

# MRI REPORT

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## ESTIMATES OF WASTE GENERATION BY THE PULP AND PAPER INDUSTRY

Draft Report

EPA Prime Contract No. 68-01-7287  
Work Assignment No. 15

MRI Project No. 9015-L

August 12, 1987

Prepare for:

U.S. Environmental Protection Agency  
Office of Solid Waste  
401 M Street, S.W.  
Washington, DC 20460

Attention: Mr. Benjamin P. Smith

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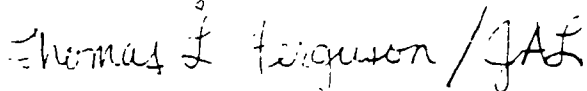
Attention: Mr. Benjamin P. Smith

## PREFACE

This draft report presents estimates of waste generation for the pulp and paper industry obtained by Midwest Research Institute (MRI) on MRI Project No. 9015-L. The personnel providing major contributions to this report were Ms. Jeannine Lehman, Mr. Ron Ramsey, Mr. Neal Frink, Mr. Rodney Gibson, and Dr. Tom Lapp.

Approved for:

MIDWEST RESEARCH INSTITUTE

A handwritten signature in cursive script that reads "Thomas L. Ferguson / JAL".

Thomas L. Ferguson  
Manager, Listing Support Program

August 12, 1987

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SECTION 3.0  
PAPER AND ALLIED PRODUCTS  
(SIC 26)

3.1 INDUSTRY OVERVIEW

In 1982, the pulp and paper industry (SIC Major Group 26) consisted of 5,926 establishments with total shipments valued at approximately \$80 trillion. The actual number of establishments may differ due to the complex and diverse nature of the industry. Approximately 72 percent of the pulp, paper, paperboard, and building board production occurs in companies which are integrated (EPA, 1980) yet waste quantities are often reported by process step. This makes it extremely difficult to estimate the impact. MRI estimates that the 5,400 facilities that are converters (SIC 264, 265) will not be adversely affected by the proposed regulation whereas the remaining 530 facilities will feel a major impact. The pulp and paper industry generates  $6.7 \times 10^9$  MT/yr of wastewaters and  $3.8 \times 10^6$  MT/yr of wastewater treatment sludges (EPA, 1980). MRI estimates that  $4.8 \times 10^9$  MT/yr of treated wastewater and  $2.7 \times 10^9$  MT/yr of wastewater treatment sludges have concentrations of chloroform, tetrachloroethylene, trichloroethylene and 2,4,6-trichlorophenol above the proposed regulatory levels. Additionally, MRI estimates that none of the approximately  $11.5 \times 10^6$  MT/yr of process wastes will be regulated as hazardous.

Table 3-1 presents a summary of the number of facilities, annual wastes generated, and potentially hazardous constituents in the pulp and paper industry.

3.2 INDUSTRY CHARACTERIZATION

Paper and Allied Products (SIC Major Group 26) includes the manufacture of pulps from wood and other cellulose fibers, and from rags; the manufacture of paper and paperboard; and the manufacture of paper and

TABLE 3-1

**SUMMARY OF NUMBER OF FACILITIES, ESTIMATED ANNUAL WASTE GENERATION,  
AND HAZARDOUS CONSTITUENTS IN THE PULP AND PAPER INDUSTRY**

=====

NO. OF FACILITIES (Census of Manufactures, 1982)

Total 5,926  
Fewer than 20 employees 2,066

WASTES GENERATED ANNUALLY

	Total Waste Quantity (MT/YR) <sup>b</sup>	Currently Hazardous Quantity (MR/YR)	Quantity Currently Non- Hazardous (MT/YR) <sup>b</sup>	Quantity Failing TCLP (MT/yr) <sup>a</sup>
<u>Process Wastes</u>				
-Wood Preparation Wastes	8.2 x 10 <sup>6</sup>	0	8.2 x 10 <sup>6</sup>	0
-Pulping Wastes	1.1 x 10 <sup>6</sup>	0	1.1 x 10 <sup>6</sup>	0
-Papermaking Wastes	2.2 x 10 <sup>6</sup>	0	2.2 x 10 <sup>6</sup>	0
 <u>Waste Treatment Sludges</u>	 3.8 x 10 <sup>6</sup>	 0	 3.8 x 10 <sup>6</sup>	 2.7 x 10 <sup>6</sup> -
 <u>Wastewaters</u>	 6.7 x 10 <sup>9</sup>	 0	 6.7 x 10 <sup>9</sup>	 4.8 x 10 <sup>9</sup> -

Potentially Hazardous TCLP Constituents in Wastes

2,4,6-Trichlorophenol  
Chloroform  
Methylene Chloride  
Benzene  
Trichloroethylene  
Tetrachloroethylene

<sup>a</sup> MRI estimate

<sup>b</sup> EPA, 1980

paperboard into converted products such as paper coated off the paper machine, paper bags, paper boxes, and envelopes. (Standard Industrial Classification Manual, 1972)

This industry is further categorized as follows:

## **261 PULP MILLS**

### **2611 Pulp Mills**

Establishments primarily engaged in manufacturing pulp from wood or from other materials such as rags, linters, waste paper, and straw. Logging camps operated by pulp mills, and not separately reported, are also included in this industry.

