MANAGEMENT AND BENEFITS OF PULP AND PAPER MILL RESIDUALS

George Velema
Domtar Inc.,
Cornwall Mill
P.O. Box 40, 810 Second Street West
Cornwall, ON K6H 5S3

ABSTRACT

Domtar Inc. operates a comprehensive land application program for two of its pulp and/or paper mills located in Ontario. Solid organic residues known as Pulp and Paper Mill Biosolids (PPMB) generated by the effluent treatment plants of both mills are used as soil amendments, fertilizer or mulch in agriculture, silviculture and land rehabilitation projects. The 10-year-old program has developed to sustainably recycle 100 percent of PPMB organic type residues that were formerly managed as waste and landfilled. Landfilling and incineration is still a common management option for most of the Pulp and Paper industry in Canada. The Pulp and Paper Research Institute of Canada determined, from the results of a survey in 1995, that industry generated 7.1 million dry tones of residues; 23% of which were PPMB. An estimated 119,000 dry tones of PPMB were land applied in Canada, representing 7% of the total available. A 2001 follow-up survey indicated that this had increased to where 42% practised some degree of land application. Land application of PPMB is safe, ecologically sustainable, environmentally responsible, agronomically beneficial, and economically sensible. Although the regulatory regimes in Canada at the provincial and federal levels discourage the recycling of "industrial wastes", many opportunities exist for the wise use of these resources through land application, provided programs deal with their communities and publics in an open and proactive manner.

INTRODUCTION

The Canadian pulp and paper industry generated an estimated 7.1 million tonnes of solid residues in 1995. The main materials involved were wood and bark (60%), pulp and paper mill biosolids (PPMB) 23%, inorganic residues (12%) and miscellaneous (5%) [1]. According to the Pulp and Paper Research Institute of Canada (PAPRICAN) survey, 88% of all PPMB were landfilled or burned. Only 7% were recycled by means of land application. A follow-up survey conducted by PAPRICAN in 2001 [2] indicated that while all the mills had some form of primary and/or secondary treatment, 61% had an "Activated Sludge" biotreatment system generating a secondary or combined (primary plus secondary) biosolid on a daily basis. These mills have a daily disposal requirement using landfilling, incineration or land application. The survey showed that 51% of these mills practised land application and land applied more than 95% of their biosolids. Most of the PPMB was used on agricultural land (70%) while only 4% was used in silvicultural land. Land rehabilitation accounted for the balance of 26%.

Domtar's experience at the Cornwall mill, for example, follows the industry pattern. In the early nineties all of the process residues, amounting to 125,000 to 150,000 tonnes per year, were landfilled. However a change in attitude and methods was needed because existing landfill had reached capacity and new landfill space was difficult to acquire [3]. As a result, the Cornwall mill now landfills only 3% of its residues. This is the result of comprehensive Land Application and Recycling Programs. Eighty percent of residues generated are land applied. The balance (17%) sold or recycled. All of the mill's combined PPMB is land applied (Table I).

Table I **Diversion from Landfilling to Beneficial use - Cornwall Mill**
All Solid Waste in Thousands of Wet Metric Tonnes (as is basis)

Year	Generated	Sold	Recycled	Land Applied	% Diverted
1994	110	0	2	9	11
1995	137	6	18	75	72
1996	128	10	3	95	84
1997	97	13	1	76	93
1998	122	16	6	96	97
1999	124	20	4	97	97
2000	126	20	4	95	95
2001	147	20	5	117	97
2002	123	18	3	93	92

Since 1994, 693,000 tonnes of residues from the 1.1 million tonnes generated by the Cornwall mill have been land applied. Included in this total are 476,000 tonnes of PPMB. Over the period, 79% of all residues have been used on agricultural land, 18% in silviculture and 3% in land reclamation projects (See Table II).

