PERSPECTIVES ON SOLID WASTE MANAGEMENT IN CANADA

CASE STUDIES OF LEADING-EDGE SOLID WASTE DIVERSION PROJECTS

VOLUME - III -







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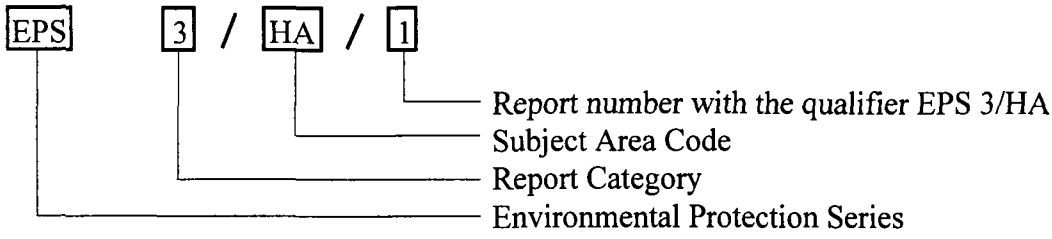

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Case Studies of Leading-edge Solid Waste Diversion Projects

Volume III of the Perspectives on Solid Waste Management in Canada Series

by Resource Integration Systems Ltd.
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Review Notice

This report has been reviewed by members of the Hazardous Waste Branch, Environment Canada and approved for publication. Approval does not necessarily signify that the contents reflect the views and policies of Environment Canada. Mention of trade names or commercial products does not constitute recommendation or endorsement for use.

This report, the third of the series "Perspectives on Solid Waste Management in Canada", was prepared by Resource Integration Systems Ltd., with the assistance of Guilford and Associates. Each of the reports for this series is intended to serve as a stand-alone document, and also as part of the integrated study. The complete set of reports is available through Environmental Protection Publications.

Abstract

This report is intended for three main audiences. First, it is for municipal planners/officials who want to learn from the experiences of other municipalities in planning and implementing their own waste diversion programs. It is also for those in both the research community and businesses who are interested in the state of waste diversion technologies/systems in place across Canada and elsewhere. Finally, the report provides information to federal and provincial officials with waste management and/or technology development responsibilities within their departments.

The 24 case studies are presented in detail, and in an easy-to-access format. Wherever possible, point form has been used. Similar information is presented on each of the projects, including detailed recovery, cost and technical data. The case studies are both descriptive and analytical in approach (i.e., each case study includes a summary evaluation identifying key reasons for the success/failure of the program, R&D/commercialization needs and opportunities identified through the case study, and an assessment of the potential replicability of the project throughout Canada).

Contained within several of the case studies are sidebar examples of how technologies/systems similar to (or competing with) those described in the case studies have been implemented in other municipalities. Contacts are provided with each case study.

The emphasis for selecting case studies was on waste recycling/ diversion technologies and systems rather than on waste reduction programs.

Résumé

Ce rapport s'adresse à trois grands auditoires. En premier lieu, aux planificateurs et aux fonctionnaires municipaux qui veulent tirer leçon des expériences des autres municipalités dans la planification et l'exécution de leurs programmes de valorisation des déchets; ensuite aux chercheurs et aux hommes d'affaires intéressés à faire le point sur les techniques et les systèmes de valorisation des déchets appliqués dans l'ensemble du Canada et à l'étranger; enfin, aux fonctionnaires fédéraux et provinciaux qui occupent des postes de responsabilité en matière de gestion des déchets ou de développement technologique.

Les 24 études de cas sont décrites dans le détail, sous une forme qui en facilite la consultation. Toutes les fois que cela a été possible, on a privilégié le style télégraphique. Les renseignements sur chaque projet sont ordonnés de façon semblable, y compris les données détaillées sur la récupération, les coûts et les paramètres techniques. Les études de cas sont à la fois descriptives et analytiques, c'est-à-dire que chaque étude comprend une évaluation sommaire dans laquelle on présente les principaux motifs de la réussite ou de l'échec du programme, les besoins et les occasions en matière de recherche-développement ou de commercialisation ainsi qu'une évaluation des possibilités de reproduire le projet dans tout le Canada.

Dans plusieurs études de cas, on trouvera, en encadré, des exemples de la mise en œuvre, dans d'autres municipalités, de techniques ou de systèmes semblables (ou concurrents) à ceux qui font l'objet de l'étude de cas. Pour chaque étude, on donne les coordonnées des sources de renseignements.

La sélection des études de cas a favorisé les techniques et les systèmes de recyclage et de valorisation plutôt que les programmes de réduction des déchets.

Foreword

The series Perspectives on Solid Waste Management in Canada *is a study of effective systems and technologies to collect, handle, and process nonhazardous waste in Canada. The focus of the study is on alternatives to landfill - i.e., emerging and developed systems and technologies to help achieve Canada's goal [as established through the Canadian Council of Ministers of the Environment (CCME)] of 50% diversion of waste from disposal by the year 2000.*

Environment Canada was the lead agency for this project. The Steering Committee included representation from: Industry Canada; Natural Resources Canada (Forestry and Energy Departments); Federation of Canadian Municipalities; National Research Council; Ontario Waste Management Association, and the Ontario Ministry of the Environment and Energy. In addition, the project was supported through the input of four advisory groups, representing over 50 experts from across the country with specific expertise in key project areas.

The series "Perspectives on Solid Waste Management in Canada" *contains three volumes:*

- *Volume I - Assessment of the Physical, Economic, and Energy Dimensions of Solid Waste Management in Canada;*
- *Volume II - Options for Integrated Municipal Solid Waste Diversion; and*
- *Volume III - Case Studies of "Leading-edge" Solid Waste Diversion Projects.*

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Glossary

Backyard composting	Composting of residential organic materials by a household, usually in the backyard. Generally considered a method of source reduction.
Buy-back	A staffed facility which usually purchases post-consumer recyclable containers and materials such as aluminum cans, glass and newspapers from the public. Buy-back centres seldom perform materials processing. Buy-backs may also consist of mobile units which travel from stop to stop collecting recyclable material.
Centralized composting	Process using a central facility within a defined area to compost organic material collected and transported to the facility.
Co-collection	The collection of recyclables together with other municipal garbage; separated later for recycling or disposal.
Collection	The process of picking up refuse or secondary materials from a generation source such as a household or business.
Curbside collection	The collection of refuse or recyclables (generated by households or businesses) from the curb.
Deposit/refund systems	System to collect money for an item which is then redeemed when the used product is returned.
Disposal bans	Regulation which prohibits the disposal of certain materials or products (e.g., yard waste, or lead-acid batteries) in landfills and/or incinerators; typically bans target items that contribute substantial volume or toxicity to the solid waste stream.
Drop-off/depot	A facility where the public can bring recyclable materials. Separate drop boxes may be available for different material such as newspaper, glass or metal. Drums or carts may be placed under each opening to collect material as it is deposited. Centres are usually unattended, but this may change as markets demand cleaner material.
Flow control	Legislation which limits free market access to specific wastes and ensures their disposal at a processing or ultimate disposal facility.
Full cost accounting	Assigning all known costs of recycling to the program, including those shared with other operations or programs. May also be applied to landfills.

Grasscycling	Leaving grass clippings on the lawn and allowing them to decompose naturally instead of collecting them for composting or disposal.
HHW	Household hazardous waste.
IC&I	Industrial, commercial and institutional.
Igloo	Igloo-shaped container for collection of recyclables.
Integrated waste management	A hierarchical method of solid waste management. The following practices are ranked in order of preference: source reduction, reuse, recycling, energy and material recovery, and landfill disposal.
In-vessel composting	Composting involving a closed tank or unit with physical controls.
Landfill mining	A process by which materials are recovered from a landfill by excavation. Organic matter may be reused as a daily cover, and material such as wood, metal, brick, plastics and glass may be recovered and recycled.
Landspreading	A procedure whereby organic material is applied directly to land (usually agricultural) to improve the physical and chemical properties of soil.
Mandatory separation requirements	A regulation which requires waste generators to separate designated recyclable materials from the waste stream for recycling.
Mandatory waste audits	A regulation which requires waste generators to perform waste audits.
Mandatory waste reduction plan	Legislation which requires organizations to prepare plans to reduce the amount of their waste sent for disposal. Plans may include source reduction, composting and recycling elements.
Market development	Policies or measures used by organizations or governments to stimulate demand for secondary materials (i.e., procurement policies, regulations or mandated recycled content).
Material recovery facility	A facility which separates and processes source-separated secondary materials (such as glass, metals, plastics or paper) into marketable materials.
Mixed waste processing	A procedure by which waste is taken to a facility and, through manual or mechanical means, has some of the recyclable material removed. The remaining fraction may be used to make a fuel product, be composted or both.

Municipal solid waste composting	A process which involves the controlled decomposition of municipal solid waste and includes some form of pre-processing to remove non-compostable material.
OCC	Old corrugated container.
ONP	Old newspaper.
On-site composting	Composting conducted at or near the source of generation of the organic material.
Precycling	A public education campaign to promote environmentally sound purchasing decisions by consumers, as well as to encourage the reduction of unnecessary purchases and packaging. Precycling involves recognizing the connection between products purchased and their eventual impact on the environment as a result of their disposal (e.g., overpackaging or non-recyclability).
Processing	Preparation of solid waste for further treatment through such activities as hand sorting, magnetic and/or mechanical separation or shredding.
Procurement	The purchase of goods or services, usually by an organization or government. Procurement policies or regulations may establish requirements for purchasing goods which contain a minimum level of recycled content and/or are recyclable.
RDF	Refuse derived fuel.
Rendering	The cooking of animal wastes to produce oil, fats or animal feed. Rendering is a form of recycling.
Reuse	The use of a product such as a refillable beverage bottle more than once, possibly with some slight modification (e.g., cleaning or repair).
Reuse/repair centre	Organization or business which reuses and/or mends items which would otherwise be disposed.
Source reduction	A policy which promotes waste and/or toxicity reduction and seeks to minimize waste generation through energy and materials conservation methods.
Source separation	The separation of materials suitable for recycling or composting from solid waste at the source of generation (e.g., households, businesses).
Swap day	An organized municipal event in which householders are asked to place any reusable items on their lawn and resident are encouraged to tour the community and scavenge for items.

Tipping fee surcharges	A surcharge or a levy applied on a per-tonne basis to all wastes delivered to landfill sites, waste-to-energy plants and/or other waste handling facilities.
Toxic taxi	A vehicle used to collect household hazardous waste at the source.
User-pay (generator-pay)	Waste collection system in which generators pay for disposal according to the tonnage or volume of waste produced. Generator-pay systems may result in a reduction of the amount of solid waste entering the landfill.
Variable tipping fees	Differing fees may be charged at waste recovery, processing and disposal facilities based on the particular kind of wastes in a specific load and/or the extent to which waste has been source separated.
Vermicomposting	Describes process by which worms digest organic wastes.
Waste composition	The various component materials of the waste stream, typically described as a percentage of the entire waste stream by weight and/or by volume.
Waste diversion	The amount of municipal solid waste diverted from disposal through reduction, reuse and recycling efforts.
Waste diversion credits	A financial incentive provided by municipalities to encourage or to reward recycling based on the tonnage diverted from the waste stream.
Waste exchange	System for transferring waste material from one company to another that can use it. For example, packaging foam received by one company can be transferred to a stuffed toy manufacturer for use as stuffing.
Waste stream	The waste output of a community, region or facility. Total waste can be categorized into different waste stream components (e.g., wet organic waste, construction waste, household hazardous waste or white goods).
Wet/dry collection	The separation of residential solid waste into at least two components for collection: wet wastes which are organic and are collected for composting; and dry wastes, which are sorted at a central facility and the recyclables are removed for further processing.
Windrow composting	A composting process whereby piled organic material is placed in a series of rows, usually five or six feet deep. The rows are turned periodically for natural aeration.
Xeriscaping	The practice of landscaping with slow-growing, drought-tolerant plants to conserve water and to reduce yard and grass clippings.

Sources

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Section 1

Introduction

This report is intended for three main audiences. First, it is for municipal planners/officials who want to learn from the experiences of other municipalities in planning and implementing their own waste diversion programs. It is also for those in both the research community and businesses who are interested in the state of waste diversion technologies/systems in place across Canada and elsewhere. Finally, the report provides information to federal and provincial officials with waste management and/or technology development responsibilities within their departments.

The 24 case studies are presented in detail and in an easy-to-access format. Wherever possible, point form has been used. Similar information is presented on each of the projects, including detailed recovery, cost and technical data. The case studies are both descriptive and analytic in approach—i.e., each case study includes a summary evaluation identifying the key reasons for the success or failure of the program, R&D or commercialization needs and opportunities identified through the case study, and an assessment of the potential replicability of the project throughout Canada.

Contained within several of the case studies are sidebar examples of how technologies/systems similar to (or competing with) those described in the case studies have been implemented in other municipalities. Contacts are provided for each case study. Readers are encouraged to use the case study resources listed for those projects most relevant to their needs.

The 24 case studies were selected from an initial list of more than 150 potential projects, using 10 primary criteria (in consultation with the project steering committee):

- The project illustrated a successful approach to at least one important aspect of waste diversion.
- The diversion effects of the system are monitored and known.
- The project had been in operation for a reasonable period—preferably 12 months (although some allowance was made for emerging projects and technologies).
- The case studies addressed systems and technical approaches that suit both large and small communities (i.e., examples of both).
- Case studies were selected from across Canada and provided geographic representation.
- Case studies from Europe and the United States were included only if a good example of the system being illustrated was not available in Canada.
- Case studies were chosen to help illustrate the information presented in the companion volume *Options for Integrated Municipal Solid Waste Diversion.*
- Case studies were selected to address the full range of options available to divert waste (i.e., wet and dry materials, high- and low-tech).
- One or more of the case studies profiled a community with an integrated approach, including an energy-from-waste plant and well developed recycling and composting programs.
- The case studies helped to identify systems and technologies (i.e., R&D or commercialization needs and opportunities) needed in Canada systems and technologies that might be adapted to Canadian situations, and Canadian systems

and technologies that are suitable for export to other countries.

As also noted in *Options for Integrated Municipal Solid Waste Diversion* (and because of the R&D and commercialization thrust of the project), the emphasis for selecting case studies was on waste recycling/diversion technologies and systems rather than on waste reduction programs.

The appendix summarizes key information on each of the case studies.

Section 2

Case Study 1 Genesis Organic Inc. Composting, Corner Brook, Newfoundland

1 Abstract

Genesis Organic Inc. composts specific organic waste materials from IC&I facilities located in and around Corner Brook, Newfoundland.

The company accepts only wood bark, fish offal and chicken manure generated by local pulp and paper, fish processing and poultry industries. Feedstocks are accepted intermittently from IC&I locations (usually in the spring) and are valued because they are uncontaminated. Compost is processed in passively aerated static piles on a bed of bark. The process requires from 6 to 8 weeks (on rare occasions composting can last 10 months if weather conditions are unusually cold). In some of the piles, PVC pipes or weeping tiles provide some passive aeration. The bark very successfully absorbs odours and no concerns have been identified.

The composting operation includes a bagging system that heat-seals the product in 30-litre bags, ready for markets. In total, the composting operation employs 5 staff on-site, approximately 8 months of the year (compost is produced between April and November). Markets for the compost are growing. The process is technically successful (with some limitations) and is likely to be replicable in other parts of the country. It is particularly applicable in areas where local industries send large quantities of compostable materials to landfill and is an effective method of diverting these streams to a useful purpose.

2 Community Description

Location

- Outskirts of Corner Brook, Newfoundland.
- A 20-acre site close to the municipal landfill.

Waste Management Context

- Corner Brook has 22,410 residents in 7,400 households.
- Corner Brook faces economic pressures due to changing employment conditions and an unemployment rate of nearly 24% (1993).
- There are varying opinions on the remaining landfill capacity; one is that the landfill can be built up with the footprint extended; the other is that it may be nearing capacity.
- The landfill receives 600 cubic yards (cu. yd.)/wk of residential waste and 2,500 cu. yd./week of bark . The amount of other IC&I waste was not available. Bark waste sent to landfill has been cut in half (from about 5,000 cu. yd. a few years ago) due to changing economic conditions.
- A landfill tipping fee is levied against most IC&I waste. The cost of disposal and hauling for loads greater than 10 cu. yd. is approximately $52.
- Until recently, there were only minor restrictions on waste disposal from local fish processing plants, which had been permitted to dump wastes into the ocean. Now more controlled disposal is required. The Genesis site is authorized by the Newfoundland Department of Environment and Lands to receive the local fish processing wastes.
- Residential recycling buy-back programs operate for glass (1¢/lb.), Polyethylene/ teraphthalate (PET) (10¢/lb.), and aluminum(40¢/lb.).

3 Program Description

Purpose and Sectors Involved

- To use specific local organic waste materials to produce a soil enhancement product, and to divert these wastes from the local landfill.
- Only uncontaminated IC&I materials are accepted from three major local industries: poultry farming, pulp and paper and fisheries. No substitutions are accepted to ensure a consistent and uncontaminated feedstream.

Type/Method of Recovery

Feedstock

- Tree bark waste from a pulp and paper mill is mixed with chicken manure from farms and/or fish offal from fisheries. Fresh feedstock is generally accepted during the spring or fall to coincide with the beginning and end of production (i.e., at intervals specified by Genesis). Smaller loads may be received through the summer.
- Genesis maintains a stockpile of approximately 2 million cu. yd. of tree bark waste.
- Materials are composted and bagged for sale as a soil supplement (not a fertilizer).
- No advertising is necessary to notify suppliers when wastes will be accepted because the business is well known in the community, and a good relationship exists between suppliers and the company.

Operation

- The production of finished compost (turning piles and bagging) takes place between April and November. During the winter months, unturned piles continue to compost, though at a relatively slower rate. If sales require additional quantities of bagged material, finished compost can be bagged during the winter months.
- The Genesis production process involves a constant flow of product at different stages of decomposition. At any one time, there is a quantity of finished, partially decomposed and new material at the beginning of the process.
- The organic waste is composted in outdoor piles. The bagging operation is conducted indoors.
- Finished compost is sold to local wholesalers and through a wide distribution network.

Process Description

The two main components of this system include:

Composting

- The compost pad consists of a large pit (approximately 180 m long and 45 m wide). The pit is filled with tree bark to a depth of approximately 25 to 30 m. Composting takes place on top of the tree bark, which has been graded to provide a level surface area.
- Organics are composted in outdoor piles. Two main methods are used to aerate piles, and most piles are turned with an excavator on an as-needed basis.
- In the first method, a number of piles are gravity aerated by using perforated plastic pipes. In these cases, PVC pipe (approximately 10 cm in diameter) is placed on the tree-bark surface with a pile of mixed bark and fish offal or chicken manure built on top of the pipes. The ends of the pipes are left uncovered so that air can move into the core of the pile. Holes are drilled into the pipe so that air can circulate inside the pile.
- In the second method, several layers of piping (10-centimeter weeping tile) are built into the piles (i.e., one set of pipes at the base of the pile and one layer in the middle of the pile). The ends of the pipes are left uncovered so that air can circulate inside the

pile. The extra set of pipes is designed to provide more oxygen at the core.

- The compost piles can generate a maximum core temperature of 74° to 79°C though this range is not optimum for composting. Under ideal conditions, compost is produced within six to eight weeks.
- Since weather is often rainy, windy, and cool, ideal conditions are not often achieved, and the composting time can extend to 6 to 10 months.

Bagging

- Finished compost is bagged in a 20 m^2 building.
- The bagging operation is based on modified Amodas bagging equipment (from West Virginia).
- Bagging equipment includes a feed conveyor, computerized discharge chute (which releases 30 L of compost at a time), a bagger, a heat sealer for the bags, a bag flattener, a carousel which can hold up to four skids of material, and a shrink wrapper.
- Prior to bagging, finished compost is finely ground in a tub grinder. This reduces particle size, removes possible contamination (e.g., stones and oversized material) and improves the look of the finished product.
- Finished compost is moved by front-end loader into the hopper of a feed conveyor which moves material into the bagger. Plastic bags are placed manually around the end of the discharge chute. Once they are secure, a release button is pushed and 30 L of material falls into each bag. The bags then fall onto a conveyor, which passes them through a heat sealer. Bags are passed under a flattener, which makes them uniform for efficient storage. Finally, bags of compost are loaded by hand on a skid. The loading platform can be elevated by the operator to assist in this operation.
- A rotating carousel holds up to four skids of material. Each skid holds up to 84 30-L bags of compost. Two panels on the loading platform can be engaged to evenly pack bags on the skid. After one skid is full, the carousel rotates and positions a new skid in front of the loading platform. Finally, skids of material are moved by forklift to a shrink wrapper and stored in a warehouse outside for transport to market.
- The bagging operation can produce 20,000 bags of compost in 10 days.

Staffing

- Total staff includes three employees, one plant manager, one marketing manager, a secretary, and two out-of-country marketing representatives.
- The production process is generally between April and November. Production staff may work between 13 and 24 weeks during this period, depending on the weather and sales. In addition, staff will work on different tasks as required (e.g., moving from compost production to bagging).

History/Progress

- The full-scale bagging operation began in May, 1993. Composting has been ongoing since 1989.