## **262 PAPER MILLS, EXCEPT BUILDING PAPER MILLS**

### **2621 Paper Mills, Except Building Paper Mills**

Establishments primarily engaged in manufacturing paper (except building paper Industry 2661) from wood pulp and other fibers, and which may also manufacture converted paper products. Pulp mills combined with paper mills, and not separately reported, are also included in this industry; where separately reported, they are classified in Industry 2611.

## **263 PAPERBOARD MILLS**

### **2631 Paperboard Mills**

Establishments primarily engaged in manufacturing paperboard, including paperboard coated on the paperboard machine, from wood pulp and other fibers; and which may also manufacture converted paperboard products. Pulp mills combined with paperboard mills, and not separately reported, are also included in this industry; where separately reported, they are classified in Industry 2611.

**264 CONVERTED PAPER AND PAPERBOARD PRODUCTS, EXCEPT CONTAINERS AND BOXES**

**2641 Paper Coating and Glazing**

Establishments primarily engaged in manufacturing coated, glazed, or varnished paper from purchased paper. Also included are establishments primarily manufacturing pressure sensitive tape with backing of any material other than rubber.

**2642 Envelopes**

Establishments primarily engaged in manufacturing envelopes of any description from purchased paper and paperboard.

**2643 Bags, Except Textile Bags**

Establishments primarily engaged in manufacturing bags from purchased paper, cellophane, acetate, polyethylene, polypropylene, pliofilm, foil, and similar sheet or film materials.

**2645 Die-Cut Paper and Paperboard and Cardboard**

Establishments primarily engaged in diecutting purchased paper and paperboard; and in manufacturing cardboard by laminating, lining, or surface coating paperboard.

**2646 Pressed and Molded Pulp Goods**

Establishments primarily engaged in manufacturing all kinds of pressed and molded pulp goods, including papier-mache articles other than statuary and art goods (Industry 3299).

**2647 Sanitary Paper Products**

Establishments primarily engaged in manufacturing, from purchased



paper, sanitary paper products, such as facial tissues and handkerchiefs, table napkins, toilet paper, towels, disposable diapers, and sanitary napkins and tampons.

2648 Stationery, Tablets and Related Products

Establishments primarily engaged in manufacturing stationery, tablets, looseleaf fillers, and related items from purchased paper.

2649 Converted Paper and Paperboard Products, Not Elsewhere Classified

Establishments primarily engaged in manufacturing from purchased paper or paperboard miscellaneous converted paper or paperboard products, not elsewhere classified.

**265 PAPERBOARD CONTAINERS AND BOXES**

2651 Folding Paperboard Boxes

Establishments primarily engaged in manufacturing set-up paperboard boxes from purchased paperboard.

2653 Corrugated and Solid Fiber Boxes

Establishments primarily engaged in manufacturing corrugated and solid fiber boxes and related products from purchased paperboard or fiber stock. Important products of this industry include corrugated and solid fiberboard boxes, pads, partitions, display items, pallets, single face products, and corrugated sheets.

2654 Sanitary Food Containers

Establishments primarily engaged in manufacturing food containers from special food board. Important products of this industry

include fluid milk containers; folding paraffined cartons for butter, margarine, and shortening, ice cream containers; frozen food containers; liquid tight containers; round nested food containers; paper cups for hot or cold drinks; pails for food and ice cream; and stamped plates, dishes, spoons and similar products.

#### 2655 Fiber Cans, Tubes, Drums, and Similar Products

Establishments primarily engaged in manufacturing fiber cans, cones, drums, and similar products from purchased materials, with or without metal ends, and vulcanized fiber boxes.

### 266 BUILDING PAPER AND BUILDING BOARD MILLS

#### 2661 Building Paper and Building Board Mills

Establishments primarily engaged in manufacturing building paper and building board from wood pulp and other fibrous materials. Pulp mills combined with building paper and building board mills, and not separately reported, are also included in this industry; where separately reported, they are classified in Industry 2611.