Table II **Land Application – Cornwall and Ottawa Mills**
Delivery to Agriculture, Silviculture, Land Rehabilitation by material type
January 1, 1994 – December 31, 2002

In thousands of wet tonnes (as is basis)							
Destination		**Combined PPMB**		**Primary PPMB (Cornwall)**	**Lime (Cornwall)**	**Wood Products (Cornwall)**	**Total**
		Cornwall	**Ottawa/Hull***				
Agriculture	mt	401	49	11	137	---	598
	%	84		30	100	---	79
Silviculture	mt	67	0	14	---	42	123
	%	14		37	---	97	18
Rehabilitation	mt	8	0	12	---	1	21
	%	2		33	---	3	3
TOTAL	mt	476	49	37	137	43	742

* Ottawa/Hull PPMB – June 1, 1998 to December 31, 2002

The considerable experience and body of research amassed by Domtar and the industry at large shows that land application is safe, sustainable, responsible, beneficial and economical. Even so, provincial and federal regulatory agencies are reluctant to endorse the practise for fear of adverse public reaction. The public perception is that PPMB and municipal sewage biosolids are one and the same and that they may contain harmful ingredients such as heavy metals, dioxins/furans, bioaerosols, pathogens, viruses, moulds and fungi, endocrine disruptors and other contaminants. These issues are often misrepresented in the press and on the Internet without opportunity for rebuttal. PPMB are classified as “industrial organic waste” and smell bad: this tends to alarm local communities. Such alarms, along with erroneous health and safety claims, can kill a successful program.

Table III **Land Application – Cornwall Mill**
Analysis of Cornwall and Ottawa/Hull Combined Biosolids compared to Commercial Products

Date: February 2003

	Ontario* Guideline	Domtar Cornwall Combined Biosolids (Jan-Dec 2002)	Domtar Ottawa/Hull Combined Biosolids (Jan-Sept 2002)	Commercial Composted Cow Manure +	Commercial Organic Compost +	Commercial Topsoil +	Urea Granular Fertilizer (46-0-0)	Granular Weed/Feed (24-3-4)
% Solids		34.3	33.2	40	34	32	91	95
% Organics		82.4	71.2	63	90.2	72	96.4	46
% Ash		17.6	28.8	37	9.8	28	1.6	54
C:N		22.6	58.9	61.1	67.6	44.1	0.17	0.47
pH		7.4	7.2	7.0	6.4	7.6	7.6	6.4
Appearance		Brown	Grey	Black	Black	Black	White	White/Grey
Composition (as per label)		Microbial cells, fibre, clay and Calcium Carbonate	Cellulose Fibre, Microbial cells, Ash	Composted Cow Manure (NPK) (1.4,0.8, 1.1)	Commercial Organic Compost Rich Softwood Bark, Fish, Shellfish	100% Natural Topsoil	Urea Fertilizer (46-0-0)	Weed and Feed (24-3-4) (0.56% 24-D, 0.28% Mecaprop)
Source		Domtar Cornwall Mill	Domtar Ottawa/Hull Mill	Premier Horticulture	Genesis Organics Inc.	Canadian Tire Corp.	Nutrite Hydro Agri Canada	Nu-Grow Corp.
Regulated Metals (mg/kg)								
Arsenic	170	0.8	ND @ 6	1.5	1.1	3.4	<0.7	<0.7
Cadmium	34	1.7	ND @ 1	ND @ 1	ND @ 1	ND @ 1	ND @ 1	ND @ 1
Chromium	2,800	13.6	22.1	10	3.3	8.6	10	ND @ 2
Cobalt	340	ND @ 2	ND @ 2	3.0	ND @ 2	3.3	2.4	ND @ 2
Copper	1,700	25.1	27.7	90	7.9	16	ND @ 2	5.3
Lead	1,100	5.3	ND @ 5	ND @ 5	ND @ 5	ND @ 5	ND @ 5	ND @ 5
Mercury	11	0.03	0.02	0.03	0.05	0.10	ND @0.02	0.02
Molybdenum	94	2.2	2.2	ND @ 2	ND @ 2	ND @ 2	ND @ 2	ND @ 2
Nickel	420	6.5	5.8	10	2.7	8.5	2.6	ND @ 1
Selenium	34	ND @ 1	ND @ 1	ND @ 5	ND @ 5	ND @ 5	ND @ 2	ND @ 2
Zinc	4,200	135	47.8	350	98	41	12	61
Macronutrients (mg/kg)								
Nitrogen (TKN)		17,833	5,122	9,700	10,000	14,000	45,000	18,000
Phosphorus (Total)		3,150	886	10,000	4,800	610	140	14,000
Potassium		1,195	288	18,000	1,900	470	780	2,800
Calcium		37,083	12,067	41,000	23,000	44,000	65,000	13,000
Magnesium		1,858	643	5,200	1,300	1,900	1,900	440
Sulphur		4,267	1,011	4,500	2,700	4,300	500	23,000
Other Elements (mg/kg)								
Aluminum		3,317	3,289	5,900	670	3,100	1,900	67
Barium		110	11.1	430	140	140	7.7	ND @ 5
Beryllium		ND @ 0.5	ND @ 0.5	ND @ 0.5	ND @ 0.5	ND @ 0.5	ND @ 0.5	ND @ 0.5
Boron		19	ND @ 5	49	9.4	16	5.9	710
Sodium		1,236	236	3,800	1,300	94	680	490
Dioxins (ppt)	100	3.49007***	1.9143	2.4106***	2.4151***	2.422***	NA	2.3549***
Anions (mg/kg)								
Chloride		123	74.2	3,500	530	27	620	43,000
Sulfates		526	102.6	1,300	43	180	690	1,700
Analytical Labs		Maxxam	Maxxam	Maxxam	Maxxam	Maxxam	Maxxam	Maxxam
Number of Analysis		12	9	1	1	1	1	1