Performance/Results

- A stabilized soil amendment product has been produced with very little odour and good water retention and soil amendment properties.
- An estimated 2 million cu. yd. of bark have been diverted from landfill.
- An estimated 45,000 t/yr. fish offal and 13,000 t/yr. chicken manure or fish offal are also utilized.

Ownership/Financing/Government Involvement

- The site is privately owned by three individuals.
- The owners of Genesis have contributed approximately $500,000 which was matched by a $500,000 grant from the Atlantic Canada Opportunity Agency.

Program Cost

- Detailed operating costs are confidential.
- Bagging equipment was purchased for $250,000.
- Labour costs range from $8 to $13/hour.

Problems/Modifications

- Over-all, the compost operation produces a highly marketable product.
- Passive aeration techniques using perforated pipes are less effective than pile turning. One problem is that the ends of the pipes tend to get covered with wind-blown material. As a result, oxygen supplies to the pile core can become restricted. In addition, during the winter the pipes allow cold air inside the pile, which can reduce the pile temperature and slow the composting process.
- Compost operations have developed over years of testing and experimentation with raw material selection, sourcing and production economics. In this sense, centralized composting is as much an art as it is a science.

Expansion Plans

- To operate at capacity sufficient to have enough finished compost on hand to fill 40,000 to 50,000 bags. This is required to meet peak seasonal demand in the spring of 1995 and to increase production as required in following years.

Contractual Elements

- Contractual relationships have been established with a network of distributors operating throughout Newfoundland, Nova Scotia, New Brunswick, Prince Edward Island, Ontario, New England and overseas (e.g., Saudi Arabia and Egypt).

4 Resources

Contact

Wayne Wheeler
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Corner Brook, Nfld.
A2H 6G1
(709)634-4769

Reports and Surveys

- none

5 Summary Evaluation

Reasons for Success Or Failure of Program

- The process is based on extensive experimentation with Agriculture Canada to develop a consistent, high quality product.
- Using tree bark waste helps minimize odours because it absorbs oils and generates heat relatively quickly (in a sense, baking the fish oil). Because of its size, bark is an effective bulking agent which helps sustain aerobic conditions in composting piles.
- The material is uncontaminated and meets the process specifications. This simplifies process controls.
- The composting process is not highly technical and relies on readily available feedstocks.

- Considerable efforts have been directed toward developing markets and a market identity.
- Passive aeration in cold and windy conditions is less effective than turned piles.
- Greater reliance on turned piles will help to maintain aerobic conditions and to speed the composting process.
- The approach requires a large supply of easily accessible and inexpensive bark waste and a relatively large tract of land.
- This process does not require (or accommodate) feedstock on a continuous basis.
- Markets have been relatively weak but are growing, and increased demand has been noted.

R&D Needs/Commercialization Opportunities

- Continue to identify new regional, national and international markets.
- Test effectiveness of composting process on other carbon-rich feedstocks (e.g., a similar process has been successful using fish and straw for composting).
- Test potential for winter composting (e.g., enclosed piles).
- Identify methods which accelerate the time required to produce finished compost, thereby creating a relatively continuous demand for feedstock (to increase diversion).

Replicability of Project

- Highly replicable (depending on a source of carbon-rich feedstock and financing to cover up-front development costs and marketing initiatives).

Case Study 2 The Answer Garden Products/Consolidated Envirowaste Industries Inc. composting facility, Aldergrove, British Columbia

1 Abstract

The Answer Garden Products facility is a highly successful in-vessel and open windrow composting operation owned by Consolidated Envirowaste Industries Inc. of British Columbia.

The operation accepts a wide and diverse range of organic materials from municipal and IC&I sources in the area. Food processing plants, paper mills, apartments and farms provide a useful source of feedstock on a year-round basis. The plant also receives leaf and yard waste from the Greater Vancouver Regional District (GVRD) and other local municipal programs as well as residential organics from a nearby three-stream (wet/dry/waste) collection system. The plant combines in-vessel and open windrow composting elements. The plant successfully developed a variety of marketable products which are sold throughout western Canada and in the northwestern United States. Compost is mixed on-site into various fertilizers, planting mixes and soil conditioners which may be bagged loose (on-site) or sold in a pelletized form (pelletizing done on-site).

Although various technical problems have been encountered (with odours and equipment breakdown), these problems have been addressed and the facility is operating smoothly. This plant currently receives and processes approximately 60,000 t/yr. It is expected to expand to full capacity of 100,000 t/yr.

2 Community Description

Location

- The composting facility is an hour east of Vancouver (up the Fraser Valley) in the City of Aldergrove.
- The area is semi-rural.
- The facility is located on a 30-acre site.
- The buildings on-site (i.e., in-vessel composting, compost storage, and warehouse) occupy 50,000 sq. ft. of space.

Waste Management Context

- Provincial law in British Columbia mandated that every regional district complete a waste management master plan by the end of 1995. The plan must detail how the regional district will achieve a 50% reduction by the year 2000. Communities are working to develop these plans.
- The facility has received all required permits from provincial departments.

3 Program Description

Purpose and Sectors Involved

- The Answer Garden Products facility is a private operation that receives a wide range of IC&I, agricultural and some municipal organic wastes.
- A wide range of materials is processed in the composting operation including supermarket, restaurant and hotel, yard and garden, and fish processing waste.

Type/Method of Recovery

- The facility produces potting mixes, soil conditioners and pelletized organic fertilizers.
- Materials are collected from IC&I establishments and from municipal programs (e.g., Mission B.C. operates the three-stream

residential collection). Materials are hauled to the site by local contractors.

- Envirowaste operates leaf and yard waste depots on behalf of GVRD, where materials are collected (and monitored for contamination) and chipped on-site in a tub grinder prior to transport to Aldergrove.
- Tipping fees at the site range from $0 to $69/t (which is similar to the Vancouver tipping fee). Fees are determined by the type of materials, level of contamination and so on.
- The operation includes in-vessel and open windrow composting, as well as compost mixing, pelletizing, and bagging.
- The type of end product required influences the choice of processes, material used, and length of time for curing.
- Envirowaste designed and developed the facility.

Processing

- Materials are received at the plant at the weight scale/inventory control centre where the accounts receivable process begins.
- Incoming materials are sorted by hand at the front end to remove obvious contaminants.
- All wastes are sent to the in-vessel operation; most yard and garden waste and paper sludges are sent to the open windrow compost site.

Open Windrow/Block Pile Compost

- The open windrow/block pile compost operation occurs on a 5-acre asphalt pad.
- Organics are composted in long windrows and, as they decay, are heaped into higher stacks (depending on the materials involved and the preferred end-product).
- Windrows are turned using a front-end loader. Depending on the desired product, material may be transferred through a hopper to a stacker conveyor (as it becomes more stable) to create high stacks of compost material.
- A system of underground pipes is linked with soaker hoses and sweep sprinklers for moisturizing the piles (as determined by the stage of curing).
- A closed-loop water filtration system has been designed. Leachate is collected, filtered and used again for watering the compost piles.
- After 5 to 10 months, the compost is finished. Composting curing time depends on the desired end-product. Compost blended for retail sale typically requires the greatest length of time.

In-vessel Compost

- After weighing, materials are inspected visually to identify primary components (e.g., food waste versus chicken manure). Materials are combined in various mixes to suit different product needs.
- Once selected, materials are blended by a loader (a dedicated mixer is planned as a future capital expense) to make an optimum biomass.
- When an appropriate biomass blend has been developed, some materials are shredded and the organics are moved by skid steer to the in-vessel building which contains two International Process Systems (IPS) agitators. These are used for primary composting (both machines have been tailored and modified to company needs).
- The recipe used and the exact length of time for processing depends on the type of materials composted and the desired end-product.
- Materials are processed in-vessel between 15 and 21 days.
- Conveyors move the compost to covered storage, to await screening in a trommel

screen. The trommel screen typically screens to 3 to 8".

- Following screening, the compost is placed on the curing pad.
- Compost is later blended with other organics, under cover, to develop the final product.
- A leachate collection system directs the compost leachate into an aerated lagoon and an engineered marsh. Much of the collected liquid is directed back to the process for moistening the compost.

Pelletizing (on-site)

- The compost mix may be pelletized in a pellet mill. This custom-designed device produces pelletized organic fertilizer from the blended product (in two mixes: one for lawn/ground cover, the other as an all-purpose additive).
- Mixed material is fed into the hopper where all moisture is removed and pellets are formed.

Bagging

- Pellets and/or finished product are loaded into the bagging hopper (using a loader). A Verville bagging press and an Inglett bagger make bagged product.
- The machine produces bags from 4.5 to 40 L sizes.
- An 85-L bag can also be produced in bale form.
- Bags are heat-sealed by the machine.

Bio-filter System

- A bio-filter system was added to scrub ammonia and to control odours emitted from the in-vessel compost plant.
- The system includes two fans which take exhaust from the in-vessel system and pull it through a system of underground pipes. The pipes have aeration holes which allow vapours to escape through a soil medium for biological scrubbing of the ammonia.
- The biofilter system is set up in a 4,500-square-foot open area adjacent to the in-vessel building.
- Company officials report a 99% efficiency rate.

Leachate Collection System

- All leachate is collected in a lined trench (800 ft. x 6 ft. with a depth of 2 ft. to 4 ft.).
- Leachate drains from the trench to a lagoon where it is treated by aeration.
- After treatment, the water is pumped back through a system of pipes to hydrate the windrow compost piles.
- Any leachate that is not recirculated in the hydration system is directed through an engineered marsh for final "polishing" through a bio-adjustment system.
- Any emissions must meet provincial standards.

Staff Requirements

- 20 regular staff are maintained.
- This increases to 50 staff in periods of peak demand (i.e., January to May).
- During the spring, the plant operates on a double shift to accommodate excess needs for pelletizing and bagging compost and local bulk sales.

History/Progress

- The plant has been operating full-scale since 1991.

Performance/Results

- The plant (summer 1994) processes approximately 60,000 t/year with plans to expand to full capacity of 100,000 t.

- Approximately one-third of incoming material (i.e., 20,000 t/year) is processed in the in-vessel system.
- The finished compost meets existing guidelines for a variety of products of different qualities and grades.
- The compost is marketed for retail in the U.S. and Canada and in bulk to the B.C. mainland.

Ownership/Financing/Government Involvement

- The facility is a private sector operation.
- The company is publicly traded on the Vancouver Stock Exchange.
- No government financing was received.

Program Cost

- Start-up costs were $2 million. A total of $6 million has been invested in land, equipment, building and site improvement costs, and pre-financing.
- Tipping fees range from $0 to $69/t.
- Fees vary according to the type of material accepted and the degree of contamination and processing required.

Problems/Modifications

- The existing in-vessel machines did not meet desired production performance levels. The company has developed its own agitating turner machine in conjunction with the University of British Columbia and will be installing units in this and other facilities under development.
- Odour problems were a factor in early stages (and neighbouring residents lodged complaints).
- The ammonia venting system from the in-vessel composting plant has been supplemented with the new bio-filter/ scrubbing system to prevent odour emissions.

Expansion Plans

- Site planners expect to take the plant to full operating capacity of 100,000 t/year. Further expansions on-site are planned.
- The company will develop and build other facilities, using their own technology in urban or rural settings in line with waste stream specifics.
- The company is prepared to offer consulting design/building expertise elsewhere.

Contractual Elements

- The facility is operated by employees.
- Aldergrove may contract directly with waste generators or simply be provided with material supplied by haulers linked with waste generators.

4 Resources

Contact

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Reports and Surveys

- Environment Canada/The Composting Council of Canada. May 1993. *National Survey of Solid Waste Composting Operations in Canada.*

5 Summary Evaluation

Reasons for Success or Failure of Program

- Location: there is a wide range of materials available year-round that feed the plant; this location is not as prone to seasonal swings due to the temperate climate. Feedstocks are therefore more reliable.
- The company is versatile in that it runs the compost operation, participates in various curbside/organics collection systems, and runs a depot leaf and yard waste collection system for the GVRD.
- Maintaining two processing systems on-site (windrow and in-vessel) allows flexibility to accommodate a wide range of materials.
- All incoming loads are weighed and carefully inspected. Staff know exactly what materials are fed into the compost recipes, and the process can be controlled accordingly.
- The wide range of materials composted allows for a diversity of products.
- The process is flexible to accommodate the range of materials available in the area, and process engineers have modified procedures as required to suit the varying feedstream.
- Obtaining approvals/government decisions took much longer than expected. The planning process should allow for this unless government approval processes are changed.
- Machinery breakdowns can be caused by varying materials being fed into the in-vessel system or including a wider range than the system is designed to accommodate.
- Extensive machinery modifications were completed. These retrofits will be designed into any new systems developed.
- Original in-vessel machinary was essentially redesigned by company staff to process the wide range of available materials. Through this process, the company has developed a unique form of its own hardware.
- If a new system is designed, it would likely include full enclosure of receiving facilities, with remote control processing.
- A bio-filter has been added to the in-vessel system for odour control.

R&D Needs/Commercialization Potential

- The system can accommodate all organic feedstock due to its modular design. A waste stream as small as 2,500 t/yr can be handled.
- The company is continually experimenting with and perfecting new compost recipes.
- The entire system and specific elements of the composting process will be marketed by the company.
- Bio-filtration and related compost impact studies are also under way.

Replicability of the Project

- This system is replicable in other parts of Canada for organic waste streams that exceed 2,500 t/yr. It produces a high quality compost for bulk or bag markets.
- A source-separated feedstock is desirable, and it in turn helps to create higher quality compost. Foreign matter removal from the feedstock is standard operating procedure.
- Staff must be well-trained in the art of composting.
- The in-vessel operation can be conducted on a small site (as little as one acre, dependant on volume), but more land area is required for the outdoor composting process. Effective odour control allows the plant to be located in an urban area.

Case Study 3 Beilstein In-vessel Composting Facility, Beilstein, Germany

1 Abstract

A Herhof Rottobox in-vessel composting facility started operation in Beilstein in September 1993. This plant is considered the most automated in-vessel composting system in Europe, requiring a staff of only three for its operation. The plant can process 10,000 t/year in a completely enclosed system, with a retention time of 26 days, or it can process up to 20,000 t/year with a combination of in-vessel first-stage composting and open-windrow curing.

Feedstock for the plant is source separated organics from households in the Lahn-Dill area (population 210,000), and from 10% of the households in the city of Wetzler (population 55,000). The district has had a source separation program for household organics in a three-bin system (brown for organics, blue for papers and grey for garbage) since 1990.

One of the unique features of the plant is the integrated "soil factory" which is part of the composting building. The Beilstein composting plant is located adjacent to a quarry which is owned by the same company. Finished compost is blended with fines from the quarry, humus and topsoil to make 11 different blends of soil conditioner. All end products are packaged at the soil factory in plastic bags to retain the dark colour, which is preferred by customers buying the product for cemetery maintenance. In addition, a number of greenhouses are located at the site. At the time of the site visit (June 1994), the company was experimenting with taking carbon dioxide from the composting vessels and using this to enhance the growth of a variety of plants. Heat from the composting vessels is used to heat the building, the greenhouses and also some nearby residences.

2 Community Description

Location

- Beilstein, Germany.
- Part of Lahn-Dill Waste Management District, which is adjacent to the district of Giessen.

Waste Management Context

The Lahn-Dill district has a populaton of 210,000, and the city of Wetzler has a population of 55,000.

The district started considering the bio-waste issue in 1985. Many sites and different technologies were examined. The district approached Herhof, who were developing an in-vessel composting system. A pilot project with 30,000 people started in 1987 and ran for two years. Bio-waste collection was expanded district-wide in 1990, due to the success of the pilot.

3 Program Description

Purpose and Sectors Involved

The plant composts mostly residential and some commercial organic wastes.

Type/Method of Recovery

All households have been included in a three-bin residential waste collection system since 1990.

- The brown bin is for organics (collected every two weeks).
- The blue bin is for papers (collected once per month).
- The grey bin is for garbage (collected every two weeks).

- Green Dot material is collected in yellow plastic bags once per month.
- Glass is collected in igloos available at a density of one per 500 people (a requirement of the Green Dot system).

Process Description

The capacity of the plant is:

- 20,000 t/yr if only the first stage is carried out in the Rottoboxes (i.e., a completely in-vessel operation) and the other stages are carried out in the open;
- 14,000 t/yr if the first two stages are carried out in the Rottoboxes, and the third is carried out outdoors; and
- 10,000 t/yr if all three stages are carried out in Rottoboxes.

The facility has a high-tech control room. The temperature and CO_2 level in each Rottobox are monitored and displayed on computer screens as required. The wind direction is monitored on a continuous basis to have historical data on hand if odour complaints are filed at a later date. The plant is located at the top of a steep hill, outside the town of Sinn, adjacent to a quarry. The closest house is 200 m away.

Front End Treatment

Feedstock is dumped on a concrete pad outside the loading area. The doors are not high enough to allow direct loading from collection trucks to the conveyor (the plant is located in an existing building which was modified, and some trucks are too high for the existing door). The plant maintains a supply of chopped green waste (from commercial sources) to use as "structure" for the heavier bio-waste from residential sources. The feedstream is loaded onto the conveyor by backhoe and sent to a shaker, to a magnetic separator, and then to a manual sorting station. The manual sort is carried out by two people to remove contaminants. Even though the residential source separation system for organics is four years old, they still find approximately 1% contamination (e.g., rocks and plastics) in the feedstream. The manual sorting station is well lit and ventilated but very small. After the manual sort, material goes into a shredder to reduce its size to 150 mm and lower. Waste is then fed automatically to the Herhof Rottoboxes.

In-vessel Composting System

The concept with the Herhof Rottobox system is that the material stays stationary; aeration is provided from outside, but the material is not moved or agitated in any way. Leachate recirculation is also provided.

Composting takes place in three stages

In **step 1**, material stays in the Rottobox for ten days. During this period, the mass of the incoming waste is reduced by 55%. For the first three days, the temperature is at 40° to 50°C, microbes break down easily degradable matter, and CO_2 is produced; a high air feed rate is maintained. During days four to eight, the air supply is cut back, the temperature increases to 60°C (by day five) and stays at this temperature for three days. The heat sterilizes the compost. During days eight to ten, the air flow is increased and the temperature lowers to 30°C. At the end of ten days, compost suitable as mulch and for some farm applications has been produced.

Prior to step 2, material from step 1 goes through a hammermill to open up the surfaces and to add moisture. **Step 2** composting takes nine days in the Rottoboxes. **Step 3** composting takes seven days in the Rottoboxes. If steps 2 and 3 take place in the open, a period of 12 weeks is needed. The same quality can be accomplished in 16 days in-vessel. Biokomp (the plant operators) were still refining the process during the June 1994 site visit, so the open windrow application was not under way.

The plant has 10 Rottoboxes. The two end boxes act as biofilters for odour control. Finished compost goes through a hammermill for removal of small contaminants. There is an integrated soil factory where compost is blended with fines

and topsoil from the quarry operations, peat and humus (this is the term the sales manager used) to produce 11 different products. End products are packaged in opaque plastic to protect the compost from light. The colour of compost changes when it is exposed to light, and customers generally want dark compost for cemeteries.

Each tonne of organic waste received at the Herhof plant is reduced by 55% to a mass of 450 kg after 26 days in the in-vessel system.

History/Progress

See Waste Management Context section.

Performance/Results

Lahn Dill estimate that annual generation is 480 kg/person.

Grey bin waste (garbage) is 265 kg/person, and the remainder is recycled or composted.

Recovery of other materials in 1993 was:

- 19,000 t of paper and cartons (71.7 kg/capita),
- 3,000 t of packaging waste recovered by the German Green Dot (DSD) system (in yellow bags) (11.3 kg/capita),
- 6,200 t glass (23.4 kg/capita), and
- 26,000 t compost (kitchen and garden waste) (120.6 kg/capita).

The diversion rate is therefore calculated at 45%.

Ownership/Financing/Government Involvement

The plant was constructed privately by Herhof. An existing building was retrofitted for this purpose. The operation is located at the side of an operating quarry, which is also owned and operated by a company related to Herhof. The composting facility is operated by Biokomp, a subsidiary of Herhof. Biokomp is also in the energy business. The district of Lahn-Dill pays Herhof a tipping fee for materials delivered for composting.

Program Cost

All conversions are based on a rate of 1.1DM = $1 Cdn.

Capital Costs

Capital costs for the facility were not provided. It was located in an existing retrofitted building at a location owned by the equipment supplier (Herhof). An investment of $2.3 to $2.7 million was required for the soil factory, which is located within the composting building. Capital costs of $640 to $1000/t of capacity (including building, excluding land) were quoted by the sales manager. This cost assumes a 20-year amortization for the Herhof Rottoboxes (the vessels), and a 10-year amortization for the equipment.

Operating Costs

Operating costs (including capital investment) were quoted at $135 to $200/t.

Staffing

The facility requires four staff in the composting plant and one in the soil factory. Employees indicated that staff requirements are one driver, one manager, and two pickers for the manual sort at the front end of the plant. There appeared to be many more staff on site during the site visit (June 1994). However, the staff were still working out start-up issues at that time.

Comparative Costs of Other Waste Management Methods

Herhof staff quoted landfill costs of $230 to $320/t and incineration costs of $450 to $640/t in the area. Composting was less expensive in the Lahn-Dill District. Municipal official from Lahn-Dill quoted costs of landfill at $320/t.