### 3.3 INDUSTRY STRUCTURE

The geographical distribution, size, and value of shipments for establishments in the pulp and paper mill industry in 1982 are shown in Table 3-2. Paper mills, except building papers (SIC 262) constitute the largest portion of the industry (50% of the total establishments and 62% of the total value of shipments). Ninety-four (94%) percent of the industry employs 20 or more employees.

TABLE 3-2

**PULP AND PAPER INDUSTRY STATISTICS FOR SELECTED STATES**  
**(Census of Manufacturers, 1982)**

SIC Code	Industrial Group and Geographic Area	Total (No.) <sup>a</sup>	With 20 Employees or more (No.) <sup>a</sup>	With < 20 Employees (No.) <sup>a</sup>	Value of Shipments (million dollars)
261	<b>Pulp Mills</b>	35	35	0	3,110.4
	Alabama	2	2	0	(D)
	Alaska	2	2	0	(D)
	California	3	3	0	(D)
	Florida	3	3	0	(D)
	Georgia	4	4	0	549.5
	Louisiana	1	1	0	(D)
	Maine	3	3	0	(D)
	Mississippi	1	1	0	(D)
	North Carolina	3	3	0	(D)
	South Carolina	1	1	0	(D)
	Tennessee	3	3	0	(D)
	Washington	5	5	0	363.2
	Wisconsin	4	4	0	(D)
262	<b>Paper Mills, Except Building Paper</b>	289	273	16	20,994.6
	Alabama	6	6	0	1,663.3
	Arizona	3	2	1	(D)
	Arkansas	3	3	0	(D)
	California	9	8	1	(D)
	Connecticut	5	4	1	(D)
	Florida	2	2	0	(D)
	Georgia	6	5	1	(D)
	Kentucky	3	3	0	(D)
	Louisiana	5	5	0	744.6
	Maine	16	16	0	2,116.9
	Maryland	1	1	0	(D)
	Massachusetts	30	30	0	638.9
	Michigan	22	21	1	986.4
	Minnesota	6	6	0	641.7
	Mississippi	3	3	0	(D)

TABLE 3-2 (CONTINUED)

PULP AND PAPER INDUSTRY STATISTICS FOR SELECTED STATES  
(Census of Manufacturers, 1982)

SIC Code	Industrial Group and Geographic Area	Total (No.) <sup>a</sup>	With 20 Employees or more (No.) <sup>a</sup>	With < 20 Employees (No.) <sup>a</sup>	Value of Shipments (million dollars)
	New Hampshire	13	12	1	281.5
	New Jersey	8	6	2	303.9
	New York	36	32	4	1,096.3
	North Carolina	6	6	0	872.7
	Ohio	16	14	2	883.8
	Oregon	7	7	0	752.7
	Pennsylvania	14	14	0	1,301.8
	South Carolina	2	2	0	(0)
	Tennessee	4	4	0	614.8
	Texas	4	4	0	(0)
	Vermont	7	6	1	(0)
	Virginia	3	3	0	(0)
	Washington	13	13	0	1,251.4
	Wisconsin	36	35	1	2,960.7
263	Paperboard Mills	201	194	7	9,531.1
	Alabama	8	8	0	758.6
	Arkansas	4	4	0	687.2
	California	18	17	1	391.7
	Connecticut	7	7	0	(0)
	Florida	5	5	0	(0)
	Georgia	12	12	0	1,186.6
	Idaho	1	1	0	(0)
	Illinois	7	7	0	104.6
	Indiana	10	10	0	163.6
	Louisiana	6	6	0	625.8
	Massachusetts	5	4	1	62.7
	Michigan	13	11	2	290.6
	Minnesota	1	1	0	(0)
	Mississippi	3	3	0	(0)
	Montana	1	1	0	(0)

TABLE 3-2 (CONTINUED)

PULP AND PAPER INDUSTRY STATISTICS FOR SELECTED STATES  
(Census of Manufacturers, 1982)

SIC Code	Industrial Group and Geographic Area	Total (No.) <sup>a</sup>	With 20 Employees or more (No.) <sup>a</sup>	With < 20 Employees (No.) <sup>a</sup>	Value of Shipments (million dollars)
	New Jersey	10	10	0	86.7
	New York	11	9	2	(D)
	Ohio	18	18	0	305.1
	Oklahoma	3	3	0	(D)
	Oregon	5	5	0	485.3
	Pennsylvania	15	15	0	(D)
	South Carolina	6	5	1	421.0
	Tennessee	7	7	0	(D)
	Texas	6	6	0	(D)
	Virginia	9	9	0	664.0
	Washington	4	4	0	664.0
	Wisconsin	6	6	0	(D)
264	Converted Paper and Paperboard Products Except Containers and Boxes	2,737	1,487	1,250	(D)
	Alabama	15	9	6	(D)
	Arizona	4	1	3	(D)
	Arkansas	23	20	3	(D)
	California	311	161	150	(D)
	Colorado	5	4	1	27.9
	Connecticut	22	11	11	(D)
	Delaware	1	1	0	(D)
	District of Columbia	1	1	0	(D)
	Florida	80	37	43	(D)
	Georgia	87	52	35	(D)
	Idaho	2	2	0	(D)
	Illinois	229	123	106	(D)
	Indiana	78	48	30	(D)
	Iowa	26	15	11	295.3
	Kansas	29	9	20	(D)

