fiber yield for paper manufacture. The principle source of paper-making fibers in the United States is wood from trees, the largest vascular plants available. The fibrous particles used to make paper are made of cellulose, a primary component of the cell walls of vascular plant tissues. The cellulose fibers must be removed from a chemical matrix (e.g., lignin, hemicelluloses, and resins) and result in a mixture of relatively pure fibers.

Wood used to make pulp can be in a variety of forms and types. Wood logs, chips, and sawdust are used to make pulp. Due to different physical and chemical properties, however, certain pulping processes are most efficient on specific wood types (see **Pulping**). The type of wood used can also make a difference in the final characteristics of the pulp. In general, softwood fibers are longer than those from hardwood and have thinner cell walls. The longer fibers of softwood promote inter-fiber bonding and produce papers of greater strength.

Secondary fibers comprise the next most common furnish constituent. Secondary fibers consist of pre-consumer fibers (e.g., mill waste fibers) and post-consumer fiber. Post-consumer fiber sources are diverse, but the most common are newsprint and corrugated boxes (See Exhibit 9). Although secondary fibers are not used in as great a proportion as wood furnish, approximately 70 percent of pulp and paper manufacturers use some secondary fibers in their pulp production and approximately 200 mills (approximately 40 percent of total number of mills) rely exclusively on secondary fibers for their pulp furnish.[11] Office of Water estimates place the number of mills relying completely on secondary fibers as a furnish source at 285, approximately 50 percent of all mills.[12] Secondary fibers must be processed to remove contaminants such as glues or bindings, but, depending on the end product, may or may not be processed to remove ink contaminants or brighten the pulp.

Secondary fiber use is increasing in the pulp and paper industry due to consumer demand for products made from recycled paper and a lack of adequate virgin fiber (see **Bleaching**). Within the secondary fiber category, consumption of fiber from recovered paper is growing more than twice as fast as overall fiber consumption.[13] The utilization of secondary fibers, expressed as a percentage of the total fibers used to make pulp, is at approximately 30 percent and is climbing slowly.[14] In a resource-deficient country such as Japan, the secondary fiber utilization rate is at about 50 percent, whereas the average utilization rate in Europe is approximately 40 percent. Due to losses of fiber substance and strength during the recycling process, a 50 percent utilization rate is considered the present maximum overall utilization rate for fiber recycling.[15]

In 1992, corrugated containers comprised about 50 percent of the secondary fiber used in paper and paperboard production. Secondary fiber sources are seldom used as feedstocks for high quality or grade paper products. Contaminants (e.g., inks, paper colors) are often present, so production of low-purity products is often cost-effective use of secondary fibers, although decontamination technologies are available. Approximately 75 percent of all secondary fiber in North America is presently used for multi-ply paperboard or the corrugating paper used to manufacture corrugated cardboard. Over the next decade, an increasing proportion of the total amount will be deinked for newsprint or other higher-quality uses.

Exhibit 9: Relative Wastepaper Usage as Secondary Fiber in 1992

Paper Type	*% of Total Wastepaper Usage in 1992*
Mixed Paper	13%
Old Newspaper	17%
Old Corrugated Cardboard	49%
Pulp Substitutes	11%
High-grade Deinked	10%

Source: American Forest and Paper Association, *1994 Statistics, Data Through 1993*. Washington, D.C.:AF&PA, 1994.

Other types of furnish include cotton rags and linters, flax, hemp, bagasse, tobacco, and synthetic fibers such as polypropylene. These substances are not used widely, however, as they are typically for low volume, specialty grades of paper.

The types of furnish used by a pulp and paper mill depend on the type of product produced and what is readily available. Urban mills use a larger proportion of secondary fibers due to the post-consumer feedstock close at hand. More rurally located mills are usually close to timber sources and thus may use virgin fibers in greater proportion.

Furnish Preparation

Furnish is prepared for pulp production by a process designed to supply a homogenous pulping feedstock. In the case of roundwood furnish (logs), the logs are cut to manageable size and then debarked. At pulp mills integrated with lumbering facilities, acceptable lumber wood is removed at this stage. At these facilities, any residual or waste wood from lumber processing is returned to the chipping process; in-house lumbering rejects can be a significant source of wood furnish at a facility. The bark of those logs not fit for lumber is usually either stripped mechanically or hydraulically with high powered water jets in order to prevent contaminantion of pulping operations. Depending on the moisture content of the bark, it may then be burned for energy production. Hydraulic debarking methods may require a drying step before burning. Usually, hydraulically removed bark is collected in a water flume, dewatered, and pressed before burning. Treatment of wastewater from this process is difficult and costly, however, whereas dry debarking methods can channel the removed bark directly into a furnace.[16] If not burned for energy production, bark can be used for mulch, ground cover, or as an ingredient in charcoal.

Debarked logs are cut into chips of equal size by chipping machines. Chippers usually produce uniform wood pieces 20 mm long in the grain direction and 4 mm thick. The chips are then put on a set of vibrating screens to remove those that are too large or small. Large chips stay on the top screens and are sent to be recut, while the smaller chips are usually burned with bark. Certain mechanical pulping processes, such as stone groundwood pulping, use roundwood; however, the majority of pulping operations require wood chips. Non-wood fibers are handled in ways specific to their composition. Steps are always taken to maintain fiber composition and thus pulp yield.

Chemical Pulping

Chemical pulps are typically manufactured into products that have high-quality standards or require special properties. Chemical pulping degrades wood by dissolving the lignin bonds holding the cellulose fibers together. Generally, this process involves the cooking/digesting of wood chips in aqueous chemical solutions at elevated temperatures and pressures. There are two major types of chemical pulping currently used in the U.S.: 1) kraft/soda pulping and 2) sulfite pulping. These processes differ primarily in the chemicals used for digesting. The specialty paper products rayon, viscose, acetate, and cellophane are made from dissolving pulp, a variant of standard kraft or sulfite chemical pulping processes.

Kraft pulping (or sulfate) processes produced approximately 80 percent of all US pulp tonnage during 1993 according to the American Forest and Paper Association (AF&PA) and other industry sources. According to EPA industry surveys, approximately 30 percent of all pulp and paper mills use the kraft process for some portion of pulp manufacture.[17] The success of the process and its widespread adoption are due to several factors. First, because the kraft cooking chemicals are selective in their attack on wood constituents, the pulps produced are notably stronger than those from other processes (i.e., Kraft is German for "strength"). The kraft process is also flexible, in so far as it is amenable to many different types of raw materials (i.e., hard or soft woods) and can tolerate contaminants frequently found in wood (e.g., resins). Lignin removal is high in the kraft process, up to 90 percent- allowing high levels of bleaching without pulp degradation due to delignification (see **Pulp Bleaching**). Finally, the chemicals used in kraft pulping are readily recovered within the process, making it very economical and reducing potential environmental releases (See *Chemical Recovery Systems* below).

The kraft process uses a sodium-based alkaline pulping solution (liquor) consisting of sodium sulfide (Na_2S) and sodium hydroxide (NaOH) in 10 percent solution. This liquor (white liquor) is mixed with the wood chips in a reaction vessel (digester). The output products are separated wood fibers (pulp) and a liquid that contains the dissolved lignin solids in a solution of reacted and unreacted pulping chemicals (black liquor). The black liquor undergoes a chemical recovery process (see *Chemical Recovery Systems*) to regenerate white liquor for the first pulping step. Overall, the kraft process converts approximately 50 percent of input furnish into pulp.

The kraft process evolved from the soda process. The soda process uses an alkaline liquor of only sodium hydroxide (NaOH). The kraft process has virtually replaced the soda process due to the economic benefits of chemical recovery and improved reaction rates (the soda process has a lower yield of pulp per pound of wood furnish than the kraft process).

Sulfite pulping was used for approximately 4 percent of U.S. pulp production in 1993 (AF&PA). Softwood is the predominant furnish used in sulfite pulping processes. However, only non-resinous species are generally pulped. The sulfite pulping process relies on acid solutions of sulfurous acid (H_2SO_3) and bisulfite ion (HSO_3^-) to degrade the lignin bonds between wood fibers.

Sulfite pulps have less color than kraft pulps and can be bleached more easily, but are not as strong. The efficiency and effectiveness of the sulfite process is also dependent on the type of wood furnish and the absence of bark. For these reasons, the use of sulfite pulping has declined in comparison to kraft pulping over time.

Semi-chemical pulping

Semi-chemical pulping comprised 6 percent of U.S. pulp production in 1993 (AF&PA). Semi-chemical pulp is often very stiff, making this process common in corrugated container manufacture. This process primarily uses hardwood as furnish.

The semi-chemical process involves partial digestion of furnish in a weak chemical solution followed by mechanical refining for fiber separation. At most, the digestion step in the semi-chemical pulping process consists of heating pulp in sodium sulfite (Na_2SO_3) and sodium carbonate (Na_2CO_3) Other semi-chemical processes include the Permachem process and the two-stage vapor process. The yield of semi-chemical pulping ranges from 55 to 90 percent, depending on the process used, but pulp residual lignin content is also high so bleaching is more difficult.

Mechanical pulping

Mechanical pulping accounted for 10 percent of U.S. pulp production in 1993 (AF&PA). Mechanically produced pulp is of low strength and quality. Such pulps are used principally for newsprint and other non-permanent paper goods. Mechanical pulping uses physical pressure instead of chemicals to separate furnish fibers. Processes include: 1) stone groundwood, 2) refiner mechanical, 3) thermo-mechanical, 4) chemi-mechanical, and 5) chemi-thermo-mechanical. Pulp yields are high, up to 95 percent when compared to chemical pulping yields of 45- 50 percent, but energy usage is also high. To offset its weakness, mechanical pulp is often blended with chemical pulp.

Secondary fiber pulping

Secondary fiber pulping accounted for approximately 30 percent of domestic pulp production in 1992 (AF&PA). More than 200 mills rely exclusively on recovered paper for pulp furnish.[18] In addition, consumption of fiber from recovered paper is growing more than twice as fast as overall fiber consumption. Secondary fibers are usually presorted before they are sold to a pulp and paper mill. If not, secondary fibers are processed to remove contaminants before pulping occurs. According to the USEPA 1990 National Census of Pulp, Paper, and Paperboard Manufacturing Facilities, approximately 70 percent of all pulp and paper mills process secondary fiber at their facilities in some way. Common contaminants consist of adhesives, coatings, polystyrene foam, dense plastic chips, polyethylene films, wet strength resins, and synthetic fibers. In some cases, contaminants of greater density than the desired secondary fiber are removed by centrifugal force while light contaminants are removed by flotation systems. Centri cleaners are also used to remove material less dense than fibers (wax and plastic particles).[19]

Inks, another contaminant of secondary fibers, may be removed by heating a mixture of secondary fibers with surfactants. The removed inks are then dispersed in an aqueous media to prevent redeposition on the fibers. Continuous solvent extraction has also been used to recover fibers from paper and board coated with plastics and/or waxes. Only 8 percent of U.S. mills engaged in deinking of secondary fibers as of 1993. Deinking capacity is rapidly increasing, however. There are currently 83 recovered paper deinking facilities in operation in the U.S. with another 44 planned for construction or start-up between 1995 and 1997.[20]

Secondary fiber pulping is a relatively simple process. The most common pulper design consists of a large container filled with water, which is sometimes heated, and the recycled pulp. Pulping chemicals (e.g., sodium hydroxide, NaOH) are often added to promote dissolution of the paper or board matrix. The source fiber (corrugated containers, mill waste, etc.) is dropped into the pulper and mixed by a rotor. Debris and impurities are removed by two mechanisms: a ragger and a junker. The ragger withdraws strings, wires, and rags from the stock secondary fiber mixture. A typical ragger consists of a few "primer wires" that are rotated in the secondary fiber slurry. Debris accumulates on the primer wires, eventually forming a "debris rope" which is then removed. Heavier debris are separated from the mixture by centrifugal force and fall into a pocket on the side of the pulper. The junker consists of a grappling hook or elevator bucket. Heat, dissolution of chemical bonds, shear forces created by stirring and mixing, and grinding by mechanical equipment may serve to dissociate fibers and produce a pulp of desired consistency in various pulping machinery.

Contaminant removal processes depend on the type and source of secondary fiber to be pulped. Mill paper waste can be easily repulped with minimal contaminant removal. Recycled post-consumer newspaper, on the other hand, may require extensive contaminant removal, including deinking, prior to reuse. Overall, the quality of secondary fiber strongly affects the quality of the paper products. As noted in *Furnish Composition*, above, approximately 75 percent of all secondary fiber in North America is presently used for multi-ply paperboard or the corrugating paper used to manufacture corrugated cardboard. Over the next decade, an increasing proportion of the total amount will be deinked for newsprint or other higher-quality uses.

III.A.2. Pulp Processing

After pulp production, pulp processing removes impurities, such as uncooked chips, and recycles any residual cooking liquor via the washing process (Exhibit 10). Pulps are processed in a wide variety of ways, depending on the method that generated them (e.g., chemical, semi-chemical). Some pulp processing steps that remove pulp impurities include screening, defibering, and deknotting. Pulp may also be thickened by removing a portion of the water. At additional cost, pulp may be blended to insure product uniformity. If pulp is to be stored for long periods of time, drying steps are necessary to prevent fungal or bacterial growth.

Residual spent cooking liquor from chemical pulping is washed from the pulp using brown stock washers. Efficient washing is critical to maximize return of cooking liquor to chemical recovery (See *Chemical Recovery Systems* below) and to minimize carryover of cooking liquor (known as brown stock washing loss) into the bleach plant, because excess cooking liquor increases consumption of bleaching chemicals. Specifically, the dissolved organic compounds (lignins and hemicelluloses) contained in the liquor will bind to bleaching chemicals and thus increase bleach chemical consumption. In addition, these organic compounds function as precursors to chlorinated organic compounds (e.g., dioxins, furans), increasing the probability of their formation. The most common washing technology is rotary vacuum washing, carried out sequentially in two or four washing units. Other washing technologies include diffusion washers, rotary pressure washers, horizontal belt filters, wash presses, and dilution/extraction washers.

Pulp screening, removes remaining oversized particles such as bark fragments, oversized chips, and uncooked chips. In *open* screen rooms, wastewater from the screening process goes to wastewater treatment prior to discharge. In *closed loop* screen rooms, wastewater from the process is reused in other pulping operations and ultimately enters the mill's chemical recovery system. Centrifugal cleaning (also known as liquid cyclone, hydrocyclone, or centricleaning) is used after screening to remove relatively dense contaminants such as sand and dirt. Rejects from the screening process are either repulped or disposed of as solid waste.

Chemical Recovery Systems

The chemical recovery system is a complex part of a chemical pulp and paper mill and is subject to a variety of environmental regulations. Chemical recovery is a crucial component of the chemical pulping process: it recovers process chemicals from the spent cooking liquor for reuse. The chemical recovery process has important financial and environmental benefits for pulp and paper mills. Economic benefits include savings on chemical purchase costs due to regeneration rates of process chemicals approaching 98 percent, and energy generation from pulp residue burned in a recovery furnace.[21] Environmental benefits include the recycle of process chemicals and lack of resultant discharges to the environment.

Both kraft and sulfite chemical pulping processes use chemical recovery systems, although the actual chemical processes at work differ markedly. Due to its widespread usage, only the kraft chemical recovery system will be covered in depth in this document. Sulfite chemical recovery systems are discussed briefly at the end of this section.

Kraft Chemical Recovery Systems

The kraft chemical recovery process has not been fundamentally changed since its patent issue in 1884, but has been refined into a stepwise progression of chemical reactions. New technologies are under development, however, as two black liquor gasification processes (Chemtrec and MTCI) were brought to the pilot stage at pulp mill sites in 1991.

The precise details of the chemical processes at work in the chemical recovery process can be found in Smook, *Handbook for Pulp and Paper Technologists,* 2nd Edition, 1992 and will not be discussed here. The kraft chemical recovery process consists of the following general steps:

<u>Black liquor concentration</u>

Residual weak black liquor from the pulping process is concentrated by evaporation to form "strong black liquor." After brown stock washing (See *Pulp Processing*) in the pulping process the concentration of solids in the weak black liquor is approximately 15 percent; after the evaporation process, solids concentration can range from 60 - 80 percent. In some older facilities, the liquor then undergoes oxidation for odor reduction. The oxidation step is necessary to reduce odor created when hydrogen sulfide is stripped from the liquor during the subsequent recovery boiler burning process. Almost all recovery furnaces installed since 1968 have non-contact evaporation processes that avoid these problems, however, so oxidation processes are not usually seen in newer mills. Common modern evaporator types include multiple effect evaporators as well as a variety of supplemental evaporators. Odor problems with the kraft process have been the subject of control measures (See Section II.B. Raw Material Inputs and Pollution Outputs in the Production Line for more information).

<u>Recovery boiler</u>

The strong black liquor from the evaporators is burned in a recovery boiler. In this crucial step in the overall kraft chemical recovery process, organic solids are burned for energy and the process chemicals are removed from the mixture in molten form. Molten inorganic process chemicals (smelt) flow through the perforated floor of the boiler to water-cooled spouts and dissolving tanks for recovery in the recausticizing step.

Energy generation from the recovery boiler is often insufficient for total plant needs, however, so facilities augment recovery boilers with fossil-fuel-fired and wood-waste-fired boilers (hogged fuel) to generate steam and often electricity. Industry-wide, the utilization of pulp wastes, bark, and other papermaking residues supplies 56 percent of the energy requirements of pulp and paper companies.[22] (See III.A.3. Energy Generation for more information).

Recausticizating

Smelt is recausticized to remove impurities left over from the furnace and to convert sodium carbonate (Na_2CO_3) into active sodium hydroxide (NaOH) and sodium sulfide (Na_2S). The recausticization procedure begins with the mixing of smelt with "weak" liquor to form green liquor, named for its characteristic color. Contaminant solids, called dregs, are removed from the green liquor, which is mixed with lime (CaO). After the lime mixing step, the mixture, now called white liquor due to its new coloring, is processed to remove a layer of lime mud ($CaCO_3$) that has precipitated. The primary chemicals recovered are caustic (NaOH) and sodium sulfide (Na_2S). The remaining white liquor is then used in the pulp cooking process. The lime mud is treated to regenerate lime in the calcining process.

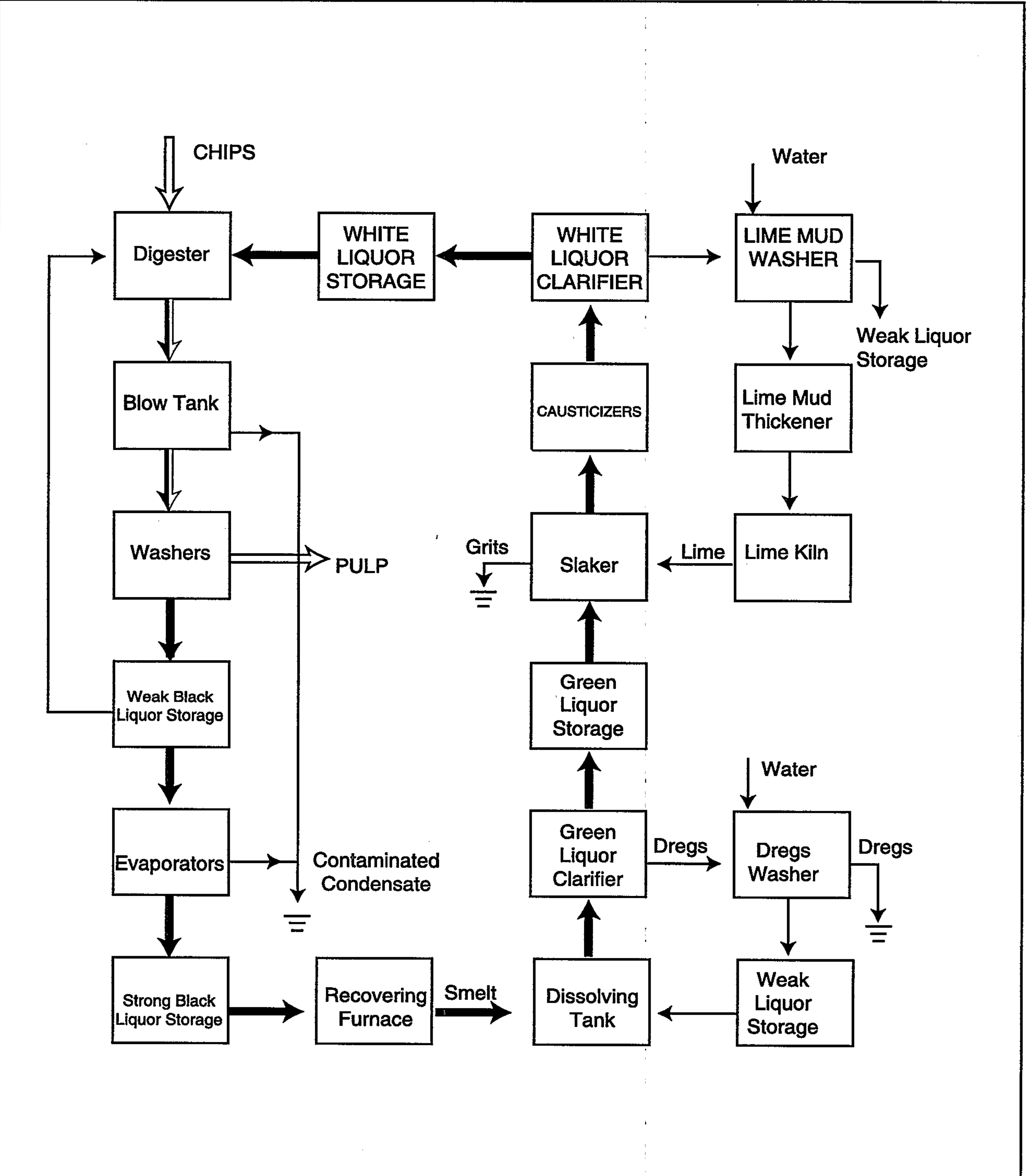
Calcining

In the calcining process, the lime mud removed from the white liquor is burned to regenerate lime for use in the lime mixing step. The vast majority of mills use lime kilns for this process, although a few mills now use newer fluidized bed systems.

Sulfite Chemical Recovery Systems

There are a variety of sulfite chemical pulping recovery systems in use today. Heat and sulfur can be recovered from all liquors generated, however the base chemical can only be recovered from magnesium and sodium base processes (See Smook, 1992 for more information).

Exhibit 10: The Kraft Pulping Process (with chemical recovery)



(Source: Smook, G.A. *Handbook for Pulp & Paper Technologists*. Second Edition. Vancouver: Angus Wilde Publications, 1992.)

III.A.3. Bleaching

Bleaching is defined as any process that chemically alters pulp to increase its brightness. Bleached pulps create papers that are whiter, brighter, softer, and more absorbent than unbleached pulps. Bleached pulps are used for products where high purity is required and yellowing (or color reversion) is not desired (e.g. printing and wrapping papers, food contact papers). Unbleached pulp is typically used to produce boxboard, linerboard, and grocery bags. Of the approximately 72 million tons of pulp (including recycled pulp) used in paper production in the United States in 1993, approximately 50 percent percent was bleached in some fashion.[23]

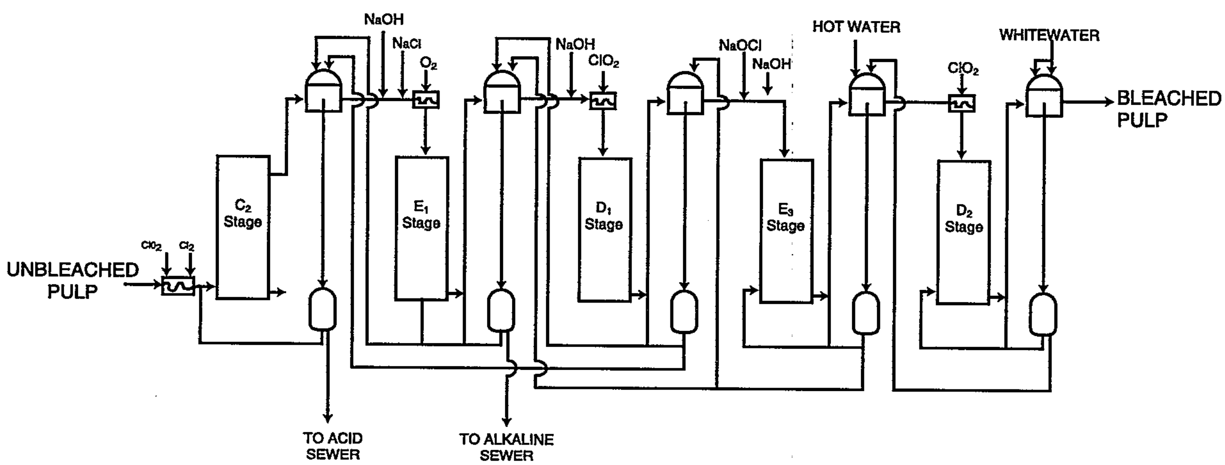
Any type of pulp may be bleached, but the type(s) of fiber furnish and pulping processes used, as well as the desired qualities and end use of the final product, greatly affect the type and degree of pulp bleaching possible. Printing and writing papers comprise approximately 60 percent of bleached paper production. The lignin content of a pulp is the major determinant of its bleaching potential. Pulps with high lignin content (e.g., mechanical or semi-chemical) are difficult to bleach fully and require heavy chemical inputs. Excessive bleaching of mechanical and semi-chemical pulps results in loss of pulp yield due to fiber destruction. Chemical pulps can be bleached to a greater extent due to their low (10 percent) lignin content.

