# St. Lawrence TECHNOLOGIES

## ABSTRACT

The pulp and paper industry, a key sector of the Canadian economy, must comply with new environmental regulations. A study has been conducted on the various techniques of pulp and paper sludge management to assess the impact of the new regulations on sludge production and to survey available solutions.

At the technological level, appropriate recycling and reuse methods must be developed or validated. Technological transfer must also be encouraged. At the management level, pulp and paper industries must adopt a more global approach to the selection of the optimal solution. Effective management practices can minimize disposal costs or prove cost-effective for the industry.

INDUSTRIAL WASTEWATER

# SLUDGE MANAGEMENT IN THE PULP AND PAPER INDUSTRY

## MAIN FEATURES

- **Industry concerns**
  - Substantial increase in the amount of sludge produced following the application of the new regulations
  - Major problems with sludge and solid waste disposal.
- **Technological needs**
  - Development of new, clean technologies to minimize sludge production
  - Development of sludge reuse/recycling methods as alternatives to landfilling.
- **Management needs**
  - Better cooperation between the industry and government
  - Development of codes of good environmental practice.

ST. LAWRENCE ACTION PLAN

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Conservation and Protection
St. Lawrence Centre

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## OBJECTIVES OF THE STUDY

To date, landfilling has been the simplest and least costly disposal option for pulp and paper sludges. However, existing landfill sites exhibit environmental problems related to the leaching of the toxic contaminants present in the sludge.
Increased sludge volumes, the shortage of available landfill sites and the new environmental standards necessitate the development of new processes and a review of traditional sludge and waste management methods.
The study has been conducted by H.A. Simons Ltd. for the Québec Forest Industries Association Ltd. (QFIA), in collaboration with the St. Lawrence Centre of Environment Canada, and the ministère de l'Environnement du Québec.

The objectives of the study were:

1. To assess the impact of the new regulations on the amount and type of sludge produced by the pulp and paper industry
2. To list sludge disposal options as an alternative to landfilling
3. To identify the industry's technological and management needs.

# BACKGROUND

The pulp and paper industry is responsible for the generation of numerous solid wastes, primary and secondary treatment sludges and de-inking process sludges. Québec's pulp and paper plants had to dispose of 2656 dried tonnes (dt)/d of solid wastes in 1990. These were made up of 46% primary treatment sludge, 45% bark, 5% ash, 3% de-inking sludge and 1% secondary sludge. 1990 waste production levels, along with estimates for 1995, are shown in the diagram.

Although sludge is potentially reusable, it is primarily considered a waste product for disposal. Indeed, 81% of primary treatment sludge is buried in landfills, a mere 18% is converted (14% by combustion in bark boilers, 4% by composting), and 1% is recycled. Secondary treatment and de-inking sludges are generally landfilled at present.

The new regulations will cause an increase in the quantity of secondary and de-inking process sludges from its current level of 106 dt/d to some 682 dt/d in 1995, thereby aggravating the industry's already serious disposal problems. A review of traditional sludge and waste management methods will be necessary.

# TREATMENT AND RECOVERY TECHNIQUES

Sludge management in the pulp and paper industry consists of several handling and treatment processes. Sludge must be dewatered in order to reduce its volume and water content to a level appropriate to its final destination (landfilling or reuse). The study identified several dewatering and recycling methods applicable to pulp and paper industry sludge.

- **Dewatering**

All dewatering techniques listed in table 1 are operational and present no problems for the treatment of primary sludges. On the other hand, secondary treatment and de-inking process sludges are more difficult to dewater due to their varying water contents and properties. They can be thickened, however, by combining them with primary treatment sludges. This will depend on subsequent treatment, required dryness and available equipment. The belt press and the screw-type press are currently widely-used to obtain a high level of dryness (up to 50%).

- **Recycling and reuse**

Among the methods for reuse that are applicable to pulp and paper industry sludge (see table 2), combustion in a bark boiler seems to be the most suitable, so long as energy recovery is possible. This method has fewer constraints than composting, the manufacture of various products or land spreading, and can reduce sludge volumes by 95%. The main disadvantages are a reduction in the boiler's efficiency, an increase in the auxiliary fuel demand and the generation of ashes. At plants not equipped with bark boilers, combustion can take place on a fluidized bed.

Wet oxidation may be applicable for sludge high in inorganic matter. This technique is suitable for liquid sludges, however equipment costs are high.

Depending on the plant's location, spreading on agricultural lands or forests is a reuse option for pulp and paper sludge. Combustion ashes can also be used as a pH stabilizer for acidic soil, or as a fertilizer (calcium, potassium and magnesium). This type of recycling method is best suited to municipalities already utilizing land spreading.

Pulp and paper sludges can also be used in the manufacture of various products such as compost, insulating panels or cardboard: the marketability of such products, however, depends on the laws of supply and demand. Sludge that is rich in inorganic matter can be used in the manufacture of cement (combustion in a cement kiln). This technique is especially suitable for de-inking process sludges and combustion ashes.