TABLE 3-2 (CONTINUED)

**PULP AND PAPER INDUSTRY STATISTICS FOR SELECTED STATES**  
**(Census of Manufacturers, 1982)**

SIC Code	Industrial Group and Geographic Area	Total (No.) <sup>a</sup>	With 20 Employees or more (No.) <sup>a</sup>	With < 20 Employees (No.) <sup>a</sup>	Value of Shipments (million dollars)
	Kentucky	13	9	4	(D)
	Louisiana	10	8	2	205.1
	Maine	4	4	0	(D)
	Maryland	9	9	0	(D)
	Massachusetts	152	92	60	(D)
	Michigan	90	46	44	(D)
	Minnesota	48	18	30	(D)
	Mississippi	12	9	3	(D)
	Missouri	66	39	27	(D)
	Nebraska	5	3	2	(D)
	New Hampshire	17	10	7	(D)
	New Jersey	192	111	81	1,331.0
	New York	387	169	218	(D)
	North Carolina	71	42	29	(D)
	Ohio	167	75	92	(D)
	Oklahoma	9	4	5	(D)
	Oregon	22	12	10	(D)
	Pennsylvania	163	94	69	(D)
	Rhode Island	15	9	6	(D)
	South Carolina	16	10	6	(D)
	Tennessee	46	32	14	(D)
	Texas	121	66	55	(D)
	Utah	2	2	0	(D)
	Vermont	2	2	0	(D)
	Virginia	34	18	19	(D)
	Washington	37	18	19	(D)
	West Virginia	9	5	4	(D)
	Wisconsin	105	69	36	2841.7
265	Paperboard Containers and Boxes	2,661	1,870	791	19,145.6
	Alabama	34	23	11	(D)
	Arizona	11	5	6	39.4
	Arkansas	29	24	5	D

TABLE 3-2 (CONTINUED)

**PULP AND PAPER INDUSTRY STATISTICS FOR SELECTED STATES**  
**(Census of Manufacturers, 1982)**

SIC Code	Industrial Group and Geographic Area	Total (No.) <sup>a</sup>	With 20 Employees or more (No.) <sup>a</sup>	With < 20 Employees (No.) <sup>a</sup>	Value of Shipments (million dollars)
	California	241	166	75	2,202.3
	Colorado	15	15	-	(D)
	Connecticut	49	39	10	(D)
	Delaware	7	7	-	(D)
	Florida	64	34	30	(D)
	Georgia	88	64	24	824.1
	Idaho	3	3	-	(D)
	Illinois	210	145	65	1,596.1
	Indiana	86	64	22	(D)
	Iowa	18	16	2	(D)
	Kansas	11	10	1	212.7
	Kentucky	30	25	5	(D)
	Louisiana	18	16	2	(D)
	Maine	5	5	-	45.0
	Maryland	41	29	12	(D)
	Massachusetts	117	89	28	607.5
	Michigan	104	63	41	(D)
	Minnesota	36	30	6	371.3
	Mississippi	16	12	4	(D)
	Missouri	74	53	21	(D)
	Nebraska	9	8	1	(D)
	New Hampshire	7	6	1	(D)
	New Jersey	184	116	68	(D)
	New York	239	151	88	1,118.3
	North Carolina	91	72	19	642.2
	Ohio	196	127	69	1,167.9
	Oklahoma	11	7	4	57.8
	Oregon	12	10	2	(D)
	Pennsylvania	182	129	53	1,256.2
	Rhode Island	35	22	13	(D)
	South Carolina	35	27	8	(D)
	Tennessee	70	56	14	467.7
	Texas	122	76	46	821.8
	Vermont	1	1	-	(D)

TABLE 3-2 (CONTINUED)

PULP AND PAPER INDUSTRY STATISTICS FOR SELECTED STATES  
(Census of Manufacturers, 1982)

SIC Code	Industrial Group and Geographic Area	Total (No.) <sup>a</sup>	With 20 Employees or more (No.) <sup>a</sup>	With < 20 Employees (No.) <sup>a</sup>	Value of Shipments (million dollars)
	Virginia	47	32	15	(D)
	Washington	27	22	5	(D)
	West Virginia	8	7	1	(D)
	Wisconsin	78	64	14	(D)
266	Building Paper and Board Mills	3	1	2	366.1
	Georgia	3	1	2	(D)

(D) Withheld to avoid disclosing data for individual companies; data are included in higher level totals.