For more information, the *Summary of Technologies for the Control and Reduction of Chlorinated Organics from the Bleached Chemical Pulping Subcategories of the Pulp and Paper Industry*, 1990 from the Office of Water Regulations and Standards is recommended. Typical bleaching processes for each pulp type are detailed below.

Chemical pulps are bleached in traditional bleach plants (see Exhibit 11) where the pulp is processed through three to five stages of chemical bleaching and water washing. The number of cycles is dependent on the whiteness desired, the brightness of initial stock pulp, and plant design.

Bleaching stages generally alternate between acid and alkaline conditions. Chemical reactions with lignin during the acid stage of the bleaching process increase the whiteness of the pulp. The alkaline extraction stages dissolve the lignin/acid reaction products. At the washing stage, both solutions and reaction products are removed. Chemicals used to perform the bleaching process must have high lignin reactivity and selectivity to be efficient. Typically, 4-8 percent percent of pulp is lost due to bleaching agent reactions with the wood constituents cellulose and hemicellulose, but, these losses can be as high as 18 percent.

Exhibit 11: Typical Bleach Plant



(Source: U.S. EPA, Development Document for Proposed Effluent Limitations Guidelines and Standards for the Pulp, Paper, and Paperboard Point Source Category. October 1993.)

The most common chemicals used in the bleaching process are sodium hydroxide, elemental chlorine, and chlorine dioxide. The use of chlorine dioxide in the bleach process has steadily increased relative to molecular chlorine usage due to its reduction in the formation of chlorinated organics in bleach plant effluent and lower bleach plant chemical consumption. Common bleaching chemicals are presented below along with the approximate percentage of mills using them, their chemical formulae, and bleach chemical code letter:

Exhibit 12: Common Chemicals Used in Bleaching Process

Bleaching Chemical	Approximate % of Mills[a]	Chemical Formula	Code Letter
Sodium Hydroxide	100%	$NaOH$	E
Elemental Chlorine	99%	Cl_2	C
Chlorine Dioxide	89%	ClO_2	D
Hypochlorite	69%	$HClO$, $NaOCl$, $Ca(OCl)_2$	H
Oxygen	64%	O_2	O
Hydrogen Peroxide	43%	H_2O_2	P
Sulfur Dioxide	10%	SO_2	S
Sulfuric Acid	9%	H_2SO_4	A

[a]Approximate percentage of total number of papergrade kraft, soda, and dissolving soda mills that bleach chemical wood pulp in traditional bleach plants; not based on amount of pulp bleached by mills.

Source: USEPA. *1990 National Census of Pulp, Paper, and Paperboard Manufacturing Facilities.* 1990.

Bleaching process descriptions commonly refer to chemical reaction stages by their chemical code letter. The following table represents the most common bleaching sequences used in the U.S. and Canada in 1991.

Exhibit 13: Bleaching Sequences	
Sequence	**Percent of Mills**
C-E-D-E-D	38%
C-E-H-E-D	19%
C-E-H-D-E-D	13%
C-E-H, C-E-H-P	8%
Other (e.g., chlorine dioxide first stage)	22%

Source: *Multimedia Analysis of Alternative Pulp and Paper Technologies*, 1991.

The production of chlorinated pollutants such as dioxin as well as production of chloroform results from the bleaching of pulps with chlorine and chlorine derivatives. A variety of bleaching processes have been developed which may be chlorine free, where bleaching chemicals such as ozone (Z), oxygen (O), and peroxide (P), replace chlorine and chlorine derivatives. Currently, at least one U.S. mill uses ozone in its bleaching process and others are installing or actively considering ozone bleaching. Overall, there has been a recent major trend in the industry toward reductions in both the types and amount of chlorine and chlorine-containing chemicals used for pulp bleaching, such that the data presented in the above table may not fully represent the distribution of bleaching processes currently in use by the industry. Some changes include: in 1994 chlorine dioxide usage (in tons) was, for the first time, greater than elemental chlorine usage in the bleach process,[24] use of hypochlorite has diminished in response to concerns about chloroform emissions, chlorine injection process modifications have been made, and significant efforts have been made to improve delignification to minimize dioxin formation while reducing bleach chemical usage. Some of these delignification technologies include extended delignification during kraft pulping, solvent pulping, and pulping in the presence of the catalyst anthraquinone. Oxygen delignification is also used as a post-pulping method of increasing delignification. These processes can be more costly, lead to reduced pulp yield and strength, and be potential sources of other pollutants. Some positive aspects of these processes may include: lower bleach chemical costs, lower energy consumption, reduced toxicity, reduced color, and reduced BOD. Totally chlorine-free (TCF) bleaching of selected market grades of sulfite and kraft pulps has been demonstrated in Europe, but, as of October 1993, no commercial production of market grade high brightness softwood kraft pulps had been demonstrated in the United States. As of 1994, one mill has implemented a TCF process to produce mid to high brightness pulps. It should be noted, based on American Forest and Paper Association data, that 9 out of 10 pulp and paper mills currently in operation have non-detectable levels of dioxin in effluent.

Semi-chemical pulps are typically bleached with hydrogen peroxide (H_2O_2) in a bleach tower.

Mechanical pulps are bleached with hydrogen peroxide (H_2O_2) and/or sodium hydrosulfite (Na_2SO_3). Bleaching chemicals are either applied without separate equipment during the pulp processing stage (i.e., in-line bleaching), or in bleaching towers. Full bleaching of mechanical pulps is generally not practical due to bleaching chemical cost and the negative impact on pulp yield.

Deinked secondary fibers are usually bleached in a bleach tower, but may be bleached during the repulping process. Bleach chemicals may be added directly into the pulper. The following are examples of chemicals used to bleach deinked secondary fibers: hypochlorite ($HClO$, $NaOCl$, $Ca(OCl)_2$), hydrogen peroxide (H_2O_2), and hydrosulphite ($Na_2S_2O_4$).

III.A.4. Stock Preparation

At this final stage, the pulp is processed into the stock used for paper manufacture. Market pulp, which is to be shipped off-site to paper or paperboard mills, is processed little, if at all at this stage. Processing includes pulp blending specific to the desired paper product desired, dispersion in water, beating and refining to add density and strength, and addition of any necessary wet additives. Wet additives are used to create paper products with special properties or to facilitate the papermaking process. Wet additives include resins and waxes for water repellency, fillers such as clays, silicas, talc, inorganic/organic dyes for coloring, and certain inorganic chemicals (calcium sulfate, zinc sulfide, and titanium dioxide) for improved texture, print quality, opacity, and brightness.

III.A.5. Processes in Paper Manufacture

The paper and paperboard making process consists of the following general steps:

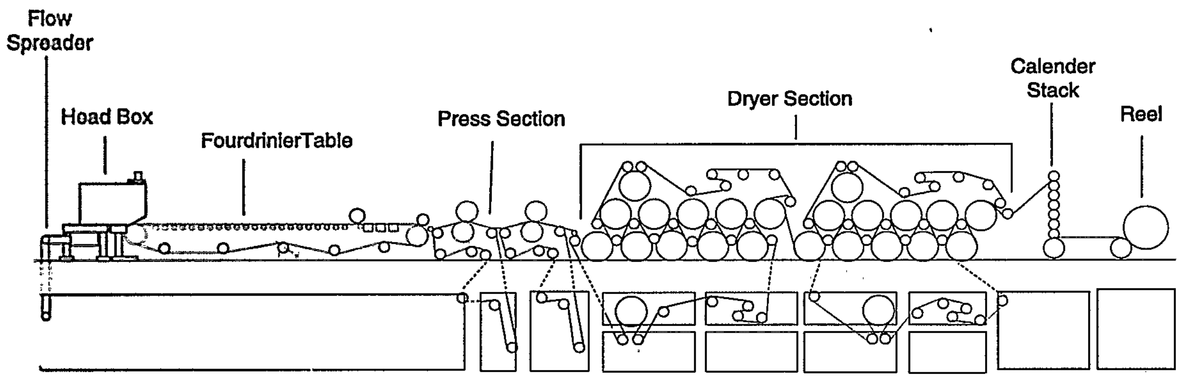
Exhibit 14: Paper and Paperboard Making Process

Sequential Process	Description
Wet End Operations	Formation of paper sheet from wet pulp
Dry End Operations	Drying of paper product, application of surface treatments, spooling for storage

Wet End Operations

The processed pulp is converted into a paper product via a paper production machine, the most common of which is the Fourdrinier paper machine (see Exhibit 15). In the Fourdrinier system, the pulp slurry is deposited on a moving wire belt that carries it through the first stages of the process. Water is removed by gravity, vacuum chambers, and vacuum rolls. This waste water is recycled to the slurry deposition step of the process due to its high fiber content. The continuous sheet is then pressed between a series of rollers to remove more water and compress the fibers.

Exhibit 15: Fourdrinier Paper Machine



(Source: U.S. EPA, *Development Document for Proposed Effluent Limitations Guidelines and Standards for the Pulp, Paper and Paperboard Point Source Category*. October 1993.)

Dry End Operations

After pressing, the sheet enters a drying section, where the paper fibers begin to bond together as steam heated rollers compress the sheets. In the calender process the sheet is pressed between heavy rolls to reduce paper thickness and produce a smooth surface. Coatings can be applied to the paper at this point to improve gloss, color, printing detail, and brilliance. Lighter coatings are applied on-machine, while heavy coatings are performed off-machine. The paper product is then spooled for storage.

III.A.6. Energy Generation

Pulp and paper mill energy generation is provided in part from the burning of liquor waste solids in the recovery boiler, but other energy sources are needed to make up the remainder of mill energy needs. Over the last decade the pulp and paper industry has changed its energy generation methods from fossil fuels to a greater utilization of processes or process wastes. The increase in use of wood wastes from the wood handling and chipping processes depicted in Exhibit 16 below is one example of this industry-wide movement. During the 1972-1990 period, the proportion of total industry power generation from the combination of woodroom wastes, spent liquor solids, and other self-generation methods increased by approximately 15 percent, while fuel oil and natural gas use decreased 20 percent. Increases in purchased steam and coal use, made up the difference.

Power boilers at pulp and paper mills are sources of particulate emissions, SO_2, and NO_x. Pollutants emitted from chemical recovery boilers include SO_2, and total reduced sulfur compounds (TRS).

Exhibit 16: Estimated Energy Sources for the U.S. Pulp and Paper Industry, 1972, 1979, 1990 by percentages

Energy source	*1972*	*1979*	*1990*
Purchased steam	5.4	6.7	7.3
Coal	9.8	9.1	13.7
Fuel oil	22.3	19.1	6.4
Natural gas	21.5	17.8	16.4
Waste wood and wood chips (Hogged fuel) and bark	6.6	9.2	15.4
Spent liquor solids	33.7	37.3	39.4
Self-generated power	0.6	0.8	1.2

Source: American Paper Institute Data as presented in Smook, G.A. *Handbook for Pulp & Paper Technologists*. Second edition. Vancouver: Angus Wilde Publications, 1992.

III.B. Raw Material Inputs and Pollution Outputs in the Production Line

Pulp and paper mills use and generate materials that may be harmful to the air, water, and land: pulp and paper processes generate large volumes of wastewaters which might adversely affect freshwater or marine ecosystems, residual wastes from wastewater treatment processes may contribute to existing local and regional disposal problems, and air emissions from pulping processes and power generation facilities may release odors, particulates, or other pollutants. Major sources of pollutant releases in pulp and paper manufacture are at the pulping and bleaching stages respectively. As such, non-integrated mills (i.e., those mills without pulping facilities on-site) are not significant environmental concerns when compared to integrated mills or pulp mills.

Water

The pulp and paper industry is the largest industrial process water user in the U.S.[25] In 1988, a typical pulp and paper mill used 16,000 to 17,000 gallons of water per ton of pulp produced.[26] General water pollution concerns for pulp and paper mills are effluent solids, biochemical oxygen demand, toxicity, and color. Toxicity concerns arise from the presence of chlorinated organic compounds such as dioxins, furans, and others (collectively referred to as adsorbable organic halides, or AOX) in wastewaters after the chlorination/extraction sequence.

Due to the large volumes of water used in pulp and paper processes, virtually all U.S. mills have primary and secondary wastewater treatment systems installed to remove particulate and biochemical oxygen demand (BOD) produced in the manufacturing processes. These systems also provide significant removals (e.g., 30-70 percent) of other important parameters such as adsorbable organic halides (AOX) and chemical oxygen demand (COD).

The major sources of effluent pollution in a pulp and paper mill are presented in Exhibit 17.

Exhibit 17: Common Water Pollutants From Pulp and Paper Processes

Source	*Effluent characteristics*
Water used in wood handling/debarking and chip washing	Solids, BOD, color
Chip digester and liquor evaporator condensate	Concentrated BOD, can contain reduced sulfur
"White waters" from pulp screening, thickening, and cleaning	Large volume of water with suspended solids, can have significant BOD
Bleach plant washer filtrates	BOD, color, chlorinated organic compounds
Paper machinewater flows	Solids, often precipitated for reuse
Fiber and liquor spills	Solids, BOD, color

Source: Smook, G.A. *Handbook for Pulp & Paper Technologists*. Second edition. Vancouver: Angus Wilde Publications, 1992.

Screening and cleaning operations during the pulp processing stage are usually sources of large volumes of wastewaters. This effluent stream, called white water due to its characteristic color, can contain significant BOD if washing efficiency is low and is always a source of suspended solids from wood particles. Similar white water wastes are also produced during the papermaking process. White waters can be reused to dilute furnish mixtures or the solids can be collected for reuse. Fiber and liquor spills can also be a source of mill effluent. Typically, spills are captured and pumped to holding areas to reduce chemical usage through spill reuse and to avoid loadings on facility wastewater treatment systems. Separate pump systems recycle recoverable materials into the process cycle. The condensates from chip digesters and chemical recovery evaporators are a low-volume, but high BOD effluent source. Some of these condensates contain reduced sulfur compounds.

Wastewater treatment systems can be a significant source of cross-media pollutant transfer. For example, waterborne particulate and some chlorinated compounds settle or absorb onto treatment sludge and other compounds may volatilize during the wastewater treatment process.

Air

The following table is an overview of the major types and sources of air pollutant releases from various pulp and paper processes:

Exhibit 18: Common Air Pollutants From Pulp and Paper Processes

Source	*Type*
Kraft recovery furnace	Fine particulates
Fly ash from hog fuel and coal-fired burners	Course particulates
Sulfite mill operations	Sulfur oxides
Kraft pulping and recovery processes	Reduced sulfur gasses
Chip digesters and liquor evaporation	Volatile organic compounds
All combustion processes	Nitrogen oxides

Source: Smook, G.A. *Handbook for Pulp & Paper Technologists*. Second edition. Vancouver: Angus Wilde Publications, 1992.

Water vapors are the most visible air emission from a pulp and paper mill, but are not usually regulated unless they are a significant obscurement or climate modifier.

Pulp and paper mill power boilers and chip digesters are generic pulp and paper mill sources of air pollutants such as particulates and nitrogen oxides. Chip digesters and chemical recovery evaporators are the most concentrated sources of volatile organic compounds. The chemical recovery furnace is a source of fine particulate emissions and sulfur oxides. In the kraft process, sulfur oxides are a minor issue in comparison to the odor problems created by four reduced sulfur gasses, called together total reduced sulfur (TRS): hydrogen sulfide, methyl mercaptan, dimethyl sulfide, and dimethyl disulfide. The TRS emissions are primarily released from wood chip digestion, black liquor evaporation, and chemical recovery boiler processes. TRS compounds create odor nuisance problems at lower concentrations than sulfur oxides: odor thresholds for TRS compounds are approximately 1000 times lower than that for sulfur dioxide. Humans can detect some TRS compounds in the air as a "rotten egg" odor at as little as 1 ppb.

Pulp and paper mills have made significant investments in pollution control technologies and processes. According to industry sources, the pulp and paper industry spent more than $1billion per year from 1991-1994 on environmental capital expenditures. In 1991 and 1992, this represented 20 percent of total capital expenditures.[27] Chemical recovery and recycling systems in the chemical pulping process significantly reduce pollutant outputs while providing substantial economic return due to recovery of process chemicals. Chemical recovery is necessary for the basic economic viability of the kraft process. According to EPA sources, all kraft pulp mills worldwide have chemical recovery systems in place. Some sulfite mills, however, still do not have recovery systems in place. Scrubber system particulate "baghouses" or electrostatic precipitators (ESPs) are are often mill air pollution control components.

Residual Wastes

The significant residual waste streams from pulp and paper mills include bark, wastewater treatment sludges, lime mud, lime slaker grits, green liquor dregs, boiler and furnace ash, scrubber sludges, and wood processing residuals. Because of the tendency for chlorinated organic compounds (including dioxins) to partition from effluent to solids, wastewater treatment sludge has generated the most significant environmental concerns for the pulp and paper industry. To a lesser extent, concern has also been raised over whether chlorinated organics are partitioned into pulp products, a large portion of which become a post-consumer residual waste.

With the exception of bark, wastewater treatment sludge is the largest volume residual waste stream generated by the pulp and paper industry. Sludge generation rates vary widely among mills. For example, bleached kraft mills surveyed as part of EPA's 104-Mill Study reported sludge generation that ranged from 14 to 140 kg sludge per ton pulp.[28] Total sludge generation for these 104 mills was 2.5 million dry metric tons per year, or an average of approximately 26,000 dry metric tons per year per plant. Pulpmaking operations are responsible for the bulk of sludge wastes, although treatment of papermaking effluents also generates significant sludge volumes. For the majority of pulp and integrated mills that operate their own wastewater treatment systems, sludges are generated onsite. A small number of pulp mills, and a much larger proportion of papermaking establishments, discharge effluents to publicly-owned wastewater treatment works (POTWs).

Potential environmental hazards from wastewater sludges are associated with trace constituents (e.g., chlorinated organic compounds) that partition from the effluent into the sludge. The 1988 results of the "104-Mill Study" showed that dioxins and furans were present in bleached pulp mill sludges, resulting in calls to regulate both landfill disposal and land application of such sludges (See Federal Regulations section). Landfill and surface impoundment disposal are most often used for wastewater treatment sludge; in 1988 only eleven of 104 bleached kraft mills disposed of any sludge through land application or conversion to sludge-derived products (e.g., compost, animal bedding).

Process Inputs and Pollutant Outputs

Kraft chemical pulping and traditional chlorine-based bleaching are both commonly used and may generate significant pollutant outputs. Kraft pulping processes produced approximately 80 percent of total US pulp tonnage during 1993 according to the American Forest and Paper Association (AF&PA) and other industry sources. While the use of traditional chlorine bleaching is in decline, a significant proportion of kraft mills currently use the process.

Pollutant outputs from mechanical, semi-chemical, and secondary fiber pulping are small when compared to kraft chemical pulping. In the pulp and paper industry, the kraft pulping process is the most significant source of air pollutants. Pollutant outputs from chlorine bleaching, the chlorinated by-products chloroform and dioxin, are particular problems due to their persistence, non-biodegradability, and toxicity. The following table (Exhibit 19) and Exhibits illustrate the process inputs and pollutant outputs for a pulp and paper mill using kraft chemical pulping and traditional chlorine-based bleaching. Currently, extensive chlorine dioxide substitution is practiced in many bleaching processes in place of traditional chlorine bleaching. The process outlined below produces a large portion of U.S. pulp.

Exhibit 19 presents the process steps, material inputs, and major pollutant outputs (by media) of a kraft pulp mill practicing traditional chlorine bleaching. The following resources are recommended for pollutant production data (e.g., pounds of BOD per ton of pulp produced) for those pollutants presented in Exhibit 19:

- *Pollution Prevention Technologies for the Bleached Kraft Segment of the U.S. Pulp and Paper Industry.* August 1993. (EPA-600-R-93-110)
- *Development Document for Proposed Effluent Limitations Guidelines and standards for the Pulp, Paper, and Paperboard Point Source Category.* October 1993. (EPA-821-R-93-019)

- *Pulp, Paper and Paperboard Industry - Background Information for Proposed Air Emission Standards: Manufacturing Processes at Kraft, Sulfite, Soda, and Semi-Chemical Mills, NESHAP.* October 1993. (EPA-453-R-93-050a)

Exhibit 20 is a process flow diagram of the kraft process, illustrating chemical pulping, power recovery, and chemical recovery process inputs and outputs. Exhibit 21 is a schematic of characteristic air emission sources from a kraft mill.

Exhibit 19: Kraft Chemical Pulped-Chlorine Bleached Paper Production

Process Step	Material Inputs	Process Outputs	Major Pollutant Outputs*	Pollutant Media
Fiber Furnish Preparation	Wood logs Chips Sawdust	Furnish chips	dirt, grit, fiber, bark	Solid
			BOD	Water
			TSS	
Chemical Pulping Kraft process	Furnish chips	Black liquor (to chemical recovery system), pulp (to bleaching/processing)	resins, fatty acids	Solid
			color	Water
			BOD	
			COD	
			AOX	
			VOCs (terpenes, alcohols, phenols, methanol, acetone, chloroform, MEK)	
			VOCs (terpenes, alcohols, phenols, methanol, acetone, chloroform, MEK)	Air
	Cooking chemicals: sodium sulfide (Na_2S), NaOH, white liquor (from chemical recovery)		reduced sulfur compounds (TRS)	
			organo-chlorine compounds (e.g., 3,4,5- trichloroguaiacol)	

Exhibit 19: Kraft Chemical Pulped-Chlorine Bleached Paper Production

Process Step	Material Inputs	Process Outputs	Major Pollutant Outputs*	Pollutant Media
Bleaching	Chemical pulp	Bleached pulp	dissolved lignin and carbohydrates	Water
			color	
			COD	
			AOX	
			inorganic chlorine compounds (e.g., chlorate (ClO_3^-))[1]	
	Elemental chlorine (Cl_2), chlorine containing compounds		organo-chlorine compounds (e.g., dioxins, furans, chlorophenols)	
	Hypochlorite (HClO, NaOCl, $Ca(OCl)_2$) Chlorine dioxide (ClO_2)		VOCs (acetone, methylene chloride, chloroform, MEK, carbon disulfide, chloromethane, trichloroethane)	Air / Water
Papermaking	Additives, Bleached/ Unbleached pulp	Paper/paperboard product	particulate wastes	Water
			organic compounds	
			inorganic dyes	
			COD	
			acetone	
Wastewater Treatment Facilities	Process wastewaters	Treated effluent	sludge	Solid
			VOCs (terpenes, alcohols, phenols, methanol, acetone, chloroform, MEK)	Air
			BOD	Water
			TSS	
			COD	
			color	
			chlorophenolics	
			carbon disulfide	
			VOCs (terpenes, alcohols, phenols, methanol, acetone, chloroform, MEK)	

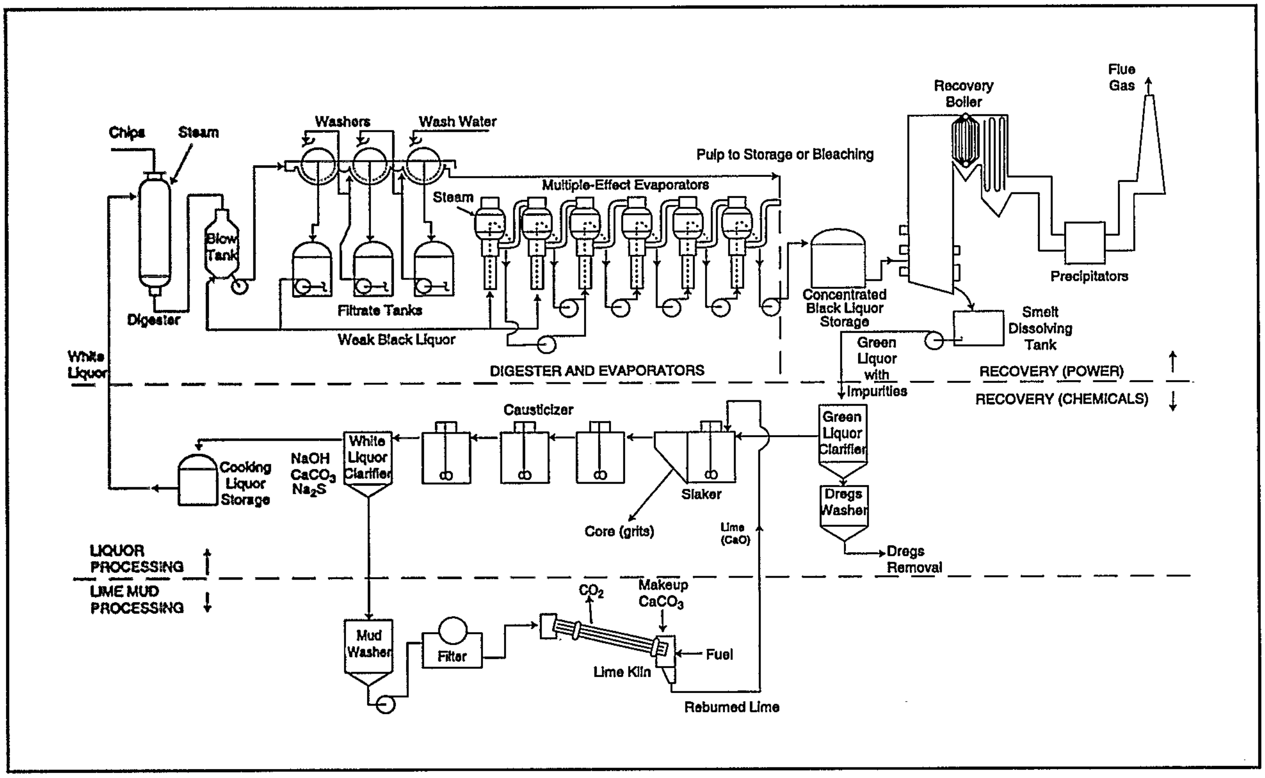
Exhibit 19: Kraft Chemical Pulped-Chlorine Bleached Paper Production

Process Step	Material Inputs	Process Outputs	Major Pollutant Outputs*	Pollutant Media
Power Boiler	Coal, Wood, Unused furnish	Energy	bottom ash: incombustible fibers	Solid
			SO_2, NO_x, fly ash, coarse particulates	Air
Chemical Recovery System				
Evaporators	Black liquor	Strong black liquor	evaporator noncondensibles (TRS, volatile organic compounds: alcohols, terpenes, phenols)	Air
			evaporator condensates (BOD, suspended solids)	Water
Recovery Furnace	Strong black liquor	Smelt	fine particulates, TRS, sulfur dioxide	Air
		Energy		
Recausticizing	Smelt	Regenerated white liquor	dregs	Solids
		Lime mud	waste mud solids	Water
Calcining (Lime Kiln)	Lime mud	Lime	fine and coarse particulates	Air

* Pollutant outputs may differ significantly based on mill processes and material inputs (e.g., wood chip resin content).
[1] Chlorate only significantly produced in mills with high rates of chlorine dioxide substitution to reduce dioxin and furan production.