* 1986 OMAF, MOE, MH sludge Guidelines
*** - TEQ (0.5 MDL)
ND = Non-detectable
NA = Not Analyzed
+ Products purchased at Canadian Tire Store (Cornwall – June 15, 2002)

PPMB ARE SAFE!

In Ontario, as in most other jurisdictions, PPMB and other non-agricultural residues proposed for land application must meet standards relating to the maximum allowable concentration of inorganic and organic contaminants. Ontario regulates eleven metals and organic contaminants such as dioxins/furans. Standards for maximum permissible metal additions to soil are also established. Although individual PPMB vary in their characteristics based on their source processes, PPMB are generally very low in contaminants. Metals are generally comparable to background levels found in native uncontaminated agricultural soils and to common agricultural or horticultural products purchased by the public for use on land and gardens and are therefore not a cause for concern. While the pulp and paper industry is reputed to be a generator of dioxins/furans, the fact is that since the implementation of secondary effluent treatment at almost all pulp and paper mills, the level of dioxins/furans in the final effluent and in the biotreatment solid residuals (PPMB) have been also reduced to background environmental levels (See Table III).

The question of "pathogens" in PPMB is also frequently raised. The standard indicator for faecal contamination of drinking water and food are fecal coliform bacteria. This group of bacteria are assumed to originate only from the mammalian gut and, when detected, could indicate the presence of certain strains of pathogenic bacteria such as *E.coli* 0157:H7. However, harmless "fecal" coliforms actually grow in pulp and paper mill waters. Their numbers are not a result of fecal contamination or any microbial health hazard present in those waters, or in the PPMB produced during the biotreatment of the waters. Therefore, the use of coliform indicator assays is not applicable to PPMB [4]. More sophisticated PCR genetic testing for toxic encoding genes of toxigenic strains of *E.coli* have proven their absence. Testing conducted by Domtar Cornwall mill has also ruled out the presence of a series of other common pathogens. The overall conclusion is that if mill process, design, and piping allow no measurable human or animal fecal waste to enter the waste water or waste water treatment system, then the PPMB will not present a health risk.

The bioaerosols issue is closely related to that of pathogens. Bioaerosols are defined as airborne particles consisting of or originating from micro-organisms – i.e. bacteria, viruses and moulds. These particulates come from organic matter, plants, soil, animals and humans and become airborne through the release of dust and water droplets. A recent review [5] commissioned by the Quebec Ministry of the Environment points out that the great majority of micro-organisms present in the environment, especially in soil, manure or biosolids, have no negative effect on health. The review found no study in the literature on bioaerosols released during land application of PPMB, but said that the "risk to human health should be theoretically comparable to or lower than the risk associated with municipal biosolids". The relatively low risk from municipal biosolids bioaerosols is to workers directly working with biosolids. The pathway of risk is through direct contact, which can be mitigated through standard hygiene practices [5]. Epidemiological studies show that risk associated with pathogens and airborne pathogens are extremely low for people living close to sites where municipal biosolids are applied. In fact, the potential health risks associated with the application of biosolids for farms and the general population are relatively low when compared to those associated with manure management, especially liquid manure.