<sup>a</sup> . SIC code totals reflect the summation of totals for individual states and may differ from Census of Manufactures totals. Individual state data is provided by Census of Manufactures (1982).



### 3.4 GENERAL PROCESS DESCRIPTION, WASTE GENERATION AND DISPOSAL

The production of pulp, paper and paperboard involves several standard manufacturing processes including raw material preparation, pulping, bleaching and papermaking. These processes are described in the following sections and are illustrated schematically in Figure 3-1. Refer to Table 3-3 for waste summary.

Raw material preparation. Wood preparation includes log washing, bark removal, chipping and screening. Bark from whole logs is removed prior to chipping and removal can be accomplished by dry or wet methods. In some cases, water is used as a presoak to soften bonds between the wood and bark prior to barking. Coarse screens are then used to remove large pieces of bark and wood slivers. Barking wastewater is passed through fine screens with the screenings combined with the coarse screening materials. The combined screenings can be dewatered in a press and burned in a bark boiler. This eliminates a source of solid waste while generating power. Approximately  $8.2 \times 10^6$  MT/yr of bark and wood wastes are generated and approximately  $5.3 \times 10^6$  MT/yr of that will be burned for fuel (EPA, 1980). MRI estimates that of the remaining  $2.9 \times 10^6$  MT/yr, none will be deemed hazardous.

Pulping and Recovery. Pulping involves the reduction of cellulosic raw material into pulp suitable for further processing. Pulping processes vary from simple mechanical action, as in groundwood pulping, to complex chemical digesting sequences, such as in the alkaline (soda or kraft), sulfite, or semi-chemical (NSCC) processes. Wastes from mechanical pulping include screening dirt and slivers and wastewater that is either recycled or discharged to the treatment system.

Wastes from chemical pulping vary greatly due to the type of chemical pulping process employed. Basically there are three chemical pulping processes used most frequently. They are the kraft, sulfite, and semi-chemical processes. The kraft process produces a stronger pulp and is currently the dominant pulping process worldwide. Kraft pulp now accounts for over 80% of the chemical pulp produced in this country.

TABLE 3-3

## WASTE GENERATION FOR THE PULP AND PAPER INDUSTRY

PROCESS	WASTE TYPE	TOTAL QUANTITY PRODUCED (MT/YR)	ESTIMATED QUANTITY FAILING (MT/YR)	CONSTITUENT	ESTIMATED RANGE (ppm)	POINT ESTIMATE (ppm)	TREATMENT/DISPOSAL
<u>Process Wastes</u>							
-Wood Preparation	Waste Wood and Bark	8.2x10 <sup>6b</sup>	0 <sup>a</sup>	None			- 65% recycled for fuel <sup>b</sup> - 35% landfilled <sup>b</sup>
-Pulping	Kraft Chemical Recovery Wastes	594,000 <sup>b</sup>	0 <sup>a</sup>	None			
	Sulfite Chemical Recovery Wastes	20,000 <sup>b</sup>	0 <sup>a</sup>	None			- Incinerated <sup>b</sup> - Landfilled <sup>b</sup>
	Pulping Rejects	460,000 <sup>b</sup>	0 <sup>a</sup>	None			- 80% recovered <sup>b</sup> - 20% landfilled <sup>b</sup>
	Cellulosic Fines	unknown	0 <sup>a</sup>	None			- Recycled <sup>b</sup> - Landfilled <sup>b</sup>
-Papermaking	Wastepaper Rejects	2.2 x 10 <sup>6b</sup>	0 <sup>a</sup>	None			- Recycled <sup>b</sup> - Landfilled <sup>b</sup>
<u>Wastewater Treatment</u>	Wastewater	6.7x10 <sup>9b</sup>	4.8x10 <sup>9a</sup>	Phenol	0.006-1.4	0.11 (130)	- NPDES discharge <sup>d</sup>
				2,4-Dichlorophenol	ND-0.22	0.1 (39)	
				* 2,4,6-Trichlorophenol	0.006-0.4	0.03 (60)	
				Pentachlorophenol	ND-0.05	0.007 (26)	
				* Chloroform	0.001-9.7	0.5 (84)	
				* Tetrachloroethylene	ND-0.18	0.014 (12)	
				Bis(2-ethylhexyl) phthalate	ND-0.2	0.025 (111)	
				Di-n-butyl phthalate	ND-0.03	0.004 (54)	
				Toluene	ND-0.4	0.015 (79)	
				* Chromium	0.001-18	0.06 (142)	
				Lead	0.005-0.0018	0.18 (130)	
				* Mercury	0.001-9	0.0005 (142)	