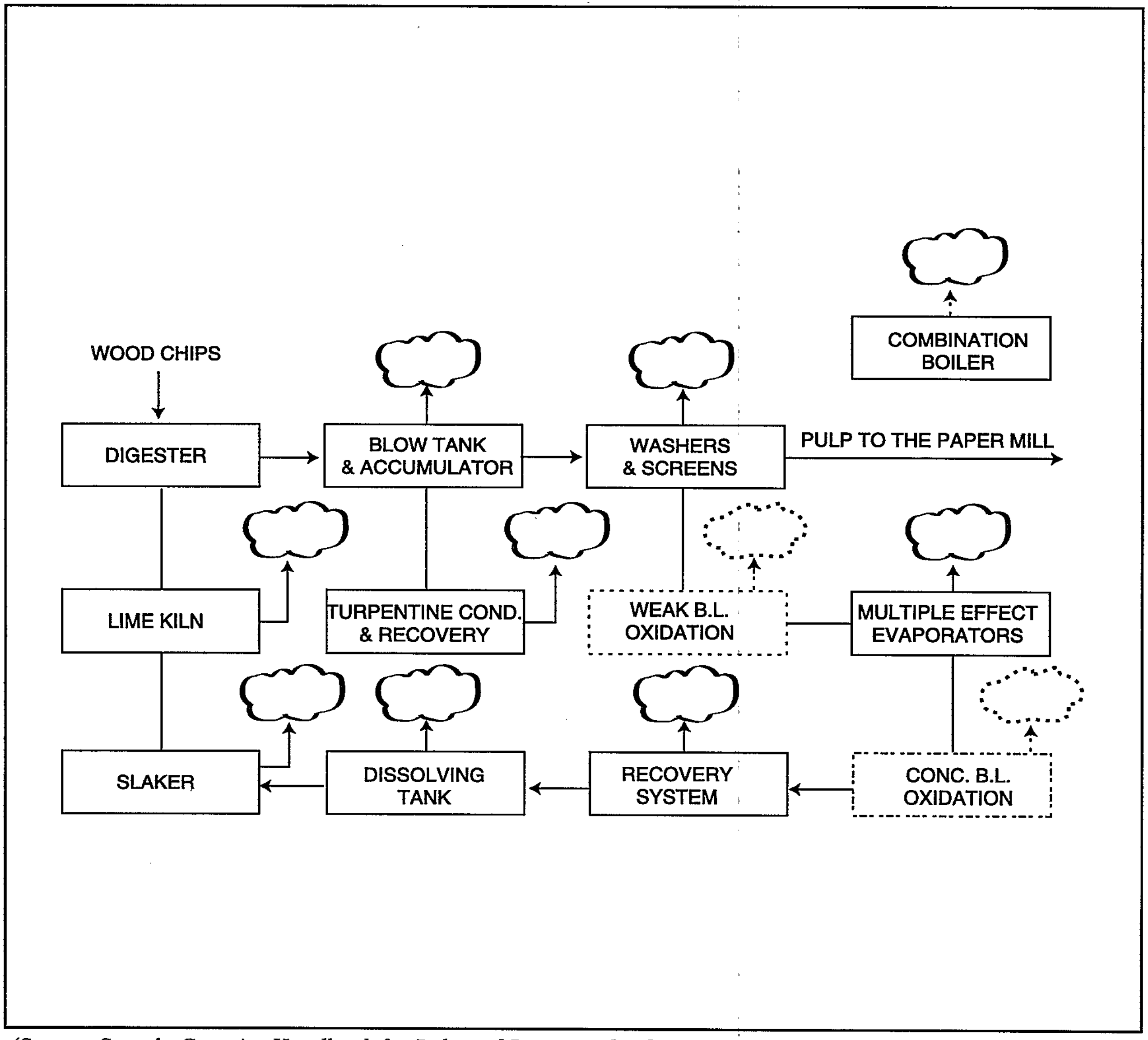
Sources: *Pollution Prevention Technologies for the Bleached Kraft Segment of the U.S. Pulp and Paper Industry* (EPA-600-R-93-110), *Development Document for Proposed Effluent Limitations Guidelines and standards for the Pulp, Paper, and Paperboard Point Source Category (1993)* and air release data from *Pulp, Paper and Paperboard Industry - Background Information for Proposed Air Emission Standards: Manufacturing Processes at Kraft, Sulfite, Soda, and Semi-Chemical Mills (NESHAP; 1993).*

Exhibit 20: Kraft Process Flow Diagram



(Source: Smook, Gary A. *Handbook for Pulp and Paper Technologists.* Second edition. Vancouver: Angus Wilde Publications, 1992.)

Exhibit 21: Air Pollutant Output from Kraft Process



(Source: Smook, Gary A. *Handbook for Pulp and Paper Technologies*. Second Edition. Vancouver: Angus Wilde Publications, 1992.)

III.C. Management of Chemicals in Wastestream

The Pollution Prevention Act of 1990 (PPA) requires facilities to report information about the management of TRI chemicals in waste and efforts made to eliminate or reduce those quantities. These data have been collected annually in Section 8 of the TRI reporting Form R beginning with the 1991 reporting year. The data summarized below cover the years 1992-1995 and are meant to provide a basic understanding of the quantities of waste handled by the industry, the methods typically used to manage this waste, and recent trends in these methods. TRI waste management data can be used to assess trends in source reduction within individual industries and facilities, and for specific TRI chemicals. This information could then be used as a tool in identifying opportunities for pollution prevention compliance assistance activities.

From the yearly data presented below it is apparent that the portion of TRI wastes reported as recycled on-site has increased and the portions treated or managed through energy recovery on-site have decreased between 1992 and 1995 (projected). While the quantities reported for 1992 and 1993 are estimates of quantities already managed, the quantities reported for 1994 and 1995 are projections only. The PPA requires these projections to encourage facilities to consider future waste generation and source reduction of those quantities as well as movement up the waste management hierarchy. Future-year estimates are not commitments that facilities reporting under TRI are required to meet.

Exhibit 22 shows that the pulp and paper industry managed about 2 trillion pounds of production-related waste (total quantity of TRI chemicals in the waste from routine production operations) in 1993 (column B). Column C reveals that of this production-related waste, about 10 percent was either transferred off-site or released to the environment. Column C is calculated by dividing the total TRI transfers and releases by the total quantity of production-related waste. In other words, about 90 percent of the industry's TRI wastes were managed on-site through recycling, energy recovery, or treatment as shown in columns E, F and G, respectively. The majority of waste that is released or transferred off-site can be divided into portions that are recycled off-site, recovered for energy off-site, or treated off-site as shown in columns H, I and J, respectively. The remaining portion of the production related wastes (three percent), shown in column D, is either released to the environment through direct discharges to air, land, water, and underground injection, or it is disposed off-site.

Exhibit 22: Source Reduction and Recycling Activity for Pulp and Paper Industry (SIC 26) as Reported within TRI									
A	B	C	D	On-Site			Off-Site		
				E	F	G	H	I	J
Year	Quantity of Production-Related Waste (10^6 lbs.)[a]	% Released and Transferred[b]	% Released and Disposed[c] Off-site	% Recycled	% Energy Recovery	% Treated	% Recycled	% Energy Recovery	% Treated
1992	2,080	10%	10%	5%	10%	74%	.02%	.02%	3%
1993	1,958	9%	9%	5%	10%	74%	.02%	.03%	2%
1994	1,991	--	8%	5%	11%	73%	.02%	.03%	2%
1995	1,949	--	8%	5%	11%	73%	.02%	.02%	2%

[a] Within this industry sector, non-production related waste < 1% of production related wastes for 1993.
[b] Total TRI transfers and releases as reported in Section 5 and 6 of Form R as a percentage of production related wastes.
[c] Percentage of production related waste released to the environment and transferred off-site for disposal.

IV. CHEMICAL RELEASE AND TRANSFER PROFILE

This section is designed to provide background information on the pollutant releases that are reported by this industry. The best source of comparative pollutant release information is the Toxic Release Inventory System (TRI). Pursuant to the Emergency Planning and Community Right-to-Know Act (EPCRA), TRI includes self-reported facility release and transfer data for over 600 toxic chemicals. Facilities within SIC Codes 20-39 (manufacturing industries) that have more than 10 employees, and that are above weight-based reporting thresholds are required to report TRI on-site releases and off-site transfers. The information presented within the sector notebooks is derived from the most recently available (1993) TRI reporting year (which then included 316 chemicals), and focuses primarily on the on-site releases reported by each sector. Because TRI requires consistent reporting regardless of sector, it is a useful tool for drawing general comparisons across industries.

Although this sector notebook does not present historical information regarding TRI chemical releases, please note that in general, toxic chemical releases have been declining over time. In fact, according to the 1993 Toxic Release Inventory Data Book, reported releases dropped by 43 percent between 1988 and 1993. Although on-site releases have decreased, the total amount of reported toxic waste has not declined because the amount of toxic chemicals transferred off-site has increased. Transfers have increased from 3.7 billion pounds in 1991 to 4.7 billion pounds in 1993. Better management practices have led to increases in off-site transfers of toxic chemicals for recycling. More detailed information can be obtained from EPA's annual Toxics Release Inventory Public Data Release book (which is available through the EPCRA Hotline at 800-535-0202), or directly from the Toxic Release Inventory System database (for user support call 202-260-1531).

Wherever possible, the sector notebooks present TRI data as the primary indicator of chemical release within each industrial category. TRI data provide the type, amount and media receptor of each chemical released or transferred. When other sources of pollutant release data have been obtained, these data have been included to augment the TRI information.

TRI Data Limitations

The reader should keep in mind the following limitations regarding TRI data. Within some sectors, the majority of facilities are not subject to TRI reporting because they are not considered manufacturing industries, or because they are below TRI reporting thresholds. Examples are the mining, dry cleaning, printing, and transportation equipment cleaning sectors. For these sectors, release information from other sources has been included.

The reader should also be aware that TRI "pounds released" data presented within the notebooks is not equivalent to a "risk" ranking for each industry. Weighting each pound of release equally does not factor in the relative toxicity of each chemical that is released. The Agency is in the process of developing an approach to assign toxicological weightings to each chemical released so that one can differentiate between pollutants with significant differences in toxicity. As a preliminary indicator of the environmental impact of the industry's most commonly released chemicals, the notebook briefly summarizes the toxicological properties of the top five chemicals (by weight) reported by each industry.

General Definitions

SIC Code -- is the Standard Industrial Classification (SIC) is a statistical classification standard used for all establishment-based Federal economic statistics. The SIC codes facilitate comparisons between facility and industry data.

TRI Facilities -- are manufacturing facilities that have 10 or more full-time employees and are above established pollutant release and transfer thresholds. Manufacturing facilities are defined as facilities in Standard Industrial Classification primary codes 20-39. Facilities must submit estimates for all chemicals that are on the EPA's defined list and are above throughput thresholds.

Data Table Column Heading Definitions

The following definitions are based upon standard definitions developed by EPA's Toxic Release Inventory Program. The categories below represent the possible pollutant destinations that can be reported.

RELEASES -- are an on-site discharge of a toxic chemical to the environment. This includes emissions to the air, discharges to bodies of water, releases at the facility to land, as well as contained disposal into underground injection wells.

Releases to Air (Point and Fugitive Air Emissions) -- Include all air emissions from industry activity. Point emission occur through confined air streams as found in stacks, ducts, or pipes. Fugitive emissions include losses from equipment leaks, or evaporative losses from impoundments, spills, or leaks.

Releases to Water (Surface Water Discharges) -- encompass any releases going directly to streams, rivers, lakes, oceans, or other bodies of water. Any estimates for stormwater runoff and non-point losses must also be included.

Releases to Land -- includes disposal of toxic chemicals in waste to on-site landfills, land treated or incorporation into soil, surface impoundments, spills, leaks, or waste piles. These activities must occur within the facility's boundaries for inclusion in this category.

Underground Injection -- is a contained release of a fluid into a subsurface well for the purpose of waste disposal.

TRANSFERS -- is a transfer of toxic chemicals in wastes to a facility that is geographically or physically separate from the facility reporting under TRI. The quantities reported represent a movement of the chemical away from the reporting facility. Except for off-site transfers for disposal, these quantities do not necessarily represent entry of the chemical into the environment.

Transfers to POTWs -- are wastewaters transferred through pipes or sewers to a publicly owned treatments works (POTW). Treatment and chemical removal depend on the chemical's nature and treatment methods used. Chemicals not treated or destroyed by the POTW are generally released to surface waters or landfilled within the sludge.

Transfers to Recycling -- are sent off-site for the purposes of regenerating or recovering still valuable materials. Once these chemicals have been recycled, they may be returned to the originating facility or sold commercially.

Transfers to Energy Recovery -- are wastes combusted off-site in industrial furnaces for energy recovery. Treatment of a chemical by incineration is not considered to be energy recovery.

Transfers to Treatment -- are wastes moved off-site for either neutralization, incineration, biological destruction, or physical separation. In some cases, the chemicals are not destroyed but prepared for further waste management.

Transfers to Disposal -- are wastes taken to another facility for disposal generally as a release to land or as an injection underground.

IV.A. EPA Toxics Releases Inventory For the Pulp and Paper Industry

According to Toxic Release Inventory (TRI) data from SIC codes 261-265, the pulp and paper industry released (to the air, water, or land) and transferred (shipped off-site) a total of approximately 218 million pounds of toxic chemicals during calendar year 1993[b]. This represents less than 4 percent of the total pounds of TRI chemicals released and transferred by all manufacturers that year. In comparison, the chemical industry (SIC 28) produced 2.5 billion pounds that year, accounting for 33 percent of all releases and transfers during that period.

The pulp and paper industry's releases have been declining in recent years. The 1993 release total represented a 8 percent reduction over the previous year, and a 22 percent reduction since 1988. This reduction was not as great as manufacturers' average of 43 percent for that period. The pulp and paper industry had the sixteenth lowest decrease in TRI releases and transfers of all TRI reporting industries. The greatest reductions were achieved in the electrical and electronic equipment sector (SIC 36) with a 69 percent reduction.

Given that pulp and paper industry production increased approximately 20 percent during the 88-92 period, one possible reason for these reductions in TRI data was the industry's efforts at pollution prevention. At the facility level, the pulp and paper industry reported the ninth highest level of pollution prevention activities among the 19 TRI reporting industries. Within the two digit SIC code 26, which includes paper conversion in addition to pulp and paper mills, 40 percent indicated source reduction activities at their facilities, somewhat higher than the average for all TRI facilities. The activities cited most often by the pulp and paper industry were good operating practices, process modifications, and raw material modifications. The highest pollution prevention activity was done by the laboratory, medical, and photographic instrument manufacturing industry (SIC 38) at 54 percent industry participation.

Comparisons of the pounds released or transferred per facility demonstrate that the pulp and paper industry had the highest per facility TRI chemical releases of all industries in 1993. The mean amount of toxic chemical **releases** per facility was approximately 120,000 pounds for all TRI facilities. The toxic chemical releases of the average pulp and paper facility were fivefold that amount, approximately 550,000 pounds. The second highest per

[b] Unless otherwise indicated, TRI data for SIC codes 261-265 were used for pulp and paper release and transfer values in this section and the tables therein.

facility releases were from the chemical industry (SIC 28) at approximately 316,000 pounds per facility. The mean amount **transferred** by facilities was greater than that of pulp and paper mills (202,000 pounds transferred off-site per facility compared to 156,700 per mill). The industry with the largest transfers per facility was the petroleum industry (SIC 29), which transferred approximately 1,894,000 pounds per facility. This value was by far the largest of TRI industries (three times that of the closest industry) and skewed the TRI mean transfer value.

Media comparison of TRI releases

The total amount of TRI toxic chemicals generated by the pulp and paper industry is a gross profile of the types and relative amounts of chemical outputs from mill processes. Additional information which can be related back to possible compliance requirements is available from the distribution of chemical releases across specific media within the environment. The TRI data requires filers to separate the total releases for the pulp and paper industry for air, water, and land releases. This distribution across media can also be compared to the profile of other industry sectors.

The pulp and paper industry releases 87 percent of its total TRI poundage to the air, approximately 10 percent to water and POTWs, and 2 percent is transferred off site or disposed on land. This release profile differs from other TRI industries which average approximately 93 percent to air 6 percent to land, and 1 percent to water. A larger proportion of water releases correlates with the water intensive processes of the pulp and paper industry. An average mill requires 10 million gallons of influent water per day and will produce the corresponding amount of effluent waters. Examining the pulp and paper industry's TRI reported toxic chemicals by chemical, highlights the likely origins of industry releases (see Exhibit 23).

Air releases can be traced to a variety of sources. Approximately 50 percent are methanol, a by-product of the pulp making process. The other major air toxic chemicals: chlorinated compounds, sulfuric acid, and the chelator methyl ethyl ketone, originate in the bleaching stage. Methanol also accounts for approximately 40 percent of the water releases by pulp and paper facilities. Overall, methanol represents over 49 percent of the pulp and paper industry's TRI releases and transfers.

The diversity of processes in the pulp and paper industry can be seen in the diversity of chemicals found in the TRI report. The TRI chemical used by the greatest number of mills is sulfuric acid. In addition, some TRI chemicals are each only used by a few mills, suggesting process specific needs such as paper finishing or use in wet additives.

Exhibit 23: Releases for Pulp and Paper Facilities in TRI for 1993, by Number of Facilities Reporting (Releases reported in pounds/year)

CHEMICAL NAME	# REPORTING CHEMICAL	FUGITIVE AIR	POINT AIR	WATER DISCHARGES	UNDERGROUND INJECTION	LAND DISPOSAL	TOTAL RELEASES	AVG. PER FACILITY
SULFURIC ACID	239	33,964	12,820,988	141,347	0	22,165	13,018,464	54,471
CHLORINE	182	93,244	1,267,957	35,863	0	3,000	1,400,064	7,693
HYDROCHLORIC ACID	162	592,882	27,782,172	640,935	0	0	29,015,989	179,111
AMMONIA	160	205,774	4,678,739	6,603,167	0	53,363	11,541,043	72,132
METHANOL	144	5,988,377	68,737,288	7,103,389	0	534,976	82,364,030	571,972
PHOSPHORIC ACID	141	1,769	10	34,957	0	30,370	67,106	476
ACETONE	120	342,478	6,210,032	406,826	2	34,131	6,993,469	58,279
CATECHOL	101	40	350	45,188	0	3,605	49,183	487
CHLOROFORM	88	3,578,682	7,816,331	261,466	0	9,399	11,665,878	132,567
CHLORINE DIOXIDE	87	12,264	1,357,528	250	0	0	1,370,042	15,748
METHYLETHYL KETONE	68	24,476	1,303,147	49,569	0	14,373	1,391,565	20,464
PHENOL	51	11,666	224,547	36,216	0	3,849	276,278	5,417
FORMALDEHYDE	33	16,350	839,567	16,963	0	5,581	878,461	26,620
ZINCCOMPOUNDS	28	254	315,280	233,759	0	2,710,743	3,260,036	116,430
NITRICACID	22	280	18	2,500	0	0	2,798	127
AMMONIUM	21	0	0	71,898	0	6,324	78,222	3,725
ETHYLENE GLYCOL	21	3,254	2,199	36,403	0	263	42,119	2,006
GLYCOL ETHERS	19	68,990	71,044	191,342	0	1,160	332,536	17,502
XYLENE(MIXED ISOMERS)	15	9,635	391,332	1,358	0	37	402,362	26,824
ACETALDEHYDE	14	1,606	843,584	1,355	0	680	847,225	60,516
COPPER COMPOUNDS	8	0	255	1,206	0	2,816	4,277	535
AMMONIUM	7	174	0	1,503,700	0	1,700	1,505,574	215,082
1,2,4-TRIMETHYLBENZENE	7	39,570	36,200	9,685	0	750	86,205	12,315
BARIUM COMPOUNDS	6	32	945	13,790	0	149,626	164,393	27,399
TOLUENE	6	110,852	1,439,370	73	0	0	1,550,295	258,383
CHROMIUM COMPOUNDS	5	250	3,396	67,500	0	43,214	114,360	22,872
DIETHANOLAMINE	5	300	250	750	0	0	1,300	260
MANGANESE COMPOUNDS	5	0	255	36,136	0	37,600	73,991	14,798
N-BUTYLALCOHOL	4	6,790	58,000	3,069	0	0	67,859	16,965
BENZENE	3	162	299,249	26	0	11	299,448	99,816
NAPHTHALENE	3	500	19,530	2,870	0	5,135	28,035	9,345
DICHLOROMETHANE	2	241,000	18,800	311	0	1	260,112	130,056
MANGANESE	2	5	27,700	111,029	0	51,572	190,306	95,153
METHYLISOBUTYL KETONE	2	0	69,661	85	0	1	69,747	34,874
STYRENE	2	15,121	34	0	0	0	15,155	7,578
ACRYLIC ACID	1	0	0	92	0	0	92	92
ANTIMONY COMPOUNDS	1	0	0	0	0	160	160	160
ASBESTOS(FRIABLE)	1	750	0	0	0	0	750	750
BIPHENYL	1	3	0	430	0	0	433	433
BUTYLBENZYL PHTHALATE	1	5,800	47,000	0	0	0	52,800	52,800
DECABROMODIPHENYL	1	0	0	0	0	380	380	380
DIBUTYL PHTHALATE	1	0	0	0	0	0	0	0
FREON 113	1	0	0	0	0	0	0	0
HYDROGEN FLUORIDE	1	0	31,532	0	0	0	31,532	31,532
NITRILOTRIACETIC ACID	1	0	0	0	0	0	0	0
O-CRESOL	1	0	150,000	0	0	0	150,000	150,000
PROPYLENE	1	0	0	0	0	0	0	0
TOTAL	309	11,407,294	136,864,290	17,665,503	2	3,726,985	169,664,074	549,070

Exhibit 24: Transfers for Pulp and Paper Facilities in TRI in 1993, by Number of Facilities Reporting (Transfers reported in pounds/year)

CHEMICAL NAME	# REPORTING CHEMICAL	POTW DISCHARGES	DISPOSAL	RECYCLING	TREATMENT	ENERGY RECOVERY	TOTAL TRANSFERS	AVG. PER FACILITY
SULFURIC ACID	239	102,531	5,964	750	18,390	0	127,635	534
CHLORINE	182	13,943	255	0	2,750	0	16,948	93
HYDROCHLORIC ACID	162	120,311	500	750	0	0	121,561	750
AMMONIA	160	579,150	119,472	250	35,753	0	734,625	4,591
METHANOL	144	34,845,356	997,221	5,632	7,071,107	397,364	43,316,680	300,810
PHOSPHORIC ACID	141	5	0	0	600	0	605	4
ACETONE	120	671,274	22,661	184	71,885	5,296	771,300	6,428
CATECHOL	101	63,552	632	0	3,605	3,361	71,150	704
CHLOROFORM	88	424,947	3,376	266	51,003	0	479,592	5,450
CHLORINE DIOXIDE	87	0	0	0	0	0	0	0
METHYLETHYL KETONE	68	244,721	12,156	26,826	12,780	20,501	316,984	4,662
PHENOL	51	229,830	12,756	0	9,169	2,560	254,315	4,987
FORMALDEHYDE	33	31,889	7,254	250	7,740	30	47,163	1,429
ZINC COMPOUNDS	28	1,970	566,918	57,343	5,500	0	631,731	22,562
NITRIC ACID	22	0	0	0	0	0	0	0
AMMONIUM	21	14,767	500	0	0	0	15,267	727
ETHYLENE GLYCOL	21	135,500	113	2,950	10,018	0	148,581	7,075
GLYCOL ETHERS	19	289,631	2,607	0	16,893	0	309,131	16,270
XYLENE(MIXED ISOMERS)	15	0	0	997	250	500	1,747	116
ACETALDEHYDE	14	0	0	0	0	0	0	0
COPPER COMPOUNDS	8	5,439	37,256	3,954	10	0	46,659	5,832
AMMONIUM	7	3,892	29	0	0	0	3,921	560
1,2,4-TRIMETHYLBENZENE	7	250	262	0	2,500	0	3,012	430
BARIUM COMPOUNDS	6	19,000	41,631	55,081	150	0	115,862	19,310
TOLUENE	6	0	0	11,585	3,400	124,312	139,297	23,216
CHROMIUM COMPOUNDS	5	2,167	10,073	0	0	0	12,240	2,448
DIETHANOLAMINE	5	39,013	33	0	0	0	39,046	7,809
MANGANESE COMPOUNDS	5	0	40,900	0	0	0	40,900	8,180
N-BUTYLALCOHOL	4	0	0	0	38,000	1,500	39,500	9,875
BENZENE	3	0	0	0	0	0	0	0
NAPHTHALENE	3	0	0	0	0	0	0	0
DICHLOROMETHANE	2	0	0	0	0	0	0	0
MANGANESE	2	0	28,911	62,318	0	0	91,229	45,615
METHYLISOBUTYL KETONE	2	0	0	0	0	0	0	0
STYRENE	2	0	0	0	0	0	0	0
ACRYLIC ACID	1	0	0	0	0	0	0	0
ANTIMONY COMPOUNDS	1	0	3,300	0	0	0	3,300	3,300
ASBESTOS(FRIABLE)	1	750	498,000	0	0	0	498,750	498,750
BIPHENYL	1	0	0	0	0	0	0	0
BUTYLBENZYL PHTHALATE	1	7,200	0	0	0	0	7,200	7,200
DECABROMODIPHENYL OXIDE	1	0	8,000	0	0	0	8,000	8,000
DIBUTYL PHTHALATE	1	0	0	0	0	2,510	2,510	2,510
FREON 113	1	0	0	0	0	0	0	0
HYDROGEN FLUORIDE	1	0	0	0	0	0	0	0
NITRILOTRIACETIC ACID	1	0	0	0	0	0	0	0
O-CRESOL	1	0	0	0	0	0	0	0
PROPYLENE	1	0	0	0	0	0	0	0
TOTAL	309	37,847,088	2,420,780	229,136	7,361,503	557,934	48,416,441	156,688

The TRI database contains a detailed compilation of self-reported, facility-specific chemical releases. The top reporting facilities for this sector are listed below (Exhibit 25). Facilities that have reported only the SIC codes covered under this notebook appear on the first list. The second list (Exhibit 26) contains additional facilities that have reported the SIC code covered within this report, and one or more SIC codes that are not within the scope of this notebook. Therefore, the second list includes facilities that conduct multiple operations -- some that are under the scope of this notebook, and some that are not. Currently, the facility-level data do not allow pollutant releases to be broken apart by industrial process.