Vacuum pyrolysis, Supercritical water oxidation or the Carver-Greenfield process are among the most promising methods that could generate marketable by-products. These methods, however, are still at the research and development stages.

Other technologies (fluidized bed gasification, hydrolysis and fabrication of briquettes) have not yet proven cost-effective for the pulp and paper industry.

## TABLE 1 — DEWATERING METHODS

| Method | Sludge types | | | Initial dryness (%) | Final dryness (%) | Comments |
|---|---|---|---|---|---|---|
| | P or C | S | D | | | |
| Gravity table | X | X | | 0.5 to 2 | 10 to 15 | Used as first-stage dewatering techniques |
| Rotary drum filter | X | | | 0.25 to 2 | 3 to 5 | |
| Rotary vacuum filter | X | | | 2 to 4 | 18 to 25 | Seldom-used techniques |
| V-type press | X | | | 15 to 20 | 22 to 40 | |
| Ring-type press | X | | | > 16 | approx. 40 | |
| Centrifuge | X | X | X | 0.5 to 2 | 10 to 30 | |
| Belt press | X | X | X | 2 to 8 | 20 to 35 | Widely-used techniques |
| Screw-type press | X | | X | 4 to 15 | 33 to 50 | |
| Filter press | X | X | | 2 to 3 | 30 to 50 | Significant potential for pulp and paper sludge, but used mainly on sewage sludge |
| Heat treatment | | X | | 3 to 5 | 40 | |
| Rotary dryer | X | X | X | 30 | NA | Mainly used for bark |

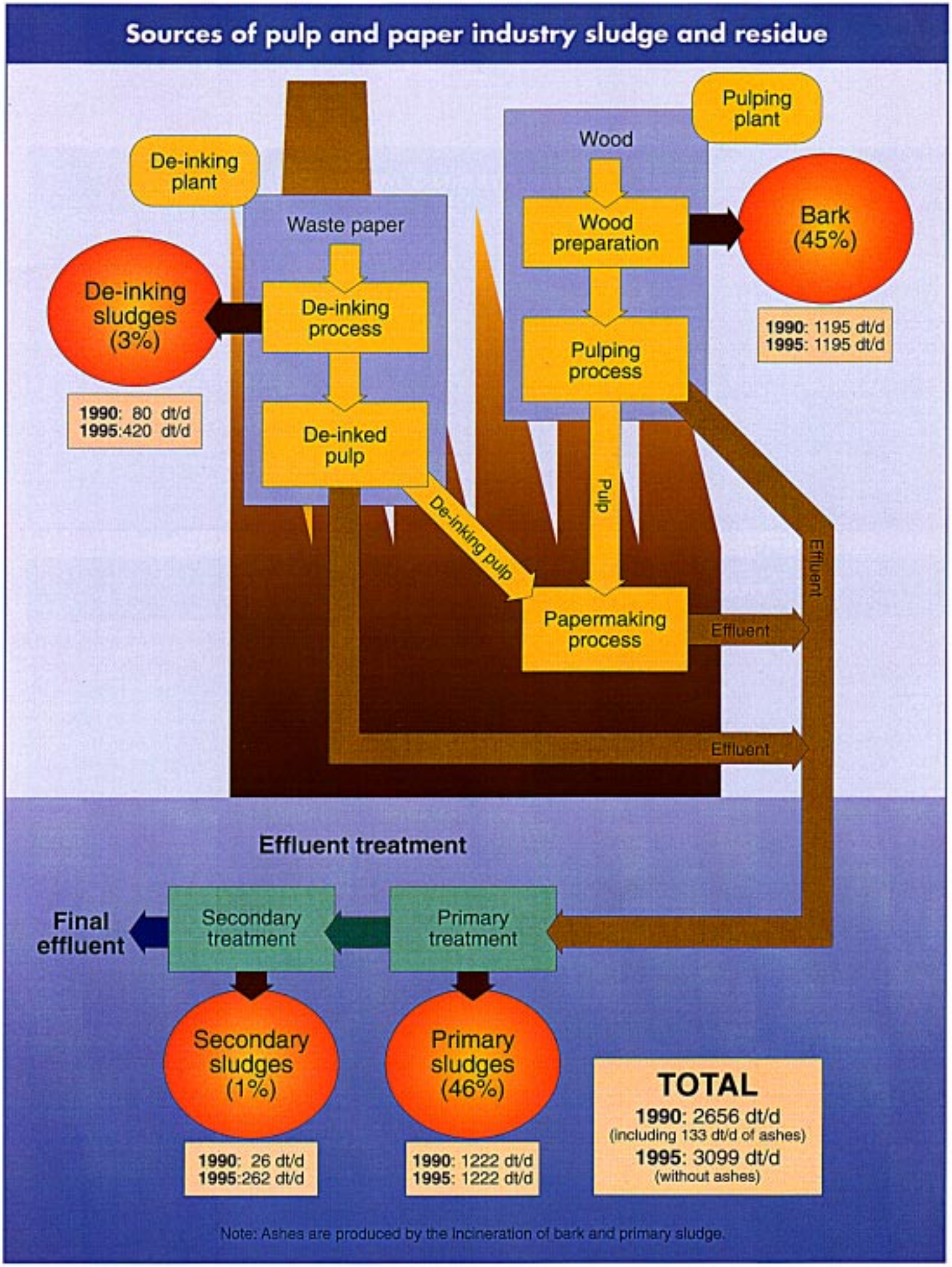
P: Primary sludge
C: Secondary sludge or de-inking sludge combined with primary sludge
S: Secondary sludge; D: De-inking sludge
NA: Not available