Households are charged $72/person a year for waste management. This includes collection of blue, green and grey containers, two bulky waste

collections a year, and three toxic waste collections per year.

Problems/Modifications

The plant had been operating approximately nine months when visited. No major problems were evident. The plant is located in an existing building. Ceiling/roof heights in some areas have caused problems with respect to unloading incoming feedstreams. For this reason, all incoming waste must be unloaded on to a large concrete pad and then loaded on to the feed conveyor by smaller vehicles.

Expansion Plans

None indicated. Herhof staff mentioned that they will be looking at anaerobic treatment in the near future.

Contractual Elements

Biokomp/Herhof have a contract with the district of Lahn-Dill whereby they are paid $180/t of input to the plant. Composting is less expensive than other waste management methods in the area.

4 Resources

Contacts

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Herr Rinstock, Lahn Dill District

Reports and Surveys

- Herhof Composting Systems (brochure)
- Back to Nature - Forward to the Future (Herhof brochure)
- Site visit report, June 1994

5 Summary Evaluation

Reasons for Success Or Failure of Program

One of the major advantages of this system is its location adjacent to a quarry, which is an ideal source of fines to blend with the finished compost to produce marketable materials. Another advantage is that the feedstream comes from a population that has been source separating organics for four years. Therefore the quality of the incoming feedstream is high and likely contributes to the success of the operation. Energy benefits of the system are noteworthy.

This project has shown first-hand the problems associated with locating composting operations within existing buildings. Door heights have caused major unloading problems because they are too high for the trucks used for organics collection.

R&D Needs/Commercialization Potential

Using waste carbon dioxide for enhancing plant growth is an ideal add-on benefit of a composting operation such as this. Heat recovery from the aerobic composting operation is worth further investigation.

The combination of composting with quarry operations offers excellent commercial potential. Use of excess heat from the composting operation to heat adjacent homes is a potential advantage which could be explored.

Replicability of the Project

The in-vessel composting operation would be applicable to any part of Canada with a requirement to process an organic feedstream. The combination of composting and quarrying operations appears to be mutually beneficial.

Case Study 4 DRANCO Anaerobic Digestion of Household Organics, Brecht, Belgium

1 Abstract

The DRANCO facility opened in July, 1992. It has a capacity of 10,000 t/year of organic waste (on a wet basis), which is anaerobically digested for 20 days and aerobically cured for 10 days. Biogas produced by the process is used for power generation, with the power sold to the grid. The finished product (Humotex), a stable humus material, is sold to two companies.The facility is located at the landfill site. The surrounding area is farmland and low density housing. The feedstock to the facility is source separated household organics (food and yard waste), along with non-recyclable paper, from a population of 75,000 (26,000 single-family households). All households are provided with a 120-L brown bin for organics separation. Bins are collected on a bi-weekly basis. A similar facility with a capacity of 20,000 t/year opened in Salzburg, Austria in June 1994. The Salzburg facility has incorporated a number of improvements following operating experience at Brecht.

2 Community Description

Location

The facility, outside Brecht, Belgium, is a rural, low-density housing area about a one-hour drive north of Brussels, in Flanders. The intermunicipal authority serves 20 rural municipalities surrounding Antwerp. The facility serves a number of these municipalities (13 villages). The area feeding the facility has a population of about 75,000. The site is located adjacent to a landfill and shares the scales and wastewater treatment facility with the landfill.

Waste Management Context

Belgium has limited space and there is strong public opposition to landfills. Siting of landfills is approved only upon demonstration of effective waste diversion initiatives. Source separation of organic wastes and non-recyclable paper generated by households is mandatory in Belgium.

3 Program Description

Purpose and Sectors Involved

The facility was constructed to handle predominantly residential source-separated organics from 26,000 single-family households in 13 villages. The facility has the ability to take IC&I waste but was taking all residential waste in June 1994 (it was taking IC&I waste at the time of a previous site visit in December 1993).

Type/Method of Recovery

Households are provided with a 120-L brown bin for source separation and storage of organics (i.e., food waste and other putrescible material, and difficult-to-recycle paper wastes, including disposable diapers and wrapping paper). Staff estimate that 40% of the residential waste stream is source-separated and disposed of in the organic bin. A second (grey) bin is provided for storage of garbage. Each bin is collected bi-weekly. Depots for recyclables collect a small amount of material. The region also has a backyard composting program (the cost of $50/composter is subsidized) but no data were available on participation. Bulky waste is collected every six months. Source separation of organics by householders began in July 1992. The Brecht DRANCO facility opened in 1992.

Process Description

Receiving Area and Pre-treatment

Waste is received in a vented and covered receiving area. Organics are dumped onto a tipping floor and bulldozed onto a conveyor system. Large contaminants are removed by hand. Negative air pressure is vented to the aerobic composting/curing area. Depending on the moisture content of the incoming waste, a bulking agent may be used. In December 1993, a dry cellulose fibre (from a local sausage producer) was added to the feed stream. Incoming waste is comminuted in a homogenizing drum and fed to a rotating trommel screen (40-mm holes, 4 RPM, 2 hours retention) to homogenize the feedstream and reduce its size. Oversize material (10% of the feedstream) is sent to landfill (this stream includes some disposable diapers and yard waste). Paper absorbs moisture from the organics in this process, and additional water is added as required to correct the moisture content. This feed stream is mixed with 50% digested material for introduction to the digester. The feedstream is steam heated to 50° C and pumped to the digester.

Digestion

A positive displacement pump (from the cement industry) pumps the feedstream to the top of the digester. The digester is 7 m diameter, 21 m high, with a volume of 808 m^3 (like a metal silo, 7 storeys high). A 35% Total Solids (TS) content is maintained in the digester. There is no internal mixing. Two screws, 3 m long, are used for mixing and are operated from outside the digester (DRANCO patent). Instrumentation in the digester is relatively simple and includes ultrasonic height measurement. Digestion is a thermophilic process, operated at 55°C. The digester is operated at a 50% digested sludge return rate (this is a very high rate, which provides a stable process). Retention time in the digester is 20 days. About 5% of digester contents are bled off every day. The digested material is dewatered, using a screw press, to 55% solids. Press liquor is pre-treated along with landfill leachate in an on-site aeration basin (which is shared with the landfill), and then pumped 4 km to a wastewater treatment plant.

Curing

The digested material is refined using a vibrating screen (10 mm). About 10% of the incoming tonnage is screened at this stage (i.e., plastics and sticks). Digested material then undergoes 10 days of curing in aerobic conditions for oxidation and nitrification of the finished product (slight sharp ammonia smell arises from digester output; the finished product smells like earth). Curing takes place in a covered area, with the air provided through holes in the concrete floor.

Energy Production and Management

The Brecht facility produces 100 m^3 gas/t of input (150 m^3/t is expected in Salzburg because of the higher food content of the feedstream). About 7% of the gas from the digester is used for heating and steam for the process; the remainder of the biogas is used to generate electricity. Of the electricity used, 60% goes to the power grid, 40% is for facility use. The plant does not generate electricity at night because it is not allowed to sell to the grid after 10 p.m. in Belgium (not a problem in Holland or Germany). Gas is generally flared at night for this reason. Some gas is stored in gas bags made of "flexible" material (the site representative could not confirm if this was plastic). This approach is cheaper than using a steel storage tank, but is not as strong as steel, and is less secure (Salzburg used steel tanks).

A steel storage tank could be used at Brecht, but would be more expensive and would require a larger engine to use the stored gas. A 290-kw engine is used in Brecht (Salzburg has a 1,000 kw engine for a 20,000 t/yr plant). Lost heat from the engines is not recovered, as no local industry is able to use it. The plant is located at the landfill for practical reasons. The optimal location for such a facility would be beside an industry that used waste heat.

Marketing of Humotex

Humotex contains a carbon/nitrogen ratio of about 12, and is sold to two private companies (long-term contract), who pay $14/t. The plant operator believes that the companies mix Humotex with different feedstreams (e.g., chicken manure) to produce a variety of blends for different clients.

Staffing and Operating Hours

- 10,000 t/year capacity
- three people, one shift/day, seven hours/day

History/Progress

The DRANCO demonstration installation in Ghent (Belgium) was constructed in 1984 and was used to develop dry thermophilic digestion of municipal solid waste. DRANCO is a fully patented process, protected by two main patents; the first covers the microbiological aspects of dry anaerobic fermentation at total solids content of 25 to 40%, the second covers the sliding frame digester system. Organic Waste Systems (OWS) owns DRANCO technology, operates the DRANCO Brecht facility, and has an exclusive agreement with Laidlaw in Canada. OWS worked closely with neighbours during the planning and development stages of the facility to mitigate environmental and social impacts.

Performance/Results

The plant operators estimate that organics make up 45 to 50% of the household waste stream, and that paper makes up an additional 20 to 25% of the waste stream. Some of this paper is recyclable. The non-recyclable fraction should be included in the organics fraction, where it improves the carbon-to-nitrogen ratio of the waste stream and also soaks up some of the moisture and odours.

Each tonne of waste received at the Brecht facility produces 350 kg finished material, 130 kg of biogas (100 m^3), 320 kg wastewater, 200 kg waste (to landfill; 10% screened at the front end, and 10% screened from digested material) for a total of 1,000 kg.

Brecht is a rural area, with significant garden waste, particularly in spring, when the incoming feedstream consists of 20% food, 70% yard waste, and 10% non-recyclable paper.

The incoming stream has a higher percentage of food in winter when garden waste is down. Most villages claim 40% diversion of waste through this system alone.

Ownership/Financing/Government Involvement

Ownership/Operation

The facility is privately owned by Laidlaw Brecht (51%) and OWS (49%), and is operated by OWS. The regional authority must supply the facility with a minimum of 8,000 t of organic waste annually for the next seven years (eight-year contract started in 1992). OWS is responsible for the treatment of the waste, the sale of end products, and the management of residues. The regional authority is to assume ownership of the facility after completion of the contract.

Financing

The facility received a one-time European Community subsidy of $770,000 for development of an alternative (renewable) energy production facility. The Belgian government provided $1.27 million in an interest-free loan over three years. Laidlaw provided a $3.18 million loan. The tip fee at the facility was reported at $95/t in 1992. The contract provides a guaranteed tip fee which is indexed to inflation (the specific tipping fee was not provided during the June 1994 site visit).

Program Cost

Collection system costs were not reported. The tipping fee at the landfill was quoted at about $70/t in June 1994. Operating costs of the anaerobic treatment system were quoted at about $95/t.

The original facility capital costs were $5.56 million in 1992, exclusive of weigh scales and wastewater treatment facility (which are shared with the landfill, and were already on-site). Cost of these two additional elements would have been an extra $2.45 million. The facility would cost more if constructed today. Amortized over 20 years, the capital cost is $44/t. Revenues include 25¢/kWh for electricity during peak periods, and $12/t for Humotex.

Cost estimates for a 25,000 t/year facility were quoted as follows by the plant operators:

Capital Cost

- $13 million

Annual Cost

- $1.52 million (15 years, 8% interest) capital
- $820,000 operating

Revenues

- $111,000 Humotex sales (8,500 t/y)
- $248,000 electricity sales (2700 MWh)

Net Costs

- $1,970,000 or $79/t.

Problems/Modifications

Municipalities had initially used 240-L bins for collection of organics. These were collected only when full. To ensure collection, residents filled these carts with all types of wastes. The municipality decided that the 240-L bins were too big, and that people filled them with wastes that had not been traditionally disposed of. The plant operators concluded that people used whatever capacity was provided to them, which is a problem if they are given a large bin. A new Belgian law limits the size of the organic container to 120 L.

No odour problems are reported nine months of the year, but householders complain about odours from household bins in warm weather. The municipality suggested that people put old newspapers (ONP) at the bottoms of their carts to absorb moisture and minimize odours. This may have helped somewhat, but odour problems at the household level are not fully resolved. Weekly collection of organics would solve the odour problem but would increase municipal costs. Plant staff report that they would design more air venting into the plant if they were starting again. The Salzburg plant has been designed with more air venting. No other significant problems were identified.

Expansion Plans

No changes are planned at the Brecht facility. A much larger plant was constructed in Salzburg, Austria. It has incorporated a number of new features into the design. A DRANCO facility has recently been chosen by Cardiff, Wales for processing of mixed waste.

Contractual Elements

See Ownership/Financing/Government Involvement section

4 Resources

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Reports and Surveys

- Ontario Ministry of Environment and Energy, *Municipal 3Rs Infrastructure: A Reference Guide*. International Case Studies, prepared for the Waste Reduction Office, 1994.
- Case study notes compiled from site visit, 9 December 1993.
- Case study notes compiled from site visit, 6 June 1994.

5 Summary Evaluation

Reasons for Success or Failure of Program

The approach has a few limitations at Brecht, because there is no industry to use the waste heat, and power cannot be sold to the grid after 10 p.m. This results in almost one third of potential energy being wasted. This is a location-specific issue that would not affect other plants. The ideal setting for a similar plant is one where all energy and other outputs can be used.

The facility became operational in 1992. OWS worked closely with neighbours during the planning and development stages of the facility to mitigate environmental and social impacts. They claim to have no public relations problems. It should be noted that the facility is located beside an operating landfill. Since the surrounding area is primarily farmland, the smell of livestock manure is already prevalent.

The program is considered very successful, as the anaerobic technology works well to process source-separated household organics, to produce a marketable end product (Humotex), and also to generate power. The facility takes up remarkably little space (estimated at 25% of the space requirements of an aerobic in-vessel facility of similar capacity) and is therefore a very compact plant. The facility is energy self-sufficient and is a net exporter of energy (power to grid). If the facility were located near a suitable industrial site, waste heat could also be used.

R&D Needs/Commercialization Potential

Odour problems from storage of household organics in household carts for bi-weekly collection have not been resolved. Anaerobic treatment has the added benefit (when compared to aerobic composting) of biogas generation and the potential for power export from the plant. This technology is used more in European than in North American settings (although it has not been used very much for processing household organics on either continent). To date, it has not been used extensively for managment of residential waste. The potential to refine this technology in Canada for export elsewhere should be pursued, particularly because of its energy benefits. An ideal market for this approach is a location with high power costs which also has a shortage of landfill space.

Replicability of the Project

The approach is suitable for treatment of wet kitchen organics, which have the highest potential for gas production. The general feeling is that the approach is proven on a relatively small scale (10,000 to 20,000 t/year), and is very suitable for treatment of source-separated household organic wastes in this size range. The added benefit of energy production and the potential waste heat recovery from boilers makes this approach suitable in locations which can benefit from these outputs. The fact that the process is energy self-sufficient is a major advantage. The plant needs only three staff, operating seven hours/day to operate a facility treating 10,000 t/year. The technology is also suitable for locations and sites with space constraints (anaerobic digestion requires only 25% of the space required by an in-vessel aerobic facility of equivalent capacity).

BTA Technology

The DRANCO facility in Belgium is one example of the successful application of anaerobic technology for processing household organics. The city of Salzburg, Austria has chosen a two-stage anaerobic-aerobic process for treating source-separated household organics. The anaerobic technology is preferable for processing heavy, wet household organics, which have a very high oxygen demand and are sometimes problematic when composted in aerobic plants. The city of Cardiff, Wales recently chose the DRANCO process for treatment of their mixed residential waste stream.

The BTA anaerobic treatment process was developed in Germany during the 1980s. It requires a retention time of only 48 hours for processing of organics, compared with about three weeks for the DRANCO process. This design feature has a significant impact on plant size and design. The biogas produced by the process is approximately 70% methane. One third of the energy output is required for plant needs, and the remaining two thirds can be used for district heating or power generation.

There are four BTA plants in Europe. The municipality of Helsingor, outside Copenhagen in Denmark, has had a full-scale plant for some time. Other BTA plants are in Baden-Baden and Badkissing, Germany. Canada Composting Inc. has secured the rights to the BTA process in Canada and the United States. They have obtained a certificate of approval to construct a 120,000 t/year facility in Newmarket, Ontario. Project financing is being finalized at this time. The plant will be the first of its kind in North America.

There are a number of locations where anaerobic technology has been used for the treatment of household organics. A plant in Tahiti processes 44,000 t/year of municipal solid waste along with 30,000 t/year of green waste. In Finland, a plant at Vasa has processed 25,000 t/year of household waste and sewage sludge since 1990. The county of Kent, England is planning to construct a 40,000 t/year anaerobic facility for processing of domestic and commercial waste. The Valorga plant in Amiens, France processes 72,000 t/year of mixed municipal waste using anaerobic technology. Another plant near Grenoble, France processes 8,000 t/year.

Case Study 5 Comprehensive Source Separation Program, District of Giessen, Germany

1 Abstract

The district of Giessen is located in Germany, near Frankfurt. It has a population of approximately 240,000, half of whom are served by a three-stream waste collection system. The remaining population is served by a two-stream (fibres/garbage) collection system, which will be expanded to three-stream in the future. The open windrow composting facility operated by the district has experienced on-going odour problems, and because of consistent public and political pressure, considerable effort and expense have been required to provide a short-term solution.

The district initially spent $5.4 million on two cover structures for the open windrow operation. These helped to solve the odour problem, but additional efforts were required. It was determined that the turning of wet material was the source of the strongest odours. The solution was to carry out the first-stage composting of wet material (which takes six weeks) at a separate composting site in a rural area, where intermittent odours are less of a concern. Partially composted bulk garden wastes are used as a bulking/drying material and are mixed with wet waste in a 60:40 ratio. After six weeks of composting, the material is trucked back to the original composting site for two to three months of curing in covered windrows. Although this approach is successful in solving odour problems, it is too costly for long-term consideration. Longer term plans are either to find a new composting site (the existing site is in an urban area, adjacent to a sewage treatment plant), or to construct an in-vessel system.

The district composts about 15,000 t/year, and produces 5,000 t/year of finished compost. All of this material is sold to a variety of customers.

2 Community Description

Location

- District of Giessen, Germany.
- Population 240,000; households 106,500.
- Mostly single-family households; percentage of multi-family is not known.
- Most multi-family households are in buildings of three storeys or less (an elevator must be installed in higher buildings, therefore developers/owners prefer smaller buildings).

Waste Management Context

Residents of the district are "anti-incineration" for at least two reasons: concern about emissions, and concern that incineration provides a disincentive to source separation. The landfill situation is critical. One landfill was closed in April 1993. The second has one year of capacity remaining. Separate organics collection began in Giessen in 1986, and in the areas outside the city in 1988. Approximately 50% of the residents are now served by the separate organics collection system.

3 Program Description

Purpose and Sectors Involved

System manages residential waste.

Type/Method of Recovery

- About 120,000 inhabitants are served by a three-stream waste collection system: blue bins for all paper materials collected once per month, grey bins for garbage (collected

two times/month), green bins for organics (collected two times/month).

- The remaining 120,000 inhabitants are served by a two-bin system: blue for fibres (collected two times/month), and grey for garbage (collected two times/month).
- All households have brush/yard collection once a year (in May or July), and one bulky goods (e.g., old furniture) collection per year.
- Yellow bag (green dot) packaging material is collected curbside once per month.
- Depots for collection of glass are available at a density of one per 500 people.
- There has been a backyard composting program for one to two years, but information is not available on the number of households participating (backyard composters cost $32; the householder gets a $18 rebate from Giessen).
- Household hazardous waste is collected in a mobile depot.
- A central depot accepts most materials — i.e., metals, papers/books, clothes, bicycles/ radiators, batteries, polystyrene, wood and C&D materials.
- The central depot provides a rental service for party dishes to discourage the use of disposable dishware. Residents can help themselves to anything at the depot.

Process Description

Composting

The district of Giessen has had on-going operating problems at the composting site, and staff are evaluating options for improvement. They have implemented a number of expensive measures to guarantee acceptable operation of the site in the short term. This involves running two composting sites: site #1 is the original composting site, and site # 2 is a temporary site where the more odorous operations take place.

The current operation is as follows:

- Brush/heavy garden waste is brought to site #1 for composting in open windrows. This material does not cause an odour problem.
- The composted brush is then taken to compost site #2 (near the American army base in a rural area) to mix in 40:60 ratio with kitchen organics (from the green bin collection) for first-stage composting of kitchen organics (which takes about six weeks).
- After six weeks, the composted mixture is brought back to Site #1 (at least 20 km away), where it is run through a trommel screen (40-mm) to remove contaminants. The remaining stream is then composted in covered windrows for two to three months.

The finished compost is run through 10-mm and 20-mm trommel screens to produce compost for different markets. Some of the finished compost is packaged in 40-L bags (made of compostable paper) and is sold for $2.70 per 40-L bag. Compost is sold at a lower price to large users (farmers, etc.) who are charged $18/m^3. The site markets all finished compost, which has had its quality tested to achieve certification. A staff of 13 run the composting site.