Exhibit 25: Top 10 TRI Releasing Pulp and Paper Facilities, 1993[c]

Rank	Facility	Total TRI Releases in Pounds
1	Westvaco Corp. Kraft Div. - North Charleston, SC	5,297,899
2	Westvaco Corp. Bleached Board Div. - Covington, VA	4,752,355
3	ITT Rayonier Inc. Port Angeles Pulp Div. - Port Angeles, WA	3,661,010
4	Inland Container Corp. Rome Linerboard Div. - Rome, GA	3,245,815
5	Stone Container Corp. Containerboard & Paper Div. - Florence, SC	3,049,918
6	Scott Paper Co. - Mobile, AL	3,009,185
7	CPI Kraft Div. - Wisconsin Rapids, WI	2,881,855
8	Champion International Corp. Courtland Mill - Courtland, AL	2,874,701
9	Great Southern Paper - Cedar Springs, GA	2,522,520
10	Alabama River Pulp Co. Inc. -Claiborne, AL	2,433,605

Source: U.S. EPA, Toxic Release Inventory Database, 1993.

[c] Being included in this list does not mean that the release is associated with non-compliance with environmental laws.

Exhibit 26: Top 10 TRI Releasing Facilities Reporting Pulp and Paper Industry SIC Codes to TRI, 1993[d]			
Rank	**SIC Codes Reported in TRI**	**Facility**	**Total TRI Releases in Pounds**
1	2611, 2631	Westvaco Corp. Kraft Div. - North Charleston, SC	5,297,899
2	2631	Westvaco Corp. Bleached Board Div. - Covington, VA	4,752,355
3	2611	ITT Rayonier Inc. Port Angeles Pulp Div. - Port Angeles, WA	3,661,010
4	2611, 2631, 2821, 2653	Union Camp Corp. - Savannah, GA	3,499,470
5	2611, 2631	Inland Container Corp. Rome Linerboard Div. - Rome, GA	3,245,815
6	2611, 2621, 2631, 2679	Union Camp Corp. Fine Paper and Building Products Div. -Franklin, VA	3,085,254
7	2621, 2631	Stone Container Corp. Containerboard & Paper Div. - Florence, SC	3,049,918
8	2621	Scott Paper Co. - Mobile, AL	3,009,185
9	2611	CPI Kraft Div. - Wisconsin Rapids, WI	2,881,855
10	2621	Champion International Corp. Courtland Mill - Courtland, AL	2,874,701
Source: U.S. EPA, Toxics Release Inventory Database, 1993.			

IV.B. Summary of Selected Chemicals Released

The following is a synopsis of current scientific toxicity and fate information for the top chemicals (by weight) that facilities within this sector self-reported as released to the environment based upon 1993 TRI data. Because this section is based upon self-reported release data, it does not attempt to provide information on management practices employed by the sector to reduce the releases of these chemicals. Information regarding pollutant release reductions over time may be available from EPA's TRI and 33/50 programs, or directly from the industrial trade associations that are listed in Section IX of this document. Since these descriptions are cursory, please consult the sources referenced below for a more detailed description of both

[d] Being included on this list does not mean that the release is associated with non-compliance with environmental laws.

the chemicals described in this section, and the chemicals that appear on the full list of TRI chemicals appearing in Section IV.A.

The brief descriptions provided below were taken from the *1993 Toxics Release Inventory Public Data Release* (EPA, 1994), and the Hazardous Substances Data Bank (HSDB), accessed via TOXNET. TOXNET is a computer system run by the National Library of Medicine. It includes a number of toxicological databases managed by EPA, National Cancer Institute, and the National Institute for Occupational Safety and Health.[c] HSDB contains chemical-specific information on manufacturing and use, chemical and physical properties, safety and handling, toxicity and biomedical effects, pharmacology, environmental fate and exposure potential, exposure standards and regulations, monitoring and analysis methods, and additional references. The information contained below is based upon exposure assumptions that have been conducted using standard scientific procedures. The effects listed below must be taken in context of these exposure assumptions that are more fully explained within the full chemical profiles in HSDB. For more information on TOXNET, contact the TOXNET help line at 800-231-3766.

Methanol (CAS: 67-56-1)

Toxicity. Methanol is readily absorbed from the gastrointestinal tract and the respiratory tract, and is toxic to humans in moderate to high doses. In the body, methanol is converted into formaldehyde and formic acid. Methanol is excreted as formic acid. Observed toxic effects at high dose levels generally include central nervous system damage and blindness. Long-term exposure to high levels of methanol via inhalation cause liver and blood damage in animals.

Ecologically, methanol is expected to have low toxicity to aquatic organisms. Concentrations lethal to half the organisms of a test population are expected to exceed 1 mg methanol per liter water. Methanol is not likely to persist in water or to bioaccumulate in aquatic organisms.

Carcinogenicity. There is currently no evidence to suggest that this chemical is carcinogenic.

[c] Databases included in TOXNET are: CCRIS (Chemical Carcinogenesis Research Information System), DART (Developmental and Reproductive Toxicity Database), DBIR (Directory of Biotechnology Information Resources), EMICBACK (Environmental Mutagen Information Center Backfile), GENE-TOX (Genetic Toxicology), HSDB (Hazardous Substances Data Bank), IRIS (Integrated Risk Information System), RTECS (Registry of Toxic Effects of Chemical Substances), and TRI (Toxic Chemical Release Inventory).

Environmental Fate. Liquid methanol is likely to evaporate when left exposed. Methanol reacts in air to produce formaldehyde which contributes to the formation of air pollutants. In the atmosphere it can react with other atmospheric chemicals or be washed out by rain. Methanol is readily degraded by microorganisms in soils and surface waters.

Physical Properties. Methanol is highly flammable.

Hydrochloric Acid (CAS: 7647-01-1)

Toxicity. Hydrochloric acid is primarily a concern in its aerosol form. Acid aerosols have been implicated in causing and exacerbating a variety of respiratory ailments. Dermal exposure and ingestion of highly concentrated hydrochloric acid can result in corrosivity.

Ecologically, accidental releases of solution forms of hydrochloric acid may adversely affect aquatic life by including a transient lowering of the pH (i.e., increasing the acidity) of surface waters.

Carcinogenicity. There is currently no evidence to suggest that this chemical is carcinogenic.

Environmental Fate. Releases of hydrochloric acid to surface waters and soils will be neutralized to an extent due to the buffering capacities of both systems. The extent of these reactions will depend on the characteristics of the specific environment.

Physical Properties. Concentrated hydrochloric acid is highly corrosive.

Sulfuric Acid (CAS: 7664-93-9)

Toxicity. Concentrated sulfuric acid is corrosive. In its aerosol form, sulfuric acid has been implicated in causing and exacerbating a variety of respiratory ailments.

Ecologically, accidental releases of solution forms of sulfuric acid may adversely affect aquatic life by inducing a transient lowering of the pH (i.e., increasing the acidity) of surface waters. In addition, sulfuric acid in its aerosol form is also a component of acid rain. Acid rain can cause serious damage to crops and forests.

Carcinogenicity. There is currently no evidence to suggest that this chemical is carcinogenic.

Environmental Fate. Releases of sulfuric acid to surface waters and soils will be neutralized to an extent due to the buffering capacities of both systems. The extent of these reactions will depend on the characteristics of the specific environment.

In the atmosphere, aerosol forms of sulfuric acid contribute to acid rain. These aerosol forms can travel large distances from the point of release before the acid is deposited on land and surface waters in the form of rain.

Chloroform (CAS: 67-66-3)

Toxicity. Target organs of chloroform toxicity include the liver, kidneys, heart, eyes, and skin. Short-term exposure to high concentrations of chloroform leads to inebriation and excitation, followed by central nervous system depression, including fainting, dizziness, and anesthesia; gastrointestinal upsets, including nausea, vomiting, and salivation; kidney damage; and liver damage. Exposure to very high concentrations of chloroform may lead to respiratory depression, loss of motor functions, coma, and death due to heart, liver or kidney failure. Long-term exposure to chloroform is associated with liver and kidney damage, and mood changes. Contact with the eyes and skin causes reversible damage.

Populations at special risk from exposure to chloroform include individuals with liver, kidney, or central nervous system damage, and chronic alcoholics.

Carcinogenicity. Chloroform is a probable human carcinogen, based on evidence in animals due to both oral and inhalation exposure.

Environmental Fate. The majority of chloroform releases to the environment are to the atmosphere; releases to water and land will be primarily lost by evaporation and will also end up in the atmosphere. Atmospheric releases may be transported long distances and will photodegrade with a half-life of a few months. Releases onto the land that do not evaporate will also leach through the soil and persist in the groundwater for a long time. Little chloroform is adsorbed to soil particles. Biodegradation is generally slow.

Chloroform is not expected to bioconcentrate in the food chain, though contamination of food is likely due to its use as an extractant and its presence in drinking water.

Ammonia (CAS: 7664-41-7)

Toxicity. Anhydrous ammonia is irritating to the skin, eyes, nose, throat, and upper respiratory system.

Ecologically, ammonia is a source of nitrogen (an essential element for aquatic plant growth), and may therefore contribute to eutrophication of standing or slow-moving surface water, particularly in nitrogen-limited waters such as the Chesapeake Bay. In addition, aqueous ammonia is moderately toxic to aquatic organisms.

Carcinogenicity. There is currently no evidence to suggest that this chemical is carcinogenic.

Environmental Fate. Ammonia combines with sulfate ions in the atmosphere and is washed out by rainfall, resulting in rapid return of ammonia to the soil and surface waters.

Ammonia is a central compound in the environmental cycling of nitrogen. Ammonia in lakes, rivers, and streams is converted to nitrate.

Physical Properties. Ammonia is a corrosive and severely irritating gas with a pungent odor.

IV.C. Other Data Sources

The toxic chemical release data obtained from TRI captures the vast majority of facilities in the pulp and paper industry. It also allows for a comparison across years and industry sectors. Reported chemicals are limited, however, to the 316 required by TRI. Some pulp and paper emissions may not be captured by TRI. The EPA Office of Air Quality, Planning, and Standards has compiled air pollutant emission factors for determining the total air emissions of priority pollutants (e.g., total hydrocarbons, SO_x, NO_x, CO, particulates, etc.) from many sources.

The Aerometric Information Retrieval System (AIRS) contains a wide range of information related to stationary sources of air pollution, including the emissions of a number of air pollutants which may be of concern within a particular industry. With the exception of volatile organic compounds (VOCs), there is little overlap with the TRI chemicals reported above.

Exhibit 27 summarizes annual releases of carbon monoxide (CO), nitrogen dioxide (NO_2), particulate matter of 10 microns or less (PM10), total particulates (PT), sulfur dioxide (SO_2), and volatile organic compounds (VOCs).

Exhibit 27: Pollutant Releases (short tons/year)

Industry Sector	CO	NO_2	PM_{10}	PT	SO_2	VOC
Metal Mining	5,391	28,583	39,359	140,052	84,222	1,283
Nonmetal Mining	4,525	28,804	59,305	167,948	24,129	1,736
Lumber and Wood Production	123,756	42,658	14,135	63,761	9,419	41,423
Furniture and Fixtures	2,069	2,981	2,165	3,178	1,606	59,426
Pulp and Paper	**624,291**	**394,448**	**35,579**	**113,571**	**541,002**	**96,875**
Printing	8,463	4,915	399	1,031	1,728	101,537
Inorganic Chemicals	166,147	103,575	4,107	39,062	182,189	52,091
Organic Chemicals	146,947	236,826	26,493	44,860	132,459	201,888
Petroleum Refining	419,311	380,641	18,787	36,877	648,155	369,058
Rubber and Misc. Plastics	2,090	11,914	2,407	5,355	29,364	140,741
Stone, Clay and Concrete	58,043	338,482	74,623	171,853	339,216	30,262
Iron and Steel	1,518,642	138,985	42,368	83,017	238,268	82,292
Nonferrous Metals	448,758	55,658	20,074	22,490	373,007	27,375
Fabricated Metals	3,851	16,424	1,185	3,136	4,019	102,186
Computer and Office Equipment	24	0	0	0	0	0
Electronics and Other Electrical	367	1,129	207	293	453	4,854
Motor Vehicles, Bodies, Parts	35,303	23,725	2,406	12,853	25,462	101,275
Dry Cleaning	101	179	3	28	152	7,310

Source: U.S. EPA Office of Air and Radiation, AIRS Database, May 1995.

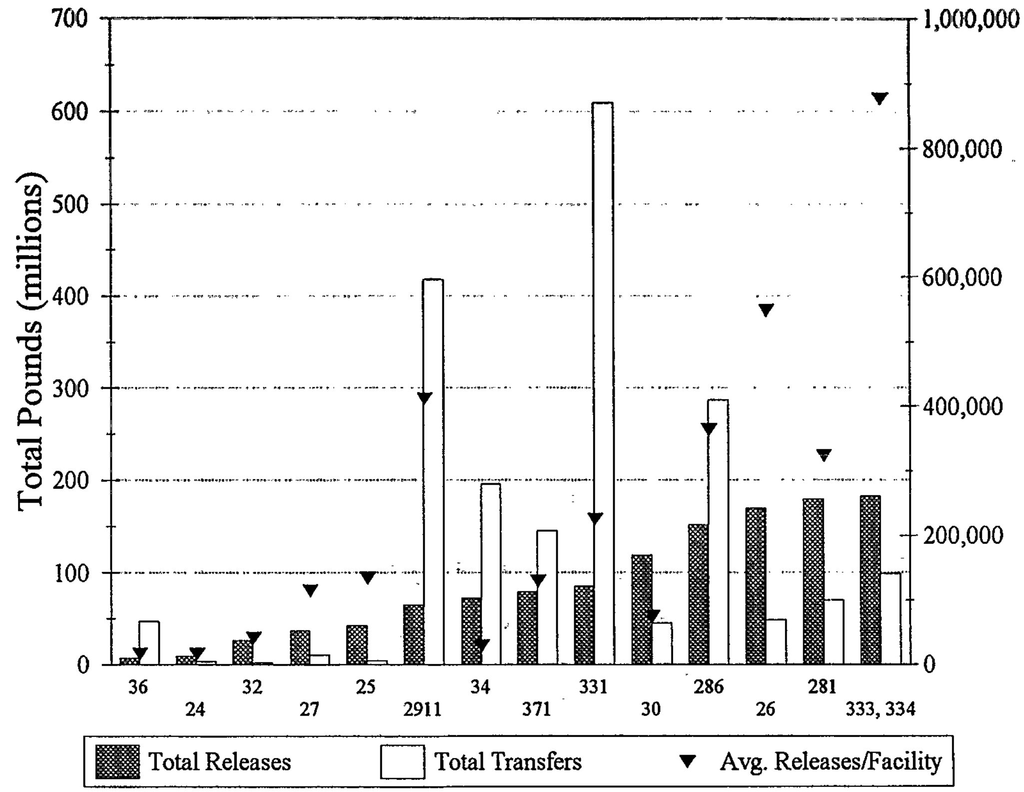
IV.D. Comparison of Toxic Release Inventory Between Selected Industries

The following information is presented as a comparison of pollutant release and transfer data across industrial categories. It is provided to give a general sense as to the relative scale of releases and transfers within each sector profiled under this project. Please note that the following figure and table do not contain releases and transfers for industrial categories that are not included in this project, and thus cannot be used to draw conclusions regarding the total release and transfer amounts that are reported to TRI.

Similar information is available within the annual TRI Public Data Release Book.

Exhibit 28 is a graphical representation of a summary of the 1993 TRI data for the Pulp and Paper industry and the other sectors profiled in separate notebooks. The bar graph presents the total TRI releases and total transfers on the left axis and the triangle points show the average releases per facility on the right axis. Industry sectors are presented in the order of increasing total TRI releases. The graph is based on the data shown in Exhibit 29 and is meant to facilitate comparisons between the relative amounts of releases, transfers, and releases per facility both within and between these sectors. The reader should note, however, that differences in the proportion of facilities captured by TRI exist between industry sectors. This can be a factor of poor SIC matching and relative differences in the number of facilities reporting to TRI from the various sectors. In the case of Pulp and Paper industry the 1993 TRI data presented here covers 309 facilities. These facilities listed SIC 2611-2631 (Pulp, Paper, and Paperboard Mills) as primary SIC codes.

Exhibit 28: Summary of 1993 TRI Data:
Releases and Transfers by Industry



SIC Range	Industry Sector	SIC Range	Industry Sector	SIC Range	Industry Sector
36	Electronic Equipment and Components	2911	Petroleum Refining	286	Organic Chemical Mfg.
24	Lumber and Wood Products	34	Fabricated Metals	26	Pulp and Paper
32	Stone, Clay, and Concrete	371	Motor Vehicles, Bodies, Parts, and Accessories	281	Inorganic Chemical Mfg.
27	Printing	331	Iron and Steel	333, 334	Nonferrous Metals
25	Wood Furniture and Fixtures	30	Rubber and Misc. Plastics		

Exhibit 29: Toxics Release Inventory Data for Selected Industries

Industry Sector	SIC Range	# TRI Facilities	1993 TRI Releases		1993 TRI Transfers		Total Releases + Transfers (million lbs.)	Average Releases + Transfers per Facility (pounds)
			Total Releases (million lbs.)	Average Releases per Facility (pounds)	Total Transfers (million lbs.)	Average Transfers per Facility (pounds)		
Stone, Clay, and Concrete	32	634	26.6	42,000	2.2	4,000	28.8	46,000
Lumber and Wood Products	24	491	8.4	17,000	3.5	7,000	11.9	24,000
Furniture and Fixtures	25	313	42.2	135,000	4.2	13,000	46.4	148,000
Printing	2711-2789	318	36.5	115,000	10.2	32,000	46.7	147,000
Electronic Equip. and Components	36	406	6.7	17,000	47.1	116,000	53.7	133,000
Rubber and Misc. Plastics	30	1,579	118.4	75,000	45	29,000	163.4	104,000
Motor Vehicles, Bodies, Parts, and Accessories	371	609	79.3	130,000	145.5	239,000	224.8	369,000
Pulp and Paper	**2611-2631**	**309**	**169.7**	**549,000**	**48.4**	**157,000**	**218.1**	**706,000**
Inorganic Chem. Mfg.	2812-2819	555	179.6	324,000	70	126,000	249.7	450,000
Petroleum Refining	2911	156	64.3	412,000	417.5	2,676,000	481.9	3,088,000
Fabricated Metals	34	2,363	72	30,000	195.7	83,000	267.7	123,000
Iron and Steel	331	381	85.8	225,000	609.5	1,600,000	695.3	1,825,000
Nonferrous Metals	333, 334	208	182.5	877,000	98.2	472,000	280.7	1,349,000
Organic Chemical Mfg.	2861-2869	417	151.6	364,000	286.7	688,000	438.4	1,052,000
Metal Mining	10	Industry sector not subject to TRI reporting.						
Nonmetal Mining	14	Industry sector not subject to TRI reporting.						
Dry Cleaning	7216	Industry sector not subject to TRI reporting.						

Source: U.S. EPA, Toxics Release Inventory Database, 1993.

V. POLLUTION PREVENTION OPPORTUNITIES

The best way to reduce pollution is to prevent it in the first place. Industries have creatively implemented pollution prevention techniques that improve efficiency and increase profits while at the same time minimizing environmental impacts. This can be done in many ways such as reducing material inputs, re-engineering processes to reuse by-products, improving management practices, and employing substitution of toxic chemicals. Some smaller facilities are able to actually get below regulatory thresholds just by reducing pollutant releases through aggressive pollution prevention policies.

In order to encourage these approaches, this section provides both general and company-specific descriptions of some pollution prevention advances that have been implemented within the pulp and paper industry. While the list is not exhaustive, it does provide core information that can be used as the starting point for facilities interested in beginning their own pollution prevention projects. When possible, this section provides information from real activities that can, or are being implemented by this sector -- including a discussion of associated costs, time frames, and expected rates of return. This section provides summary information from activities that may be, or are being implemented by this sector. When possible, information is provided that gives the context in which the technique can be effectively used. Please note that the activities described in this section do not necessarily apply to all facilities that fall within this sector. Facility-specific conditions must be carefully considered when pollution prevention options are evaluated, and the full impacts of the change must examine how each option affects air, land and water pollutant releases.

Pollution Prevention Opportunities for the Pulp and Paper Industry

The chemical recovery systems used in chemical pulping processes are an example of pollution prevention technologies that have evolved alongside process technologies. An efficient chemical recovery system is a crucial component of chemical pulping mill operation: the chemical recovery process regenerates process chemicals, reducing natural resource usage and associated costs, as well as discharges to the environment and producing energy. Many recent pollution prevention efforts in the pulp and paper industry have focused on reducing the releases of toxics, in particular, chlorinated compounds. Pollution prevention techniques have proven to be more effective in controlling these pollutants than conventional control and treatment technologies. Most conventional, end-of-pipe treatment technologies are not effective in destroying many chlorinated compounds and often merely transfer the pollutants to another environmental medium. Efforts to prevent chlorinated releases have, therefore, focused on source reduction and material substitution techniques such as defoamers, bleaching chemical or wood chip substitution to reduce the industry's use and releases of chlorinated compounds. Such source reduction efforts and material substitutions usually require substantial changes in the production process. In addition to the major process changes aimed at reducing toxics releases, the industry is implementing a number of pollution prevention techniques to reduce water use and pollutant releases (BOD, COD, and TSS) such as: dry debarking, recycling of log flume water, improved spill control, bleach filtrate recycle, closed screen rooms, and improved storm water management. The pulp and paper industry has also worked to increase the amount of secondary and recycled fibers used for the pulping process. According to industry sources, the pulp and paper industry set and met a 1995 goal of 40 percent recycling and reuse of all paper consumed in the U.S. Currently, the industry has set a new goal of recovering 50 percent of all paper consumed in the U.S. for recycle and reuse by the year 2000. These figures should be compared with the utilization rate of secondary fibers (secondary fibers as a percentage of the total fibers used to make pulp) which is at approximately 30 percent and is climbing slowly.[29] Current secondary fiber utilization rates in resource deficient countries such as Japan are close to 50 percent.

