St. Lawrence TECHNOLOGIES

ABSTRACT

A pilot project was conducted at the wastewater treatment plant of the City of Bromont to study the use of Common reeds for disposing of biological sludges and reduce sewage treatment costs for municipalities of fewer than 25 000 residents.

The use of reed beds to treat contaminated sludges was developed in Europe, and brought to the United States in the 1980s. It is an environmentally-sound and cost-effective alternative to sanitary landfilling.

Reed beds dewater and mineralize sludges so that they can be reclaimed for agricultural purposes. This treatment technology allows concentrations of heavy metals like copper, zinc, and nickel in sludge to be brought to below the maximum permissible levels for sludge reclamation.

INDUSTRIAL WASTEWATER

MINERALIZATION OF SLUDGES BY PLANTS: A TREATABILITY STUDY

HIGHLIGHTS

- **Technology**
  - Removal of water by percolation and evaporation
  - Oxygenation of root system.
- **Environment**
  - No discharges to the environment
  - No unpleasant odours
  - Blends into natural settings
  - Reduction of a material mostly landfilled or incinerated.
- **Cost**
  - Investment cost lower than that of other established dewatering technologies
  - Minimal operating costs
  - No specialized labour required
  - Does not require costly mechanical equipment.

Saint-Laurent Vision 2000

Environment Canada / Environnement Canada
Protection / Protection
Québec Region / Région du Québec

GROUPE SODINCO INC.

Bromont

Canada Economic Development / Développement économique Canada

PROJECT OBJECTIVES

The Bromont wastewater treatment plant comprises six aerated lagoons. It generates an annual total of some 4000 tonnes of sludges containing 2% dry matter; the sludges of two of the six lagoons are contaminated with heavy metals. The City of Bromont, in partnership with Environment Canada, opted for a reed bed treatment scheme proposed by the Sodinco Group Inc.

The project design was based on three main objectives:

1. to demonstrate the effectiveness of reed beds to dry and mineralize sludges
2. to demonstrate the possibility of reducing the concentrations of some heavy metals, including molybdenum, zinc, nickel, and manganese, in sludge from the Bromont plant
3. to determine the design and operating criteria of such a system in Quebec.

Due to its innovative nature, the project was scientifically monitored by the *Institut de Recherche en Biologie Vegetale* (IRBV) in 1996 and 1997. This consisted of periodically characterizing the various components of the system, i.e. the raw sludge, leachate, dewatered sludge, and accumulations of heavy metals in plant tissue. The heavy metals selected for analysis are those typically characterized in sludge destined for agricultural reclamation (i.e. Al, As, B, Cd, Co, Cr, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Se and Zn).

BACKGROUND

Twenty percent of the estimated 170 000 tonnes of dry sludge produced annually in Quebec is generated by municipalities.

The costs associated with the management and disposal of these treatment sludges are a heavy burden on municipal budgets, especially for small towns with fewer than 25 000 inhabitants. Any method that is apt to reduce these quantities of sludge means significant savings in the medium and long term.

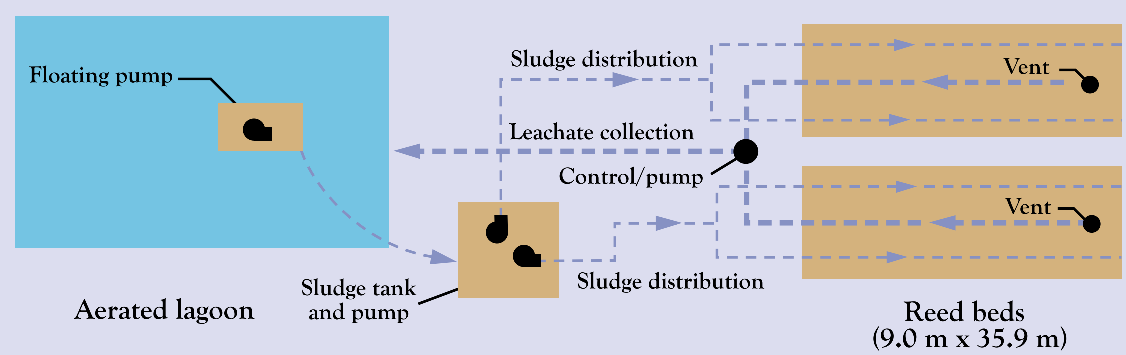
TECHNOLOGY

The process consists of the periodic application of a certain volume of sludge on reed beds formed of two distinct layers of material. Composed of sand, the top layer functions as a plant support and sludge filter. The main function of the bottom layer, made of natural or crushed gravel, is to drain percolation waters. The sludges are retained at the surface of the bed where the reeds do the work of dewatering and mineralizing; percolation waters are returned to the head of the plant's treatment sequence.