White Goods Processing

A separate facility for refurbishing and dismantling white goods is located in the neighbouring town of Zaug. This facility is staffed by disadvantaged workers and has a very labour-intensive approach. Appliances collected in bulk collections are tested and refurbished/ reused where possible. The facility handles 20,000 fridges/year and 15,000 other appliances such as washing machines. They have developed CFC recovery equipment on site, and are now manufacturing and selling these units to German companies (orders for five at $27,000). All metals and cable are stripped from appliances and are recycled. The recovered CFC foam from refrigerators is sent to another company. There

is currently no market for fridge interiors (made from polystyrene), this material is currently shredded on-site before being sent to landfill. Capacitors are currently handled as hazardous waste; a system to avoid this is being developed. The facility plans on getting involved in computer refurbishing and dismantling. The facility is located in a residential area, and it needed a special roof to minimize noise.

History/Progress

Odour problems at the composting site have forced the district to implement an expensive system of two composting sites (See Problems/Modifications). This is considered a temporary measure.

Performance/Results

Available residential waste diversion and disposal data for 1992 and 1993 is as follows:

Material	1993 (tonnes)	1992 (tonnes)
Fibres	13,826	16,221
Organic Kitchen waste	10,656	9,500
Garden waste	4,615	6,000
Glass	N/A	N/A
Green Dot Packaging	N/A	N/A
Garbage disposed of	**52,733**	**61,613**

Ownership/Financing/Government Involvement

The district owns and operates the composting site. No information was available on other arrangements. Green Dot material is collected privately by a separate municipal collection system.

Program Cost

Costs to Residents

Each home pays $100/per capita/year on its tax bill for waste management.

The ceiling for any family/household is $400/ year (i.e., families with more than two children do not pay extra).

Landfill Tipping Fees

Landfill tipping fees in Giessen depend on the type of material involved. Charges are per cubic metre (as older landfills did not have weigh scales). Prices quoted in DM/m^3 are converted to $/t assuming a density of 0.28 t/m^3, and a conversion rate of 1.1DM = $1 Cdn.

- compacted household waste, no recyclables: $118/t.
- compacted household or commercial waste with recyclables: $1480/t.
- C&D waste: $275 /t.
- tires: $17/unit (go to cement kilns).

Landfill tipping fees in neighbouring regions (Nord Rhein, Westfalen) are $272/t (excluding transportation).

Processing Costs

The costs for 1993-1994 were not available. Cost data for 1991 were:

Garbage collection	$3 million
Garbage disposal	$1 million
Fibre collection and processing	$1.5 million
Glass collection and processing	$0.3 million
Other waste collection and processing	$1 million
Organics collection and processing	$2.65 million
Compost revenues	($0.5 million)
Other programs	$1 million
Administrative cost	$1.5 million
Public education and promotion	$0.7 million
Capital recovery/reserve funds	$4 million
Total Annual Cost	**$16.6 million**

White goods processing is provided at a rate of 40DM/refrigerator, and 25DM/unit for other appliances.

Problems/Modifications

There have been problems with odours at the composting site. It is located near a sewage treatment plant with uncovered trickling filters, but the residents did not have a problem with odours until the compost plant started up. The composting site is located on a mixed-waste processing plant that has never worked properly.

Two large covered structures were constructed over the open windrows at a cost of $5.4 million. These helped, but they did not eliminate the odours.

The odour problems were solved by taking kitchen organics to a separate site for the first six weeks of composting. This wet material is mixed 60:40 with composted brush.

The current system of running two composting sites and trucking material from one site to another is very expensive, but is necessary to keep the politicians and the residents happy. This is considered a temporary solution.

Future Expansion Plans

The district has purchased Schaeffer "Compostainers", and wants to distribute these to all households. (Only 50% of households are currently using the organic collection system.) The district is looking for a new composting site, but this is not easy to find. The district is also looking at in-vessel composting but has not found a system that will answer all of its problems.

Contractual Elements

No data available.

4 Resources

Contact

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Reports and Surveys

Site visit notes, June 1994.

Ontario Ministry of Environment and Energy, *Municipal 3Rs Infrastructure: A Reference Guide.* International Case Studies, prepared for the Waste Reduction Office, 1994.

5 Summary Evaluation

Reasons for Success or Failure of Program

- Odour problems at the compost facility are related to the early-stage composting of wet kitchen waste and have been a major defect of the system.
- The two-stage composting design has worked, but it is too expensive for the longer term.
- In-vessel composting or anaerobic processing of the wet waste stream in particular might solve the odour problem.
- White-goods dismantling has been innovative. Staff developed a CFC recovery system on-site which is being commercialized in a small way, and they also developed crushing equipment suitable for this type of operation.

R&D/Commercialization Potential/ Replicability of the Project

The three-stream collection system is viable for any part of Canada that wants to implement a source-separation program with central composting of household organics. The case study shows the large expense involved in trying to solve central composting problems when odour problems have developed and local residents object to the facility.

Case Study 6 Jet-A-Way Inc., Boston, Massachusetts

1 Abstract

Jet-A-Way operates a construction and demolition (C&D) waste recycling facility in Boston, Massachusetts. The processing facility is fully enclosed and utilizes both mechanical and manual separation systems to recover metals, wood waste and different-sized aggregates. The facility's licensed input capacity was increased by the state from 250 to 450 tonnes per day (tpd) in 1993 (225 to 405 tpd operating capacity). The facility achieves 61% recovery of incoming C&D waste. The process design and mechanical separation equipment was provided by Lindemann Recycling Equipment.

2 Community Description

Location

- Boston, Massachusetts and its suburbs.
- Receives material from approximately a 20-mile radius in the south and west areas of the city.

Waste Management Context

Waste generated from construction, renovation and demolition activities is prohibited from municipal landfills in Massachusetts. C&D wastes represent 10 to 30% by weight of the solid waste stream in North America. There is, however, no estimate for C&D waste generation in the Boston area.

Jet-A-Way collects C&D wastes and allows other haulers to drop off materials for processing for a fee. C&D wastes generated in Boston and not processed by Jet-A-Way are sent to transfer stations and trucked to C&D landfills outside the city.

For residue materials, Jet-A-Way uses a number of C&D landfills located anywhere from 10 to 60 miles from the facility. Tipping fees for these landfills range from $41 to $56/t. The incinerator closest to the facility is 50 miles away and charges a tipping fee of $44 to $50/t.

3 Program Description

Purpose and Sectors Involved

The facility recovers usable materials from mixed C&D waste. It receives C&D waste from Jet-A-Way vehicles, other waste haulers, construction and demolition companies and contractors within the Greater Boston area.

Type/Method of Recovery

The facility uses mechanical recovery systems and manual separation to recover usable materials from incoming mixed C&D loads.

Process Description

The facility has three separate areas for separation and recovery. First is the infeed area where loads are dumped onto a tipping floor. A bulldozer runs over the material to reduce its volume and size. Mechanical grapples separate and remove oversized wood waste (e.g., tree stumps or doors) and metals (e.g., aluminum siding or rebar) for recycling. The grapple also removes oversized, unprocessable wastes such as carpeting, plastics and furniture. This material is placed in bins for disposal.

Next, the mixed waste is loaded into a hopper and on to an incline conveyor. A spotter on the conveyor removes non-ferrous metals and unprocessable waste. The conveyor feeds material into a trommel screen.

Materials less than 3" in size pass through the grates at the beginning of the trommel and are discharged onto a conveyor and then into a bin. This material consists primarily of dirt, wood and small stones.

Materials between 3" and 8" pass through the grates at the end of the trommel onto a conveyor. An overhead magnet removes ferrous items. The conveyor then passes by a manual picking area where wood, other metals and stone are removed and dropped down chutes in the elevated platform into 40 yd^3 bins. The residual material on the conveyor drops into a bin for disposal.

Materials that are more than 8" in size pass through the first trommel and onto a conveyor; this passes by a manual picking area where wood, other metals and stone are removed and dropped down chutes in the elevated platform into 40 yd^3 bins. The residual material on the conveyor drops into a bin for disposal.

History/Progress

The facility was opened in September 1990. Jet-A-Way contracted with Camp, Dressler and McKee (CDM) to analyze options and equipment. The Boston department of health required that the operation be fully enclosed. Lindemann was selected over other vendors because its equipment could fit within the building parameters, and it had a proven track record in New York City and Basel, Switzerland.

Performance/Results

The facility operates 5.5 days per week. The operating licensed capacity was recently increased from 225 to 405 tonnes per day. In 1993, the facility received 75,600 t of C&D waste.

The following is a breakdown of incoming wastes:

- 50%—fines less than 3" in size removed by the trommel.
- 6%—stone and concrete that are manually separated from both sorting conveyors.
- 5%—ferrous and non-ferrous metals.
- 61%—facility's over-all waste diversion rate.

The fines are used as a substitute for daily landfill cover. The stone and concrete is sold as fill material or for use as road base by paving contractors. The ferrous and non-ferrous metals are sold directly to secondary metals markets.

An additional 6% of wood has also been removed in the past, but it is currently not economical to manually separate wood, due to limited market opportunities.

Ownership/Financing/Government Involvement

Owned and operated by Jet-A-Way Inc. of Boston, MA. The company is 100% women- and minority-owned.

Program Cost

The C&D facility is located in a 25,000-square-foot building. The footprint of the Lindemann equipment is 6,500 square feet. The tipping area for incoming C&D wastes is 6,000 square feet.

The following cost data were provided by Jet-A-Way.

Capital equipment costs—$2.1 million

Ancillary equipment costs—$687,000

Building costs—$4.2 million

Operating Costs

Labour—$6.30/t
Transportation
costs to landfill—$8.60 to $12.40/t
Equipment costs—N/A
Overhead costs—N/A
Cost to service financial bond—N/A
Processing cost/ton—N/A

Tipping fees charged by Jet-A-Way to haulers—gate rate is $110/t, best customer rate averages $74/t Cdn.

When the facility opened, the tipping fee was $130/t. Rates have declined since then due to increased competition for C&D waste in a declining construction economy. The facility is volume-sensitive, and Jet-A-Way has had to reduce fees to ensure that material is brought to them.

Problems/ Modifications

When opened, the facility used a secondary trommel to further separate material less than 3" that was discharged from the first trommel into two size ranges: less than 0.5" and 0.5"-3" sizes. The second trommel has since been bypassed due to frequent clogging problems with the small-sized materials. It was also found that the additional cost to separate the fine material was not justifiable in relation to outlet markets.

Expansion Plans

None; there is no room to expand. (The facility is located on a small, three-acre property.)

Contractual Elements

N/A

4 Resources

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Reports and Surveys

Article in *BioCycle* (March, 1991): "An Inside View of C&D Recycling".

5 Summary Evaluation

Reasons for Success Or Failure of Program

- John Kelso stated, "You must do a comprehensive and accurate analysis of the incoming waste stream and your outgoing options, both disposal and recycling." CDM's estimates of incoming volumes and composition were not accurate. For example, CDM estimated fines to represent 70% of incoming material. When the facility opened, the fines represented only about 40%. CDM used results from the Lindemann system in Basel when planning and designing the Jet-A-Way operation. The difference between the two cities in waste composition resulted in the decision to add the second trommel.
- Waste composition of the C&D waste stream varies seasonally. Winter months are generally slower, with most of the waste being interior demolition and renovation materials. In spring and summer, there is considerably more heavy demolition and construction activity.
- There is a need to limit the size of fixed-cost burden (i.e., capital costs). Jet-A-Way has been saddled with a considerable financial bond which remains a burden. The capital costs could have been reduced considerably by not adding the second trommel and if they had not needed to enclose the system within a building.
- Jet-A-Way does not control what comes in, so they have had to ensure that they are on top of developments for market options. This includes landfill closings, increases and decreases in tipping fees, and incinerators changing their specifications. They have learned that you need to be flexible.
- The facility was constructed during a decline in the construction industry in Boston.

- The city's requirement to have the facility fully enclosed has been a problem for Jet-A-Way. The limited storage capacity within the building for separated and residual materials requires that Jet-A-Way haul away the same volume of material that is received each day. Vehicle traffic is also a problem with the current setup within the building.
- The facility effectively separates C&D wastes and diverts over 60% of incoming material from landfill.
- Lindemann equipment that is used has proven reliable. Maintenance costs and shutdowns have been less than anticipated.

R&D Needs/Commercialization Potential

- They are currently working with the Massachusetts Department of Environmental Protection (DEP) to test the use of the fines as daily cover for landfills.
- Jet-A-Way's greatest need is to have as many outlets for separated and residual materials as possible. Identifying other value-added uses for the fines and wood waste would be helpful.
- The only option for wood waste is to transport it to an energy-from-waste plant in Maine which is permitted to accepted mixed wood. There are currently no other non-disposal options for the separated C&D wood.

C&D processing operations in North America that employ a labour-intensive approach to separation are quite common. In these cases, labour-intensive equipment (such as front-end loaders, claws and grapples) and manual separation are used to remove recoverable materials such as wood, metals and aggregates from piles of mixed C&D wastes. In effect, easily recoverable materials are "cherry picked" for processing and marketing. The effectiveness of these types of operations ranges from 10 to 40% diversion.

A more advanced C&D processing facility includes more mechanically based separation systems. Manual separation is usually still required; however, the bulk of the separation takes place using mechanized equipment (e.g., a trommel screen). Jet-A-Way is an example of a facility that is mechanically intensive. Other types of equipment that can be used include disc screens, vibrating screens, flotation tanks, tub grinders, impact crushers and shredders.

On-site processing using portable screens, crushers and grinders has become more prevalent in the past few years. On-site processing is usually limited to large-scale demolition projects where there is staging and storage space available for brick, concrete, wood and metals. On-site processing eliminates transportation costs of shipping to a centralized C&D processing facility. Examples where on-site processing has been employed include the Lakeshore Village and Skydome projects in Toronto.

Replicability of the Project

Processing of C&D wastes in North America requires different approaches from processing traditional residential or commercial recyclables (e.g., office paper, glass bottles) because of the composition, generation, volume and densities of C&D wastes. C&D wastes typically are high-volume, bulky, and have high densities. C&D waste generation and composition will vary due to the type of project (e.g., new construction versus building demolition), season, and location (e.g., high use of brick in northeastern U.S. and Canada and less in western states and provinces).

This type of operation is replicable in Canada, particularly in municipalities that have sufficient population, relatively high disposal costs and limited C&D waste disposal options. Areas in Canada where these conditions apply include the greater Vancouver area, greater Toronto area and Montreal.

Harkow Recycling

Harkow Recycling is a C&D processing and transfer operation located in the Toronto Harbour District. In the past, Harkow has employed a manually intensive separation approach to diverting recoverable materials from incoming C&D loads. Harkow is currently in the process of building a state-of-the-art C&D processing facility that is anticipated to achieve more than 80% separation of incoming loads.

Harkow currently receives 100,000 t per year of mixed C&D waste from various local waste haulers and building contractors. Incoming loads are dumped on a tipping floor where easily recoverable materials can be removed either manually or with a front-end loader. The materials currently separated and recovered include metals, wood, cardboard and large pieces of concrete and brick. Current diversion using this manual-separation approach is estimated at 15%. Harkow further processes the wood waste using a tub grinder. In 1993, tipping fees at Harkow were $85 per tonne for mixed C&D loads and $65 per tonne for separated loads of wood waste.

Harkow is planning to open a new facility in October 1994. It will be fully enclosed in a 90,000-square-foot building. The facility will feature pre-sorting using grapples and loaders, a combination of trommel and disc screens, an air classification system, flotation tanks, shredders and manual separation. The facility is designed to handle 80 tonnes per hour or 150,000 t per year.

An estimated 350,000 t of C&D waste is generated annually in Metropolitan Toronto.

Case Study 7 Urban Drop-off Depots for Recyclables, Calgary, Alberta

1 Abstract

In reponse to pressure from local citizens and environmental groups, in the late 1980s, Calgary began investigating a wide range of existing recycling programs across North America to determine the system best suited for the city. The city decided to conduct a test to compare the cost and diversion rates of a drop-off depot system versus a weekly residential curbside collection program. Residents from each of the city's 14 wards were involved in the trial. Following a full year of monitoring, it was determined that from both a cost and a diversion perspective, the establishment of a city-wide drop-off depot system was most appropriate.

Implementation of a city-wide drop-off depot program began in 1992. On average, an attempt was made to place one depot every square mile; however, this is influenced by population densities and the availability of a suitable and willing host. Typical locations for drop-off depots include shopping malls and community centres.

At present, old newspapers, old magazines, glass bottles and jars, and steel cans can be recycled through Calgary's program. There are currently 29 depots in place. In 1993, a total of 7,313 t of material was collected (about 27.6 kg/household served/year).

2 Community Description

Location

In comparison to urbanized areas in central Canada, Calgary spreads over a wide area. With a population of 710,677, the city covers an area of over 670 square kilometers. Portions of the city are divided into neighbourhoods or community associations. These associations are geographically distinct and often have their own recreational facilities, sports, and community groups. Calgary's depot program takes advantage of these associations as a means of providing localized advertising and support.

Waste Management Context

The city of Calgary estimates that it has sufficient landfill capacity to last for 40 to 50 years. The current tipping fee is $30/t. Virtually all beverage containers sold in Alberta are under deposit and are returned through licensed third-party depots.

3 Program Description

Purpose and Sectors Involved

To date, providing recycling opportunities to the residential sector has been the primary focus of Calgary's drop-off program; however, the depots are also accessible to the IC&I sector. No plans are under way to directly target IC&I organizations, as it is felt that it is not within the city's mandate.

Type/Method of Recovery

Each drop-off depot is equipped with a minimum of four self-tipping drop-off bins (four-yd^3 containers for glass and metal cans, and six-yd^3 containers for ONP). Depending on the type of material collected in each container, the size and shape of the opening is altered. This helps to prevent cross-bin contamination. Each container is well labelled. Each depot location also has two one-yd^3 bags for garbage.

Drop-off containers are emptied as frequently as once a day with a specialized collection vehicle. The contents of the bin are hydraulically tipped into a side-mounted receiving hopper, where they are visually inspected for contamination. The

material is then tipped into the storage area of the truck. Each truck collects only one type of recyclable material at a time. This allows collection vehicles to deliver material directly to an end market or an intermediate processor, and ensures that the storage capacity of the vehicle is fully utilized.

A fleet of four trucks services the drop-off depots. Each truck has a capacity of 18-yd^3, and is currently operated by municipal forces. Depending on the type of material collected, a truck is able to service seven or eight depots in one day.

Drop-off depots have been purposely located in high-traffic, publicly accessible areas such as shopping malls and well-used parking lots. The design and layout of each drop-off location takes into consideration features such as available lighting, ease of access, parking and appearance.

History/Progress

A pilot program to compare the cost-effectiveness of a curbside (blue box) and drop-off (depot) program began in December 1990. As a result of the study, the city decided to implement a depot program. In 1992, 15 depots were installed in Calgary; by the end of 1993, a total of 29 depots was open.

Performance/Results

Surveys conducted in the pilot stages (to determine usage patterns) indicated that about 47% of all households use the drop-off depots on a monthly basis. This compared favourably with the participation rates of the curbside collection pilot, which estimated monthly participation to be 72%. (Two separate surveys were conducted—one survey in June 1991, and another in September 1991.) Costs for the curbside pilot were about $380/t recovered, while costs for the pilot depot program were $118/t recovered.

Although skewed because of the number of depots that were gradually added over the course of the year, recovery rates for recyclables collected through depots for 1993 were as follows:

Material	kg/household/ year	Total annual tonnage
Old newspaper	22.8	6,047
Glass	3	800
Steel	1.8	466
Total	**27.6***	**7,313**

*Note: Recovery numbers are based on the total number of households served.

Program Cost

Excluding capital costs and material revenues, the cost to collect and market recyclables through Calgary's drop-off depot program is $127 per tonne. Including revenues for materials, the cost drops to about $97 per tonne.

The cost to set up each depot is about $30,000 (includes containers, signs and installation). Depot container costs range from $3,000 to $3,500 per unit. Each 18-yd^3-capacity truck costs about $51,000.

Problems/Modifications

Some complaints have been received from senior citizens who are unable to easily deliver their recyclable materials to local depot locations. To help resolve this, one community association has established a buddy system that links homebound seniors with neighbours who pick up the seniors' recyclables and deliver them to a depot.

Expansion Plans

An additional five depots were scheduled to be constructed before the end of 1994. With the placement of these remaining depots, staff believe all areas will have adequate access. Emphasis will then be directed to improving the capture rate of recyclable materials. A backyard composting program was considered for 1995.

4 Resources

Contact

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Reports and Surveys

City of Calgary Engineering Department. *Design and Implementation of a Residential Recycling Program: Pilot Project Status Report,* October 15, 1990, revised edition.

City of Calgary Engineering Department, *Pilot Residential Recycling Program—Final Report,* April 1992.

5 Summary Evaluation

Reasons for Success or Failure of Program

One of the keys to success for the program is the design of the depot. Design considerations included visibility, ease of access, parking space (for participants), lighting, attractive and well-labelled bins, general appearance and layout. The well-labelled bins minimize contamination. A large sign is included at each depot to promote the program.

All depots are very well maintained—every effort is made to avoid drop-off container overflows or accumulations of garbage around the depot sites. A separate waste container is included for garbage. Overflow is avoided by servicing depots seven days a week.

Collection vehicles are flexible enough to collect recyclable materials and garbage from the residential sector. This flexibility helps to ease collection at peak load times such as long weekends.

To reduce operating costs, the city has made a conscious decision to reduce material processing costs. Recyclables are taken directly to an end market or intermediate processor. While this has decreased costs, it does make them more susceptable to changes in the marketplace.