Because the pulp and paper industry is highly capital intensive and uses long-established technologies with long equipment lifetimes, major process-changing pollution prevention opportunities are expensive and require long time periods to implement. The pulp and paper industry is a dynamic one, however, that constantly makes process changes and material substitutions to increase productivity and cut costs. The industry is moving towards pollution prevention as illustrated by the above average percentage of facilities in the industry (43.1 percent) reporting pollution prevention activities to TRI and the above average participation in the 33/50 Program (25 percent) to reduce toxic chemicals releases (See Section \III.C.1). The trend towards materials substitutions is also reflected in an increasing demand for alternative pulping and bleaching chemicals.

One of the factors that will drive the industry towards pollution prevention much more rapidly in the future are the proposed integrated NESHAP and effluent limitation guidelines for the pulp and paper industry. (See Section I.E. - Future Regulatory Requirements.) These regulations are being developed together in part to reduce the costs of compliance, to emphasize the multi-media nature of pollution control, and to promote pollution prevention. Many of the proposed technology-based effluent limitation guidelines for the control of toxic releases consist of process changes that will substitute chlorine dioxide for elemental chlorine and that completely eliminate elemental chlorine in bleaching processes. The NESHAP standards also allow Hazardous Air Pollutant (HAP) reductions through recycling of wastewater streams to a process unit and routing pulping emissions to a boiler, lime kiln, or recovery furnace.

Brief descriptions of some of pollution prevention techniques found to be effective at pulp and paper facilities are provided below. For more detail on the pollution prevention options listed below and for descriptions of additional alternative pulping and bleaching processes refer to the Office of Pollution Prevention and Toxics' 1993 report, *Pollution Prevention Technologies for the Bleached Kraft Segment of the U.S. Pulp and Paper Industry* and other pollution prevention/waste minimization documents listed in Resource Materials section. It should be noted that although many of the pollution prevention opportunities listed below are primarily aimed at reducing toxics releases, the process changes can often lead to reductions in the conventional pollutants such as BOD_5 and TSS as well as COD, AOX, and contribute to reduced water use, sludge volumes generated, and air emissions.

Extended Delignification. Extended delignification further reduces the lignin content of the pulp before it moves to the bleach plant. Because the amount of bleaching chemicals required to achieve a certain paper brightness is proportional to the amount of lignin remaining in the pulp after the pulping process, extended delignification can reduce the amounts of bleaching chemicals needed. A number of different extended delignification processes have been developed. These processes involve: increasing the cooking time; adding the cooking chemicals at several points throughout the cooking process; regulating the cooking temperatures; and carefully controlling the concentration of hydrogen sulfide ions and dissolved lignin. Importantly, the process changes do not degrade the cellulose which would normally accompany increased cooking time. Extended delignification processes have been developed for both batch and continuous pulping processes. The lignin content of the brownstock pulp has been reduced by between 20 and 50 percent with no losses in pulp yield or strength using such processes. In consequence, chlorinated compounds generated during bleaching are reduced in approximate proportion to reductions in the brownstock lignin content. In addition, the same changes have resulted in significant reductions in BOD_5, COD and color. One study demonstrated a 29 percent decrease in BOD_5 resulting from an extended delignification process. Facility energy requirements have been shown to increase slightly with extended delignification. However, off-site power requirements (associated with decreased chemical use) have been estimated to more than offset the on-site increases. As of 1993, extended delignification accounted for 20 percent of worldwide bleached kraft capacity and 21 percent of U.S. mills. A significant number of changeovers to the process are currently underway.

Oxygen Delignification. Oxygen delignification also reduces the lignin content in the pulp. The process involves the addition of an oxygen reactor between the kraft pulping stages and the bleach plant. The brownstock pulp from the digester is first washed and then mixed with sodium hydroxide or oxidized cooking liquor. The pulp is fluffed, deposited in the oxygen reactor, steam heated, and injected with gaseous oxygen wherein it undergoes oxidative delignification. The pulp is then washed again to remove the dissolved lignin before moving to the bleaching plant. Oxygen delignification can reduce the lignin content in the pulp by as much as 50 percent resulting in a potentially similar reduction in the use of chlorinated bleaching chemicals and chlorinated compound pollutants. The process can be used in combination with other process modifications that can completely eliminate the need for chlorine-based bleaching agents. In addition, unlike bleach plant filtrate, the effluent from the oxygen reactor can be recycled through the pulp mill recovery cycle, further reducing the non-pulp solids going to the bleaching plant and the effluent load from the bleach plant. The net effect is reduced effluent flows and less sludge generation. Facility energy requirements have been shown to increase with oxygen delignification, however, the decrease in off-site power requirements (associated with decreased chemical use) have been estimated to exceed the on-site increases resulting in a decrease in overall energy requirements. Also, the recovered energy and reduced chemical use offset the cost. As of 1993, oxygen delignification projects have been installed or were planned for 27 U.S. pulp and paper mills, accounting for more than 40 percent of bleach kraft pulp production.

Ozone Delignification. As a result of a considerable research effort, ozone delignification (ozone bleaching) is now being used in the pulp and paper industry . The technology has the potential to eliminate the need for chlorine in the bleaching process. Ozone delignification is performed using processes and equipment similar to that of oxygen delignification. The ozone process, however, must take place at a very low pH (1.0 to 2.0), requiring the addition of sulfuric acid to the pulp prior to the ozonation. In addition to low pH, a number of process conditions are critical for ozone delignification: organic materials must be almost completely washed out of the brownstock pulp; temperatures must stay at about 20 °C; and ozone reactive metals must be removed prior to the ozonation stage. Oxygen delignification and/or extended delignification processes are considered a prerequisite for successful ozone bleaching. When used in combination, the two processes can result in a high quality bright pulp that requires little or no chlorine or chlorine dioxide bleaching. Overall emissions from the combination of the oxygen and ozone processes are substantially lower than conventional processes because effluents from each stage can be recycled. Pilot systems consisting of ozone delignification in combination with oxygen delignification and oxygen extraction have shown reductions in BOD_5 of 62 percent, COD of 53 percent, color of 88 percent, and organic chlorine compounds of 98 percent. However, ozone is unstable and will decompose to molecular oxygen, thus ozone must be generated on-site and fed immediately to the pulp reactor. Ozone generation systems are complex and account for a high percentage of the total costs. Facility energy use will increase due to the on-site production of ozone, however, this energy will be offset by the energy that would normally be used to produce chlorine and chlorine dioxide.

Anthraquinone Catalysis. The addition of anthraquinone (a chemical catalyst produced from coal tar) to the pulping liquor has been shown to speed up the kraft pulping reaction and increase yield by protecting cellulose fibers from degradation. The anthraquinone accelerates the fragmentation of lignin, allowing it to be broken down more quickly by the pulping chemicals. This lowers the amount of lignin in the prechlorination pulp, thus reducing the amount of bleaching chemicals needed. Anthraquinone catalysts are increasingly used in combination with oxygen delignification and extended delignification to overcome boiler capacity bottlenecks arising from these delignification processes.

Black Liquor Spill Control and Prevention. The mixture of dissolved lignin and cooking liquor effluent from the pulping reactor and washed pulp is known as black liquor. Raw black liquor contains high levels of BOD, COD, and organic compounds. Spills of black liquor can result from overflows, leaks from process equipment, or from deliberate dumping by operators to avoid a more serious accident. Spills of black liquor can have impacts on receiving waters, are a source of air emissions, and can shock the microbial action of wastewater treatment systems. Black liquor losses also result in the loss of the chemical and heat value of the material. Systems needed to control black liquor spills are a combination of good design, engineering, and, most importantly, operator training. A few elements of an effective spill control system include: physical isolation of pieces of equipment; floor drainage systems that allow spills to be collected; backup black liquor storage capacity; sensors that provide immediate warning of potential or actual spills; and enclosed washing and screening equipment.

Enzyme Treatment of Pulp. Biotechnology research has resulted in the identification of a number of microorganisms that produce enzymes capable of breaking down lignin in pulp. Although the technology is new, it is believed that a number of mills are currently conducting enzyme treatment trials. The microorganisms capable of producing the necessary enzymes are called xylanases. Xylanases for pulp bleaching trials are available from several biotechnology and chemical companies. Since enzymes are used as a substitute for chemicals in bleaching pulp, their use will result in a decrease in chlorinated compounds released somewhat proportional to the reduction in bleaching chemicals used. Enzymes are also being used to assist in the deinking of secondary fiber. Research at the Oak Ridge National Laboratories has identified cellulase enzymes that will bind ink to the smaller fiber particles facilitating recovery of the ink sludge. Use of enzymes may also reduce the energy costs and chemical use in retrieving ink sludge from deinking effluent.

Improved Brownstock and Bleaching Stage Washing. Liquor solids remaining in the brownstock pulp are carried over to the bleach plant and then compete with the remaining lignin in the pulp for reaction with the bleaching chemicals. Improved washing, therefore, can reduce the required amount of bleaching chemicals and the subsequent reductions in chlorinated compounds as well as conventional pollutants. Modern washing systems with improved solids removal and energy efficiency are beginning to replace the conventional rotary vacuum washers. State-of-the-art washing systems include: atmospheric or pressure diffusion washers, belt washers, and pulp presses. Opportunities for reduced effluent flows and water use are also present in the bleaching plant. Acid filtrates from hypochlorite or chlorine dioxide stages can be used as dilution and wash water for the first bleaching stage. Similarly, second extraction stage filtrates can be used as dilution and wash water in the first extraction stage. Most new mills are designed with these counter-current washing systems and some mills are retrofitting their existing wash systems.

Chlorine Dioxide Substitution. The substitution of chlorine dioxide for elemental chlorine as a bleaching agent is gaining widespread use due to its beneficial impacts on pulp and effluent quality. The use of chlorine dioxide in place of chlorine increases the proportion of oxidative reactions thereby reducing the formation of residual chlorinated organic pollutants. Chlorine dioxide bleaching produces about 20 percent of the chlorinated compounds produced using elemental chlorine. A substitution of 50 to 70 percent in the first bleaching stage has become relatively common in recent years. Chlorine dioxide substitutions approaching 100 percent have been shown to increase pulp yields and quality. The use of chlorine dioxide, however, is two to four times more expensive than the equivalent oxidizing power using elemental chlorine. Because chlorine dioxide is unstable and cannot be stored, it must be continually generated at the mill. The processes used to manufacture chlorine dioxide generate a number of byproducts that may have environmental impacts, including, spent acids, chlorine gas, salt cakes and acid cakes. A number of alternative chlorine dioxide generation processes are being developed to reduce or eliminate the formation of such byproducts.

Split Addition of Chlorine/Improved pH Control. Although these process modifications are not widespread throughout the industry (currently in practice at 11 mills), one company has reported notable results. Reducing the chlorine concentration during the bleaching process by adding elemental chlorine in incremental charges has been shown to reduce the formation of unwanted chlorinated organic compounds. A high pH in the chlorination stage is also known to reduce the formation of chlorinated organic compounds, but normally this also results in a decreased pulp yield. A high pH, in combination with split chlorine addition, however, has been observed to reduce the formation of chlorinated compounds without a loss of yield. It was reported that by using split chlorine addition, the generation of certain dioxin and furan molecules were reduced by up to 70 percent. With the addition of pH control these discharges reportedly fell by 90 percent. However, consistency in reduction of chlorinated organic pollutants has be problematic.

Improved Chipping and Screening. The size and thickness of wood chips is critical for proper circulation and penetration of the pulping chemicals. Chip uniformity is controlled by the chipper and screens that remove under and oversized pieces. Standard equipment normally does not sort chips by thickness although it has been demonstrated that chip thickness is extremely important in determining the lignin content of pulp. Improper chip thicknesses can therefore result in increased use of bleaching chemicals and the associated chlorinated compounds and conventional pollutants. Some mills are beginning to incorporate equipment that will separate chips according to their thickness as well as by length and width.

Oxygen-Reinforced/Peroxide Extraction. Oxygen-reinforced extraction (or oxidative extraction) and peroxide-reinforced extraction processes used separately or together have been shown to reduce the amount of elemental chlorine and chlorine dioxide needed in the bleaching process while increasing the pulp brightness. Gaseous elemental oxygen (in the case of oxygen-reinforced extraction) and aqueous hydrogen peroxide (in the case of peroxide extraction) are used as a part of the first alkaline extraction stage to facilitate the solubilization and removal of chlorinated and oxidized lignin molecules. Oxygen-reinforced extraction has seen widespread adoption by the industry in recent years. It is estimated that up to 80 percent of mills in the U.S. are using oxygen-reinforced extraction. The use of peroxide extraction is also increasing. As of 1987, it was estimated that 25 percent of domestic mills were using peroxide extraction. As of 1993, EPA estimates that approximately 70 percent of domestic mills practice some type of enhanced extraction process.

Improved Chemical Controls and Mixing. The formation of chlorinated organics can be minimized by avoiding excess concentrations of chlorine-based bleaching chemicals within reactor vessels. This can be accomplished by carefully controlling the chemical application rates and by ensuring proper mixing of chemicals within the reactor. Modern chemical application control and monitoring systems and high-shear mixers have been developed which decrease formation of chlorinated organic compounds.

VI. SUMMARY OF APPLICABLE FEDERAL STATUTES AND REGULATIONS

This section discusses the Federal statutes and regulations that may apply to this sector. The purpose of this section is to highlight, and briefly describe the applicable Federal requirements, and to provide citations for more detailed information. The three following sections are included.

- Section VI.A. contains a general overview of major statutes
- Section VI.B. contains a list of regulations specific to this industry
- Section VI.C. contains a list of pending and proposed regulations

The descriptions within Section VI are intended solely for general information. Depending upon the nature or scope of the activities at a particular facility, these summaries may or may not necessarily describe all applicable environmental requirements. Moreover, they do not constitute formal interpretations or clarifications of the statutes and regulations. For further information, readers should consult the Code of Federal Regulations and other state or local regulatory agencies. EPA Hotline contacts are also provided for each major statute.

VI.A. General Description of Major Statutes

Resource Conservation and Recovery Act (RCRA)

The Resource Conservation And Recovery Act (RCRA) of 1976, which amended the Solid Waste Disposal Act, addresses solid (Subtitle D) and hazardous (Subtitle C) waste management activities. The Hazardous and Solid Waste Amendments (HSWA) of 1984 strengthened RCRA's hazardous waste management provisions and added Subtitle I, which governs underground storage tanks (USTs).

Regulations promulgated pursuant to Subtitle C of RCRA (40 CFR Parts 260-299) establish a "cradle-to-grave" system governing hazardous waste from the point of generation to disposal. RCRA hazardous wastes include the specific materials listed in the regulations (commercial chemical products, designated with the code "P" or "U"; hazardous wastes from specific industries/sources, designated with the code "K"; or hazardous wastes from non-specific sources, designated with the code "F") and materials which exhibit a hazardous waste characteristic (ignitability, corrosivity, reactivity, or toxicity and designated with the code "D").

Regulated entities that generate hazardous waste are subject to waste accumulation, manifesting, and record keeping standards. Facilities that treat, store, or dispose of hazardous waste must obtain a permit, either from

EPA or from a State agency which EPA has authorized to implement the permitting program. Subtitle C permits contain general facility standards such as contingency plans, emergency procedures, record keeping and reporting requirements, financial assurance mechanisms, and unit-specific standards. RCRA also contains provisions (40 CFR Part 264, Subpart S and §264.10) for conducting corrective actions which govern the cleanup of releases of hazardous waste or constituents from solid waste management units at RCRA-regulated facilities.

Although RCRA is a Federal statute, many States implement the RCRA program. Currently, EPA has delegated its authority to implement various provisions of RCRA to 46 of the 50 States.

Most RCRA requirements are not industry specific but apply to any company that transports, treats, stores, or disposes of hazardous waste. Here are some important RCRA regulatory requirements:

- **Identification of Hazardous Wastes** (40 CFR Part 261) lays out the procedure every generator should follow to determine whether the material created is considered a hazardous waste, solid waste, or is exempted from regulation.

- **Standards for Generators of Hazardous Waste** (40 CFR Part 262) establishes the responsibilities of hazardous waste generators including obtaining an ID number, preparing a manifest, ensuring proper packaging and labeling, meeting standards for waste accumulation units, and record keeping and reporting requirements. Generators can accumulate hazardous waste for up to 90 days (or 180 days depending on the amount of waste generated) without obtaining a permit.

- **Land Disposal Restrictions** (LDRs) are regulations prohibiting the disposal of hazardous waste on land without prior treatment. Under the LDRs (40 CFR Part 268), materials must meet land disposal restriction (LDR) treatment standards prior to placement in a RCRA land disposal unit (landfill, land treatment unit, waste pile, or surface impoundment). Wastes subject to the LDRs include solvents, electroplating wastes, heavy metals, and acids. Generators of waste subject to the LDRs must provide notification of such to the designated TSD facility to ensure proper treatment prior to disposal.

- **Used Oil Management Standards** (40 CFR Part 279) impose management requirements affecting the storage, transportation, burning, processing, and re-refining of the used oil. For parties that merely generate used oil, regulations establish storage standards. For a party considered a used oil marketer (one who generates and sells off-specification used oil directly to a used oil burner), additional tracking and paperwork requirements must be satisfied.

- **Tanks and Containers** used to store hazardous waste with a high volatile organic concentration must meet emission standards under RCRA. Regulations (40 CFR Part 264-265, Subpart CC) require generators to test the waste to determine the concentration of the waste, to satisfy tank and container emissions standards, and to inspect and monitor regulated units. These regulations apply to all facilities who store such waste, including generators operating under the 90-day accumulation rule.

- **Underground Storage Tanks** (USTs) containing petroleum and CERCLA hazardous substance are regulated under Subtitle I of RCRA. Subtitle I regulations (40 CFR Part 280) contain tank design and release detection requirements, as well as financial responsibility and corrective action standards for USTs. The UST program also establishes increasingly stringent standards, including upgrade requirements for existing tanks, that must be met by 1998.

- **Boilers and Industrial Furnaces** (BIFs) that use or burn fuel containing hazardous waste must comply with strict design and operating standards. BIF regulations (40 CFR Part 266, Subpart H) address unit design, provide performance standards, require emissions monitoring, and restrict the type of waste that may be burned.

EPA's RCRA/Superfund/UST Hotline, at (800) 424-9346, responds to questions and distributes guidance regarding all RCRA regulations. The RCRA Hotline operates weekdays from 8:30 a.m. to 7:30 p.m., ET, excluding Federal holidays.

Comprehensive Environmental Response, Compensation, And Liability Act (CERCLA)

CERCLA, a 1980 law commonly known as Superfund, authorizes EPA to respond to releases, or threatened releases, of hazardous substances that may present an imminent and substantial endangerment to public health, welfare, or the environment. CERCLA also enables EPA to force parties responsible for environmental contamination to clean it up or to reimburse the Superfund for response costs incurred by EPA. The Superfund Amendments and Reauthorization Act (SARA) of 1986 revised various sections of CERCLA, extended the taxing authority for the Superfund, and created a free-standing law, SARA Title III, also known as the Emergency Planning and Community Right-to-Know Act (EPCRA).

The CERCLA **hazardous substance release reporting regulations** (40 CFR Part 302) direct the person in charge of a facility to report to the National Response Center (NRC) any environmental release of a hazardous substance which exceeds a reportable quantity. Reportable quantities are defined and listed in 40 CFR §302.4. A release report may trigger a response by EPA or by one or more Federal or State emergency response authorities.

EPA implements **hazardous substance responses** according to procedures outlined in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 CFR Part 300). The NCP includes provisions for permanent cleanups, known as remedial actions, and other cleanups referred to as "removals." EPA generally takes remedial actions only at sites on the National Priorities List (NPL), which currently includes approximately 1,300 sites. Both EPA and states can act at other sites; however, EPA provides responsible parties the opportunity to conduct removal and remedial actions and encourages community involvement throughout the Superfund response process.

EPA's RCRA/Superfund/UST Hotline, at (800) 424-9346, answers questions and references guidance pertaining to the Superfund program. The CERCLA Hotline operates weekdays from 8:30 a.m. to 7:30 p.m., ET, excluding Federal holidays.

Emergency Planning And Community Right-To-Know Act (EPCRA)

The Superfund Amendments and Reauthorization Act (SARA) of 1986 created EPCRA, also known as SARA Title III, a statute designed to improve community access to information about chemical hazards and to facilitate the development of chemical emergency response plans by State and local governments. EPCRA required the establishment of State emergency response commissions (SERCs), responsible for coordinating certain emergency response activities and for appointing local emergency planning committees (LEPCs).

EPCRA and the EPCRA regulations (40 CFR Parts 350-372) establish four types of reporting obligations for facilities which store or manage specified chemicals:

- **EPCRA §302** requires facilities to notify the SERC and LEPC of the presence of any "extremely hazardous substance" (the list of such substances is in 40 CFR Part 355, Appendices A and B) if it has such substance in excess of the substance's threshold planning quantity, and directs the facility to appoint an emergency response coordinator.

- **EPCRA §304** requires the facility to notify the SERC and the LEPC in the event of a non-exempt release exceeding the reportable quantity of a CERCLA hazardous substance or an EPCRA extremely hazardous substance.

- **EPCRA §311 and §312** require a facility at which a hazardous chemical, as defined by the Occupational Safety and Health Act, is present in an amount exceeding a specified threshold of chemical use to submit to the SERC, LEPC and local fire department material safety data sheets (MSDSs) or lists of MSDS's and hazardous chemical inventory forms (also known as Tier I and II forms). This information helps the local government respond in the event of a spill or release of the chemical.

- **EPCRA §313** requires manufacturing facilities included in SIC codes 20 through 39, which have ten or more employees, and which manufacture, process, or use specified chemicals in amounts greater than threshold quantities, to submit an annual toxic chemical release report. This report, commonly known as the Form R, covers releases and transfers of toxic chemicals to various facilities and environmental media, and allows EPA to compile the national Toxic Release Inventory (TRI) database.

All information submitted pursuant to EPCRA regulations is publicly accessible, unless protected by a trade secret claim.

EPA's EPCRA Hotline, at (800) 535-0202, answers questions and distributes guidance regarding the emergency planning and community right-to-know regulations. The EPCRA Hotline operates weekdays from 8:30 a.m. to 7:30 p.m., ET, excluding Federal holidays.

Clean Water Act (CWA)

The primary objective of the Federal Water Pollution Control Act, commonly referred to as the CWA, is to restore and maintain the chemical, physical, and biological integrity of the nation's surface waters. Pollutants regulated under the CWA include "priority" pollutants, including various toxic pollutants; "conventional" pollutants, such as biochemical oxygen demand (BOD), total suspended solids (TSS), fecal coliform, oil and grease, and pH; and "non-conventional" pollutants, including any pollutant not identified as either conventional or priority.

The CWA regulates both direct and indirect discharges. The **National Pollutant Discharge Elimination System (NPDES)** program (CWA §402) controls direct discharges into navigable waters. Direct discharges or "point source" discharges are from sources such as pipes and sewers. NPDES permits, issued by either EPA or an authorized State (EPA has presently authorized forty States to administer the NPDES program), contain industry-specific, technology-based and/or water quality-based limits, and establish pollutant monitoring reporting requirements. A facility that intends to discharge into the nation's waters must obtain a permit prior to initiating a discharge. A permit applicant must provide quantitative analytical data identifying the types of pollutants present in the facility's effluent. The permit will then set forth the conditions and effluent limitations under which a facility may make a discharge.

A NPDES permit may also include discharge limits based on Federal or State water quality criteria or standards, that were designed to protect designated uses of surface waters, such as supporting aquatic life or recreation. These standards, unlike the technological standards, generally do not take into account technological feasibility or costs. Water quality criteria and standards vary from State to State, and site to site, depending on the use classification of the receiving body of water. Most States follow EPA guidelines which propose aquatic life and human health criteria for many of the 126 priority pollutants.

Storm Water Discharges

In 1987 the CWA was amended to require EPA to establish a program to address **storm water discharges**. In response, EPA promulgated the NPDES storm water permit application regulations. Stormwater discharge associated with industrial activity means the discharge from any conveyance which is used for collecting and conveying stormwater and which is directly related to manufacturing, processing or raw material storage areas at an industrial plant (40 CFR 122.26(b)(14)). These regulations require that facilities with the following storm water discharges apply for an NPDES permit: (1) a discharge associated with industrial activity; (2) a discharge from a large or medium municipal storm sewer system; or (3) a discharge which EPA or the State determines to contribute to a violation of a water quality standard or is a significant contributor of pollutants to waters of the United States.

The term "storm water discharge associated with industrial activity" means a storm water discharge from one of 11 categories of industrial activity defined at 40 CFR 122.26. Six of the categories are defined by SIC codes while the other five are identified through narrative descriptions of the regulated industrial activity. If the primary SIC code of the facility is one of those identified in the regulations, the facility is subject to the storm water permit application requirements. If any activity at a facility is covered by one of the five narrative categories, storm water discharges from those areas where the activities occur are subject to storm water discharge permit application requirements.

Those facilities/activities that are subject to storm water discharge permit application requirements are identified below. To determine whether a particular facility falls within one of these categories, the regulation should be consulted.

Category i: Facilities subject to storm water effluent guidelines, new source performance standards, or toxic pollutant effluent standards.