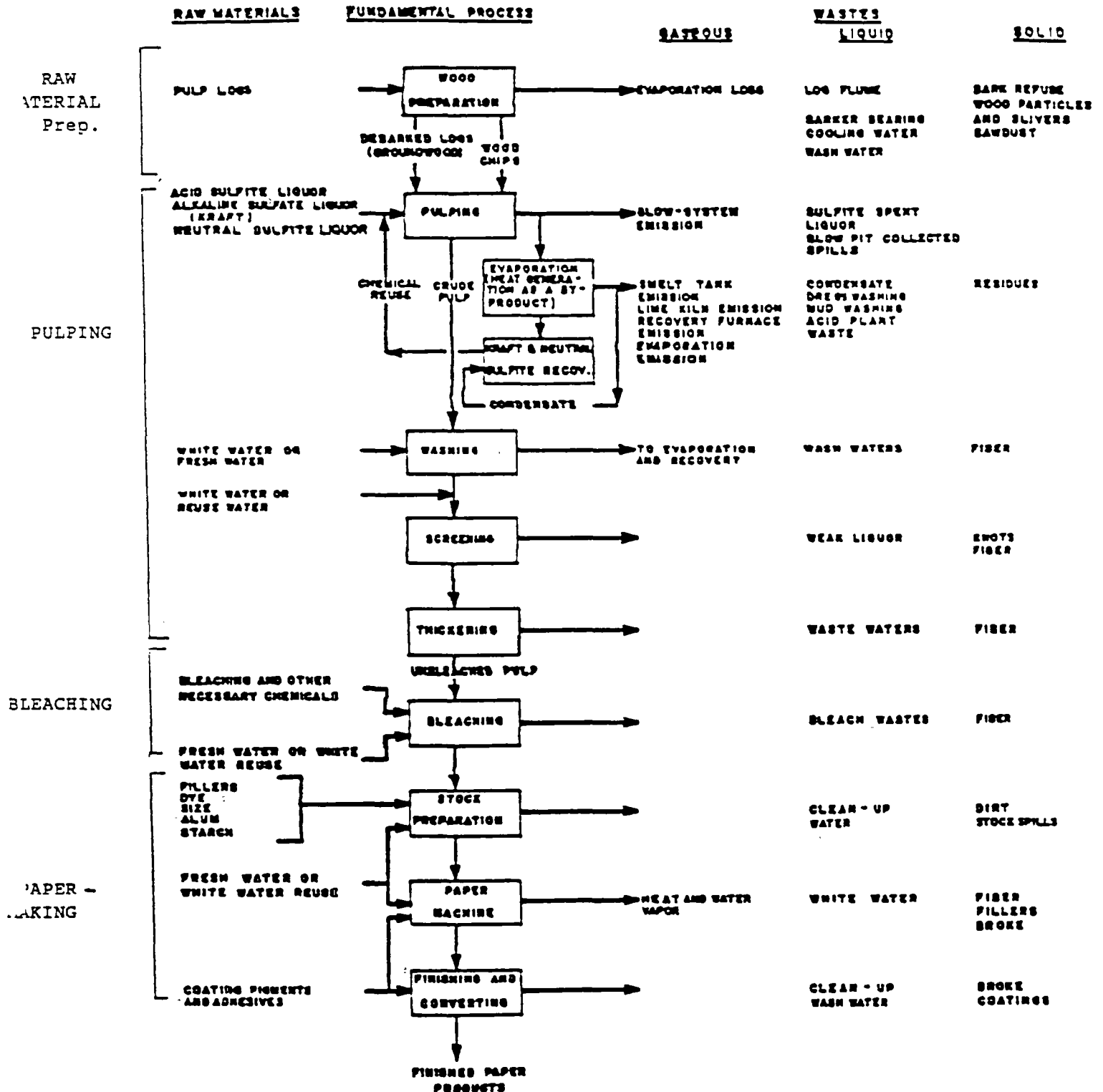
TABLE 3-3 (CONTINUED)