Endocrine disrupting substances from pharmaceutical products entering sewage wastewater are associated with municipal biosolids. Other possible endocrine disrupters are nonyl phenol ethoxylates – ingredients in industrial detergents that were formerly used in the pulp and paper industry, but have been widely replaced.

PPMB are simply organic materials originating from woody plant material and consisting of cellulose fibres, microbial mass and some inorganic fillers such as lime ($CaC0_3$) and clay. PPMB are similar to municipal biosolids and animal manure in their use, benefit, and management, but differ in three important respects:

1. PPMB do not contain pathogens
2. Nutrients, specifically nitrogen in the form of Ammonium (NH_4^+) and Nitrate ($N0_3^-$) – which are soluble and leachable – and phosphorous, are a small component of PPMB. The nitrogen is mostly in organic form and is made available to plants only after microbial degradation in the soil matrix.
3. The industrial processes from which PPMB are derived are contained, stable, consistent, reliable, monitored and controlled. PPMB are regularly sampled and analysed. The experience of one pulp and paper mill, which has land applied PPMB for 18 years, indicates that the variability in the concentration of regulated contaminants is so mall that the probability of exceeding a restricted parameter is less than 1 in 500,000,000.

LAND APPLICATION OF PPMB IS ECOLOGICALLY SUSTAINABLE

Organic matter is fundamental to the health of soil. Healthy soil is essential for the growing of food and fibre in soil. The normal annual tilling of soil for the culture of crops removes approximately 1% of the total organic matter through oxidation of exposed soil. In addition, the removal of crops and forage to feed people, directly or indirectly, by way of livestock, for production of animal food products removes additional organic matter. Likewise, the harvesting of timber and fibre removes organic matter that would otherwise cycle in the forest ecosystem. Organic matter in the form of food and wood products is transported from the farm or forest and concentrated for consumption and processing in centres of population and industry. The by-products from industrial processes and the waste generated by final consumers are then simply disposed of. Most often this waste is further concentrated and entombed in landfills.

This scenario is clearly not sustainable ecologically. Organic matter from the land must be returned to the land. In 1995, the Pulp and Paper Industry landfilled or burned 88% of all PPMB generated. Only 7% and 6% respectively were land applied or composted [1]. This situation has improved so that by 2001, 42% of Canadian pulp and paper mills practised land application to some degree. Mills with Activated Sludge Treatment systems land applied significant proportions of their treatment residues. Still, some jurisdictions such as British Columbia, New Brunswick and Newfoundland do not practise land application of PPMB at all [2]. Other jurisdictions grudgingly allow land application of PPMB. Ontario and Quebec have a strict regulatory regime with many unnecessary restrictions and a slow bureaucratic approval process for the permitting of individual application sites. This discourages large generators of recyclable organic material from doing the right thing ecologically. Authorities should instead encourage and support the land application of residues that are proven to be safe and beneficial.

LAND APPLICATION IS ENVIRONMENTALLY RESPONSIBLE

Before 1994, the Domtar Cornwall mill landfilled all of its materials. The Ottawa mill landfilled all of its PPMB until 1998. In the case of Cornwall, the company owned a licensed landfill on the mill premises. By the early 1990's that facility was rapidly reaching its capacity. Another site was identified, but the community opposed that location. A second site was chosen and a detailed environmental investigation of the site was completed. The environmental approval process was estimated to take at least two years. In the meantime, a land application program was initiated to try to divert as much residue from the landfill as possible by recycling materials for use inside the mill, to outside users and for land application. The diversion rate climbed from 11% in 1994 to 97% in 1998 at Cornwall (See Table I). About 80% of all solid waste generated is presently land applied. Land application, therefore, can be the key to a successful solid waste program.

A comprehensive land application program enables the diversion of the bulk of organic residues generated at pulp and paper mills. The separation and accounting of various waste streams enables other recycling opportunities for recycling, reuse and reduction of waste. This approach fits with Domtar Inc.'s environmental policy, which mandates its employees to conserve resources. Both PPMB and landfill space are considered by the company to be resources, that are being conserved through a land application program.