Category ii: Facilities classified as SIC 24-lumber and wood products (except wood kitchen cabinets); SIC 26-paper and allied products (except paperboard containers and products); SIC 28-chemicals and allied products (except drugs and paints); SIC 291-petroleum refining; and SIC 311-leather tanning and finishing.

Category iii: Facilities classified as SIC 10-metal mining; SIC 12-coal mining; SIC 13-oil and gas extraction; and SIC 14-nonmetallic mineral mining.

Category iv: Hazardous waste treatment, storage, or disposal facilities.

Category v: Landfills, land application sites, and open dumps that receive or have received industrial wastes.

Category vi: Facilities classified as SIC 5015-used motor vehicle parts; and SIC 5093-automotive scrap and waste material recycling facilities.

Category vii: Steam electric power generating facilities.

Category viii: Facilities classified as SIC 40-railroad transportation; SIC 41-local passenger transportation; SIC 42-trucking and warehousing (except public warehousing and storage); SIC 43-U.S. Postal Service; SIC 44-water transportation; SIC 45-transportation by air; and SIC 5171-petroleum bulk storage stations and terminals.

Category ix: Sewage treatment works.

Category x: Construction activities except operations that result in the disturbance of less than five acres of total land area.

Category xi: Facilities classified as SIC 20-food and kindred products; SIC 21-tobacco products; SIC 22-textile mill products; SIC 23-apparel related products; SIC 2434-wood kitchen cabinets manufacturing; SIC 25-furniture and fixtures; SIC 265-paperboard containers and boxes; SIC 267-converted paper and paperboard products; SIC 27-printing, publishing, and allied industries; SIC 283-drugs; SIC 285-paints, varnishes, lacquer, enamels, and allied products; SIC 30-rubber and plastics; SIC 31-leather and leather products (except leather and tanning and finishing); SIC 323-glass products; SIC 34-fabricated metal products (except fabricated structural metal); SIC 35-industrial and commercial machinery and computer equipment; SIC 36-electronic and other electrical equipment and components; SIC 37-transportation equipment (except ship and boat building and repairing); SIC 38-measuring, analyzing, and controlling instruments; SIC 39-miscellaneous manufacturing industries; and SIC 4221-4225-public warehousing and storage.

Pretreatment Program

Another type of discharge that is regulated by the CWA is one that goes to a publicly-owned treatment works (POTWs). The national **pretreatment program** (CWA §307(b)) controls the indirect discharge of pollutants to POTWs by "industrial users." Facilities regulated under §307(b) must meet certain pretreatment standards. The goal of the pretreatment program is to protect municipal wastewater treatment plants from damage that may occur when hazardous, toxic, or other wastes are discharged into a sewer system and to protect the toxicity characteristics of sludge generated by these plants. Discharges to a POTW are regulated primarily by the POTW itself, rather than the State or EPA.

EPA has developed general pretreatment standards and technology-based standards for industrial users of POTWs in many industrial categories. Different standards may apply to existing and new sources within each category. "Categorical" pretreatment standards applicable to an industry on a nationwide basis are developed by EPA. In addition, another kind of pretreatment standard, "local limits," are developed by the POTW in order to assist the POTW in achieving the effluent limitations in its NPDES permit.

Regardless of whether a State is authorized to implement either the NPDES or the pretreatment program, if it develops its own program, it may enforce requirements more stringent than Federal standards.

EPA's Office of Water, at (202) 260-5700, will direct callers with questions about the CWA to the appropriate EPA office. EPA also maintains a bibliographic database of Office of Water publications which can be accessed through the Ground Water and Drinking Water resource center, at (202) 260-7786.

Safe Drinking Water Act (SDWA)

The SDWA mandates that EPA establish regulations to protect human health from contaminants in drinking water. The law authorizes EPA to develop national drinking water standards and to create a joint Federal-State system to ensure compliance with these standards. The SDWA also directs EPA to protect underground sources of drinking water through the control of underground injection of liquid wastes.

EPA has developed primary and secondary drinking water standards under its SDWA authority. EPA and authorized States enforce the primary drinking water standards, which are, contaminant-specific concentration limits that apply to certain public drinking water supplies. Primary drinking water standards consist of maximum contaminant level goals (MCLGs), which are non-enforceable health-based goals, and maximum contaminant levels (MCLs), which are enforceable limits set as close to MCLGs as possible, considering cost and feasibility of attainment.

The SDWA **Underground Injection Control** (UIC) program (40 CFR Parts 144-148) is a permit program which protects underground sources of drinking water by regulating five classes of injection wells. UIC permits include design, operating, inspection, and monitoring requirements. Wells used to inject hazardous wastes must also comply with RCRA corrective action standards in order to be granted a RCRA permit, and must meet applicable RCRA land disposal restrictions standards. The UIC permit program is primarily State-enforced, since EPA has authorized all but a few States to administer the program.

The SDWA also provides for a Federally-implemented Sole Source Aquifer program, which prohibits Federal funds from being expended on projects that may contaminate the sole or principal source of drinking water for a given area, and for a State-implemented Wellhead Protection program, designed to protect drinking water wells and drinking water recharge areas.

EPA's Safe Drinking Water Hotline, at (800) 426-4791, answers questions and distributes guidance pertaining to SDWA standards. The Hotline operates from 9:00 a.m. through 5:30 p.m., ET, excluding Federal holidays.

Toxic Substances Control Act (TSCA)

TSCA granted EPA authority to create a regulatory framework to collect data on chemicals in order to evaluate, assess, mitigate, and control risks which may be posed by their manufacture, processing, and use. TSCA provides a variety of control methods to prevent chemicals from posing unreasonable risk.

TSCA standards may apply at any point during a chemical's life cycle. Under TSCA §5, EPA has established an inventory of chemical substances. If a chemical is not already on the inventory, and has not been excluded by TSCA, a premanufacture notice (PMN) must be submitted to EPA prior to manufacture or import. The PMN must identify the chemical and provide available information on health and environmental effects. If available data are not sufficient to evaluate the chemicals effects, EPA can impose restrictions pending the development of information on its health and environmental effects. EPA can also restrict significant new uses of chemicals based upon factors such as the projected volume and use of the chemical.

Under TSCA §6, EPA can ban the manufacture or distribution in commerce, limit the use, require labeling, or place other restrictions on chemicals that pose unreasonable risks. Among the chemicals EPA regulates under §6 authority are asbestos, chlorofluorocarbons (CFCs), and polychlorinated biphenyls (PCBs).

EPA's TSCA Assistance Information Service, at (202) 554-1404, answers questions and distributes guidance pertaining to Toxic Substances Control Act standards. The Service operates from 8:30 a.m. through 4:30 p.m., ET, excluding Federal holidays.

Clean Air Act (CAA)

The CAA and its amendments, including the Clean Air Act Amendments (CAAA) of 1990, are designed to "protect and enhance the nation's air resources so as to promote the public health and welfare and the productive capacity of the population." The CAA consists of six sections, known as Titles, which direct EPA to establish national standards for ambient air quality and for EPA and the States to implement, maintain, and enforce these standards through a variety of mechanisms. Under the CAAA, many facilities will be required to obtain permits for the first time. State and local governments oversee, manage, and enforce many of the requirements of the CAAA. CAA regulations appear at 40 CFR Parts 50-99.

Pursuant to Title I of the CAA, EPA has established national ambient air quality standards (NAAQSs) to limit levels of "criteria pollutants," including carbon monoxide, lead, nitrogen dioxide, particulate matter, ozone, and sulfur dioxide. Geographic areas that meet NAAQSs for a given pollutant are classified as attainment areas; those that do not meet NAAQSs are classified as non-attainment areas. Under §110 of the CAA, each State must develop a State Implementation Plan (SIP) to identify sources of air pollution and to determine what reductions are required to meet Federal air quality standards.

Title I also authorizes EPA to establish New Source Performance Standards (NSPSs), which are nationally uniform emission standards for new stationary sources falling within particular industrial categories. NSPSs are based on the pollution control technology available to that category of industrial source but allow the affected industries the flexibility to devise a cost-effective means of reducing emissions.

Under Title I, EPA establishes and enforces National Emission Standards for Hazardous Air Pollutants (NESHAPs), nationally uniform standards oriented towards controlling particular hazardous air pollutants (HAPs). Title III of the CAAA further directed EPA to develop a list of sources that emit any of 189 HAPs, and to develop regulations for these categories of sources. To date EPA has listed 174 categories and developed a schedule for the establishment of emission standards. The emission standards are being developed for both new and existing sources based on "maximum achievable control technology (MACT)." The MACT is defined as the control technology achieving the maximum degree of reduction in the emission of the HAPs, taking into account cost and other factors.

Title II of the CAA pertains to mobile sources, such as cars, trucks, buses, and planes. Reformulated gasoline, automobile pollution control devices, and vapor recovery nozzles on gas pumps are a few of the mechanisms EPA uses to regulate mobile air emission sources.

Title IV establishes a sulfur dioxide emissions program designed to reduce the formation of acid rain. Reduction of sulfur dioxide releases will be obtained by granting to certain sources limited emissions allowances, which, beginning in 1995, will be set below previous levels of sulfur dioxide releases.

Title V of the CAAA of 1990 created an operating permit program for all "major sources" (and certain other sources) regulated under the CAA. One purpose of the operating permit is to include in a single document all air emissions requirements that apply to a given facility. States are developing the permit programs in accordance with guidance and regulations from EPA. Once a State program is approved by EPA, permits will be issued and monitored by that State.

Title VI is intended to protect stratospheric ozone by phasing out the manufacture of ozone-depleting chemicals and restricting their use and distribution. Production of Class I substances, including 15 kinds of chlorofluorocarbons (CFCs), will be phased out entirely by the year 2000, while certain hydrochlorofluorocarbons (HCFCs) will be phased out by 2030.

EPA's Control Technology Center, at (919) 541-0800, provides general assistance and information on CAA standards. The Stratospheric Ozone Information Hotline, at (800) 296-1996, provides general information about regulations promulgated under Title VI of the CAA, and EPA's EPCRA Hotline, at (800) 535-0202, answers questions about accidental release prevention under CAA §112(r). In addition, the Technology Transfer Network Bulletin Board System (modem access (919) 541-5742)) includes recent CAA rules, EPA guidance documents, and updates of EPA activities.

VI.B. Industry Specific Requirements

Effluent guidelines were promulgated for various subcategories of the pulp and paper industry in 1974 and 1977, with additional guidelines promulgated in 1982, primarily in the secondary fiber and nonintegrated segments of the industry. Pulp and paper facilities also may generate a number of wastestreams that are subject to RCRA requirements. In addition, they are frequently large emitters of VOCs, NO_x, SO_x and reduced sulfur compounds and thus may be subject to state requirements established by the State Implementation Plan (SIP) process. New Source Performance Standards under the Clean Air Act have been in place since 1978. In addition, all but the smaller pulp and paper mills, in terms of employees and chemical usage, are also subject to Emergency Planning and Community Right-to Know Act requirements.

Trends in the industry's production technologies and processes are greatly influenced by a series of environmental regulations initiated in 1974. Pulp and paper mills are currently the subject of an integrated rulemaking covering effluent guidelines for process wastewater discharges and National Emissions Standards for Hazardous Air Pollutants (NESHAP). RCRA rules under development may also affect wastewater treatment in surface impoundments. In addition, an ongoing risk assessment will determine the need for additional restrictions on the disposal of wastewater treatment sludge.

Federal Statutes

Clean Air Act (CAA)

In 1978, under §111 of the CAA, EPA promulgated New Source Performance Standards (NSPS) to limit emissions of particulate matter (PM) and total reduced sulfur (TRS) for kraft pulp mills (FR 7568). The NSPS applied specifically to: recovery furnaces, smelt dissolving tanks, lime kilns, digester systems, brownstock washer systems, multiple effect evaporators, black liquor oxidation systems, and condensate stripper systems. The 1978 NSPS also applies to existing plants modified after September 24, 1976.

Minor revisions and corrections to these regulations were promulgated on May 20, 1986 (FR 18538) Under §111(d), the CAA covers state plans for control of existing sources of non-criteria pollutants (e.g., TRS). Section 112 concerns hazardous air pollutant standards, some of which affect the pulp and paper industry.

Title I - Provisions for Attainment and Maintenance of the National Ambient Air Quality Standards:

- NO_x and SO_x controls established as part of State Implementation Plans (SIPs) may be applicable to energy generation at some mills.

Air emissions from pulp and paper mills are more often covered by state regulations rather than federal regulations (although the state requirements are often federally enforceable as part of the State Implementation Plan). Kraft pulp mills that have been constructed or modified after September 24, 1976 may be subject to New Source Performance Standard (NSPS) emission limitation, monitoring, and reporting requirements at 40 CFR Part 60 Subpart BB, which limit particulate matter and total reduced sulfur (TRS). (Existing kraft pulp mill sources are often covered by state TRS emission limitations, many of which were established under Clean Air Act Section 111(d)). In addition, fossil-fuel-fired boilers that heat water or other heat transfer media and have a heat input rate over 250 million Btu per hour are subject to NPS limits for particulate, sulfur dioxide, and nitrogen oxide under 40 CFR Part 60 Subpart D, if constructed or "modified" after August 17, 1971. Fossil-fuel-fired boilers that commence construction or "modification" after June 19, 1984 may be subject to more stringent limits for particulate, sulfur dioxide, or nitrogen oxide under Subpart Db; those NPS regulations apply to fossil-fuel-fired boilers greater than 100 million Btu per hour. NSPS for smaller boilers, between 10 and 100 million Btu per hour, have construction or "modification" after June 9, 1989. Some mills also operate gas turbines subject to NSPS in 40 CFR Part 60 Subpart GG.

Frequently, pulp and paper mills have installed new equipment or modified equipment that produced a significant net emissions increase above thresholds for the Prevention of Significant Deterioration (PSD) or nonattainment new source review (NSR) regulations. In those cases, the source should have received a PSD/NSR permit from either EPA or the state air pollution control agency, and such permits impose additional limitations beyond those contained in federal and state categorical emission standards, including emission limitations based on the Best Available Control Technology (BACT) or Lowest Achievable Emission Rate (LAER) for pollutants for which there was a significant increase.

State air pollution regulations frequently impose numerous additional limitations on emissions from pulp and paper mills, including limits on both stack and fugitive emissions of particulate matter, volatile organic compound emission limitations or usage restrictions, and TRS emission limitations designed to control odor.

Resource Conservation and Recovery Act (RCRA)

The pulp and paper industry generates a variety of RCRA wastes, but most are managed through wastewater treatment systems. RCRA listed wastes outside of wastewater streams are typically generated in small quantities. Other wastes may be managed on a case-by-case basis as hazardous where one or more hazardous characteristics (e.g., ignitable, toxic, reactive, corrosive) are found. The majority of the industry's wastestreams are nonhazardous wastewaters and sludge. The industry has a pulping liquor exemption.

As a result of an Environmental Defense Fund suit and resultant consent decree, the "RCRA mega-deadline" requires EPA to consider whether paper mill wastewater treatment sludges meet the criteria for listing as hazardous wastes. This determination is expected to occur pursuant to completion of the final effluent guidelines. The exception to this requirement is for effluent guidelines based on the use of oxygen delignification, ozone bleaching, prenox bleaching, enzymatic bleaching, hydrogen peroxide bleaching, oxygen and peroxide enhanced extraction, or any other technology involving substantially similar reductions in uses of chlorine-containing compounds. EPA has deferred any work on the proposed regulations regarding land application of sludges because the AF&PA and EPA signed the land application stewardship agreement.

Emergency Planning and Community Right-to-Know Act (EPCRA)

- Emergency Planning (§302(a)) - Businesses that produce, use or store "hazardous chemicals" at or above "threshold planning quantities" must: 1) submit material safety data sheets or the equivalent, and 2) Tier I/Tier II annual inventory report forms to the appropriate local emergency planning commission. Those handling "extremely hazardous substances" are also required to submit a one-time notice to the state emergency response commission.

- Emergency Notification of Extremely Hazardous Substance Release (§304) - A business that unintentionally releases a reportable quantity of an extremely hazardous substance must report that release to the state emergency planning commission and the local emergency planning commission.

- Release Reporting (§313) - Manufacturing businesses with ten or more employees that manufactured, processed, or otherwise used a listed toxic chemical in excess of the "established threshold" must file annually a Toxic Chemical Release form with EPA and the state. Approximately 296 pulp and paper facilities nationwide submitted forms summarizing their chemical releases in 1992. Documentation supporting release estimates made must be kept for three years.

Clean Water Act (CWA)

On May 9, 1974, May 29, 1974 and January 6, 1977, EPA promulgated a series of effluent guidelines for different subcategories within the pulp, paper, and paperboard industry. These regulations focused on reducing conventional pollutants, such as biochemical oxygen demand, suspended solids, and pH following some revisions and additional focus on toxic pollutant discharges regulations were revised in 1982 and 1986 (51 FR 45232). The existing effluent guidelines (BPT, BAT, NSPS, PSES, include PSN (47 FR 52006) were promulgated on November 18, 1982 for all but one of the pulp, paper and paperboard subcategories. BCT standards were promulgated in 1986 .

Wastewater discharges from most pulp and paper mills are covered by BCT and BAT effluent limitations guidelines (or, in the case of indirect discharges, pretreatment standards) in 40 CFR Part 430. Those regulations specify production-based effluent limitations for biochemical oxygen demand, total suspended solids, and pH. Many pulp and paper mills have NPDES permit limitations more stringent than the BCT and BAT guidelines would allow, because they discharge to water-quality-limited streams. Those limitations are derived by the permitting authority pursuant to Clean Water Act section 301 (b)(1)(C) and 40 CFR § 122.44(d). For many bleached chemical pulp mills, water-quality-based permit limitations for 2,3,7,8-TCDD have been issued as Individual Control Strategies under Clean Water Act Section 304(1).

Of course, pulp and paper mills are also potentially subject to numerous other generic regulations under the Clean Water Act, such as stormwater permitting requirements, spill control planning requirements for facilities that store petroleum products, general pretreatment standards under 40 CFR Part 403 for indirect dischargers, and permitting for dredge and fill activities under Clean Water Act Section 404. Most states also have their own discharge permitting and water pollution control regulations.

State Statutes

In 1986, six states (CA, KY, LA, MD, NC, and SC) had fully EPA-approved Section 111(d) plans to control TRS at kraft pulp mills, two states had approved TRS standards but their compliance schedules had not yet been approved (AR and GA), and Tennessee's and Florida's plans had been submitted to Region IV for approval. Since that time, a number of states have received approval on their plans to control TRS from existing kraft pulp mills under Section 111(d). In addition, in 1986, twelve states had state regulations on kraft pulping TRS emissions outside of Section 111(d) approved plans (AL, AZ, FL, ID, MT, NH, OH, OK, OR, TN, VA, and WA). In general, particulate matter (PM) emissions limits are established on a per ton of pulp produced basis and/or for specific processes (e.g., lime kilns, smelt tanks, and recovery furnaces). Certain states also established opacity limits and performance standards for specific processes. Investigations related to the integrated rulemaking identified seventeen states with regulations specific to the pulp and paper industry. (Contact: Debra Nicoll OW, ESAB 202-260-5385)

VI.C. Pending and Proposed Regulatory Requirements

In 1992, the pulp and paper industry was identified in the Source Reduction Review Project (SRRP) as an industry for which a more integrated (across environmental media) approach to rulemaking was warranted. In addition, the Senior Policy Council emphasized that upstream process controls were to be investigated as possible regulatory control options (Contact: Jordan Spooner 202-260-4418). On December 17, 1993, EPA proposed integrated NESHAP and effluent guidelines for the pulp and paper industry. The rules apply to mills in SIC codes 2611, 2621, 2631, and 2661. One key element of the integrated rulemaking was to propose revisions to EPA's subcategorization scheme for effluent guidelines. (The table identifies which proposed rules apply to the various pulp and paper subcategories.) The Agency is currently re-evaluating the 1993 proposal based on comments and new information.

Exhibit 30: Scope of Proposed Integrated Air and Water Rules for Pulp and Paper					
Effluent Guidelines			Clean Water Act		
Subcategory	Subpart	CAA NESHAP	Toxics: BAT/PSES	Conventionals: BPT	BMPs*
Dissolving Kraft	A	X	X	X	X
Bleached Papergrade Kraft and Soda	B	X	X	X	X
Unbleached Kraft	C	X	X	X	X
Dissolving Sulfite	D	X	X	X	X
Papergrade Sulfite	E	X	X	X	X
Semi-Chemical	F	X	X	X	X
Mechanical Pulp	G			X	
Non-Wood Chemical	H			X	X
Secondary Fiber Deink	I			X	
Secondary Fiber Non-Deink	J		X (New Sources)	X	
Fine and Lightweight Papers from Purchased Pulp	K			X	
Tissue, Filter, Nonwoven, and Paperboard from Purchased Pulp	L			X	

* Under §304(e) of CWA, EPA proposed Best Management Practices to prevent spills and other losses of pulping liquor.

Clean Air Act Amendments of 1990 (CAAA)

The Clean Air Act Amendments of 1990 included a number of provisions for which the Agency will develop regulations likely to affect pulp and paper facilities directly. Most relevant is the NESHAP for pulp and paper which has been integrated with the proposed effluent guidelines under the Clean Water Act in a recent proposal. (Contact: Penny Lassiter 919-541-5396)

Title I - Provisions for Attainment and Maintenance of the National Ambient Air Quality Standards:

- Ozone nonattainment areas are classified as: marginal, moderate, serious, severe, or extreme. "Major" stationary sources are defined as having potential emissions of 50 tons of VOCs per year in serious areas; 25 tons per year in severe areas; and 10 tons or more in extreme areas. For all other areas, a major source is one that releases 100 tons of VOCs per year. Based on TRI, over 150 pulp and paper facilities release an average of almost 500 tons of methanol per year. Pulp and paper facilities designated a major source are subject to Reasonably Available Control Technology (RACT) requirements. The state must develop and adopt non-CTG (Control Techniques Guidelines) RACT rules for such sources.

Title III - National Emissions Standards for Hazardous Air Pollutants (NESHAP):

- Maximum Achievable Control Technology (MACT) standards are scheduled for a list of 189 Hazardous Air Pollutants (HAPs) listed in §112(b). MACT standards for the pulp and paper industry were proposed along with the effluent guidelines in December 17, 1993. The proposed MACT standard was assumed to control emissions of methanol, hexane, toluene, methyl ethyl ketone, chloroform, chlorine, formaldehyde, acrolein, and acetaldehyde, many of which are VOCs subject to RACT rules under Title I. The air emission points selected for the proposed regulations included all significant points in the pulping and bleaching processes and in the process wastewater collection and treatment systems. Air and water sampling at 16 chemical pulp mills was conducted during 1993 and 1994 by American Forest and Paper Association member companies and the National Council of the Paper Industry for Air and Stream Improvement to assist EPA in developing MACT standards.

Clean Water Act (CWA)

As part of a consent decree with the Environmental Defense Fund and the National Wildlife Federation, EPA was to review the need for revised rulemaking applicable to dioxins and furans for the pulp and paper industry, including wastewater treatment sludge. The analysis of risks pays particular attention to cross-media exposure pathways. OSWER and OPPTS are the lead offices for this effort. One of the key follow-up rulemaking efforts to implement this decree were the revised effluent guidelines under the CWA. In coordination with OSW and OAQPS, the Office of Water proposed effluent guidelines for the pulp and paper industry. Revised BPT and BCT limitations are proposed for all facilities to control conventional pollutants, such as BOD and TSS. BPT concentration limits were based on water recycling and end-of-pipe treatment. Limitations for toxic and non-conventional pollutants were based on the Best Available Technology Economically Achievable (BAT) to the assigned subcategory. BAT technologies relied in-part on in-process controls and modifications. EPA also proposed NSPS and pretreatment standards for both new and existing indirect dischargers. (Contact: Donald Anderson 202-260-7137; David Layland, OSWER, 202-260-4796; Gale Cooper, OPPTS, 202-260-1855)

Resource Conservation and Recovery Act (RCRA)

Two common practices in the pulp and paper industry may be affected by upcoming RCRA rules. First, as a result of the multi-pathway risk assessment, it may be determined that land application of wastewater treatment sludge is too risky. A separate consent decree (*EDF v. Reilly*) requires EPA to consider whether sludge meet the criteria for listing as hazardous wastes, although EPA had proposed a TSCA §6 rule limiting soil concentrations of dioxins and furans. Second, combining of wastewaters in surface impoundments is allowed if there are no hazardous constituents after dilution. The point of generation principle which does not allow dilution prior to removal/minimization of the hazardous character of the waste (in this case corrosivity or ignitability) does not strictly apply. Under an emergency interim rule (58 FR 29860), CWA systems are not immediately affected and current practices are acceptable for now. RCRA rulemakings addressing these systems are scheduled to be finalized in 1995 and 1996 although some requirements of the final integrated rule may address the issues of concern under RCRA.

VII. COMPLIANCE AND ENFORCEMENT HISTORY

Background

To date, EPA has focused much of its attention on measuring compliance with specific environmental statutes. This approach allows the Agency to track compliance with the Clean Air Act, the Resource Conservation and Recovery Act, the Clean Water Act, and other environmental statutes. Within the last several years, the Agency has begun to supplement single-media compliance indicators with facility-specific, multimedia indicators of compliance. In doing so, EPA is in a better position to track compliance with all statutes at the facility level, and within specific industrial sectors.