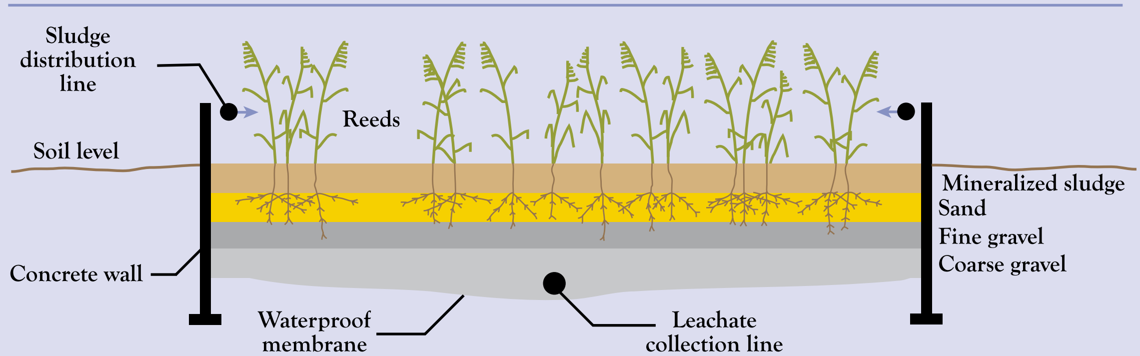
The reed beds have a life cycle of anywhere from seven to 15 years before they need to be emptied. Mineralized sludge becomes a humus with a dryness rate of close to 50%. Of the water contained in the sludge, roughly 46% is lost to drainage and 39% to evapotranspiration, for a water loss rate on the order of 85–90%.

According to a 1990 characterization, the sludges of two of the six aerated lagoons contained a higher percentage of heavy metals than the maximum permissible level for agricultural reclamation. The report identified five metals (molybdenum, nickel, lead, zinc, and manganese) as being present at concentrations nearing or exceeding the allowable limit.

SCHEMATIC 1. SLUDGE-DRYING REED BEDS



FLOW DIAGRAM



CROSS SECTION

RESULTS

Construction of the two-bed pilot system was completed in August 1996; the reeds were planted at the end of August. Sludge was first applied to Bed 1 on October 28, 1996, followed by a second application on October 31, 1996, for a total of 56.5 cubic metres (m^3) that year. No sludge was applied on Bed 2 in 1996.

Regular sludge applications on both reed beds began in June 1997. The total sludge volume treated in 1997 was 1012 m^3 — almost twice the objective of 600 m^3. The dryness rate of raw sludge taken from the aerated lagoons, however, was only 0.51%, well below the anticipated value of 2%. The dryness rate may be raised to close to 1% by modifying the pump technique.

The plants played no significant part in sludge drying or in removing heavy metals; the reed populations being so young, rhizomes and roots were not yet able to penetrate the raw sludge bed.

Of the 1000 m^3 of 0.5% dry sludge applied throughout the study, only 10 m^3 remained to be disposed of. This is equivalent to a reduction in mass of over 99%. The potential reduction in sludge volume should improve even more as the plants grow and mature.

Growth of reeds

**TABLE 1.
ACCUMULATION OF HEAVY METALS IN PLANT TISSUE IN 1997
AND CHARACTERIZATION OF DEWATERED SLUDGE**

Parameter	Accumulation of metals in tissue					Characterization of dewatered sludge (average 2 beds)
	Belowground portion		Aboveground portion			
	Plant	Bed 1	Plant	Bed 1	Bed 2	
	26/09/96	29/10/97	26/09/96	29/10/97	13/11/97	
Dryness %	-	-	-	-	-	64
TKN	-	-	-	-	-	20 167
PT	-	-	-	-	-	55 400
Al	547	1 279	828	90.5	116	31 400
Cr	10.4	18.9	26	0.5	6.5	263
Cu	6.3	34.7	3.9	4.0	4.0	802
Mn	17.9	138	31.4	43.3	106	901
Mo	0.5	2.9	1.2	2.6	3.8	49
Ni	5.7	14.8	12.6	0.2	2.4	175
Pb	0.3	-	0.4	-	-	438
Zn	22.8	47.5	35	8.2	8.0	1333

POTENTIAL AND LIMITATIONS

Molybdenum, present in untreated/treated sludge at concentrations exceeding the limit for agricultural reclamation (Category C2), is the most problematic element for the Bromont treatment plant. This is not surprising given that the only active mechanisms in the sludge drying process during its first years of operation, drainage and evapotranspiration, have no significant effect on concentrations of heavy metals in dry matter. With the establishment of a root system and the formation of the sludge layer in the years to come, though, accumulated plant tissue and bacterial activity should contribute to reducing the concentrations of metals in dewatered sludge.

A sample of five plants served to determine the initial metal concentrations in reed tissues. Metal concentrations were relatively higher in the aboveground portions of the plants than in the belowground parts, as is only logical given plant metabolism.

Metal concentrations in plant tissue have remained higher than their initial concentrations since the first full year of operation. This effect should grow over time, as the sludge layer thickens and the system of roots and rhizomes develops.

INFORMATION

This technology data sheet is based on the results of a technology development project conducted by the Group Sodinco Inc., in collaboration with the Institut de Recherche en Biologie Vegetale, and with funding from the City of Bromont, Environment Canada, and the Canada Economic Development Agency for Quebec.

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St. Lawrence TECHNOLOGIES

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