LAND APPLICATION OF PPMB IS AGRONOMICALLY BENEFICIAL

The Domtar Cornwall and Ottawa mills have land applied over 476,000 tonnes of PPMB since 1994. The opportunities for the use of PPMB in agricultural activities lie primarily in their ability to supply organic matter and nutrient to the soil. PPMB in combination with other residues such as bark to make biodegradable mulches used to enhance tree establishment and growth is another opportunity. In land rehabilitation, combinations of PPMB types and other residues can replace or rebuild topsoil at disturbed or excavated aggregate extraction and industrial site. Some examples of the various functions of PPMB are:

Plant Growth and Productivity

- Better root penetration
- Better air supply to roots
- Better moisture supply
- Supply of nutrients, with some in slow release, organic form
- pH adjustment

Soil Improvement

- Increased organic matter
- Improved water infiltration and retention capacity
- Improved soil structure
- Improved erosion control
- Improved storage and cycling of nutrients
- Increased cation exchange capacity
- Support for diverse microbial community

PPMB that have benefit for land application generally include the following types:

- Solid residues from primary wastewater treatment (primary clarifier fibre)
- Solids from secondary treatment processes
- Combined primary and secondary biosolids residues
- Biosoids from de-inking processes

Primary treatment biosolids are solid residues derived from the initial treatment of mill wastewaters using physical and chemical sedimentation processes. They are produced in a primary clarifier or large settling basin. Flocculants may be added to promote settling of the solids.

When they are dewatered, these materials have a solids content of approximately 20 – 25%, with the solids consisting of roughly 85% wood fibre, 10% calcium carbonate, and 5% inorganic clay (dry weight basis). Primary biosolids have a low nutrient content and a high C:N ratio, and consequently are of limited value as organic fertilizer but are of value in supplying organic matter to soils. They are also useful as a mulch for moisture retention, weed control and erosion prevention. Primary biosolids can be used in environmental remediation to bind excess nitrate in soil.

Secondary PPMB are produced from the sedimentation of biologically treated wastewater, and are composed primarily of microbial biomass. Systems at pulp and paper mills generally use the aerobic microbiologic process. Micro-organisms in the secondary treatment process use the organics in the wastewater as food, increasing the microbial mass. Nitrogen and phosphorus added as nutrients to biological systems treating pulp and paper mill wastewaters tend to be retained by the biomass and are therefore components of these biosolids. Because they are composed of biological cells, secondary biosolids are very difficult to dewater. For practical purposes, they must be combined with primary biosolids to be dewatered and to allow them to be land applied as solid materials.

Combined biosolids consist of a mixture of primary and secondary biosolids, which are blended to allow dewatering of the secondary materials. The properties of the combined biosolids vary considerably, and will reflect the properties of the primary and secondary biosolids based on the mixture ratio.

Combined biosolids can be dewatered to 30% to 50% total solids, and the C:N ratio may range from under 20:1 to greater than 100:1, again depending on the ratio of primary to secondary biosolids.

Solid de-inking residues refer to the primary, secondary or combined biosolids that are generated at de-inking mills that manufacture paper products from recycled de-inked fibre feedstock. They will generally be composed of paper fibre, microbial cells (if secondary treatment is used), carbonate and clay fillers, and some inorganic materials (ink residues, ash, etc.). The de-inking residues can be expected to have similar characteristics and beneficial uses as other PPMB's [6].

Both the Cornwall and Ottawa mills at Domtar produce combined biosoids. The Cornwall material has a C:N ratio of 20:1 that is very similar to manure. The Ottawa mill material has a somewhat higher C:N ratio of 45:1. The Cornwall mill also generates a small quantity of primary biosolids. Seventy percent of the Cornwall combined biosolids and all of the Ottawa material is applied in agriculture using 43 farm locations. The main crops used for the Cornwall combined biosolids are corn, soybeans and forage. Turf, soybeans, which suits the higher C:N ratio, are grown with the Ottawa combined biosolids. An ongoing agricultural research program with the local agricultural college of the University of Guelph supports the agronomic prescriptions as to rate, timing, frequency and method of application. Some 36 studies (See Table IV) and reports conducted specifically on the agronomy of these crops using Domtar PPMB and promoted as "Domtar Soil Conditioner".