A major step in building the capacity to compile multimedia data for industrial sectors was the creation of EPA's Integrated Data for Enforcement Analysis (IDEA) system. IDEA has the capacity to "read into" the Agency's single-media databases, extract compliance records, and match the records to individual facilities. The IDEA system can match Air, Water, Waste, Toxics/Pesticides/EPCRA, TRI, and Enforcement Docket records for a given facility, and generate a list of historical permit, inspection, and enforcement activity. IDEA also has the capability to analyze data by geographic area and corporate holder. As the capacity to generate multimedia compliance data improves, EPA will make available more in-depth compliance and enforcement information. Additionally, sector-specific measures of success for compliance assistance efforts are under development.

Compliance and Enforcement Profile Description

Using inspection, violation and enforcement data from the IDEA system, this section provides information regarding the historical compliance and enforcement activity of this sector. In order to mirror the facility universe reported in the Toxic Chemical Profile, the data reported within this section consists of records only from the TRI reporting universe. With this decision, the selection criteria are consistent across sectors with certain exceptions. For the sectors that do not normally report to the TRI program, data have been provided from EPA's Facility Indexing System (FINDS) which tracks facilities in all media databases. Please note, in this section, EPA does not attempt to define the actual number of facilities that fall within each sector. Instead, the section portrays the records of a subset of facilities within the sector that are well defined within EPA databases.

As a check on the relative size of the full sector universe, most notebooks contain an estimated number of facilities within the sector according to the Bureau of Census (See Section II). With sectors dominated by small businesses, such as metal finishers and printers, the reporting universe within the EPA databases may be small in comparison to Census data. However, the group selected for inclusion in this data analysis section should be consistent with this sector's general make-up.

Following this introduction is a list defining each data column presented within this section. These values represent a retrospective summary of inspections or enforcement actions, and solely reflect EPA, state and local compliance assurance activity that have been entered into EPA databases. To identify any changes in trends, the EPA ran two data queries, one for the past five calendar years (August 10, 1990 to August 9, 1995) and the other for the most recent twelve-month period (August 10, 1994 to August 9, 1995). The five-year analysis gives an average level of activity for that period for comparison to the more recent activity.

Because most inspections focus on single-media requirements, the data queries presented in this section are taken from single media databases. These databases do not provide data on whether inspections are state/local or EPA-led. However, the table breaking down the universe of violations does give the reader a general measurement of the EPA's and states' efforts within each media program. The presented data illustrate the variations across regions for certain sectors.[f] This variation may be attributable to state/local data entry variations, specific geographic concentrations, proximity to population centers, sensitive ecosystems, highly toxic chemicals used in production, or historical noncompliance. Hence, the exhibited data do not rank regional performance or necessarily reflect which regions may have the most compliance problems.

Compliance and Enforcement Data Definitions

General Definitions

Facility Indexing System (FINDS) -- this system assigns a common facility number to EPA single-media permit records. The FINDS identification number allows EPA to compile and review all permit, compliance, enforcement and pollutant release data for any given regulated facility.

Integrated Data for Enforcement Analysis (IDEA) -- is a data integration system that can retrieve information from the major EPA program office

[f] EPA Regions include the following states: I (CT, MA, ME, RI, NH, VT); II (NJ, NY, PR, VI); III (DC, DE, MD, PA, VA, WV); IV (AL, FL, GA, KY, MS, NC, SC, TN); V (IL, IN, MI, MN, OH, WI); VI (AR, LA, NM, OK, TX); VII (IA, KS, MO, NE); VIII (CO, MT, ND, SD, UT, WY); IX (AZ, CA, HI, NV, Pacific Trust Territories); X (AK, ID, OR, WA).

databases. IDEA uses the FINDS identification number to "glue together" separate data records from EPA's databases. This is done to create a "master list" of data records for any given facility. Some of the data systems accessible through IDEA are: AIRS (Air Facility Indexing and Retrieval System, Office of Air and Radiation), PCS (Permit Compliance System, Office of Water), RCRIS (Resource Conservation and Recovery Information System, Office of Solid Waste), NCDB (National Compliance Data Base, Office of Prevention, Pesticides, and Toxic Substances), CERCLIS (Comprehensive Environmental and Liability Information System, Superfund), and TRIS (Toxic Release Inventory System). IDEA also contains information from outside sources such as Dun and Bradstreet and the Occupational Safety and Health Administration (OSHA). Most data queries displayed in notebook sections IV and VII were conducted using IDEA.

Data Table Column Heading Definitions

Facilities in Search -- are based on the universe of TRI reporters within the listed SIC code range. For industries not covered under TRI reporting requirements, the notebook uses the FINDS universe for executing data queries. The SIC code range selected for each search is defined by each notebook's selected SIC code coverage described in Section II.

Facilities Inspected -- indicates the level of EPA and state agency inspections for the facilities in this data search. These values show what percentage of the facility universe is inspected in a 12 or 60 month period.

Number of Inspections -- measures the total number of inspections conducted in this sector. An inspection event is counted each time it is entered into a single media database.

Average Time Between Inspections -- provides an average length of time, expressed in months, that a compliance inspection occurs at a facility within the defined universe.

Facilities with One or More Enforcement Actions -- expresses the number of facilities that were party to at least one enforcement action within the defined time period. This category is broken down further into federal and state actions. Data are obtained for administrative, civil/judicial, and criminal enforcement actions. Administrative actions include Notices of Violation (NOVs). A facility with multiple enforcement actions is only counted once in this column (facility with 3 enforcement actions counts as one). All percentages that appear are referenced to the number of facilities inspected.

Total Enforcement Actions -- describes the total number of enforcement actions identified for an industrial sector across all environmental statutes. A facility with multiple enforcement actions is counted multiple times (a facility with 3 enforcement actions counts as 3).

State Lead Actions -- shows what percentage of the total enforcement actions are taken by state and local environmental agencies. Varying levels of use by states of EPA data systems may limit the volume of actions accorded state enforcement activity. Some states extensively report enforcement activities into EPA data systems, while other states may use their own data systems.

Federal Lead Actions -- shows what percentage of the total enforcement actions are taken by the United States Environmental Protection Agency. This value includes referrals from state agencies. Many of these actions result from coordinated or joint state/federal efforts.

Enforcement to Inspection Rate -- expresses how often enforcement actions result from inspections. This value is a ratio of enforcement actions to inspections, and is presented for comparative purposes only. This measure is a rough indicator of the relationship between inspections and enforcement. This measure simply indicates historically how many enforcement actions can be attributed to inspection activity. Reported inspections and enforcement actions under the Clean Water Act (PCS), the Clean Air Act (AFS) and the Resource Conservation and Recovery Act (RCRA) are included in this ratio. Inspections and actions from the TSCA/FIFRA/EPCRA database are not factored into this ratio because most of the actions taken under these programs are not the result of facility inspections. This ratio does not account for enforcement actions arising from non-inspection compliance monitoring activities (e.g., self-reported water discharges) that can result in enforcement action within the CAA, CWA and RCRA.

Facilities with One or More Violations Identified -- indicates the percentage of <u>inspected</u> facilities having a violation identified in one of the following data categories: In Violation or Significant Violation Status (CAA); Reportable Noncompliance, Current Year Noncompliance, Significant Noncompliance (CWA); Noncompliance and Significant Noncompliance (FIFRA, TSCA, and EPCRA); Unresolved Violation and Unresolved High Priority Violation (RCRA). The values presented for this column reflect the extent of noncompliance within the measured time frame, but do not distinguish between the severity of the noncompliance. Percentages within this column can exceed 100 percent because facilities can be in violation status without being inspected. Violation status may be a precursor to an enforcement action, but does not necessarily indicate that an enforcement action will occur.

Media Breakdown of Enforcement Actions and Inspections -- four columns identify the proportion of total inspections and enforcement actions within EPA Air, Water, Waste, and TSCA/FIFRA/EPCRA databases. Each column is a percentage of either the "Total Inspections," or the "Total Actions" column.

VII.A. Pulp and Paper Industry Compliance History

Exhibit 31 provides an overview of the reported compliance and enforcement data for the pulp and paper industry over the past five years (August 1990 to August 1995). These data are also broken out by EPA Region thereby permitting geographical comparisons. A few points evident from the data are listed below.

- The number of different pulp and paper facilities inspected was slightly more than 86 percent of those identified in the IDEA search. Also, these facilities were inspected on average every five months.
- The proportion of enforcement actions to inspections was relatively low at 13 percent.
- Those facilities with one or more enforcement actions had, on average, over the five year period, over four enforcement actions brought against them.

Exhibit 31: Five-Year Enforcement and Compliance Summary for Pulp and Paper Industry

A	B	C	D	E	F	G	H	I	J
Region	Facilities in Search	Facilities Inspected	Number of Inspections	Average Months Between Inspections	Facilities with 1 or More Enforcement Actions	Total Enforcement Actions	Percent State Lead Actions	Percent Federal Lead Actions	Enforcement to Inspection Rate
I	41	39	499	5	20	75	59	41	0.15
II	18	16	222	5	6	12	67	33	0.05
III	28	24	370	5	11	54	89	11	0.15
IV	69	60	1346	3	21	192	88	13	0.14
V	85	68	605	8	21	39	82	18	0.06
VI	24	20	266	5	11	26	77	23	0.10
VII	2	2	8	15	1	2	100	0	0.25
VIII	2	2	20	6	1	4	0	100	0.20
IX	11	8	75	9	4	5	20	80	0.07
X	26	26	355	4	19	93	71	29	0.26
TOTAL	306	265	3766	5	115	502	78	22	0.13

VII.B. Comparison of Enforcement Activity Between Selected Industries

Exhibits 32 and 33 allow the compliance history of the pulp and paper sector to be compared to the other industries covered by the industry sector notebooks. Comparisons between Exhibits 32 and 33 permit the identification of trends in compliance and enforcement records of the industry by comparing data covering the last five years to that of the past year. Some points evident from the data are listed below.

- Of those sectors listed, the pulp and paper industry has been one of the most frequently inspected industries over the past five years based upon its low number of months between inspections.
- State lead actions have dominated the total number of enforcement actions taken against the pulp and paper industry.
- Over the past five years, the pulp and paper and the inorganic chemicals sector have had equal rates of enforcement actions per inspection. These rates are the median value for those industry sectors listed.

Exhibits 34 and 35 provide a more in-depth comparison between the pulp and paper industry and other sectors by breaking out the compliance and enforcement data by environmental statute. As in the previous Exhibits (Exhibits 32 and 33), the data cover the last five years (Exhibit 34) and the last one year (Exhibit 35) to facilitate the identification of recent trends. Two points evident from the data are listed below.

- The number of inspections carried out under the Clean Air Act and the Clean Water Act over the past five years account for close to eighty percent of total enforcement actions within the sample. This figure has increased to ninety percent over the past year.
- The number of enforcement actions taken under the CAA as a percent of the total number of enforcement actions, has increased in the past year compared to the average of the past five years. Over this same time period, the percentage of total enforcement actions under RCRA has decreased.

Exhibit 32: Five-Year Enforcement and Compliance Summary for Selected Industries

A	B	C	D	E	F	G	H	I	J
Industry Sector	Facilities in Search	Facilities Inspected	Number of Inspections	Average Months Between Inspections	Facilities with 1 or More Enforcement Actions	Total Enforcement Actions	Percent State Lead Actions	Percent Federal Lead Actions	Enforcement to Inspection Rate
Pulp and Paper	306	265	3,766	5	115	502	78%	22%	0.13
Printing	4,106	1,035	4,723	52	176	514	85%	15%	0.11
Inorganic Chemicals	548	298	3,034	11	99	402	76%	24%	0.13
Organic Chemicals	412	316	3,864	6	152	726	66%	34%	0.19
Petroleum Refining	156	145	3,257	3	110	797	66%	34%	0.25
Iron and Steel	374	275	3,555	6	115	499	72%	28%	0.14
Dry Cleaning	933	245	633	88	29	103	99%	1%	0.16
Metal Mining	873	339	1,519	34	67	155	47%	53%	0.10
Non-Metallic Mineral Mining	1,143	631	3,422	20	84	192	76%	24%	0.06
Lumber and Wood	464	301	1,891	15	78	232	79%	21%	0.12
Furniture	293	213	1,534	11	34	91	91%	9%	0.06
Rubber and Plastic	1,665	739	3,386	30	146	391	78%	22%	0.12
Stone, Clay, and Glass	468	268	2,475	11	73	301	70%	30%	0.12
Fabricated Metal	2,346	1,340	5,509	26	280	840	80%	20%	0.15
Nonferrous Metal	844	474	3,097	16	145	470	76%	24%	0.15
Electronics	405	222	777	31	68	212	79%	21%	0.27
Automobiles	598	390	2,216	16	81	240	80%	20%	0.11

Exhibit 33: One-Year Inspection and Enforcement Summary for Selected Industries

A	B	C	D	E		F		G	H
Industry Sector	Facilities in Search	Facilities Inspected	Number of Inspections	Facilities with 1 or More Violations		Facilities with 1 or more Enforcement Actions		Total Enforcement Actions	Enforcement to Inspection Rate
				Number	Percent*	Number	Percent*		
Pulp and Paper	**306**	**189**	**576**	**162**	**86%**	**28**	**15%**	**88**	**0.15**
Printing	4,106	397	676	251	63%	25	6%	72	0.11
Inorganic Chemicals	548	158	427	167	106%	19	12%	49	0.12
Organic Chemicals	412	195	545	197	101%	39	20%	118	0.22
Petroleum Refining	156	109	437	109	100%	39	36%	114	0.26
Iron and Steel	374	167	488	165	99%	20	12%	46	0.09
Dry Cleaning	933	80	111	21	26%	5	6%	11	0.10
Metal Mining	873	114	194	82	72%	16	14%	24	0.13
Non-metallic Mineral Mining	1,143	253	425	75	30%	28	11%	54	0.13
Lumber and Wood	464	142	268	109	77%	18	13%	42	0.15
Furniture	293	160	113	66	41%	3	2%	5	0.04
Rubber and Plastic	1,665	271	435	289	107%	19	7%	59	0.14
Stone, Clay, and Glass	468	146	330	116	79%	20	14%	66	0.20
Nonferrous Metals	844	202	402	282	140%	22	11%	72	0.18
Fabricated Metal	2,346	477	746	525	110%	46	10%	114	0.15
Electronics	405	60	87	80	133%	8	13%	21	0.24
Automobiles	598	169	284	162	96%	14	8%	28	0.10

* Percentages in Columns E and F are based on the number of facilities inspected (Column C). Percentages can exceed 100% because violations can occur without a facility inspection.

Exhibit 34: Five-Year Inspection and Enforcement Summary by Statute for Selected Industries

Industry Sector	Facilities Inspected	Total Inspections	Total Enforcement Actions	Clean Air Act		Clean Water Act		Resource Conservation and Recovery Act		FIFRA/TSCA/EPCRA/Other	
				% of Total Inspections	% of Total Actions	% of Total Inspections	% of Total Actions	% of Total Inspections	% of Total Actions	% of Total Inspections	% of Total Actions
Pulp and Paper	265	3,766	502	51%	48%	38%	30%	9%	18%	2%	3%
Printing	1,035	4,723	514	49%	31%	6%	3%	43%	62%	2%	4%
Inorganic Chemicals	298	3,034	402	29%	26%	29%	17%	39%	53%	3%	4%
Organic Chemicals	316	3,864	726	33%	30%	16%	21%	46%	44%	5%	5%
Petroleum Refining	145	3,237	797	44%	32%	19%	12%	35%	52%	2%	5%
Iron and Steel	275	3,555	499	32%	20%	30%	18%	37%	58%	2%	5%
Dry Cleaning	245	633	103	15%	1%	3%	4%	83%	93%	0%	1%
Metal Mining	339	1,519	155	35%	17%	57%	60%	6%	14%	1%	9%
Non-metallic Mineral Mining	631	3,422	192	65%	46%	31%	24%	3%	27%	0%	4%
Lumber and Wood	301	1,891	232	31%	21%	8%	7%	59%	67%	2%	5%
Furniture	213	1,534	91	52%	27%	1%	1%	45%	64%	1%	8%
Rubber and Plastic	739	3,386	391	39%	15%	13%	7%	44%	68%	3%	10%
Stone, Clay, and Glass	268	2,475	301	45%	39%	15%	5%	39%	51%	2%	5%
Nonferrous Metals	474	3,097	470	36%	22%	22%	13%	38%	54%	4%	10%
Fabricated Metal	1,340	5,509	840	25%	11%	15%	6%	56%	76%	4%	7%
Electronics	222	777	212	16%	2%	14%	3%	66%	90%	3%	5%
Automobiles	390	2,216	240	35%	15%	9%	4%	54%	75%	2%	6%

Exhibit 35: One-Year Inspection and Enforcement Summary by Statute for Selected Industries

Industry Sector	Facilities Inspected	Total Inspections	Total Enforcement Actions	Clean Air Act		Clean Water Act		Resource Conservation and Recovery Act		FIFRA/TSCA/ EPCRA/Other	
				% of Total Inspections	% of Total Actions	% of Total Inspections	% of Total Actions	% of Total Inspections	% of Total Actions	% of Total Inspections	% of Total Actions
Pulp and Paper	189	576	88	56%	69%	35%	21%	10%	7%	0%	3%
Printing	397	676	72	50%	27%	5%	3%	44%	66%	0%	4%
Inorganic Chemicals	158	427	49	26%	38%	29%	21%	45%	36%	0%	6%
Organic Chemicals	195	545	118	36%	34%	13%	16%	50%	49%	1%	1%
Petroleum Refining	109	437	114	50%	31%	19%	16%	30%	47%	1%	6%
Iron and Steel	167	488	46	29%	18%	35%	26%	36%	50%	0%	6%
Dry Cleaning	80	111	11	21%	4%	1%	22%	78%	67%	0%	7%
Metal Mining	114	194	24	47%	42%	43%	34%	10%	6%	0%	19%
Non-metallic Mineral Mining	253	425	54	69%	58%	26%	16%	5%	16%	0%	11%
Lumber and Wood	142	268	42	29%	20%	8%	13%	63%	61%	0%	6%
Furniture	113	160	5	58%	67%	1%	10%	41%	10%	0%	13%
Rubber and Plastic	271	435	59	39%	14%	14%	4%	46%	71%	1%	11%
Stone, Clay, and Glass	146	330	66	45%	52%	18%	8%	38%	37%	0%	3%
Nonferrous Metals	202	402	72	33%	24%	21%	3%	44%	69%	1%	4%
Fabricated Metal	477	746	114	25%	14%	14%	8%	61%	77%	0%	2%
Electronics	60	87	21	17%	2%	14%	7%	69%	87%	0%	4%
Automobiles	169	284	28	34%	16%	10%	9%	56%	69%	1%	6%

VII.C. Review of Major Legal Actions

This section provides summary information about major cases that have affected this sector, and a list of Supplementary Environmental Projects (SEPs). SEPs are compliance agreements that reduce a facility's stipulated penalty in return for an environmental project that exceeds the value of the reduction. Often, these projects fund pollution prevention activities that can significantly reduce the future pollutant loadings of a facility.

This section discusses major legal cases and pending litigation within the pulp and paper industry as well as supplemental environmental projects (SEPs) involving pulp and paper facilities. Information regarding major cases or pending litigation is available from the Office of Regulatory Enforcement. Four SEPs are reviewed.

VII.C.1. Review of Major Cases

The Office of Regulatory Enforcement does not regularly compile information related to major cases and pending litigation within an industry sector. The staff are willing to pass along such information to Agency staff as requests are made. (Contact: Pete Rosenberg 202-260-8869) In addition, summaries of completed enforcement actions are published each fiscal year in the *Enforcement Accomplishments Report*; the summaries are not organized by industry sector. (Contact: Robert Banks 202-260-8296)

EPA has entered into several consent decrees with public interest groups but no significant litigation pending with the regulated community were identified. Earlier lawsuits (e.g., *Weyerhaeuser Company, et al. v. Costle*, 590 F. 2nd 1011) concerned applicability of effluent guidelines promulgated in 1974 and 1977. With one exception, the rules were upheld and have been superseded by later rules. The agency is now in the midst of an integrated rulemaking for the pulp and paper industry, the predominant regulations being effluent guidelines and a NESHAP.

A recent report identifies a case where a bleached Kraft paper mill's pollution prevention project, negotiated as part of an enforcement action, provided injunctive relief. That is, the project itself was the means of correcting the existing violation. This differs from supplemental environmental projects (discussed below) which are incidental to the correction of the violation.

The facility faced a $2.9 million fine for violating NPDES permit limits for chronic toxicity. While the fine was not reduced, the company investigated and adopted a totally chlorine-free (TCF) bleaching process which eliminated the use of chlorine and required some process modifications. Under a consent decree to complete the project by 1995, they will use hydrogen peroxide and oxygen for bleaching pulp and have added anthraquinone to the digester to increase lignin removal prior to bleaching. Production costs are expected to be higher and the pulp is not up to the product specifications of commodity-grade market pulp, according to industry sources.[30]

Among the benefits accruing to the company were: reduced health and safety hazards associated with handling and storing chlorine and chlorine dioxide which are highly reactive, reduced costs of plant upkeep associated with the corrosive nature of chlorine, improved community relations. A key factor in selecting this project are the possible competitive advantages in domestic and European markets where demand for TCF pulp exists and is growing. This was the first commercial application of the process technology in the U.S. and there is also the potential to license the technology to other U.S. pulp mills.

VII.C.2. Supplementary Environmental Projects

Supplemental environmental projects (SEPs) are negotiated environmental projects, of which a fraction of the costs may be applied to a facility's original fine amount. Regional summaries of SEPs actions undertaken in the 1993 -1994 federal fiscal years were reviewed. Three SEPs in FY93 and no SEPs in FY94 involved pulp and paper manufacturing facilities, as shown in the following table.

Two of the three SEPs were associated with CERCLA violations, one was associated with EPCRA violations (one facility was subject to both). The specifics of the original violations are not known although some summaries noted the specific sections of the statute violation. As is typical across industry sectors, the cost of two of the pulp and paper SEPs was less than one half the original fine amount. In one case, however, the cost of the SEP to the company exceeded the original fine amount by three- to ten-fold.

All of the SEPs were done in Region IV -- an area with significant pulping and papermaking facilities. The SEPs fall into three categories:

• **Non-process related projects:** Two of the three SEPs involved projects not directly related to the pulp and paper manufacturing processes or its outputs. These projects involved contributions of equipment and/or funds to Local Emergency Planning Committees (LEPCs). The cost to the companies of these SEPs ranged from $6,000 to $9,656.

• **Control and recovery technology installation:** One of the three SEPs involved installation of technological controls to minimize releases to the environment (from spills) and to increase on-site recycling of process chemicals. The project entailed construction of a spill containment and a process chemical recycling system. The cost to company totaled $765,000, the highest of all projects within the sector.

• **Process change:** One facility switched bleaching chemicals, eliminating the use of molecular chlorine (a more difficult to handle and hazardous form) from the manufacturing process. Specifically, the bleaching process will now be based on bleaching pulp using sodium hypochlorite. The cost to company of this process change totaled $72,000.

Exhibit 36: FY-1993-1994 Supplemental Environmental Projects Overview: Pulp and Paper Manufacture

General Information				Violation Information							
FY	Docket #	Company Name	State/ Region	Type	Initial Penalty	Final Penalty	SEP Credit	SEP Cost to Company	Pollutant of Concern	Pollutant Reduction	Supplemental Environmental Project Description
93	6-92-0313	Georgia Pacific	LA	CERCLA 103(a)	$25,000	$5,000	---	$6,000	---	---	Donated emergency and/or computer equipment to LEPC for response/planning for chemical emergencies
93	---	Southern Cellulose Products	Reg. 4	EPCRA 312	$24,000	$1,800	---	$72,000	Chlorine	Eliminated Cl inputs	Changed bleaching process chemical from chlorine to sodium hypochlorite
93	---	Jefferson Smurfit Corp.	Reg. 4	CERCLA 103/EPCRA 304,312	$78,750	$16,000	---	$765,000	Caustic process chemicals	---	Installed system for recycling and spill collection of paper process chemical and funds to county EMA for response training

Violation Information Terms

Initial penalty: Initial proposed cash penalty for violation
Final penalty: Total penalty after SEP negotiation
SEP credit: Cash credit given for SEP so that, Final penalty - SEP credit = Final cash penalty
SEP cost to company: Actual cost to company of SEP implementation

NOTE: Due to differences in terminology and level of detail between regional SEP information, in some cases the figure listed as Final penalty may be the Final cash penalty after deduction for SEP credit

VIII. COMPLIANCE ACTIVITIES AND INITIATIVES

This section highlights the activities undertaken by this industry sector and public agencies to voluntarily improve the sector's environmental performance. These activities include those independently initiated by industrial trade associations. In this section, the notebook contains a listing and description of national and regional trade associations.