## TABLE 2 — RECYCLING AND REUSE METHODS

| Method | Type | Minimum dryness | Sludge types | | | By-products | Comments |
|---|---|---|---|---|---|---|---|
| | | | P or C | S | D | | |
| **Energy recovery** | | | | | | | |
| Bark boilers | O | 30% to 5% | X | X | X | Ashes | Requires capital expenditures |
| Fluidized bed | O | 30% | X | | X | Ashes | |
| Wet oxidation | O | 5% to 8% | X | | [2] | Clay | |
| Lime kiln | D | 25% to 30% | X | | | Chemical compounds | Dependent on sludge heat value |
| VORTEX system | D | 30% | X | X | | Ashes | |
| SCWO [1] | R | 10% | X | X | | Chemical compounds | |
| PIREC process | R | NA | X | X | | Ashes | Landfilling or recovery of by-products |
| Vacuum pyrolysis | R | NA | X | X | X | Chemical compounds | |
| **Direct use** | | | | | | | |
| Land spreading | O | no minimum | X | X | X | ... | Dependent on sludge physico-chemical characteristics |
| Forest spreading | O | no minimum | X | X | | ... | |
| Land remediation | O | 30% to 40% | X | X | X | ... | |
| Caps for landfill sites | D | 20% to 30% | X | | X | ... | Geographical constraints |
| **Miscellaneous manufacture** | | | | | | | |
| Composting | O | NA | X | X | | ... | Dependent on sludge physico-chemical characteristics |
| Material manufacture | O | 3% | X | | | ... | |
| Cement kiln | O | NA | X | | X | ... | |
| Carver-Greenfield process | D | 12% | | X | | ... | Market constraints |

[1]: SCWO: Supercritical water oxidation
[2]: Developmental method for de-inking sludge
O: Operational; D: Development; R: Research
NA: Not available

## Sources of pulp and paper industry sludge and residue




Note: Ashes are produced by the incineration of bark and primary sludge.

# MANAGEMENT STRATEGY

The implementation of the new governmental regulations will lead to a direct increase in the amounts of sludge and waste produced by this industry. This leads in turn to two important requirements:

- The development of new technologies
- The development of new approaches to sludge management.

At the **technological level**, innovation and concerted efforts will be necessary in the following areas:

- Developing and testing new technologies which minimize sludge and waste production
- Using sludge in the manufacture of construction materials
- Spreading on agricultural and forest lands
- Using alkaline residue and ashes in the manufacture of cement.

The transfer of technology and an environmentally sound application in conformity with the existing regulations require:

- The field testing of these new technologies
- The preparation of codes of good environmental practices
- The development of simple and routine ecotoxicological tests to assess the potential environmental benefits of the technological changes.

At the **management level**, the adoption of a global approach will require new ways of considering solutions; for example:

- Increasing consultation, both within the industry itself and with governments
- Adopting the multiple solution approach to problem-solving
- Providing the public with information on the various management strategies.

The implementation of new pulp and paper sludge treatment and management methods may prove cost-effective in many cases, or minimize disposal costs in others.

# INFORMATION

This data sheet is based on the results of a study carried out by H.A. Simons Ltd., with financial support from the St. Lawrence Centre, the Québec Association of Forest Industries Ltd. and the ministère de l'Environement du Québec.

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St. Lawrence TECHNOLOGIES

St. Lawrence Technologies data sheets are intended for all companies, industries, organizations and individuals interested in new environmental technologies. They are produced by the Technology Development Branch of the St. Lawrence Centre, Environment Canada, as part of the St. Lawrence Action Plan. They serve to disseminate the results of technology development and demonstration projects conducted in the following four sectors: industrial wastewater; contaminated soil; hazardous wastes; contaminated sediment.

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Marcel Champagne
Communications Le Sceau Inc.
*Printed at:*
Boulanger Inc.
Published by authority of the Minister of the Environment

Cat. No.: En 1-17/4/1993E
ISSN: 1188-8903
ISBN: 0-662-20383-6

February 1993

Cette fiche est également disponible en français sous le titre :
*La gestion des boues dans l'industrie papetière.*

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