## WASTE GENERATION FOR THE PULP AND PAPER INDUSTRY

PROCESS	WASTE TYPE	TOTAL QUANTITY PRODUCED (MT/YR)	ESTIMATED QUANTITY FAILING (MT/YR)	CONSTITUENTS OF CONCERN <sup>c</sup>			TREATMENT/DISPOSAL
				CONSTITUENT	ESTIMATED RANGE (ppm)	POINT ESTIMATE (ppm)	
Wastewater Treatment (cont).	Wastewater Sludge	$3.8 \times 10^{6b}$	$2.7 \times 10^{9a}$	Nickel	0.002-0.02	0.018 (136)	-Biological treatment <sup>d</sup>
				* Methylene Chloride	ND-2.5	0.03 (70)	
				* Benzene	ND-0.15	0.007 (23)	
				Ethylbenzene	ND-0.08	0.008 (16)	
				* Trichloroethylene	ND-0.85	0.074 (20)	
				1,1,1,-Trichloroethane	ND-2.0	1.3 (20)	
				Phenol		9.93	
				2,4-Dichlorophenol		45.1	
				* 2,4,6-Trichlorophenol		20.0	
				Pentachlorophenol		21.6	
				* Chloroform		352	
				* Tetrachloroethylene		16.3	
				Bis(2-ethylhexyl) phthalate		$1.0 \times 10^3$	
				Di-n-butyl phthalate		9.88	
				Toluene		8.98	
				* Chromium		106	
				Lead		317	
				* Mercury		0.882	
				Nickel		31.7	
				* Methylene Chloride		3.08	
				* Benzene		1.50	
				Ethylbenzene		7.10	
				* Trichloroethylene		63.6	
				1,1,1,-Trichloroethane		$3.67 \times 10^3$	

<sup>a</sup> MRI estimate<sup>b</sup> EPA, 1980<sup>c</sup> EPA, 1981 - Numbers in parentheses represent number of points<sup>d</sup> EPA, 1981<sup>e</sup> Sludge concentrations estimated using Organic Leachate Model (OLM) for organic constituents, and assuming worst case scenario of 100% precipitation for metals.

# GENERAL FLOW SHEET PULPING AND PAPERMAKING PROCESS



Source: Proposed Development Document for Effluent Limitations  
Guidelines for the Pulp, Paper and Paperboard; and the Builders  
Paper and Board Mills.

(EPA, 1980).

Waste quantities generated from pulp manufacture are greatly dependent on the process used and on whether chemical recovery is practiced. In mechanical pulping, no chemicals are used and little or none of the wood material is dissolved. However, in sulfite pulping with lime and sulfurous acid, half of the wood is dissolved and both the dissolved wood and the chemical are discharged to the wastewater treatment stream, creating large quantities of waste. In kraft pulping, sodium hydroxide and sulfide<sup>o</sup> (from sulfate) are used to dissolve about half of the wood but the chemicals are recovered. In recovery the dissolved wood material is burned as a fuel. Semi-chemical pulping dissolves less of the wood material and consequently smaller waste quantities would be expected if recovery were practiced. However, recovery is not generally practiced.

Pulping process wastes include pulp rejects (460,000 MT/yr), cellulosic fines, whitewater and chemical recovery wastes (614,000 MT/yr). Currently, all of these wastes except chemical recovery wastes are managed in the wastewater treatment system and are expected to settle out with the primary or secondary treatment sludge. Some mills clarify wash waters of the pulping operations to recover and reuse cellulosic fines and pulping rejects. In this case, these wastes would be considered non-hazardous (EPA, 1980). Dissolved pulp including pulp rejects and cellulosic fines is expected to contain phenol levels in the interstitial water of the wastes. Phenol is generated during chemical and mechanical pulping when lignins and resins are separated from the cellulosic fibers. Whitewater fines are expected to contain chlorophenol and chloroform levels above the proposed regulatory level.

Bleaching. Following pulping, the unbleached pulp is brown or deeply colored due to the presence of lignins and resins or because of inefficient washing of the spent cooking liquor from the pulp. Bleaching is required to produce a light colored or white product. Bleaching is generally performed in several different stages. Some of the stages (abbreviations in parenthesis) are:

chlorination (C)  
caustic extraction (E)  
hypochlorite (H)  
chlorine dioxide (D)  
oxygen (O)  
etc.

C-E-D-E-D is a common sequence in kraft bleaching, and C-E-H in sulfite bleaching. Almost all sulfite pulps are bleached. Secondary fibers are also often bleached (i.e., wastepaper that has been de-inked). Wastes from the bleaching step include wastewaters with chlorophenol and chloroform above the current regulatory levels and waste fiber which will be landfilled. Chlorophenols and chloroform are generated during the bleaching process when chlorine bleaching agents are used. Additionally, given the presence of pentachlorophenols and alkali conditions in sulfate bleaching, there exists a potential for generation of dioxins. Dioxins generated in the sulfate bleaching step may persist through other steps of the process and into the wastewater treatment system.