One of the main advantages of this approach to recycling is that it is accessible and offers the same level of service to all sectors of the community, including residents of multi-unit dwellings. Most curbside programs offer a higher level of service to single-family households.

Because of Alberta's beverage container deposit legislation, residents were accustomed to taking various recyclables to different locations prior to the implementation of the depot program. This past behaviour may be a contributing factor to the high level of community acceptance.

R&D Needs/Commercialization Potential

New types of specialized drop-off containers and collection vehicles were developed. The glass bins were retrofitted with a spray-on insulating material to decrease the noise of breaking glass. The bin access holes were intentionally designed to restrict access to small household items. Both trucks and bins were manufactured by Haul-All Equipment Systems of Lethbridge, Alberta.

Replicability of the Project

This type of depot program would be replicable in rural areas as an extended program for the collection of exotic materials in current curbside programs, and/or as a collection system for multi-family households.

The program would also be replicable in other provinces with container deposit legislation, because residents are already accustomed to taking certain materials to a depot.

Case Study 8 Mobile Recycling Drop-off Depot Program, Pictou County, Nova Scotia

1 Abstract

Pictou County, located in northern Nova Scotia, has been operating a unique mobile recycling depot program for three years. Initiated for environmental reasons by local politicians, Pictou's program offers an adequate level of recycling services at a reasonable cost to households that are widely dispersed over a large area.

2 Community Description

Location

The population of Pictou County is approximately 49,000 spread over an area of 277,400 hectares. A total of 16,000 households is provided with recycling services through the mobile depot system. A full 54% of the county's population resides in five small towns (with populations from about 3,000 to 10,000), while the remainder lives in more rural areas.

Waste Management Context

All municipalities in Pictou County use a common landfill. A recent study has confirmed sufficient capacity until the year 2010. In 1993, a tipping fee of $25 per tonne was imposed on all incoming loads over 114 kg (loads under this amount are not charged a tipping fee).

Nova Scotia has a deposit system for collecting beer and liquor containers and a "half-back" deposit—i.e., a set deposit is paid for both refillables and recyclables, but when the container is returned, the full deposit is refunded for refillable containers, and only half the deposit is returned for recyclable containers.

3 Program Description

Purpose and Sectors Involved

Initiated in 1991, the county's mobile depot system is designed primarily to serve the residential sector. Although small IC&I waste generators are permitted to use the drop-off depots, in general they are encouraged to contract out recycling services to private haulers.

Type/Method of Recovery

Residents are currently able to drop off the following recyclable materials: old newspaper, old corrugated cardboard, low density polyethylene (LDPE), clear and coloured glass, polyethylene/terephthalate (PET), steel and aluminum cans, glossy and bond paper. Depots are staffed to prevent contamination problems and to ensure that recyclables are sorted correctly.

In 1993, the following tonnages were collected:

Material	Tonnes
Office paper	16
ONP	412
OCC	223
Aluminum	11
PET	9
LDPE	11
High density polyethylene (HDPE)	6.5
Glass	162
Total	**850.5**

A schedule of depot locations and times is regularly published in local newspapers. During the winter of 1994, a local radio station began to play 60-second

ads (five days/week) during the morning (about 8 a.m.) to inform residents of the location of the depot for each day and its hours of operation. With these advertisements, recovery increased by 200% in some towns.

Depots consist of partitioned 30 yd^3 roll-off containers designed for recycling, with doors along the upper section of one side for loading and rear doors for unloading. The trailers are Canadian-made and designed for recycling with four partitions and doors along the sides for loading. The trailers are self-contained and have their own 12-volt electric hydraulic dumping systems. They are equipped with a tandem axle and are designed to haul 6.4 t. They cost $17,000. The containers are typical roll-off containers (cost $6,800) and are hauled by a light truck (29,000 lb. gross vehicle weight) equipped with a multi-lift system for loading and unloading. The truck hauls a container and tows a trailer at the same time, delivering two depots per trip. Together the truck and lift system cost $49,000 ready for the road.

In addition to the depots, a program was put in place to pick up material from all senior citizens' complexes in Pictou county. A program to collect material from any school interested in recycling has also been in place for about two years. About 80% of the schools take advantage of this program. All municipal offices recycle office paper. These three systems are serviced with a half-ton truck on a regular basis.

Residents in urban areas have access to depots once a week, while less populated areas may receive service only monthly or once every two weeks. Depots are curently in place at 63 different locations over the course of a month. Depots are accessible only during the day. Three people operate the depot, system along with a part-time driver. One central depot, located at the landfill, is open 5.5 days a week.

At the end of each day, drop-off depots are returned to a dedicated facility located at the landfill. Recyclables are offloaded, further processed and stockpiled until sufficient quantities are accumulated for shipment to market.

The county processing facility has approximately 232 m^3 of interior space. A vertical baler was recently purchased to bale fibres and plastics, while glass crusher developed on-site is used to increase the weight of shipments. One and sometimes two people are employed at this facility.

History/Progress

Pictou county implemented its mobile depot program during the fall of 1991. Every year the number of depot locations increased, and the recycling tonnages subsequently increased.

Recycling tonnages have increased substantially since the introduction of an aggressive promotion and education program which includes presentations to schools, church groups, local clubs, shopping malls and radio advertisements.

The recycling coordinator estimates that tonnages in 1994 have increased by about 200% from 1993.

Performance/Results

In 1993, approximately 80% of the county's population had access to recycling service through 63 depot locations. Extrapolated over the total households that have access to the depot program, the average diversion rate is approximately 52 kg per household per year. Residential sector diversion is estimated to be 9 to 10%.

Ownership/Financing/Government Involvement

Collection, processing and marketing of recyclables, and overall coordination of the program, are provided by the Pictou County Planning Commission, a municipal entity.

This program was partially funded by the Resource Recovery Fund (RRF). The RRF provided 50% of the capital (approximately $66,000) and 50% of the operating costs (approximately $85,000) for 18 months.

Program Cost

In 1993, the annual cost for operating the mobile depot program was approximately $119,450. This included wages and benefits, advertising and overhead. It did not include any capital costs or revenues from the sale of materials.

Problems/Modifications

Limited accessibility and inconvenient hours of operation are the two main criticisms program staff have received from the public. A recently launched radio and cable television advertising program has helped to make residents more aware of when the depot will be in their area. This has contributed to a 200% increase in the amount of material collected in the first quarter of 1994 as compared to the same period in 1993.

A telephone study to determine the most desirable hours of operation was expected to be undertaken in the fall of 1994. It was anticipated that hours will be changed and extended into the evening.

Expansion Plans

Staff are presently assessing the costs of implementing a curbside collection program (blue bag collection) in the urban areas of the county. Plans are also in place to establish two additional depot locations.

4 Resources

Contact

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Reports and Surveys

May 1993, Porter Dillon, *Recycling Review Report for Pictou County District Planning Commission.*

May 1994, Vaughan Engineering Associated Ltd. *Phase 1 Waste Audit Draft Report,* Northern Region, Municipality of the County of Colchester.

5 Summary Evaluation

Reasons for Success or Failure of Program

Because accessibility is not continuous, staff recognize that advertising and promotion play a critical role in the success of the program. Since 1993, daily advertising of depot locations through local radio and cable TV stations has resulted in dramatically improved capture rates. This daily advertising also indirectly acts as a constant reminder to households to separate and recycle certain materials.

While the Pictou depot program has avoided the capital expenditures that would be associated with establishing permanent drop-off sites, its success relies on people being available to drop off recyclables when the depot is visiting their area.

As with all depot programs, participation is contingent on having access to a car to transport recyclables. This tends to limit the participation of some disabled or senior citizens.

A key feature of Pictou's operation involves depot staffing. Besides ensuring that recyclables are properly sorted, staff are also available to answer any questions residents have and to advise them of changes to the program.

Significant opportunities for further program expansion are likely to be achieved only through an increase in the level of service (e.g., weekly or bi-weekly curbside collection).

R&D Needs/Commercialization Potential

Research to identify the feasibility of implementing a curbside collection program in larger towns is needed.

Replicability of the Project

This type of mobile depot system is replicable in other rural parts of Canada with large areas and a low population density, with possible modifications such as increasing public access to the depots.

Case Study 9 Burnaby Energy-From-Waste Facility, Burnaby, British Columbia

1 Abstract

The Burnaby energy-from-waste facility (EFW) is one of the most environmentally effective incinerators constructed in North America. Equipped with the most advanced air cleaning and monitoring equipment available, and with a capacity of 720 tonnes per day (tpd), the facility currently operates at 94% capacity, processing waste generated in the Greater Vancouver Regional District (GVRD). Residential waste generated from local communities is sent to the EFW, serving a population of approximately 1.1 million.

Unlike some systems, the Burnaby EFW does not compete with residential recycling programs which continue to remove recyclable materials at the curb. The facility is equipped with magnetic separators to recover metals from the waste stream. Since the GVRD owns the facility, it has avoided the problems associated with a "put or pay" contract which can hinder waste reduction and diversion programs. Facility operations are contracted to the private sector. In the case of Burnaby, removal of recyclables from the waste stream has resulted in a more homogeneous, higher quality fuel.

The capital costs associated with construction were $70 million ($1988) with annual gross operating costs of $39 per tonne. Depreciation costs have been factored in with the gross operating costs at approximately $15 per tonne. Steam produced at the facility is sold to a nearby paper remanufacturing firm, generating a revenue of approximately $3 million annually.

2 Community Description

Location

- The GVRD, with a population estimated at 1.6 million in 1991, consists of 18 district municipalities and two electoral areas.
- The Burnaby EFW is located in the district municipality of Burnaby and serves the municipalities of the North Shore, Burnaby, New Westminster, Surrey and Coquitlam with a total population of approximately 1.1 million (76% of the GVRD).

Waste Management Context

- Since 1985, five landfills in the region have been closed, leaving three operating facilities: Vancouver, Cache Creek and Port Mann landfills. (The Port Mann landfill is slated for closure in 1997.)
- The landfills are supported by six transfer stations and one energy-from-waste incinerator.
- The Burnaby EFW was constructed in 1988 to help GVRD manage its increasing waste load due to a rapid increase in the population.
- Approximately 16% of GVRD municipal solid waste was processed at the facility in 1993.
- Waste diversion targets requiring 30% waste diversion by 1995 and 50% by the year 2000 can be achieved only through progressive waste reduction and diversion programs. Over the past couple of years, emphasis has been placed on waste diversion activities.

3 Program Description

Type/Method of Recovery

- Incineration facilities typically fall into two size categories: facilities that process less than 300 tpd; and facilities that process 750 to 3000 tpd.
- A 750-tpd incinerator can typically have three separate trains, each processing 250 tpd. Beyond this, the burn module at the facility needs to be expanded or a new facility constructed.
- The Burnaby facility has three separate lines (processing 240 tpd) which take up to ten tonnes of waste an hour through the combustion chamber. (This has the advantage of allowing the incinerator to continue operating even if one line is down.)
- For every one tonne of garbage combusted, approximately three tonnes of steam are produced.
- The facility contains state-of-the-art air pollution control equipment, including fabric filters and lime injectors to solidify and remove acid gases. Carbon injection technology is used for mercury abatement and a mercury capture system to remove vapourous mercury.
- The vapourous mercury removal system is the first employed in an incinerator in North America.
- Municipalities that send their waste to the facility participate in waste diversion programs, including curbside collection programs for recyclables (which includes blue box collection), backyard composting, leaf and yard waste collection, education and promotion, material bans at landfills and municipal recycling depots.
- The EFW operates as any other landfill facility—bans and diversion programs remove unwanted wastes such as drywall, bulky objects, household hazardous wastes and batteries with varying degrees of success.
- The mass burn facility is equipped with a magnetic separator to remove metal components collected in the bottom ash after combustion for resale.

History/Progress

- In 1981, a solid waste committee was established to review the existing waste management system in the GVRD and to make recommendations for future management strategies. The Committee proposed that an energy-from-waste facility be constructed to augment the existing landfills.
- Despite the higher costs associated with incineration, the solid waste committee concluded: "Incineration, the only practical alternative now, is expensive and not economical in comparison to landfill. Nevertheless, the region, in order to prepare for the future and gain actual operating experience, should undertake a refuse incineration project with energy recovery".
- The selected proposed size of the EFW plant complemented existing technologies and allowed all incinerator systems to enter into the tender process. Each of the 15 proposals received was scrutinized by GVRD staff and two outside expert consultants. In addition, the performance and experience in North America of the final, short-listed companies became an important selection criterion.
- Three bidding companies were invited to submit detailed design proposals (with an understanding that the unsuccessful bidders would receive $100,000 at the end of the process). This was the first time a competitive process for an incinerator of this size was initiated.
- The EFW plant began operations in March 1988 and has continued to play an important role in waste management in the GVRD.

- In 1993, approximately 93% of all households in GVRD had access to some form of recycling, such as curbside collection for single-family dwellings and collection or drop-off depots for multi-family and rural dwellings. Most communities offering curbside collection accept old newspapers, mixed paper, glass, ferrous metal containers, and PET/HDPE plastic containers.

Performance/Results

- Mostly residential waste from the municipalities of the North Shore, Burnaby, Surrey, Port Moody, New Westminster, Coquitlam and Port Coquitlam is sent to the Burnaby EFW which operates near capacity (94%). In addition, some IC&I waste also is incinerated.
- Additional waste targeted for incineration would require the construction of a new incinerator or expansion of the Burnaby facility unless waste diversion activities targeting materials with low energy value, (e.g., food waste, grass clippings) are diverted upfront.
- Removal of food and yard waste could increase the heat value of the municipal solid waste by 9% (i.e., 5,578 BTU/lb.)
- Existing recycling programs have not had a noticeable effect on incinerator operations, according to the operations manager; however, it has been speculated that future programs targeting paper and organics may affect the quantity of waste available. Currently, the facility processes about 720 t per day or approximately 238,000 t of waste per year.
- The facility has a capacity to process 720 tpd of waste or approximately 240,000 t per year.
- In 1993, the facility generated 52,700 t (21%) of ash from approximately 238,000 t of waste, of which 46,000 t consisted of bottom ash (solid residue left on the bottom of the burn chamber after incineration) and 6,700 t of fly ash (solid residue created during incineration that is light and captured in the air emissions).
- Fly ash must be treated as a hazardous waste through a stabilization process. The district is experimenting with a process whereby fly ash is mixed with cement to solidify the contents in the ash, but it is not yet in use.
- GVRD uses the bottom ash as an intermediate cover at one of its landfills. Also, it is used in road construction and as a cement additive.
- Residual metals can be removed from the refuse and ash by passing each through a magnetic separator. Up to 7,900 t (3%) of metal is separated from the bottom ash each year for resale.
- On average, 248,000 t of refuse produces approximately 580,000 t of steam of which 13% (78,000) is used internally and the remainder is sold to a nearby manufacturing facility.
- Gypsum wallboard/drywall has been banned from the facility to reduce acidic gas emissions.

Ownership/Financing/Government Involvement

- GVRD owns the facility but contracts the operations to a private company (Montenay). GVRD is still involved in the management.
- The agreement in place between GVRD and Montenay obliges GVRD to provide 210,000 t of waste annually to the year 2000.
- GVRD has prohibited incineration facilities smaller that 200 kg/hr in Greater Vancouver since all incinerators must meet stringent B.C. Ministry of the Environment, Lands and Parks emission standards, and the economies of scale preclude sizes smaller than 200 kg/hr.
- GVRD has two full-time employees dedicated to the Burnaby incinerator operations.
- Collection services vary considerably among the municipal districts served by the incinerator with, for example, Burnaby and New

Westminster served by the municipality, and the North Shore and Surrey served by the private sector.

- Strict B.C. Ministry of the Environment operating regulations restrict the manner in which non-municipal waste including spent oils and fuels, is disposed of. Occasionally, material from oil or fuel spills is burned at the Burnaby incinerator.

Program Cost

- The Burnaby incinerator cost $70,000,000 in capital costs (in 1988).
- Net operating costs, including revenues from sale of steam, were $39/t (in 1993), not including depreciation costs or debt amortization.
- Depreciation over the 20-year life of the facility is $3.2 million or $15.24/t.
- The break-down of expenditures is:

Operation and maintenance	$8,900,000	(91.75%)
Ash management	$260,000	(2.68%)
Emission monitoring	$540,000	(5.57%)
Total	**$9,700,000**	**(100.00%)**
Debt amortization	$9,500,000	

Revenue from sale of steam exceeded $3 million.

- It was anticipated that, in 1995, the incinerator would need improved NO_x emissions at a cost of $180,000 annually (in $1995).
- System costs for residential waste management in 1992 include $60/t to collect residential waste and $211/t to administer, collect and process the residential 3Rs program (recycling and composting programs, source reduction and reuse campaigns) and $69/t to transport and dispose of waste in landfills or the incinerator.

Expansion Plans

- GVRD has developed a solid waste management plan that proposes a system of initiatives, including programs and facilities, to enable it to achieve 50% diversion by the year 2000.
- The plan recommends that the Burnaby incinerator continue operating at near maximum capacity to the year 2000, unless changes in environmental, financial or operational conditions warrant otherwise.
- The Burnaby facility operates near maximum capacity and cannot be readily expanded to accommodate more refuse; therefore, an increase in incinerator needs will require construction of a new incinerator.
- Recent recommendations in the GVRD solid waste management plan include:
  - greater waste diversion and composting activities for the residential and IC&I sectors;
  - bans on leaf and yard waste, white goods, bulky goods, demolition and renovation waste from the residential sector;
  - bans on recyclable OCC, wood, tires, yard waste, white goods, usable bulky goods, fibres, and construction and demolition wastes from the IC&I sectors;
  - introducing user-pay on residential wastes; and
  - requiring source separation of designated materials in the IC&I sectors.
- Changes in waste composition and quantity are expected to affect the incineration process and the potential for energy generation.

Contractional Elements

- as described earlier

4 Resources

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Reports and Surveys

- Greater Vancouver Regional District and Ministry of Environment, Lands and Parks. June 1993. *GVRD Solid Waste Management Plan—Stage 2: Technical Memorandums.* Technical Memorandum 1-7.
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- Greater Vancouver Regional District. 1993. *Waste Flow and Recycling Audit.*
- Greater Vancouver Regional District. 1992. *Solid Waste Management Plan Review: Stage 1 Report.*
- Greater Vancouver Sewerage & Drainage District. October 1985. *Greater Vancouver Regional Solid Waste Management Plan.*

5 Summary Evaluation

Lessons Learned

The Burnaby incinerator has maintained a reputation for promoting state-of-the-art pollution control technology; consequently, in 1990, the Solid Waste Association of North America formally recognized the incinerator as one of most outstanding facilities in North America by awarding the facility the Meritorious Achievement Award for Waste to Energy Excellence. The Burnaby facility also has achieved recognition for being the first incinerator in North America to develop and retrofit the facility with a vapourous mercury removal system, which has effectively reduced mercury emissions to one third of the allowable limit.

Unlike facilities in the United States, the Burnaby incinerator is owned by the regional government and tenders out the operations. In the U.S., the community typically has an obligation to provide a predetermined amount of waste or to pay for the difference. This policy can prohibit the implementation of waste reduction and recycling programs, because they divert waste from the waste stream. Since the Burnaby incinerator serves only 20% of GVRD's population, there is little concern about its operations interfering with waste diversion programs and policies.

R&D Needs/Commercialization Potential

New opportunities are being explored to stabilize fly ash in a manner that permits its use as a fill material, assuming that it passes applicable special/hazardous waste regulations. The GVRD is currently testing a portland cement stabilization method. Another new stabilization method under investigation involves vitrification. Vitrification uses high temperatures to melt the substance into a non-leachable, plasma-like substance. This German technology is not yet well known and, consequently, what little information there is has made it difficult to assess the commercial viability of the technology and to adapt it to the Canadian context.

Replicability of Project

While the incineration technology itself is well understood, new research and development initiatives continue to improve the operational efficiency and pollution control effectiveness of each new facility. There is a constant need, however, to ensure that these technological improvements remain cost-effective and competitive. Burnaby has provided a prototype for other currently approved EFWs (e.g., Peel Resource Recovery Inc. in the region of Peel, Ontario) and future facilities.

Case Study 10 Seattle Integrated Solid Waste Management System, Seattle, Washington

1 Abstract

Seattle's integrated solid waste management plan was adopted in 1989 after the closure of its two landfills caused a major reassessment of its waste management systems. The system relies on a variable can rate structure, which encourages waste reduction and recycling and covers the cost of the system. A range of services provides opportunities to divert waste from disposal. These include single-family and apartment collection of recyclables, yard waste collection and composting, backyard composting, and household hazardous waste drop-off sites. The programs are promoted extensively. Sign-up rates for recycling services are as high as 90% of eligible households, and annual recovery rates for single-family households are 350 kg per household. Other services also receive high participation rates. It is estimated that, in 1993, Seattle diverted 43% of its waste from landfill, a 70% increase over 1988.

Seattle was one of the first cities in the U.S. to offer curbside recycling services and, in 1988, set a highly ambitious goal of 60% diversion by 1998. It continues to progress toward this goal, maintaining cost-effective and innovative programs and technologies.