Table IV **Domtar Inc. / University of Guelph – Research Reports**
Domtar PPMB (Domtar Soil Conditioner)

Date	Report	Authors
Domtar Cornwall Reports		
December 1998	Domtar Soil conditioner Trial on Strawberries	John Madill, William Curnoe University of Guelph
January 1996	Clarifier Fibre Sponge Test.	W.E. Curnoe, W.E. Dow OMAFRA
January 1996	Land Application of Domtar Clarifier Fibre.	W.E. Curnoe .B. Dow OMAFRA
January 1996	Land Application of Domtar Soil Conditioner from the Cornwall Pulp and Paper Mill.	W.E. Curnoe, C.B. Dow OMAFRA
December 1996	Domtar Soil Conditioner on Grass Hay from Domtar's Cornwall Facility.	W.E. Curnoe; C.B. Dow KCAT
January 1997	Split Application of Soil Conditioner from Domtar's Cornwall Facility.	W.E. Curnoe, C.B. Dow KCAT
January 1997	Spring Applied Soil Conditioner from Domtar's Cornwall Facility.	W.E. Curnoe, C.B. Dow KCAT
January 1997	Domtar Tillage Demonstration.	W.E. Curnoe, C.B. Dow KCAT
January 1997	Land Application Trial (with) Primary Clarifier Fibre (at) Osnabruck Township –1996 Progress Report.	J. Velema Eastern Ontario Model Forest
May 1997	Land Application Trials of Cornwall Paper Mill Clarifier Sludge –Final Report –Environmental Aspects –Soil, Sludge and Water Quality.	Alain Liard, Amy Lo Domtar Innovation
February 1998	Domtar Soil Conditioner on Grass Hay.	W.E. Curnoe, C.B. Dow, D.C. Irving University of Guelph
February 1998	Soil Conditioner 1996 – 1997, Split Application.	W.E. Curnoe, C.B. Dow, D.C. Irving University of Guelph
February 1998	Soil Conditioner 1996 – 1997, Spring Applied on Field Corn.	W.E. Curnoe, C.B. Dow, D.C. Irving University of Guelph
December 1998	Domtar Soil Conditioner, Spring Applied on Field Corn.	W.E. Curnoe, C.B. Dow, D.C. Irving University of Guelph
December 1998	Domtar Soil Conditioner, Split Application on Field Corn.	W.E. Curnoe, C.B. Dow, D.C. Irving University of Guelph
December 1998	Domtar Soil Conditioner, Pasture Test 1998.	W.E. Curnoe, C.B. Dow, D.C. Irving University of Guelph
January 2000	Domtar Soil Conditioner 1999, Spring Applied on Field Corn.	W.E. Curnoe, C.B. Dow, D.C. Irving University of Guelph
January 2000	Domtar Soil Conditioner 1999, Split Application on Field Corn.	W.E. Curnoe, C.B. Dow, D.C. Irving University of Guelph

Date	Report	Authors
January 2001	Domtar Soil Conditioner, Spring Applied on Field Corn.	W.E. Curnoe, C.B. Dow, D.C. Irving University of Guelph
January 2001	Domtar Soil Conditioner, Split Application on Field Corn.	W.E. Curnoe, C.B. Dow, D.C. Irving University of Guelph
January 2001	Domtar Biosolids on Soybeans Demonstration Trial 2000.	W.E. Curnoe, C.B. Dow, D.C. Irving University of Guelph
January 2002	Domtar Soil Conditioner Split Application on Field Corn, 2001	W.E. Curnoe, C.B. Dow, D.C. Irving University of Guelph
January 2002	Domtar Soil Conditioner Spring Applied on Field Corn 2001	W.E. Curnoe, C.B. Dow, D.C. Irving University of Guelph
September 2002	Domtar Soil Conditioner (Ottawa Hull & Cornwall Mills) on Field Corn – Fall 2000 and Spring 2001 Application	W.E. Curnoe, C.B. Dow, D.C. Irving University of Guelph
September 2002	Domtar Soil Conditioners (Ottawa Hull & Cornwall Mills) on Turfgrass 2001	W.E. Curnoe, D.C. Irving University of Guelph
Ottawa/Hull Reports		
March 23, 1998	Report of E.B. Eddy Biosolids	W.E. Curnoe, C.B. Dow, D.C. Irving University of Guelph
December 17, 1998	E.B. Eddy Biosolids on Corn 1998.	W.E. Curnoe, C.B. Dow, D.C. Irving University of Guelph
January 2000	E.B. Eddy Biosolids 1998 on Field Corn –1999 Yields.	W.E. Curnoe, C.B. Dow, D.C. Irving University of Guelph
January 2000	E.B. Eddy Biosolids on Field Corn 1999	W.E. Curnoe, C.B. Dow, D.C. Irving University of Guelph
January 2000	E.B. Eddy Biosolids –Demonstration on Soybeans 1999.	W.E. Curnoe, C.B. Dow, D.C. Irving University of Guelph
January 2001	E.B. Eddy Biosolids on Field Corn 2000.	W.E. Curnoe, C.B. Dow, D.C. Irving University of Guelph
January 2002	Domtar Soil Conditioner (Ottawa/Hull Mill) on Field Corn 2001	W.E. Curnoe, C.B. Dow, D.C. Irving University of Guelph
January 2002	Domtar Soil Conditioner (Ottawa/Hull Mill) on Soybeans	W.E. Curnoe, C.B. Dow, D.C. Irving University of Guelph
September 2002	Domtar Soil Conditioner (Ottawa Hull & Cornwall Mills) on Field Corn – Fall 2000 and Spring 2001 Application	W.E. Curnoe, C.B. Dow, D.C. Irving University of Guelph
September 2002	Domtar Soil Conditioners (Ottawa Hull & Cornwall Mills) on Turfgrass 2001	W.E. Curnoe, D.C. Irving University of Guelph