VIII.A. EPA Voluntary Programs

33/50 Program

The "33/50 Program" is EPA's voluntary program to reduce toxic chemical releases and transfers of seventeen chemicals from manufacturing facilities. Participating companies pledge to reduce their toxic chemical releases and transfers by 33 percent as of 1992 and by 50 percent as of 1995 from the 1988 baseline year. Certificates of Appreciation have been given out to participants meeting their 1992 goals. The list of chemicals includes seventeen high-use chemicals reported in the Toxics Release Inventory. Exhibit 37 lists those companies participating in the 33/50 program that reported the SIC code 261 through 265 to TRI. Many of the companies shown listed multiple SIC codes and, therefore, are likely to carry out operations in addition to pulp and paper manufacturing. The SIC codes reported by each company are listed in no particular order. In addition, the number of facilities within each company that are participating in the 33/50 program and that report SIC 261 through 265 to TRI is shown. Finally, each company's total 1993 releases and transfers of 33/50 chemicals and the percent reduction in these chemicals since 1988 are presented.

The pulp and paper industry as a whole used, generated or processed eight target TRI chemicals. Of the target chemicals, chloroform, methyl ethyl ketone, and toluene are released and transferred most by quantity. Chloroform is released in the greatest quantity overall; chloroform releases are almost ten times that of methylethyl ketone, the next largest release quantity. These two chemicals account for approximately 65 percent of 33/50 chemical releases and transfers from pulp and paper facilities and six percent of all of the industry's TRI releases and transfers in 1993. Chloroform and methylethyl ketone are also released by greatest number of mills in comparison to the other 33/50 chemicals. Thirty one companies listed under SIC 261-265) are currently participating in the 33/50 program. They account for 13 percent of the 245 pulp and paper companies under SIC 261-265 which is slightly lower than the average for all industries of 14 percent participation. (Contact: Mike Burns 202-260-6394; or the 33/50 Program 202-260-6907.)

Exhibit 37: 33/50 Program Participants Reporting SIC 261 through 265 (Pulp and Paper)

Name of Parent Company	City, State	SIC Codes Reported	Number of Participating Facilities	1993 Releases and Transfers (lbs)	% Reduction 1988 to 1993
Boise Cascade Corporation	Boise, ID	2611, 2621	6	866,153	50
Bomarko Inc.	Plymouth, IN	2621, 2671, 2679	1	12,000	19
Bowater Incorporated	Greenville, SC	2611, 2621	2	238,409	30
Champion International Corp.	Stamford, CT	2621	6	1,356,355	49
Consolidated Papers Inc.	Wisconsin Rapids, WI	2611, 2621	2	252,940	33
Federal Paper Board Company	Montvale, NJ	2631	2	1,197,941	50
Fletcher Paper Company	Alpena, MI	2621	1	1,001,714	***
Fort Howard Corporation	Green Bay, WI	2621	3	381,712	50
Georgia-Pacific Corporation	Atlanta, GA	2611	13	2,722,182	50
Green Bay Packaging Inc.	Green Bay, WI	2631	1	4,730	50
H Enterprises Intl.	Minneapolis, MN	2657, 2631	1	164,345	47
International Paper Company	Purchase, NY	2631	13	2,784,831	50
ITT Corporation	New York, NY	2611	3	735,332	7
James River Corp Virginia	Richmond, VA	2621	7	961,588	53
Kimberly-Clark Corporation	Irving, TX	2621, 2611	2	488,160	50
Louisiana-Pacific Corporation	Portland, OR	2611	1	294,823	50
Mead Corporation	Dayton, OH	2631	4	163,512	*
Parsons & Whittemore Entps.	Port Chester, NY	2611, 2621	1	149,405	*
Potlatch Corporation	San Francisco, CA	2631	3	276,643	60
Procter & Gamble Company	Cincinnati, OH	2611, 2621, 2676	3	612,520	*
Riverwood International USA	Atlanta, GA	2631	2	70,161	50
Scott Paper Company	Philadelphia, PA	2611, 2621	6	1,288,876	50
Sibv/Ms Holdings Inc.	Saint Louis, MO	2631	3	721,549	***
Simpson Investment Company	Seattle, WA	2611, 2621	3	749,525	50
Sonoco Products Company	Hartsville, SC	2631, 2655	1	621,380	1
Temple-Inland Inc.	Diboll, TX	2631	3	166,410	50
Tenneco Inc.	Houston, TX	2631	3	1,272,423	8
Union Camp Corporation	Wayne, NJ	2621	4	835,696	50
Westvaco Corporation	New York, NY	2621	4	877,866	50
Weyerhaeuser Company	Tacoma, WA	2611, 2621, 2631	5	1,006,356	*
Willamette Industries Inc.	Portland, OR	2611, 2621	3	677,090	34

* = not quantifiable against 1988 data. ** = use reduction goal only. *** = no numerical goal.

Source: U.S. EPA, Toxics Re ease Inventory, 1993. 1

Environmental Leadership Program

The Environmental Leadership Program (ELP) is a national initiative piloted by EPA and state agencies in which facilities have volunteered to demonstrate innovative approaches to environmental management and compliance. EPA has selected 12 pilot projects out of 40 applicants at industrial facilities and federal installations which will demonstrate the principles of the ELP program. In return for participating, pilot participants receive public recognition and are given a period of time to correct any violations discovered during these experimental projects. The information collected from the pilot ELP programs will be used to develop a full-scale ELP program. Two pulp and paper companies (Simpson Tacoma Kraft Company of Tacoma, WA and International Paper of Mansfield, LA) submitted proposals. The Simpson Tacoma Kraft Company was selected to participate in the pilot program. The company is an integrated pulp and paper mill employing 560 that produces natural and bleached pulp, kraft paper, and bleached kraft paper used primarily in the production of food and industrial grade packaging products. Their proposal included 1) mechanism to share audit information and conduct self-audits, 2) development of incentives for company to go beyond compliance, 3) development of a new approach to measure beyond compliance and pollution prevention efforts, and 4) implementation of an "Adopt a Supplier" program. (Contact: Maria Eisemann, (202) 564-7016, fax (202) 564-0050). Other proposals are available for review from the Environmental Leadership Program.(Contact: Tai-ming Chang, ELP Director, 202-564-5081 or Robert Fentress 202-564-7023.).

Project XL

Project XL was initiated in March 1995 as a part of President Clinton's *Reinventing Environmental Regulation* initiative. The projects seek to achieve cost effective environmental benefits by allowing participants to replace or modify existing regulatory requirements on the condition that they produce greater environmental benefits. EPA and program participants will negotiate and sign a Final Project Agreement, detailing specific objectives that the regulated entity shall satisfy. In exchange, EPA will allow the participant a certain degree of regulatory flexibility and may seek changes in underlying regulations or statutes. Participants are encouraged to seek stakeholder support from local governments, businesses, and environmental groups. EPA hopes to implement fifty pilot projects in four categories including facilities, sectors, communities, and government agencies regulated by EPA. Applications will be accepted on a rolling basis and projects will move to implementation within six months of their selection. For additional information regarding XL Projects, including application procedures and criteria, see the May 23, 1995 Federal Register Notice, or contact Jon Kessler at EPA's Office of Policy Analysis (202) 260-4034.

Green Lights Program

EPA's Green Lights program was initiated in 1991 and has the goal of preventing pollution by encouraging U.S. institutions to use energy-efficient lighting technologies. The program has over 1,500 participants which include major corporations; small and medium sized businesses; federal, state and local governments; non-profit groups; schools; universities; and health care facilities. Each participant is required to survey their facilities and upgrade lighting wherever it is profitable. EPA provides technical assistance to the participants through a decision support software package, workshops and manuals, and a financing registry. EPA's Office of Air and Radiation is responsible for operating the Green Lights Program. (Contact: Maria Tikoff 202-233-9178 or the Green Light/Energy Star Hotline at 202-775-6650)

WasteWi$e Program

The WasteWi$e Program was started in 1994 by EPA's Office of Solid Waste and Emergency Response. The program is aimed at reducing municipal solid wastes by promoting waste minimization, recycling collection and the manufacturing and purchase of recycled products. As of 1994, the program had about 300 companies as members, including a number of major corporations. Members agree to identify and implement actions to reduce their solid wastes and must provide EPA with their waste reduction goals along with yearly progress reports. EPA in turn provides technical assistance to member companies and allows the use of the WasteWi$e logo for promotional purposes. The pulp and paper company Georgia-Pacific is a WasteWi$e participant. (Contact: Lynda Wynn 202-260-0700 or the WasteWi$e Hotline at 800-372-9473)

Climate Wise Recognition Program

The Climate Change Action Plan was initiated in response to the U.S. commitment to reduce greenhouse gas emissions in accordance with the Climate Change Convention of the 1990 Earth Summit. As part of the Climate Change Action Plan, the Climate Wise Recognition Program is a partnership initiative run jointly by EPA and the Department of Energy. The program is designed to reduce greenhouse gas emissions by encouraging reductions across all sectors of the economy, encouraging participation in the full range of Climate Change Action Plan initiatives, and fostering innovation. Participants in the program are required to identify and commit to actions that reduce greenhouse gas emissions. The program, in turn, gives organizations early recognition for their reduction commitments; provides technical assistance through consulting services, workshops, and guides; and provides access to the program's centralized information system. Currently, the pulp and paper company Georgia-Pacific is a Climate Wise participant. At EPA, the program is operated by the Air and Energy Policy Division within the Office of Policy Planning and Evaluation. (Contact: Pamela Herman 202-260-4407)

NICE^3

The U.S. Department of Energy and EPA's Office of Pollution Prevention are jointly administering a grant program called The National Industrial Competitiveness through Energy, Environment, and Economics (NICE^3). By providing grants of up to 50 percent of the total project cost, the program encourages industry to reduce industrial waste at its source and become more energy-efficient and cost-competitive through waste minimization efforts. Grants are used by industry to design, test, demonstrate, and assess the feasibility of new processes and/or equipment with the potential to reduce pollution and increase energy efficiency. The program is open to all industries; however, priority is given to proposals from participants in the pulp and paper, chemicals, primary metals, and petroleum and coal products sectors. A project with a pulp and paper facility in California focused on increasing the amount of post consumer waste (PCW) used in the production of the paper pallets used for freight transport. The company, Damage Protection Products, will develop a 40 percent PCW pallet product and demonstrate continuous production for 5 days. Every ton of PCW that is substituted for wood fiber in this process decreases water use by 50 percent, energy use by 60 percent, reduces wastewater production by 35 percent and air pollution by 74 percent. (Contact: Bill Ives, DOE's Golden Field Office, 303-275-4755).

State and Local initiatives

Exhibit 38: Contacts for State and Local Initiatives			
State	**Program**	**Contact**	**Telephone**
Alabama	AL Dept. of Env. Management, Ombudsman and Small Business Assistance	Blake Roper, Michael Sherman	(800) 533-2336 (205) 271-7861
	AL WRATT Foundation	Roy Nicholson	(205) 386-3633
California	County Sanitation Districts of LA	Mischelle Mische	(310) 699-7411
Colorado	Region VIII HW Minimization Program	Marie Zanowich	(303) 294-1065
Florida	FL Dept. of Env. Protection, Small Business Assistance Program	Joe Schlessel	(904) 488-1344
Indiana	IN Dept. of Env. Mgmt.	Tom Neltner	(317) 232-8172
Iowa	IA Dept. of Natural Resources	Larry Gibson	(515) 281-8941
Kentucky	KY Partners, State Waste Reduction Center	Joyce St. Clair	(502) 852-7260
Maine	ME Dept. of Env. Protection	Ronald Dyer	(207) 287-2811
	ME Waste Mgmt. Agency	Gayle Briggs	(207) 287-5300
Massachusetts	Northeast States Pollution Prevention Roundtable, Northeast Waste Management Officials' Association (NEWMOA)	Terri Goldberg	(617) 367-8558
	Toxics Use Reduction Institute	Janet Clark	(508) 934-3346
Michigan	University of Detroit Mercy	Daniel Klempner	(313) 993-3385
New Hampshire	NH Small Business Technical and Env. Compliance Assistance Program	Rudolph Cartier Jr.	(603) 271-1370
New Jersey	NJ Technical Assistance Program for Industrial Pollution Prevention (NJTAP)	Kevin Gashlin	(201) 596-5864
New Mexico	Waste Management Education and Research Consortium	Ron Bhada	(505) 646-1510
North Carolina	NC State University	Michael Overcash	(919) 515-2325
Ohio	Institute of Advanced Manufacturing Sciences	Harry Stone, Sally Clement	(513) 948-2050
Oregon	OR Dept. of Env. Quality, Air Quality Small Business Assistance Program	John MacKellar Terry Obteshka	(503) 229-6828, (503) 229-5946
Rhode Island	RI Center for P2, URI	Stanley Barnett	(401) 792-2443
South Carolina	Southeast Manufacturing Technology Center (SMTC)	Jim Bishop	(803) 252-6976
Washington	WA State Dept. of Ecology	Peggy Morgan	(206) 407-6705

Exhibit 38: Contacts for State and Local Initiatives			
State	Program	Contact	Telephone
West Virginia	WV Div. of Env. Protection, Office of Water Resources, P2 Services	Barbara Taylor	(304) 256-6850
Wisconsin	WI Dept. of Development, Small Business Assistance	Dennis Leong, Phil Albert	(608) 266-9869, (608) 266-3075

VIII.B. Trade Association/Industry Sponsored Activities

VIII.B.1. Environmental Programs

Global Environmental Management Initiative

The Global Environmental Management Initiative (GEMI) is made up of group of leading companies dedicated to fostering environmental excellence by business. GEMI promotes a worldwide business ethic for environmental management and sustainable development, to improve the environmental performance of business through example and leadership. In 1994, GEMI's membership consisted of about 30 major corporations such as the pulp and paper company Georgia-Pacific.

50% Paper Recovery: A New Goal for a New Century

The membership of the American Forest and Paper Association (AF&PA) set a goal to recover for recycling 50 percent of all paper used by Americans by the year 2000. This program succeeds a voluntary program to reach a 40 percent paper recovery rate by 1995. These recovery rates were achieved in 1993, according to industry sources.

Annual Sustainable Forestry Report

In 1994, the AF&PA put a sustainable forestry initiative in place that includes an annual report from each of its members on sustainable forestry practices and accomplishments.

104 Mill Study

The pulp and paper industry participated voluntarily in the *Five Mill Study* conducted in 1986 and in the *104 Mill Study* in 1988. In 1992, API (now American Forest and Paper Association) and the National Council of the Paper Industry for Air and Stream Improvement (NCASI) surveyed 124 chemical pulping facilities to determine baseline controls and components of the MACT regulatory floor.

VIII.B.2. Summary of Trade Associations

The trade and professional organizations serving the pulp and paper industry are lead by the American Forest and Paper Association (AFPA), formerly the American Paper Institute (API). They have been actively involved in a number of recent rulemakings (under CAA, CWA and RCRA) which will affect their members. The National Council of the Paper Industry for Air and Stream Improvement (NCASI) does technical research for the industry. The Technical Association of the Pulp and Paper Industry (TAPPI), is a technical clearinghouse for the industry; they disseminate technical information to production facility staff throughout the U.S.

American Forest and Paper Association
1111 19th Street, NW
Suite 210
Washington, DC 20036
Phone: (202) 463-2700
Fax: (202) 463-2423

Members: 450
Staff: 140
Contact: Josephine Cooper, V.P. for Environment and Regulatory Affairs

The National Forest Products Association merged with the American Paper Institute (API) in 1993 to become the American Forest and Paper Association (AF&PA). AF&PA is the national trade association for the forest, pulp, paper, paperboard, and wood products industry. The organization focuses on information gathering/dissemination, research on industry technical issues, and represents the industry in regulatory and legislative matters. The AF&PA takes an active role by representing its members before governmental agencies, such as on the recent integrated air and water rule. Some current environmental initiatives include the 2020 Research Agenda, 50 percent recycling goal, and the AF&PA Environmental, Health and Safety Principles. The AF&PA publishes a variety of documents for and about its membership. Some relevant publications include the annual industry wide reviews *Capacity Report* and *Statistics of Paper, Paperboard, and Wood Pulp*, the *Paper, Paperboard, and Wood Pulp Monthly Statistical Summary*, and the *Dictionary of Paper*, published every ten years. Circulation for these publications is listed at 1,000. The AFPA holds an annual meeting every March in New York City.

National Council of the Paper Industry
for Air and Stream Improvement
260 Madison Ave.
New York, NY 10016
Phone: (212) 532-9000
Fax: (212) 779-2849

Members: 100
Staff: 90
Budget: $10,000,000
Contact: Dr. Ronald Yeske

Founded in 1943, the National Council of the Paper Industry for Air and Stream Improvement (NCASI) presently conducts research on environmental problems related to industrial forestry and the manufacture of pulp, paper, and wood products. NCASI produces technical documents on environmental issues facing the pulp and paper industry and conducts industry conferences. Publications include: a biweekly bulletin on general issues and a variety of technical bulletins (40/year). NCASI also holds an annual March convention in New York city.

TAPPI
Technology Park/Atlanta
P.O. Box 105113
Atlanta, GA 30348
Phone:(404) 446-1400
Fax: (404) 446-6947

Members: 33,000
Staff: 95
Budget: $13,000,000
Contact: Charles Bohanan
Technical Divisions Operator

The Technical Association of the Pulp and Paper Industry (TAPPI) represents executives, managers, engineers, research scientists, superintendents, and technologists in the pulp, packaging, paper, and allied industries. Founded in 1915, TAPPI is split into eleven divisions, which include: environmental, research and development, paper and board manufacture, and pulp manufacture. Though its headquarters are in Atlanta, TAPPI is also divided into 27 regional groups. Overall, TAPPI provides a variety of services to its members. TAPPI conducts conferences on topics such as forest biology, environment, packaging, pulp manufacture, and R&D in addition to a more general annual conference. TAPPI also develops testing methodologies for process control and laboratory analysis. The main annual project of the TAPPI Environmental division consists of an environmental issues industry conference. In 1995, TAPPI launched a campaign to educate the public on industry environmental facts. TAPPI publications include an annual *Membership Directory*, a monthly *TAPPI Journal*, and the publication of research results. TAPPI's publications are available via an online catalogue and record retrieval system called TAPPI-net available at (800) 332-8686.

Paper Industry Management Association
2400 E. Oakton St.
Arlington Heights, IL 60005
Phone: (708) 956-0250
Fax: (708) 956-0520

Members: 5,000
Staff: 14
Budget: $2,000,000
Contact: George J. Calimafde

The Paper Industry Management Association, or PIMA, is a professional organization of pulp, paper mill, and paper converting production executives. The association has provided management oriented information to its membership since 1919. This association goal is embodied by their publications: an annual *Handbook* of the industry, a monthly *PIMA Magazine* dedicated to improving efficiency and productivity, and the annual *PIMA Pulp and Paper Mill Catalog* reference for industry management. This catalog contains information regarding equipment, raw materials, and chemical products, in addition to a trade name directory, a listing of manufacturers and suppliers, and a listing of reports relevant to pulp and paper manufacture.

IX. CONTACTS/ACKNOWLEDGMENTS/RESOURCE MATERIALS/BIBLIOGRAPHY

For further information on selected topics within the pulp and paper industry a list of publications and contacts are provided below:

Contacts[g]

Name	Organization	Telephone	Subject
Maria Eisemann	U.S. EPA, Office of Compliance	202-564-7016	Pulp and paper industry sector lead; pulp and paper ELP project information
Donald Anderson	OSWER	202-260-4796	Solid waste
Pamela Herman	U.S. EPA Air and Energy Policy Division	202-260-4407	*Climate Wise Program*
Penny Lassiter	U.S. EPA	919-541-5396	Clean Water Act
Debra Nicoll	OW, ESAB	202-260-5385	State statutes relevant to pulp and paper industry
Cindy Evans	American Forest and Paper Association	202-463-2582	Industry Statistics
Gary Stanley	Department of Commerce, Office of Machinery, Materials and Chemicals	202-482-0375	Finance, international and domestic markets, and production
Reid Miner Program Director	National Council of the Paper Industry for Air and Stream Improvement, Inc.	212-532-9349	Industry Technical Information

[g] Many of the contacts listed above have provided valuable background information and comments during the development of this document. EPA appreciates this support and acknowledges that the individuals listed do not necessarily endorse all statements made within this notebook.

General Profile

U.S. Industrial Outlook 1994, Department of Commerce

API, 1992, *Statistics of Paper, Paperboard, & Wood Pulp.*

Lockwood-Post's Directory of the Pulp and Paper and Allied Trades, 1995.

Institute of Paper Science and Technology on-line environmental abstracts.

Process Descriptions and Chemical Use Profiles

Richard J. Albert, "Effluent-Free Pulp Mill Possible with Existing Fiberline Equipment," *Pulp & Paper*, 68(7), July 1994, pp. 83-89.

American Paper Institute. *Report on the Use of Pulping and Bleaching Chemicals in the U.S. P&P Industry*, June 26, 1992.

Lee Brunner and Terry Pulliam, "Comprehensive Impact Analysis of Future Environmentally Driven Pulping and Bleaching Technologies," 1992 TAPPI *Pulping Conference*, Boston, MA.

David Forbes, "Mills Prepare for Next Century with New Pulping, Bleaching Technologies," *Pulp & Paper*, Sept. '92.

Smook, G.A. *Handbook for Pulp & Paper Technologists*. Second edition. Vancouver: Angus Wilde Publications, 1992.

Regulatory Profile

Federal Register, Proposed Rules, Friday December 17, 1993, Part II pp. 66078-66216.

Penny Lassiter
Office of Air Quality Planning and Standards
(919) 541-5396

Donald Anderson
Office of Water
(202) 260-7137

David Carver
Office of Solid Waste
(202) 260-6775

Pollution Prevention

Pollution Prevention Technologies for the Bleached Kraft Segment of the U.S. Pulp and Paper Industry, EPA/600/R-93/110

Chlorine-Free Bleaching of Kraft Pulp: Feasibility Study, sponsored by Domtar Inc., the Ontario Ministry of the Environment, and Environment Canada, June 1993. Available from Great Lakes Pollution Prevention Centre (519) 337-3423.

Neil McCubbin, *Costs and Benefits of Various Pollution Prevention Technologies in the Kraft Pulp Industry*, EPA-744R-93-002.

Howard Deal, "Environmental Pressure Causes Changes in Bleaching Technologies, Chemicals," *Pulp & Paper*, Nov. '91.

Bruce Fleming, *Alternative and Emerging Non-Kraft Pulping Technologies*, EPA-744R-93-002.

NCASI Technical Workshop-- *Effects of Alternative Pulping and Bleaching Processes on Production and Biotreatability of Chlorinated Organics*, NCASI Special Report No. 94-01, Feb. 1994.

Supplemental Environmental Projects

Monica Becker, Nicholas Ashford, *Recent Experience in Encouraging the Use of Pollution Prevention in Enforcement Settlements*, Final Report, MIT, May 1994.

Monica Becker, Nicholas Ashford, *Encouraging the Use of Pollution Prevention in Enforcement Settlements: A Handbook for EPA Regions*, MIT, May 1994.

Trade Journals

American Papermaker (404) 325-9153
Board Converting News and Recycling Markets (202) 368-1225
Non Wovens Industry (201) 825-2552
Official Boards Markets (312) 938-2300
Paper Age (202) 666-2262
Paperboard Packaging (800) 225-4569
Pulp and Paper (415) 905-2200
Pulp and Paper International (415) 905-2200
Recycled Paper News (703) 750-1158
TAPPI Journal (404) 446-1400

Resource Materials

Supporting documents for the currently proposed integrated rulemaking identify a number of research efforts and data source which were used by EPA to characterize the pulp and paper industry and its processes and their environmental consequences. A short summary of each is available in the Federal Register Notice (58 FR 66092). They include:

1990 Census of Pulp and Paper Mills - Used §308 (CWA) survey to gather technical (e.g., existing processes, performance, releases) and financial information from 565 U.S. pulp and paper mills. Used as the primary information source for the integrated rulemaking. Queries about state and local regulatory requirements were included.

Swedish Studies - Summarizes a mid-1980s project to document the biological effects of mills wastes on Baltic Sea species.

National Dioxin Study - A 1987 EPA report unexpectedly found elevated levels of dioxin in fish tissues downstream from 57 percent of the pulp and paper mill sites sampled. Further investigations found dioxin in wastewater and wastewater treatment sludge from mills. Hypothesis made that chlorine bleaching process was the source.

Five Mill Study - Cooperative effort with industry to collect detailed process information including effluent sampling. Confirmed presence of dioxin in wastewaters, pulps, and sludge.

104 Mill Study - Follow-up to Five Mill Study to determine extent of dioxin formation by representative bleaching and production processes throughout the industry.

National Study of Chemical Residues in Fish - Confirmed the pulp and paper mills were dominant source of dioxins and furans in fish tissue.

Dioxin Risk Assessment - Results from the multiple pathway investigation are scheduled for publication in late 1994.

End Notes

1. USEPA. 1990 National Census of Pulp, Paper, and Paperboard Manufacturing Facilities. 1990.

2. American Forest and Paper Association, 1994 Statistics, Data Through 1993. Washington, D.C.:AF&PA, 1994.

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4. U.S. EPA, 1993. Effluent Limitations Guidelines, Pretreatment Standards, and New Source Performance Standards: Pulp, Paper, and Paperboard Category; National Emission Standards for Hazardous Air Pollutants for Source Category: Pulp and Paper Production. 40 CFR Parts 63 and 430.

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30. American Forest & Paper Association. 1994.

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