2 Community Description

Location

- Seattle is on the west coast of the United States with a population of 531,200 and about 254,800 households.

Waste Management Context

Solid waste is managed by Solid Waste Utility (SWU) within the city's engineering department. It must cover all its costs (except closure of the landfills) through fees charged to the public.

The program evolved when a "landfill crisis" caused extensive reassessment of waste management systems:

- The two remaining municipal landfills reached capacity in the mid-1980s (1983 and 1986).
- Rates increased significantly after closure of landfills (tipping fees tripled).
- Community hostility to the siting of landfills was rising; there were concerns about major health, safety and environmental impact issues with respect to existing landfills; particularly about emission of combustible gases and designation of sites as "Superfund". Expensive and time-consuming assessment procedures increased the controversy.
- The contract with the county landfill required development of an alternative waste management system by 1993 or being locked into the county system for 40 years.

3 Program Description

Purpose and Sectors Involved

Seattle's goal is to reduce and recycle 60% of its waste by 1998. In addition to the 24% diversion achieved through private recycling in 1988, various programs were designed to have the following additional effects on the waste stream:

- 7.8% curbside recycling to single-family through four-plex dwellings,
- 4.8% curbside collection of yard waste,
- 3.6% self-haul of yard waste,
- 9.6% additional IC&I recycling,
- 4.8% additional self-haul recycling,
- 2.4% apartment recycling,
- 1.0% waste reduction, and
- 2.0% backyard composting.

Type/Method of Recovery

Variable Volume Rate Structure for Garbage Collection

- Residents pay a fee for garbage collection based on the size and number of containers set out (cost-based system sets price for all garbage cans based on cost of service).
- There is a schedule of rates to meet residents' needs (9/1/94):
  - micro-can (12 gal.) $13.07/month,
  - mini-can (20 gal.) $16.04/month,
  - can (32 gal.) $20.89/month,
  - each additional can $20.89/month, and
  - a flat extra bag rate.
- A backyard service (collection from backyard) is provided at a higher rate.

Curbside Collection of Recyclable Materials

- The curbside recyclables program is voluntary; residents sign up to receive service at no extra charge.
- The program collects ONP, mixed waste paper, tin and aluminum cans, glass bottles and jars, and PET and HDPE bottles (ferrous, PET and HDPE containers added later).
- There are two distinct programs:
  - In the south, residents setout materials monthly in 90-gal. roll-out carts, and glass is segregated into a bin inserted in the cart. Materials are collected in standard 20 yd^3 rear-loading packers.
  - In the north, residents set out materials weekly in three stackable bins: one for ONP, one for mixed paper and one for mixed containers. Specialized recycling trucks are used.

Multi-family Recycling

- Two arrangements exist to cover multi-family residential buildings: a diversion credit program for private haulers and a more structured contractual arrangement.
- Under the diversion credit program, a hauler can collect any materials, by any system, from buildings throughout the city and be paid a diversion credit per tonne diverted by the utility. There are three geographically specific contracts.
- There are two other contracts, one in the northern part of the city and the other covering a less dense, more diverse area in the southern part of the city. The same materials are collected as in the curbside recycling program. In most buildings, residents take recyclables to a central area where they are commingled in carts, except for glass, which is segregated.

Clean Green Program

- In the southern third of the city, one contractor collects yard waste bi-weekly on the same day as garbage (monthly from December through February).
- In the northern two thirds of the city, another contractor collects yard waste on a weekly basis (March through October), monthly (January and February) and twice in December.
- Both contractors use 20 yd^3 packer trucks.
- Initially, all residents were placed on the subscription list allowing collection of five 27-kg bundles per week; residents had to opt out with a sign-up card. The rate became $5.53/month as of 9/1/94.

- Any container up to 32 gal. can be used, including plastic bags, but plastic bags are now emptied at the truck.
- Residents may take yard waste to a drop-off station paying $8.45 per load (9/1/94). IC&I generators pay $98.24 per tonne (9/1/94). Self-haulers cannot drop off waste in plastic bags; plastic bags must be emptied.

Backyard Composting

- Composters are distributed free to householders who sign up for the program. Home visits were made for the first composters distributed, but now householders are asked after the bin is delivered whether they would like a visit.
- Approximately 35% of households take advantage of this service.
- Approximately 30,000 composters had been distributed by the middle of 1994.
- Seattle composter bins for yard waste come in two sizes, 12 and 21 ft^3 They were designed for durability, ease of use, recycled content and rat resistance.
- Five community composting sites are maintained for demonstration.
- A composting hotline is maintained 35 hours/week to answer questions on composting and to take orders for bins.
- Volunteers in the "Master Composter" program, after receiving 60 hours of training on community composting, perform at least 40 hours of community outreach work (i.e., workshops, presentations, and information booths).

Household Hazardous Waste

- The first permanent facility opened in 1988 and a second opened in 1993.
- Each facility is open three days per week (different days) throughout the year. They accept virtually all household hazardous waste.
- Waste materials are segregated according to hazard class (about 20 categories).
- There are 7 city-funded and 20 private establishments for returning used motor oil for reprocessing. Similarly, there are point-of-sale return centres for car batteries.

Waste Reduction

- The utility targets the residential sector with programs to reduce both solid and hazardous waste. These include:
  - "Shop Smart": a retail- and schools-based education program on packaging waste.
  - "Use It Again Seattle!": a free repair, rental and used-goods services booklet.
  - The Environmental Allowance Program: a grants program soliciting waste reduction ideas from the community.
  - Green Cleaning kits: sales kits of non-toxic household cleaning alternatives.
  - Green Gardening Program: an educational program about alternatives to garden pesticides.

Promotion/Education

- There is regular communication with customers to reinforce and to improve waste recycling and waste-handling behaviour and to reduce collection problems:
  - The "Curb Waste Times" newsletter, published in the spring and autumn, focusses on preparation and collection issues and new information.
  - Collectors and inspectors leave contamination notices at "guilty" residences.
  - Calendars remind customers of collection days.
  - Bill inserts update customers on new information.
  - The Friends of Recycling (a network of community-based volunteers) staff information booths at community events.

- Basic information is translated into the major languages spoken by customers.
- Regular market research is conducted to assess customer understanding and satisfaction with programs.

The Recycling Potential Assessment Model

- A repetitive model—the recycling potential assessment (RPA) model— was designed for initial development of the waste management plan, and for on-going planning and monitoring. It has four modules:
  - A **Waste Generation module** forecasts waste generation for 20 years based on historic data and several variables including income, household size, employment levels and disposal rates. Waste streams are characterized, by composition and generation rate, separately according to household types and IC&I sectors.
  - The **Recycling module** analyzes effectiveness (diversion) of recycling programs, both private and municipal, based on variables including materials collected, sectors included, participation and capture rates. It has the capacity to ramp these rates to reflect program evolution.
  - The **Recycling Cost module** calculates the total waste-management system cost, based on detailed cost assumptions, materials pricing forecasts and contract arrangements.
  - The **Cost/Benefit module** compares diversion system price to the cost of disposal options and determines rates which meet the utility's revenue needs.

History/Progress

- Seattle has had a volume-based rate system for some time but, with the closure of landfills and the use of the county landfill, rates rose significantly.
- In October 1988, the city adopted an ordinance requiring separation of yard waste from garbage for curbside collection, backyard composting and drop-off.
- Container delivery and collection of recyclables began in February 1988.
- The Integrated Solid Waste Management Plan was adopted in 1989.
- Rates were increased in 1989 to offset increased costs and to encourage recycling. The one-can rate marginally increased, while the additional can rate increased significantly.

Performance/Results

- Seattle's overall recycling rate was approximately 43% in 1993. The goal for 1998 is 60% of total generation; for 1993 it was 50%.

Recycling rates for Seattle in 1993 and goals for 1998

	1998 Goal	1993 Actual
Curbside recycling	7.8%	7.1%
Curbside yard waste	4.8%	5.2% (exceeded goal)
Self-haul yard waste	3.6%	1.8%
Apartment recycling	2.4%	0.5%
Backyard composting	2.0%	0.5%
Self-haul recycling	4.8%	0.7%
Waste reduction	1.0%	no data
Private recycling (non-city sponsored) (primarily IC&I; 24% in 1988)	33.6%	27.0%
TOTAL	**60.0%**	**42.8%**

- In 1988, 60% of single-family households subscribed to a one-can garbage collection service and 39% to a two-can service. By 1991, 25% subscribed to a mini-can service, 64% to a one-can service and only 11% for two or more cans. In 1993, 4% had signed up for the micro-can service, while 26% subscribed to the mini-can service, 62% to the one-can service, and 8% for two or more cans.
- Sign-ups for the commingled program in the south were 82.9% of 78,500 eligible households by the end of 1993. For the source-separated program in the north, sign-ups were at 97.1% of 70,000 eligible households (citywide: 89.6%).
- Recovery in the commingled program in 1993 was 330 kg/hhld/year (participating), totalling approximately 22,000 t/year. In the source-separated program, recovery in 1993 was 370 kg/hhld/year, totalling approximately 25,000 t/year (citywide: 350 kg/hhld/year, totalling over 45,000 t in 1993). Contamination was approximately 2.8%. The higher recovery rate in the source-separated program may be due to collection frequency, container size, demographic characteristics (income and stage of life).
- Local markets are available for steel and glass containers. Pulp mills with de-inking capacity have provided a market for newsprint and OCC. The market for mixed paper in the Pacific Rim was originally strong but is now weak due to surplus supply. The PET market has not been as attractive since price support from Johnson Controls was removed at the beginning of 1994. High transport costs are incurred: Most PET is shipped to the Pacific Rim, which is a better market than the midwestern United States.
- By the end of 1993, 70% of apartment units had a recycling service, and approximately 3,500 t were recycled.
- By the end of 1989, 61% of eligible households (including multi-family) had subscribed for curbside collection of yard waste, increasing to 66% in 1990 (93,800 accounts) and 62% by the end of 1993. The curbside program diverted 34,500 t in 1990 while the depot program diverted 13,000 t. In 1988, yard waste was found to be 17.1% of waste stream disposed of. In 1990, it had fallen to 2.8% and by the end of 1993 to 2.2%.
- Compost is marketed in bulk, throughout the county, 4 to 5% as bagged plant soil mixed with 25% bark dust.
- Approximately 30,000 composters had been distributed by 1994. An estimated 2,500 t of yard waste was composted.

- In 1993, household hazardous waste facilities served over 10,000 customers. Approximately 720 t of motor oil was recovered. Approximately 50% of waste (excluding motor oil) is latex paint and another 40% is flammable materials. Materials with high energy value are used as fuel in a kiln, while other wastes which cannot be reprocessed are disposed of in appropriate facilities.
- Commercial sector recycling increased to 45% in 1993 as compared to 39% in 1988 due largely to the greater availability of services provided by the private sector.
- Two initiatives have proved unfeasible: "dump and pick", involving the self-haul of recyclable-rich garbage for sorting at transfer stations; and private collection of recyclable-rich garbage from IC&I sector for mechanical sorting.

Ownership/Financing/ Government Involvement

- SWU covers the cost of all activities— collection, processing, disposal and administration— through rates charged for services. (Rates do not include the full cost of previous landfill closure.)

Program Cost

- Payments made to the contractors for curbside collection of recyclables in 1993 amounted to an average of $133.79/t: $135.13 for the commingled program and $132.37/t for the source-separated program. (The contract for the south was renewed in early 1993, resulting in increased costs.)
- Payments made to contractors for the Diversion Credit Apartment Recycling program amounted to an average of $132.09/t in 1993, ranging from $108.65/t to $134.43/t depending on the contractor. For the apartment contracts, payments amounted to an average of $180.65/t: $161.40/t in the denser northern part of the city, and $222.76/t in the more diverse southern part of the city. For all apartment recycling, the over-all cost was $135.02/t.
- There are two contracts for yard waste handling: one for the northern area allots $80.59/t for collection and hauling to transfer station. The city pays an additional $35.86/t to haul to the processing facility and a $18.26/t processing fee. The one for the southern area allots $120.53/t for collection and processing.
- Seattle Composters cost $53.30 and $48.10 for the 21- and 12 ft^3 sizes respectively. Bin delivery costs $5.20 each, contracted to a private firm. The average cost of the backyard composting program is $97.83/t.
- The household hazardous waste (HHW) depot capital cost (design and construction) was $325,000; the operating cost in 1990 was $325,000. A second facility capital cost was projected to be $520,000. (Higher costs are due to design improvements, increased drainage and permit requirements and lengthy siting process.) The operating budget for the two facilities in 1993 was $1.24 million, and the over-all budget for the HHW program was $1.82 million.
- The utility spends approximately $1 to $3 per household per year for promoting each of three major programs: curbside, apartment and yard. The 1993 budget was $880,000 for advertising, recruitment, communications, recognition events and three full-time staff.

Problems/ Modifications

General

- Seattle experienced increases in illegal dumping when rates were increased significantly in 1989. The city passed an illegal dumping ordinance and maintains monitoring and enforcement staff as well as mounts an education campaign. The problem appears to be under control.

- Private recycling firms have lost business. As compensation, private recyclers who show they divert additional materials from the waste stream have been provided grants, diversion credits, publicity and equipment. A full 63% of recycling collection was performed by private companies.

Customer Service

- With all the changes made to the program, inquiries initially were overwhelming. ("The phone system in the city was shut down twice".) Planning is now co-ordinated between program, promotion and customer service staff.

Recyclables Collection

- Compacting commingled recyclables caused increased contamination of paper with glass. The commingled program was modified slightly by providing an insert container for glass, which is then sorted separately at the truck. Breakage during collection (20 to 30%) also limited colour sorting at the plant in the source-separated program. A new system has been installed to improve sorting results.

Yard Waste

- Initially there was high contamination of yard waste with garbage. Monitors were hired by the city, and an inspector was hired at the processing facility. Drivers delivering contaminated loads were reported to the city and to their employers to encourage better screening. Additional promotion/education was conducted, primarily with flyers. The problem has been reduced significantly.

- The use of plastic bags for yard waste has been problematic. Plastic bags are now banned in the area where the processing facility is located. Rather than also banning the use of bags, risking confusion and non-participation, the city has agreed, for the remainder of the current contract, to pay the hauler an additional fee to cover the cost of debagging material at the truck. The city also is encouraging people to use other containers.

- The city had in its contract an option to have non-subscriber use of service monitored, but instead it proved cheaper to hire monitors, for a seven-week period. One thousand additional subscriptions were obtained.

Household Hazardous Waste

- Household hazardous waste (HHW) events were discontinued between 1985 and 1989, despite high turnout, because of the high costs and management time required and long waiting lines. It was decided that permanent depots were required. Since HHW involves a large number of containers and a diverse range of materials, collection is very labour intensive. The city is seeking more efficient ways of packaging and storing to reduce costs. Disposal costs are very high ($182,000 for 118 t in 1990). Permit requirements are numerous. Contamination with unidentifiable materials is a problem, but the utility has established procedures for on-site testing in a lab and has increased education efforts.

Apartment Recycling

- The apartment recycling program has had a slow start due to difficulty in negotiating citywide contracts. Currently, the apartment recycling programs, by themselves, are not cost-effective. Apartment recovery rates tend to be lower than for single-family curbside collection.

Expansion Plans

- A range of options being analyzed for possible implementation addresses some of the existing limitations and identified opportunities. It includes:
  - Review city garbage contracts to increase efficiencies, including considering collection frequency and co-collection of different streams.

- Review commercial garbage structures and rates.
- Evaluate backyard composting of food waste and a grasscycling pilot.
- Consider appropriate OCC recovery levels from all sectors, and design a promotion campaign and/or mandatory source separation policy.
- Study food waste stream and consider and recommend options for its recovery.
- Consider and recommend options for a self-haul processing facility.
- Evaluate relative cost-effectiveness of including small businesses in curbside collection routes with drop boxes for OCC, high-grade paper, and aluminum.
- Market development initiatives including grants program for testing new products and applications as well as for performing research on in-city applications for low-value materials such as glass and mixed paper.
- Research C&D stream and technical assistance to C&D waste generators to explore options for increased C&D recycling, including provision of diversion credits toward specific materials.
- Do a neighbourhood-by-neighbourhood education "immersion" campaign.

- There is interest in a possible weight-based rate structure if the technology is proven. Seattle has been involved in testing technology for such a system. While the potential for the technology has been shown, it is not expected to replace volume-based systems.

Contractual Elements

- The contract for garbage collection was made dependent on the quantities collected in order to provide savings from recycling.
- SWU wanted more than one contractor to ensure competition. For recyclables collection the city was divided into four areas, and it was stipulated that no contractor could have more than two areas. Contracts are for five years and include provision of containers, processing and marketing materials. The city pays on a per-ton basis (escalating at 80% of Consumer Price Index [CPI]); contracts originally had a market risk sharing arrangement by which the city and contractor shared equally gains and losses when the market price of a material varied by more than 20% from a pre-set base price. In the new contracts the city bears all risks for the curbside program.
- Contracts for multi-family collection and for yard waste collection were made on a similar basis with the objective of ensuring competition. Under these programs building owners pay a subscription fee and the contractor is paid on a per-ton basis. Under the diversion credit program, haulers are paid on a per-ton basis for materials recovered.

4 Resources

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5 Summary Evaluation

Reasons for Success or Failure of Program

- A significant correlation has been measured between rates and waste disposal—a drop of between 0.4% and 0.7% for each 1% increase in rates. However, it is generally accepted that to effectively encourage recycling, convenient service options are required to complement rate incentives.
- There is significant uncertainty about the effect of implementing new rate structures and rate levels and how this will affect revenues for programs—what level will effectively encourage recycling, what level will be regarded as punitive, what complementary services need to be provided. The RPA model has been very useful in planning.
- Given the high initial subscription rate (80 to 90%), it would have been more efficient to distribute to everybody rather than requiring people to subscribe to the service. Also, on-going sign-up and delivery of containers proved expensive and inefficient, as delivery was made repeatedly to a given area and requests for information were on-going. Scheduled universal delivery may have been more efficient and effective, and marginally interested residents may have been encouraged to sign up.
- Administration of variable can rates has required additional staff and resources for billing and customer services (e.g., public information, administrative and technical planning staff). Phasing in changes and scheduling distribution of containers could reduce the initial requirements.
- Focus groups found a very high willingness to recycle but that it was necessary to keep programs simple and convenient. It is important to pay attention to details (e.g., type of container, size, shape, colour, protection from animals). People are responsive to what neighbours are doing, so visibility is a key.
- Fluctuations in load cause some households, even entire areas, to be missed when trucks don't have time to complete routes. Requirements have been built into new contracts to provide certain make-up services.

The success of the programs is attributed to a combination of three main elements: the variable can rate incentive, the range of convenient services available, and extensive promotion and education.

- The approach does not provide for significant diversion of food waste (except for small amounts that are diverted through some home composting). The utility is considering ways of collecting and processing food waste.
- While the city has the authority to manage the IC&I waste stream, it has limited its services primarily to the residential waste stream. Information, limited technical support and some education campaigns have been provided for the IC&I sector.
- Currently there is no program for effectively recycling self-haul waste. "Dump and pick" has been determined to be unfeasible, and drop boxes at transfer stations capture only about 12% of the self-haul waste stream.
- Externalities have not been incorporated into the RPA model and therefore are not systematically considered in cost/benefit analyses.
- The 60% diversion goal does not include the C&D stream, and flow control regulations are such that wood and C&D material have been shifting out of the municipal waste stream and are not being targetted by the city's programs.

R&D Needs/Commercialization Potential

- The Recycling Potential Assessment Model has been a key element in the development and implementation of Seattle's integrated waste management system. Such planning tools may have significant potential in the development and implementation of waste management systems in other jurisdictions and contexts.
- There is a need for development and application of technology to assess residents' waste set-out on a weight basis so that diversion is increased. Seattle's experience has been that, with the volume-based rates, the volume of materials set out has been reduced to a greater extent than weight of materials set out.
- Methods to collect and divert food waste which are complementary to the existing system and build on the existing willingness to participate are required.
- More information would be useful on how the Recycling Potential Assessment Model is employed and what its capacity is for assessing the relationship between diversion, rates and revenues for planning purposes.
- Needing to make an appointment to deliver HHW material to depots may discourage diversion. It has been noted that the size of loads and the amount of garbage received at the HHW facility that requires appointments (north) is generally less than for the other (south).
- The most significant element of the program is the combination of the variable volume rate structure and the provision of convenient services for diversion of materials. Further development of waste management systems likely could draw from the considerable experience gained in establishing such a system.

Replicability of the Project

There are many urban settings in Canada comparable to Seattle and in which similar integrated systems based on a rate incentive might be established. However, Canada has less experience than the United States with solid waste management user fees. Moreover, in many Canadian jurisdictions, recycling programs have been established for some time. The effect of introducing user-pay systems in large urban areas with developed recycling systems—the willingness to pay, appropriate rate levels, how revenues would be applied to finance these systems—is uncertain.