The Domtar (Cornwall mill) Soil Conditioner can replace the need for commercial fertilizer – a potential saving of $250/ha in input costs for a crop of corn. At the same time, soil organic matter is built up without environmental impacts on soil, surface water or ground water (See Table V).

Table V Nutrient Value of Domtar Combined PPMB compared to Agricultural Inorganic Fertilizer

Nutrient	[1] Fall Application (kg/ha)	[2] Spring Application (kg/ha)	Total Available to Crop (kg/ha)	Total Equivalent Value ($/ha)	Value per wet tonne (as is)
Nitrogen	50.2	150.06	200.3	182.27 ❶	$2.20
Phosphate	25.8	38.7	64.5	56.79 ❷	$0.68
Potassium	11.9	17.85	29.75	13.69 ❸	$0.16

[1] Based on an application rate of 10 dry tonnes per hectare
[2] Based on an application rate of 15 dry tonnes per hectare
❶ Price based on local cost of Urea = $420.00/tonne – Spring 2001 (cost of urea and spreading)
❷ Price based on local cost of Phosphate: (MAP) = $405.00/tonne
❸ Price based on local cost of Potash: 0-0-60 = $278.00/tonne
NOTE: Value of organic matter content not included.

Combinations of primary and combined PPMB can be used at high application rates to quickly re-establish vegetation on worked out abandoned aggregate extraction or other industrial sites and return such areas to ecological productivity. Potential negative environmental impacts are minimal and relate to a temporary and minor flush of nitrate to the subsoil and ground water. These effects can be mitigated with the use of best management practises such as those published by OFIA [6].

The use of PMB in forest plantation – specifically hybrid poplar plantations managed by Domtar for wood fibre production is proving beneficial [7]. Significant growth response to PPMB broadcast as organic fertilizer in treated stands as compared to non-treated plantations project increased yield. Growth data collected since 1994 show that PPMB can act as an effective mulch in a one-time 10 to 20 cm application. Mulch treatment can at least partially replace the need for intensive site preparation and week control.

The Ontario Forest Industry Association has developed and published specific guidelines for the Utilization of PPMB in agriculture, silviculture and land reclamation [6] [8].

LAND APPLICATION IS ECONOMICALLY SENSIBLE

The alternative to land application of PPMB is disposal to landfill and incineration. Incinerators and landfills are capital intensive, require very strict environmental controls and, in the case of landfills, need an ongoing commitment to costly environmental monitoring. In order to landfill PPMB, particularly secondary or combined PPMB, co-mingling with other wastes would be required, thus increasing volumes for disposal. Odour control would be a challenge.

PPMB with a moisture content of 50 to 75% probably require additional energy inputs in order to dry or incinerate them. They do not represent an opportunity to derive energy from waste.

Commercial landfill tipping fees in Southern Ontario are in the order of $45 to $55/ton. A comprehensive "cradle to grave" land application program, including provision for permitting sites, research, community relations, hauling and spreading and in-field supervision, can be delivered at less than half of this cost depending on mill location and circumstances relative to the trucking distance to a suitable landbase.