Papermaking. Once pulps have been prepared, they are further mixed, blended, and non-cellulosic materials added to make the "furnish" for papermaking. This stock preparation step could involve dyeing, sizing, and starching. A dilute water suspension of pulp is prepared from the "furnish" and from this, a layer of fiber is deposited on a fine screen. This layer is then removed, pressed, dried and when desired, coated to form the final product.

Titanium, zinc sulphide, and lithopone pigments are generally used in paper-making (Masselli, 1970). Sizing of paper is done to increase resistance to penetration by liquids, particularly water. Rosin is typically used when sizing is required but natural waxes, starches, sodium silicate, glues, casein, synthetic resins, rubber latex and various hydrocarbons are also used (Masselli, 1970). Starching may be done to paper, however, its retention is difficult since it forms colloidal solutions and readily passes off with the filtered water. Coating of paper is designed to solve the problems of permeability and

printability. Chemicals which may be used as binders or coatings are polyvinylidene chloride, polypropylene, "saran" lacquer, rubber, acrylic latex, styrene-butadiene latex, polyvinyl acetate, polyvinyl alcohol, and carboxymethyl cellulose (Masselli, 1970).

Papermaking wastes include process wastewaters, which are handled in the wastewater treatment system, and other process wastes which are incinerated when they have sufficiently high organic content and landfilled or managed in the wastewater treatment system otherwise. The solid wastes from papermaking include  $2.2 \times 10^6$  MT/yr of wastepaper rejects and some fillers and wasted fiber which are landfilled (EPA, 1980). MRI estimates that none of the solid wastes will be deemed hazardous as a result of the proposed regulatory levels.

Wastewater Treatment. The pulp, paper, and paperboard industry employs many types of wastewater treatment systems to reduce the levels of pollutants contained in mill effluents. Biological treatment systems are used extensively by the industry. Aerated stabilization is the most common treatment process employed at mills discharging directly to a receiving water. Primary treatment only is employed at a relatively large number of plants. Primary treatment involves sedimentation, flotation, or filtration using mechanical clarifiers or sedimentation lagoons.

Approximately  $3.8 \times 10^6$  MT/yr of wastewater treatment sludge is generated (EPA, 1980). Primary and secondary treatment sludges are expected to have concentrations of chlorophenols, chloroform, trichloroethylene, methylene chloride, benzene and tetrachloroethylene above the proposed regulatory level. These constituents are all present in the interstitial water of the sludges above the regulatory levels. Sludges from bleached kraft, sulfite, and de-inking processes exhibit the highest levels of these constituents, with average chloroform levels estimated to be over 1 ppm. MRI estimates that  $2.7 \times 10^6$  MT/yr of waste water treatment sludges from these processes are expected to be regulated as hazardous.

Approximately  $6.7 \times 10^9$  MT/yr (EPA, 1980) of wastewater is generated from

the pulp and paper mill industry. Of this amount,  $4.8 \times 10^9$  MT/yr of wastewater generated by mills manufacturing bleach kraft pulp, bleached sulfite pulp or de-inked pulp with high levels of trichloroethylene, chlorophenols, chloroform and tetrachloroethylene are expected to be regulated as hazardous (MRI estimate).



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## APPENDIX

### Summary of Assumptions and Calculations for Pulp and Paper Industry (SIC 26)

<u>Parameters</u>	<u>Totals</u>
No. of Facilities <sup>1</sup>	5,926
Total Value of Shipments <sup>1</sup>	\$79,895.1 x 10 <sup>6</sup> /yr
Total Process Solid Waste <sup>2</sup>	11.5 x 10 <sup>6</sup> MT/yr
Wood Preparation Wood and Bark Wastes <sup>2</sup>	8.2 x 10 <sup>6</sup> MT/yr
Kraft Pulping Chemical Recovery Wastes <sup>2</sup>	594,000 MT/yr
Sulfite Pulping Chemical Recovery Wastes <sup>2</sup>	20,000 MT/yr
Pulping Rejects <sup>2</sup>	460,000 MT/yr
Cellulosic Fines <sup>2</sup>	Unknown
Papermaking Wastepaper Rejects <sup>2</sup>	2.2 x 10 <sup>6</sup> MT/yr
Wastewater <sup>2</sup>	6.7 x 10 <sup>9</sup> MT/yr
Wastewater Treatment Sludges <sup>2</sup>	3.8 x 10 <sup>6</sup> MT/yr

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<sup>1</sup> Census of Manufactures, 1982

<sup>2</sup> EPA, 1980