Case Study 11 Blue Box 2000, Centre and South Hastings, Ontario

1 Abstract

Blue Box 2000 is the name of a waste management system established in Centre and South Hastings in November 1991. It evolved from the conventional blue box program by greatly expanding the range of dry materials collected and by incorporating components to handle other elements of the waste stream including household hazardous waste and household organics. The program relies on extensive source separation, high participation, and conventional and inexpensive processing technologies to gain high diversion and cost efficiency. It invests heavily in promotion and education, technical assistance and support for diversion initiatives, and source separation and collection operations. Currently the program provides services to 39,000 households and over 1,000 IC&I establishments. It has achieved an estimated diversion rate of greater than 40% at an estimated net cost of approximately $126 t (before grants and subsidies) or $23 per household per year.

2 Community Description

Location

Located in southeastern Ontario, the Centre and South Hastings region is a mixed urban, village and rural area with a population of 95,000. Belleville, Trenton and Sidney Township are the major urban centres and represent over 70% of the population. The Centre and South Hastings Waste Management Board covers 15 municipalities comprising approximately 21,000 urban households, 4,500 apartments and 13,300 rural households. Neighbouring municipalities include another 20,000 predominantly rural households.

Waste Management Context

Belleville, Trenton and Sydney Township export their waste to a private landfill with a tipping fee of approximately $100 t. The smaller communities are served by nine smaller landfills. For many municipalities, motivation for participation in the program was due in part to the requirement for a new landfill and the high cost of existing disposal. The waste management planning process, which has endorsed a diversion target of 71% by the year 2000, was another factor.

3 Program Description

Purpose and Sectors Involved

- The program is based on the concept that diversion and revenues are maximized and overall costs can be minimized when materials are segregated at source by waste generators, thereby requiring less sophisticated (i.e., inexpensive) processing methods and increasing marketability by reducing contamination.
- To achieve significant diversion rates and to increase efficiency, high levels of effective participation are encouraged by providing services to all household types as well as the IC&I sector, and by expanding the list of materials managed by the program. It now covers most readily recyclable materials as well as household organics and household hazardous waste.

Type/Method of Recovery

Curbside and Depot Collection of Recyclables

- Materials collected include mixed household paper, magazines, boxboard, OCC, textiles,

many plastics (including polyethylene/ terephthalate, high deinsity polyethylene, poly vinyl chloride, polystyrene, "tubs" and film plastic), steel and aluminum containers, aluminum foil and trays, and glass containers.

- For weekly curbside collection, the public is asked to set materials out in six groupings around the blue box (12- to 16-gal.). Collection staff sort materials into seven compartments.
- Ten trucks (Labrie top-loading, one compartment modified for coloured glass) are used to collect recyclables from 35,000 single-family households and three rural drop-off depots.
- Reusable poly-weave bags are used to line depot carts and are removed to storage when full.

Extensive Backyard Composting

- Backyard composting is promoted by distributing composters either at no charge or at a subsidized cost (depending on the type of composter) along with significant promotion and personal contact with residents.
- Composters were distributed through an extensive door-to-door campaign and through depots (ten minutes per household was allocated for initial distribution).
- A range of composter designs and sizes was made available to meet the residents' needs.
- Organization of promotion and distribution was encouraged at the community level to achieve an intensive campaign and to ensure appropriate design of delivery.
- A hotline service and volunteer support have been provided, backed up with newsletters, newspaper articles, television programs and videos (particularly during the launch phase).

Household Hazardous Waste

- A permanent depot was established and 12 satellite depots served by a "toxic taxi" have been established; 20 events (collection days) were held in 1993.
- The focus at the permanent depots is reuse and recycling rather than simply disposal.
- Public education on alternative products and existing point-of-sale return programs (car batteries, propane tanks, paint and used motor oil) is provided.

Office of Waste Reduction

- This component provides information and support to all sectors and identifies and co-ordinates activities focusing on reduction and reuse.
- Activities include:
  - newspaper articles and cable television programs;
  - waste reduction guides for specific sectors (e.g., offices, schools, manufacturing facilities) detailing local resources, programs and ideas on how to implement programs;
  - establishing a reuse centre, which has significantly increased diversion in the local municipalities due to staff presence, convenience and high profile of centre; and
  - producing a reuse directory.

Industrial, Commercial and Institutional Programs

- Although not the mandate of the board, businesses are encouraged to participate in blue box collection, over 1,000 participate. Many businesses also have their recyclable materials brought to the processing facility, which charges a $22/t tipping fee for quantities over 1000 lbs (approx 0.5 t).

- Seminars are conducted for businesses and institutions, although they have not been well attended.
- A waste exchange service has been provided, with some successful matches to date.
- Waste audit guides have been produced, and advisory services are offered to businesses and institutions.
- Due to the increasing value of recyclables (especially paper fibres), the recycling board provides rebates to IC&I haulers according to a pricing formula based on tonnage and material type. The formula ensures that processing costs are covered, and a variable percentage of the revenue is returned to the recycling board.

History/Progress

- The Centre and South Hastings Waste Management Board was established in September 1989 to implement 3Rs activities.
- In September 1990, the *Blue Box Plus!* demonstration program was launched to gain information on expanding existing recycling programs to include mixed plastics, OCC and boxboard. The program ran for a year, testing collection and processing methods and markets for these materials.
- In November 1991, the *Blue Box 2000* program was launched, expanding the demonstration to include additional plastics, fibres, aluminum foil and trays, and textiles and to promote other waste reduction initiatives such as backyard composting. (The *Yes In My Backyard* [YIMBY] program was launched in the spring of 1992). A household hazardous waste program was launched in 1993 which includes a permanent depot and satellite events. The goal is to meet or to exceed provincial guidelines of 50% diversion of the residential waste stream.
- In each phase, the public has shown a willingness to participate in such programs, and diversion tonnage has increased significantly while per-tonne costs have been reduced.
- The board has produced several reports and actively encourages municipalities, operators and industry to visit its facilities and to learn about 3Rs programs and opportunities.
- Centre and South Hastings had the first program in Ontario to add empty aerosol and paint cans to the blue box (in June 1994).

Performance/Results

Curbside and Depot Collection of Recyclables

- Recovery of blue box materials reached an average for all municipalities (curbside and depot) of 147 kg/hhld/yr under the *Blue Box Plus* program in 1991 and an average of 175 kg/hhld/yr under the *Blue Box 2000* program in 1992. Curbside recovery ranged from 191 kg/hhld/yr for all participating municipalities to 205 kg/hhld/yr for urban curbside collection (no depots). ONP makes up approximately 77 kg/hhld/yr.
- Under a user-pay program in Sidney Township, recovery has reached 257 kg/hhld/yr.
- Capture rates for blue box materials (measured through waste composition studies) increased significantly as the programs matured. They are summarized in the following table.

Capture Rates Measured in Centre and South Hastings

Material	1991	1992	1993	1994*
Conventional blue box materials	71%	79%	80%	93%
All materials *Blue Box Plus*	62%	71%	—	—
All materials *Blue Box 2000*	—	62%	63%	83%

*Capture rates for Sidney Township (population 17,000), under a user-pay system.

- Based on five waste composition studies, dry recyclables recovered represent approximately 21% of the total residential stream (not including organics diverted through backyard composters) with a potential recovery of 36%.
- Participation in curbside recycling was measured at 84% in 1992 and reached 91% in 1993, with weekly set-out rates averaging between 58% and 62%.
- Additional trucks (from 6 to 10) were required to accommodate increased separation and collection time due to the greater number of compartments in the truck, higher set-out rates, and greater volume per set-out.

Backyard Composting

- 17,600 composters were delivered door-to-door and through depots over a three-month period in 1992, increasing participation from an estimated 25-30% to an estimated 65 - 70%. Approximately 85% of the composters were delivered door-to-door.
- Based on a survey which included inspections of composters, an estimated 82% of the composters are being used properly, suggesting an effective participation rate of 53% of households (at 65% distribution). Another 24% of householders expressed a willingness to compost but require further support; they either were not using their composters effectively or were willing to try but had not received a composter.

Household Hazardous Waste

- A total of 2,730 households participated in HHW events in 1993.
- Approximately 50% to 60% of the paint, and most of the stains, varnishes and solvents collected are reused, while an estimated 45% of material is sent for disposal.

Industrial, Commercial and Institutional Programs

- About one-third of materials handled at the processing facility are from the IC&I sector. Most are brought to the facility from large generators or haulers.
- In the first six months of 1993, monthly tonnage received averaged 270 t, with a net revenue of $8,483 or $31.43/t.

Markets

- Markets are very strong with increases in revenue in the areas of aluminum, fibres and rigid plastics. There is now revenue for plastic tubs where previously there was none. Film plastic is one of the few markets that remains weak.

Ownership/Financing/Government Involvement

- The Centre and South Hastings Waste Management Board was established in September 1989 to implement 3Rs activities. Reporting to the Centre and South Hastings Waste Management Plan Steering Committee and the 15 municipal councils which signed the agreement, the board

Curbside Collection and Depot Costs in Centre and South Hastings

	1991	1992	1993
Material recovered (tonnes)	5,088	6,828	7,200
Number of households served	33,500	39,000	39,000
Contractor (collection and processing)	$937,344	$1,131,216	$1,263,924
Revenues (material sales)	$201,216	$222,180	$354,875
Net cost ($/yr)	$736,128	$909,036	$909,049
Unit cost ($/tonne)	$145	$133	$126
Unit cost ($/hhld/yr)	$22	$23	$23

oversees the contract for collection, processing and marketing of recyclables, and is responsible for promotion, education and support for 3Rs initiatives.

- The municipalities own the collection equipment and processing facility.
- Other municipalities may join the program by paying a fee representing a share of the initial capital cost (though no equity is gained) and by covering a share of the operating expenses (based on number of households).
- Costs are assessed to Centre and South Hastings participating municipalities in two ways: Collection is assessed on *Blue Box Equivalents* for various types of collection points (single-family, various multi-family, business, various institutional); processing is assessed on a municipality wealth assessment (tax base).
- Outside municipalities are assessed for processing costs based on Blue Box Equivalents, and they arrange independently for collection.
- The Ontario Ministry of Environment and Energy has sponsored the program through the Municipal Recycling Support Program (MRSP) and provided a one-year demonstration grant to cover incremental capital and operating costs for the program.

Program Cost

- Costs for curbside collection and depots in Centre and South Hastings (net revenue, before grants and subsidies, not including municipal overheads, capital investment and depreciation) are shown in the above table.

The decrease in unit cost from 1992 to 1993 is largely due to increased revenues. If municipal overheads and capital were included, the costs would be greater by approximately $45/t. If IC&I tonnages and revenues were included, the costs would be lowered by approximately $8 t.

- In 1993, the entire program had a net cost of $1.51 million (including IC&I tonnages) and an estimated diversion of 16,545 t from all activities, resulting in a diversion cost of $91.31/t net of revenue.
- The cost of the backyard composting program (over 10 years) is estimated as:

24,000 composters	$720,000
Distribution	$180,000
Promotion	$36,000
Compost office	$230,000
Total	$1,166,000

- The estimated cost per tonne diverted (over 10 years) is between $22.60 and $36.81 (based on an estimated range of 132 to 215 kg/hhld/yr diverted by all composters). This represents an estimated saving of between $102 and $197 per composter (based on an

approximate landfill cost of $114/t) resulting in a 2.5-year payback. This compares favourably with garbage collection and disposal costs in the area, which are as high as $176/t.

Problems/Modifications

- Sorting times for some materials at the Material Recovery Facility (MRF) have improved. For example, the sorting time for boxboard was improved from 16.5 hr/t with a positive sort to 5 hr/t with a negative sort.
- Seminars for businesses and institutions were not well attended despite considerable publicity. Something of specific interest to IC&I establishments is required to encourage their attendance. It is necessary to provide information applicable to specific establishments: "Offices don't want to hear what manufacturing plants can do, and small businesses do not want to hear about setting up recycling teams to do six-month waste audits." A full 60% of businesses surveyed had not established any 3Rs activities beyond participating in the curbside blue box collection; 67% of businesses generating OCC do not recycle it. It was suggested that encouraging and facilitating inter-business networking to discuss problems and potential solutions may be more effective.
- The waste exchange has arranged some successful matches, but local IC&I activity is not sufficient to support a comprehensive, efficient program. A private C&D reuse initiative failed, since most commercial C&D waste generators were already conducting their own reuse activities; only residential waste was brought in, which could not support the effort.
- An overall diversion rate has not been reliably established. Comparing 1993 disposal rates with 1989 rates that exist indicates a diversion rate 26% lower than expected. If quantities captured in the blue box are compared with total quantities generated (measured during waste composition studies), the diversion rate is in the range of 30 to 46%. Higher yard waste generation, and a "take-all" contract which did not exist at the time of the baseline year, may account for the discrepancy.
- Tubs have not been successfully marketed; manual identification and sorting into various resin types is not economically feasible given the demand for the materials. Further testing for end-uses of mixed plastics is required. Additional market development is required for other materials also, particularly as recovery rates increase.
- Storage space in the facility has been a major concern, causing inefficient use of processing labour. Some materials are stored outside or in inconvenient areas. This can be a disadvantage of expanding an existing infrastructure.

Expansion Plans

- A user-pay demonstration program was carried out in Sidney Township. This demonstration showed promising results for significantly increasing diversion (63% for the first six months).
- Establishing a point-of-sale return program for HHW materials will be encouraged, though this would require a significant amount of effort.
- HHW service to small-quantity IC&I generators on a fee-for-service basis that benefits both the municipality and generators will be considered.

Contractual Elements

- The contract for collection, processing, and marketing recyclables, for maintenance of equipment, and for operating an information hotline is awarded to the private sector (HGC holds the current contract). When the contract is renewed, disposal costs will be the responsibility of the contractor, to encourage lower contamination.

- A fixed price is received for a specified number of households served (boxes collected), with a surcharge for additional numbers served. A fixed price is received for processing (on a per-tonne basis) with a surcharge for additional quantities processed. This kind of contract is considered mutually beneficial to contractor and municipalities. Increased participation and diversion is encouraged by the prospect of increased revenues for the contractor at a cost lower than the basic unit cost, while the unit costs are lower for the municipalities.
- The municipalities receive the revenues from the sale of secondary materials.

4 Resources

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5 Summary Evaluation

Reasons for Success or Failure of Program

Program success is largely because of the following elements:

- It made a significant investment in promotion and education and in providing technical assistance and support, including door-to-door contact with residents.
- It provides a range of services addressing different waste characteristics and differing needs among sectors. This also provides reinforcement of the program's public image and allows for the distribution of costs over the entire program.
- Exploiting a number of conventional waste diversion activities in a comprehensive program can achieve high diversion rates (potentially greater than 40 to 60% with user-pay).
- Conventional and relatively unsophisticated technology can be used. Existing infrastructure may need only minor modification when a conventional recycling program is expanded.
- Residents are willing to participate in source separation, sorting of recyclable materials and composting.
- Manufacturers and potential end-users of new recyclables must work with municipal recycling programs to develop viable markets.
- Some elements of a program may be expensive when compared to disposal (e.g., HHW collection) while others will be significantly less

expensive (e.g., backyard composting). The comprehensive program can be cheaper than collection and disposal of garbage.

- Adding materials to the program and increasing participation can contribute to economies of scale, lowering unit costs.
- Participation and capture rates increase with time given sufficient promotion and regulatory measures such as bag limits, material bans and user-pay.

R&D Needs/Commercialization Potential

- The effect of a user-pay system on diversion and program cost, currently underway in Sidney Township, is a logical extension of the program. Depending on the results, further analysis and R&D may be required.
- There is a need to investigate how processing costs are affected by the degree of source separation: Is there a significant reduction in processing costs due to pre-collection sorting, and is it greater than the increase in collection costs?
- Further market development is required for many materials such as mixed plastics (e.g., "tubs"), film plastics, some fibres (e.g., boxboard).
- Additional work should be undertaken with the IC&I sector to enhance participation and contribution to waste diversion.
- Replicability of expanding a blue box program and incorporating other elements, including extensive backyard composting in a large urban, multi-ethnic context, should be studied.
- Virtually all of the technology used in the program is conventional and has little new commercial potential by itself. However, the documentation and planning experience accumulated is of value for technical assistance to other jurisdictions. The results of the user-pay demonstration will add to this significantly.

Replicability of the Project

Centre and South Hastings is a mixed urban, village, and rural area, similar demographically to many areas in Canada. A key element of the program—its reliance on conventional and unsophisticated technology—makes it potentially attractive to and appropriate for replication in many other jurisdictions. Limited market potential for some materials may make it unfeasible to collect them in some jurisdictions.

Case Study 12 Expanded Recyclables, Drummondville, Quebec

1 Abstract

Drummondville is a small city in Quebec which has implemented a garbage and recyclables collection system based on the use of roll-out carts. The collection of recyclables in carts (rather than blue boxes) is a relatively unique approach in Canada. The new cart system was phased in first for garbage collection, then for recyclables. A wide range of recyclables (18 materials including an extensive range of fibres) is collected and commingled in a single roll-out cart. The recyclables are sent to a local non-profit processing centre which sorts and bales materials for market. The program has achieved a high rate of participation (observed only), indicating overall community support. However, the waste diversion achievements have been relatively modest.

2 Community Description

Location

Drummondville is located approximately one hour east of Montreal with a population of 43,171 and approximately 20,370 households. Approximately 65% of the population lives in multi-family dwellings (i.e., more than one household/building).

Waste Management Context

Landfill tipping fees have increased the opportunity for cost savings through diversion. The local landfill is owned by Waste Management Inc., and the tip fee is currently set at $22.40/t.

Local environmental groups lobbied the city to provide pick-up services for recyclables.

3 Program Description

Purpose and Sectors Involved

- Recyclables collection is provided for the residential sector only.
- A needs assessment is currently under way to determine how to integrate some types of IC&I waste (especially paper and cardboard) into the recycling system over the next three years.

Type/Method of Recovery

An expanded range of recyclable materials is collected and commingled in the roll-out carts. The materals collected include:

Fibres: ONP, fine paper, envelopes, books, magazines, flyers, telephone directories, kraft bags, OCC, boxboard, egg cartons. Wax paper linings must be removed from boxes.

Containers: clear- and coloured glass-food and beverage containers, PET, HDPE and ferrous and non-ferrous metal food and beverage containers.

Other materials: clean aluminum plates and metal bottle lids.

- 240-L and 360-L Schaefer roll-out carts are supplied to residents by the contractor. Carts are coloured according to function; grey for refuse and green for recyclables.
- The cart system was chosen for the management of both garbage and recyclables because it has the following advantages:
  - standardized carts,
  - improved aesthetics over trash cans and bags,
  - protection from weather, scattering of materials and vermin,

  - worker health and safety, and
  - requires only one person/truck.
- Single-family residences are supplied with 240-L carts. Carts are provided to multi-family buildings with six or fewer units based on 120-L per unit (i.e., a building with two units receives a 240-L cart, one with three units receives a 360-L cart, and one with four units receives two 240-L carts).
- Larger multi-family buildings (seven or more units) are served by a dozen steel drop-off depots (1,100 litres) located strategically throughout the city.
- Recyclables are collected bi-weekly on the same day as refuse collection.
- Recyclables are collected on three side-loaders and one rear-loader (for streets with parking meters). Two front-loaders are used for garbage collection.
- The side-loaders require only one person to operate; the rear-loader requires two people.
- The city is responsible for public education. A newsletter is produced three times per year to promote the programs, and brochures and radio announcements have been used. A local environmental group, Bloc Vert, and schools have played an active role in the promotion of the program.
- Recyclables are spot-checked to identify the "best recycling" household each week.
- Centre Récupéraction (three miles from the city), a non-profit venture, processes the collected recyclable. Processing is entirely manual. The sorting centre employs 40 people.
- Markets:
  - glass to Consumers Glass,
  - metal to Alcan, and
  - paper, OCC and plastics to Cascades.
- A HHW collection event is held annually in the spring.

History/Progress

Garbage

1984: SSI Schaefer was hired to conduct a pilot program for refuse collection in carts. The company offered to provide (free of charge) carts, garbage containers for parks, and a truck.

1985: A pilot program collecting garbage in carts began in an area of 5,000 households (25% of the city's total households).

1986: A survey was conducted to evaluate interest in rolling out the cart-based garbage collection program. Over 63% of the pilot households responded; 83% of those responded positively. In the fall of 1986, the system was rolled out by Récupération Cascades, which agreed to:

- provide and distribute carts which (upon payment of $1) revert to the city after the five-year contract expires, and
- provide weekly collection and transportation to landfill.

Citizens were to pay $30/year for five years for the 360-litre refuse carts.

May 1984 to Dec. 1991: The cost of waste collection decreased by $1.16/household (4.6%) as a result of garbage collection decreasing from twice-weekly to weekly and switching from manual rear-loading packers to a combination of automated side-, front-, and rear-loaders.

Recyclables

1988: a recycling pilot project was established by the city, Centre Récupéraction du Québec, and Récupération Cascades to collect paper and cardboard in the neighbourhood of St. Pierre. Récupération Cascades distributed 300- and 240-L green carts for collection on a weekly basis. Some dépanneurs (grocers/corner stores) also participated. A phone survey showed that residents responded positively to the recycling program.

Over the eight months of the pilot program, 75 t of paper and cardboard (49 t paper, 26 t cardboard) was collected from 275 residential carts and 25 commercial carts. The material was sent to Récupéraction's sorting centre and then marketed to the Groupe Cascades in Kingsley Falls. This yielded an 11.2% recovery rate.