COMMUNITY AWARENESS PROGRAM FOR DOMTAR'S LAND APPLICATION PROGRAM

In order to ensure the continued acceptance of a Land Application Program by the communities impacted, a pro-active Community Awareness Program is essential. The Domtar program is based on the company's Environmental Policy, which states that the corporation "will conduct its business in a manner that protects the environment,

conserves resources and ensures sustainable development while seeking continuous improvement in environmental performance". The policy commits the company to communicate with employees, customers, suppliers, public officials and, most importantly for the Domtar's Land Application Program; the local community.

The program's stated mission is "to reduce, reuse and recycle residues back to the land for the benefit of the land." Of all the various residues recycled, the land application of PPMB is the most difficult. The practice remains controversial. Many issues have and continue to be brought forward. In Domtar's case, the underlying issue, which causes most of the concern in the community, is the smell of the PPMB. Although the company is investigating technologies to minimize odour, experience indicates that the best way to address odour concerns is through a comprehensive local community relations program. The Domtar program includes various activities and events aimed at involving and educating the public.

For example, each year, Domtar hosts or helps organize a bus tour of land application sites to view methods and results. The event is aimed at educating farmers, regulators, municipal leaders, and local press. All sites receiving the PPMB have permanent signage. Other temporary signs explain the operation being conducted. Haul trucks and associated spreading equipment as well as the vehicles of operations supervisors carry signs. Domtar regularly attend local fairs and farm shows with displays to explain the program. A "Bug Show" aimed at explaining mill wastewater treatment and PPMB to elementary level school kids has been developed and is presented regularly. The Domtar Cornwall mill and the local horticultural society conduct an annual Bag/Bark Day in the spring of the year. This event provides a hands on opportunity to those of the public who like to get down and dirty. That has had a very positive result in the community. Another result of the partnership with the horticultural society is a small flower garden established at the Domtar Mill main gate demonstrating the horticultural value of PPMB.

Because the odour from the PPMB (especially during spreading) has the potential to impact rural residents, Domtar makes every effort to contact these neighbours before hauling and spreading operations begin. This provides an opportunity to explain the material and the operation to the resident and, if necessary, make changes to operational plans if special events such as a BBQ or wedding are planned in the neighbourhood.

Visits are made using Domtar ISO 14000 procedures and work instructions with each visit logged. A notice is left if the resident is not home with information on how the contractor or Domtar can be contacted. A gift of Domtar notepaper is also left with the message "Thank you for your understanding".

Landowner visits have been very successful in making the program staff and contractors aware of the reactions of local residents and have reduced the "fear factor" among local residents to the degree that only one or two complaints are received on the program each year.

Domtar environmental department staff act as advocates for the beneficial use of pulp and paper mill biosolids. Staff liaises with government regulators in connection with proposed legislation and regulations and interpretation of current guidelines. Staff has also been involved in developing Silvicultural and Agricultural Best Management Guidelines for beneficial use of PPMB.

These activities are examples of the type of action necessary to support a successful Land Application Program (See Table VI).

Table VI **Summary of Community Relations Activities from 1995 to 2002**

Event	1995	1996	1997	1998	1999	2000	2001	2002
Bio-Garden	---	1	1	1	1	1	1	1
Bug Show	1	---	---	---	2	2	2	2
EnviroNews + ECHO	43	44	45	44	45	46	43	17
Farm Shows, Fairs, Displays	7	14	10	8	11	6	6	8
Landowner Visits	---	---	---	---	---	78	168	N/A
Other Events	8	7	7	7	6	8	11	7
Presentations and Conferences	6	4	9	4	4	9	9	12
Sponsorships	---	---	---	---	---	---	3	2
Tours	3	4	6	5	1	4	3	2
Workshops	---	1	1	---	1	---	1	---

CONCLUSION

Land application of PPMB can be controversial with critics and activists raising various environmental and health issues. The facts, based on extensive research, support land application as safe for health and environment. Moreover, the recycling of clean organic residues back to the land is sustainable and the right thing to do ecologically, whereas landfilling and incineration is not. Many opportunities exist for the use of PPMB in agriculture and many potential beneficial uses also exist within the forest industry in silvicultural applications. These materials can also be used to advantage in the reclamation of aggregate extraction sites, mine tailings, industrial remediation sites, and the like.

Land application can be economical as compared to landfilling and incineration. However, a successful program needs to be proactive and open in dealing with its local communities and stakeholders.

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