1991: A five-year contract for the provision of carts, as well as the collection and processing of recyclables for full scale roll-out, was awarded to Récupération Cascades. The company provided and distributed 7,433 carts (240-L), 1,260 carts (360-L), and 20 igloos (for buildings of seven or more units) for the collection of paper, cardboard, glass, plastic and metal. Carts are collected bi-weekly with a side-loading packer truck. Materials from the igloos are collected twice a week with a specialized roll-off truck.

A similar cart-based recyclables collection system operates in the nearby city of Granby.

Performance/Results

- July–December 1992
  997 t recovered (12%)
  7,288 t disposed of (88%)
- January–December 1993
  1,777 t recovered (11.5%)
  13,665 t disposed of (88.5%)
- Approximately 12% of this recovery is from igloos; 88% is from carts.
- Contamination is 8% (e.g., broken glass, greasy paper and non-acceptable plastics).
- The participation rate for recyclables has not been measured but is estimated at 95%.
- A survey following the pilot program indicated a high level of satisfaction.
- A HHW collection event is held once a year in the spring. In 1994, 547 people from Drummondville participated in the event (held in conjunction with other communities). The following material was collected:
  - 5 t oil and solvents,
  - 8.5 t paint,
  - 13.5 t liquid waste,
  - 1,000 tires, and
  - 190 batteries.

Ownership/Financing/Government Involvement

- The collection trucks (both recycling and garbage) are owned by the contractor.
- The carts are paid for through taxes and remain the property of the city. Participation is voluntary, but payment of the tax is mandatory.

Program Cost

Cart Costs (including taxes) for five years:

- 240 litres: $23.11/yr
- 360 litres: $33.51/yr
- Igloos: $635.58/yr

At the end of the contract, all carts revert to the city for $1.

Collection Costs

- 240 litres: $16.47/yr/cart
- 360 litres: $16.47/yr/cart
- Igloos: $1650/yr/igloo

Processing Costs

- $44.51/t

Material Revenues

- retained by the sorting centre (Récupéraction)

In 1993, a population of 35,462 (In 1994 the municipality of Grantham amalgamated with Drummondville, resulting in a total population of 43,171.) was served for a total recycling cost of $429,266. This comprises an:

- average cost per person per year for recycling of $12.11 (including the cart),
- average cost per household per year of $25.30 (assuming 2.09 people/household),

- average cost of $241.63/t (assuming recovery of 1,176 t), and
- average recovery of 62.8 kg/household/year.

The average cost/person for garbage collection is $24.81. The average cost/hhld for recycling and garbage collection is $72.98.

Recycling costs paid by taxpayers in 1994 were:

- $47.12 /household (single-family dwelling)
- $26.61/household (units in buildings of two to six households)
- $18.31/household (units in buildings of seven or more households)

Problems/Modifications

Disadvantages of the cart system include the following:

- 360-litre garbage carts are not always big enough.
- Collectors must equip existing trucks with a loading mechanism or buy special trucks.
- Carts on the streets can interfere with snow removal, street cleaning and sidewalk repair.
- Carts must be cleaned out by homeowners.
- It is difficult to determine the volume necessary per household.
- Visual impact of carts is not aesthetic.
- Some carts get lost.

Future Expansion Plans

- The program plans to increase recovery from multi-family (seven or more units) buildings. The city plans to conduct a needs assessment as the first step in this effort.
- There will be an assessment of how collection of some IC&I material (paper, cardboard) can be incorporated into the existing program.

Contractual Elements

- Collection is contracted to the same private hauler who has the refuse collection contract; therefore, trucks can be used for both refuse and recyclables collection.
- A flat rate is charged for collection services based on the number of carts serviced. The rate is adjusted annually and the contracts are for five years (see Program Cost).
- The processing facility is privately operated by Centre Récupéraction on a per-tonne basis ($44.51/t).
- Revenue from the sale of materials is retained by Centre Récupéraction.

4 Resources

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5 Summary Evaluation

Reasons for Success or Failure of Program

According to the municipal representative, the carts are a key factor in the success of the

recycling program. The gradual introduction of the carts, first for refuse collection, and for recycling collection only after residents became familiar with/ accepted the carts for garbage collection, ensured success.

The second key to success is maximum communication of information to residents about what to recycle and how to prepare materials. Feedback to participants is also considered critical. The city sponsors spot checks of recyclables and awards prizes to those householders who have prepared their recyclables properly.

The low diversion achieved is likely explained by the poor participation levels from the larger multi-family buildings (7 units or more).

Although per-capita costs are relatively reasonable, the collection system appears expensive (on a per-tonne basis) as a result of collecting only a very modest tonnage each year (1,176 t).

Lessons Learned

Carts may be stolen/misplaced.

Measures to Correct Problems

Embossing carts with serial numbers and civic numbers helps to reduce cart loss.

Limitations of Approach

The igloo system for multi-family buildings has resulted in very weak recovery. The city intends to conduct a needs assessment in the near future to try to determine how to improve recovery from this sector.

R&D Needs

The city will investigate how to improve recovery from larger multi-family buildings.

The city is also planning to identify over the next few years ways to integrate collection of some IC&I materials (paper and cardboard in particular) into the existing collection system.

Commercialization Potential

The concept of a cart-based system for garbage and recyclables collection has some potential for commercialization. It appears that this particular use of the carts has proved successful from the point of view of participant acceptance, technology, integration with the existing waste collection system, and quality of materials. The major drawback is that (as used in this community) it implies an extremely high degree of processing to separate the commingled materials. To date there has been little (if any) successful Canadian experience in mechanically separating these materials. A more efficient system might be to use a similar cart system but to modify the design and to keep the fibre and the container streams separated. (See Lemsterland and Giessen case studies.) This approach would simplify processing the materials.

Replicability of the Project

This commingled, cart-based system may be suitable in locations that can support a very labour-intensive processing system to separate the commingled recyclables.

Case Study 13 Landfill Bans, Region of Peel, Ontario

1 Abstract

The region of Peel has been actively promoting waste reduction and diversion since the mid-1980s. Recognizing the need for an integrated waste-management and diversion approach, the region has implemented programs that target front-end waste generating habits and back-end waste disposal activities. The application of material bans at the landfill has enabled the region to assume indirect control over the manner in which wastes are generated and recycled within the IC&I sector. The bans also have encouraged the development and relocation of recycling companies in the area, providing access to a stable supply of recyclable materials. The program is cost effective, with relatively small capital expenditures and operating costs that include only the salaries of inspection officers and the cost of education/promotion materials. Supporting programs, such as on-site waste assessments, waste audit workshops, educational materials, an information hotline, recycling depots and funding for new recycling ventures have helped to make the program a success. However, hauling companies have resisted the landfill bans. The onus is placed on both them and generators to comply with the bans and on them to work with generators and the region to resolve the contamination issue.

2 Community Description

Location

The region of Peel is one of the fastest growing areas in Ontario with a population of 755,178 in 1992.

To the west of Metropolitan Toronto, the region consists of three municipalities: Mississauga, Brampton and Caledon.

The region is characterized as predominantly single-family housing (72%, including semi-detached houses, duplexes, and town houses).

Waste Management Context

- The Peel region has assumed an active role in waste-management system design and implementation, and it might assume a greater role in the future as a result of the enactment of Bill 7 in Ontario, which requires regional governments to assume collection and processing responsibilities by 1997. In the past, local municipalities traditionally have assumed primary responsibility for collection services.
- The region currently funds all recycling programs (funding the local municipalities to provide blue box collection services, city depots and expanded curbside collection), administers the backyard composting program, operates the two landfill sites, operates recycling depots and waste drop-off facilities, runs household hazardous waste depots and the education and promotion programs.
- The region enforces stringent material bans on the business sector to divert waste from landfills. It has established a comprehensive industrial and commercial waste-diversion program, including free waste assessments for local businesses.
- The region owns and operates two landfills and participates in an energy-from-waste operation.

- The region currently faces a number of waste management concerns, including:
  - significant decline in IC&I waste and tipping fee revenues;
  - possible transfer of collection responsibilities from the area municipalities to the region;
  - reduction in transfer payments at all government levels.
- The region has focused on opportunities to operate the waste management and diversion programs more efficiently and cost effectively. For example, tipping fees have been reduced from $150 to $80/t in an attempt to gain back IC&I waste which is currently exported to the United States.

3 Program Description

Ownership/Financing

The region has implemented material bans at landfills, which it owns and controls. The bans are supported by a series of market development, IC&I education and audit assessment, and material collection programs. All programs are funded by the region.

Sector/Purpose

- The region has no authority over waste generated by the IC&I sector but, instead, has authority over the types of materials accepted at the landfill. This authority can be an indirect but effective method for controlling the amounts and types of waste generated by the residential and private sectors.
- The region has introduced a comprehensive set of landfill bans targeting conspicuous wastes generated by the IC&I that can be effectively diverted and recycled.

Type/Method of Recovery

- Material bans have been introduced in conjunction with numerous other waste reduction programs affecting primarily the IC&I sector.
- Bans have been introduced in stages to reflect the development of supporting markets. Materials are targeted for bans only after markets have been secured. The region has helped to fund new ventures, including wood processing and tire recycling facilities to ensure that adequate markets will exist for the banned materials.
- There is a zero tolerance policy for banned materials discovered in loads of waste. Enforcement is left to the discretion of regional staff.
- Until last year, the region employed three ban enforcement officers to inspect loads coming to the landfill. Over time, the level of enforcement has declined to one person due to the reduction in IC&I waste going to landfill.
- Violations are issued to all hauling vehicles with banned materials and, where possible, vehicles are turned away with the load.
- First-time violators are issued a warning and provided with information about the bans, and their names and sources of waste are entered in a database.
- Repeat offenders are charged $50/t for a second violation and $100/t for subsequent violations. While haulers used to be suspended after the third violation, suspensions are no longer issued.
- If the load is from a single source, then the company will continue to be fined until it can demonstrate that it is effectively separating the banned materials at source. The region requires that such a generator enter a supervised access stage in which the generator phones authorities prior to sending waste to the landfill. The inspection officer then inspects and either rejects or accepts the load.

- If the load is from multiple generators, then the vehicle operator is fined and the hauler is required to provide a list of the companies producing the suspended load. The onus is placed on the hauler to contact generators of the mixed loads and to help them to develop a source separation program. The fines are discontinued when the hauler can demonstrate that the loads are no longer contaminated and has proven that the separation programs work.
- While the region placed the onus on the hauler to invoice the generator for the surcharge resulting from the violation, a copy of the violation notice is sent to the generator as additional notification of the violation. The notice also contains information about regional phone numbers and services.
- After six months of compliance, all previous violation notices are waived.
- Businesses that bring self-hauled loads are given the option to take back the banned materials—avoiding a violation—and to recycle them with a private contracter.
- Generators are offered the services of the region to conduct a waste assessment and to help develop a source separation program. Generally, after the third violation, the generator is contacted by the region and a site visit is conducted. The region also offers workshops for interested companies that prefer to conduct their own waste audits.
- During the inspections, if an officer finds recyclable materials in the load that are not banned but for which markets exist, the officer gives an opportunity notice to the generator describing further waste diversion opportunities and available markets.
- Generators can apply for exemptions for materials that are included under the ban but cannot be recycled due to problems associated with design, use or contamination. After investigating the material and proving that no end-use markets are available, the region issues an exemption. An exemption can be issued for one time or on a continuing basis. All exemptions are reviewed regularly.

History/Progress

- During the development of its solid waste management plan in the mid-1980s, the region recognized that it was quickly running out of landfill space. The largest landfill site, Britannia, was slated for closure in 1990.
- An environmental assessment process began in the mid- to late 1980s for a proposed energy-from-waste facility (built and operated by a private company) and a new landfill site. During this process, the region began introducing programs to achieve quick and effective diversion of waste from landfill. Landfill bans proved to be effective.
- The region began introducing material bans at the landfill in 1988, beginning with a ban on tires and then including to old corrugated cardboard, wood (1989) and drywall (1990).
- In 1992 the list of banned items was increased to eight categories of materials:
  - paper fibres (office paper, newspaper, telephone directories, boxboard, books, envelopes, file folders, kraft paper);
  - clean fill and rubble (asphalt, masonry, concrete, clean fill);
  - container glass (food jars and bottles, close up liquor, wine, beer, water, pop, other liquids);
  - ferrous and non-ferrous metals (i.e., white goods, all other scrap metal, and cans);
  - tires;
  - old corrugated cardboard,
  - wood (lumber, pallets, stumps, spools, crates, brush, particleboard/pressboard, and laminated wood);
  - drywall.

- Numerous programs were developed to augment the landfill bans, including on-site waste assessment programs, waste audit workshops, recycling directories, an information hotline, a yearly seminar, a pilot fine-paper collection program for small businesses, and assistance programs.
- The bans were introduced at the time of the environmental hearings for the EFW facility.
- Concerns over competing agendas between the EFW facility and the waste diversion programs were an important part of the environmental assessment hearings.
- At the time of the environmental assessment hearings, it was determined that the EFW plant would not interfere with waste reduction/diversion programs since there were sufficient quantities of waste available to feed the EFW facility.
- Until recently, the EFW accepted only residential waste and, to date, the region has experienced no difficulty meeting its obligations of providing 450 t/day of waste.

Performance/Results

It is difficult to measure the impact of waste diversion activities on the IC&I sector, because it is not homogeneous and few recyclers operate in the region. Over the past several years, the region has experienced a significant increase in recycling activities within businesses and in the number of recycling firms situated in the region and beyond. Consequently, it has been impossible to determine IC&I waste diversion rates using information from recyclers/reusers.

Reasons include:

- Many recycling companies do not record tonnages received; only dollar values from sale of the materials are known.
- Materials tend not to be geographically classified when received.
- Recyclers do not concern themselves with jurisdictional borders and will serve any jurisdiction.
- Many recycling companies are reluctant to provide numbers and prefer to give general estimates.
- Suppliers are increasingly establishing take-back programs with clients, thus avoiding the traditional recycling collection system.

- For these reasons, the region uses a simple calculation process to estimate reduction in waste that requires disposal over time.
- In 1990, the material bans placed on tires, OCC, wood and drywall diverted a total of 100,000 t of materials, representing approximately 13% diversion of the municipal solid waste stream. During this period markets were less complicated, making it easier to estimate diversion. OCC accounted for about one quarter of all solid industrial waste, (not taking into consideration the growth that occurred in the region). The region estimates that the impact of the bans may have been even greater with growth and other economic forces factored into the equation.
- Since the introduction of the expanded material bans in 1992, the region has experienced a 39.1% per-capita reduction in IC&I waste sent to landfills and 15.9% per-capita reduction in residential waste sent to landfill (based on 1987 numbers).
- After waste diversion has been built into the equation, the region estimates that 83% of the remaining IC&I waste is exported to the United States, despite the reduction in tipping fees from $150/t to $80/t. In 1991; 1992 and 1993, waste export amounted to 53,000; 253,000; and 283,000 t respectively.

Program Cost

- Total cost to the region to operate the waste management system in 1992 was $31,870,000. This cost includes funding provided to area municipalities for blue box collection and other recycling programs (e.g., leaf composting, white goods and depots). Area municipalities provided waste collection services for a cost of $10,313,000 in 1992.

Problems/Modifications

None

Expansion Plans

- The region recently completed a study to design integrated waste depot collection based on a three-tier public drop-off system, involving community recycling centres (CRC), neighbourhood recycling depots (NRD) and mini-recycling depots (MRD).
- The depots provide expanded diversion services to residential and small-quantity generators in a cost-effective manner. The NRDs will be located within a five-minute drive of major residential areas, providing drop-off services for blue box materials and other recoverable materials. The CRCs, located within a 15-minute drive, will offer a greater range of services including drop-off for blue box materials, other recyclable materials, reusable items, household hazardous waste, education and information on waste. The other depots will accept a narrower range of recyclable materials, with the MRDs located on street corners and at community centres in heavily used areas with little access to recycling programs, such as multi-unit dwellings. Some level of staffing will be required at the CRCs only.
- The region has no plans to expand the list of banned materials, particularly now that it has lost much of its IC&I waste. Future bans may be imposed on recyclable residential wastes to encourage use of a newly designed depot system.

Contractual Elements

- All collection services associated with curbside and depot recycling are provided by the private sector (with the exception that Brampton's staff collects white goods).
- In Mississauga and Brampton, curbside source-separated recyclables are sent to a material recovery facility operated by the private sector for processing and marketing. In Caledon, the source-separated recyclables are stored in roll-off containers and sent directly to markets in bulk form.
- The resource recovery facility is owned and operated by a private company with a 20-year put-or-pay contract established with the region at $67.25/t fixed tipping fee (1989 dollars). The region is also required to pay an energy shortfall fee of $14.50/t (1986 dollars) if a designated amount of waste is not delivered.

4 Resources

Contact

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Reports and Surveys

The Region of Peel. Waste management newsletters.

The Region of Peel. Summary of solid waste material ban enforcement procedures.

The Region of Peel. February 1994. Co-ordinated material recovery system study.

Annual summary reports

5 Summary Evaluation

Lessons Learned

The region has benefitted from the implementation of material bans at the landfills not only by diverting recyclable materials away from landfill but also from the information gained regarding generation habits of local businesses. Inspections enabled staff to gain greater insight into the waste generating habits and recycling opportunities of local businesses.

During inspections, staff were able to identify a range of opportunities for companies to divert recyclables from their waste streams. Bans provided a cost-effective approach to identify and to help companies experiencing waste management problems. With much of the IC&I waste currently sent to the United States, the region has lost the opportunity to deal directly with companies and to keep tabs on changes in waste management habits. The region must now rely on databases to target local businesses for waste audit workshops and information sessions.

Bans provided additional support for the recycling industry, and many recycling companies chose to locate in the region as a direct result of the bans. Recycling companies were prepared to take on new recycling activities, knowing that a secure feedstock would be provided as a result of the bans. However, the hauling industry has blamed the bans for providing additional incentive to export IC&I wastes to the United States. The region, in fact, has discovered that many companies no longer source-separate their recyclables from the waste stream before it is exported. The region has reduced the tipping fee in an effort to regain IC&I wastes but has not been successful.

Good relations with the haulers are important. Information sessions were held before each ban to allow for questions and comments. Regional staff provided assistance to haulers upon request. Staff members spoke at sales representatives meetings, and went with them to visit waste generators. They also rode along on the vehicles and provided extra copies of promotional materials. Recent consultation meetings led to an update in enforcement procedures.

Consistent enforcement is a must. It is a strong encouragement for both the haulers and waste generators and serves as a comfort for the recyclers as well.

Enforcement staff work at the landfill on a rotating basis. This allows them to follow a violation through the process. They are familiar with the needs/problems of the generators and they can visit them to provide solutions.

Case Study 14 Power Generation from Landfill Gas, Newby Island Landfill, San Jose, California

1 Abstract

The Newby Island gas recovery and power generation project was built in two stages. The first plant, Newby Island 1, was completed in 1984 and is still operating at the design capacity of 2 megawatts (MW). It was developed as a 10-year limited partnership by Laidlaw Gas Recovery Systems Inc., which has operated the plant continuously and exercised its option to purchase the project outright, from the limited partners, at the end of 1994. Laidlaw built and financed Newby Island 2 without limited partners. It was completed in 1990, and operates successfully at its design capacity of 3 MW.

Both plants employ reciprocating piston engines; in the case of Newby 1, four naturally aspirated 8-cylinder Cooper Superiors; in the case of Newby 2, three turbocharged 16-cylinder Waukeshas. The landfill is owned and operated by Browning Ferris Industries (BFI). Browning is paid a royalty based on the revenue from Pacific Gas and Electric (PG&E), which purchases the power under a somewhat complex 30-year agreement. Both plants have exceeded expectations with respect to reliability and financial return, and the gas field is expected to last for the duration of the power-sale agreements. (The contract with PG&E is known as a Standard Offer 4. It offers some advantageous terms for the developer, but is no longer offered by the utility).

The technical challenges facing the landfill gas business in the future are largely related to tightening air emission regulations, particularly for NO_x, CO and unburned hydrocarbons. Research in these areas is under way, and affordable solutions are likely to be found. Newby Island is one of 12 power generation projects owned and operated by Laidlaw Gas Recovery Systems.

2 Community Description

Location

The landfill is located in San Jose, Santa Clara County, California. The landfill is owned and operated by BFI and is the principal disposal site for commercial and residential waste in the community. San Jose has a population of approximately 1 million. The site was opened in 1956 and is expected to close in 2016. The site has a permitted area of 140 ha and receives 2,500 t/d of waste. The quantity of waste in place is unknown, but the average depth is about 30 m, and at closure will be 45 m. The gas recovery plants are located at the landfill, on a small piece of property leased from BFI.

Waste Management Context

- High energy prices.
- Availability of advantageous energy contracts when the plants were built.
- Increasingly stringent requirements to control the emissions from solid waste landfills.

3 Program Description

Purpose and Sectors Involved

The projects were developed by Laidlaw Gas Recovery Systems, with a royalty arrangement with BFI (the landfill owner) and a power sale agreement with PG&E. The goal was to control the emission of landfill gases and to recover the energy on a commercial basis.

Type/Method of Recovery

Landfill gas, consisting of about 50% methane, is recovered from the landfill using a system of

gas wells drilled into the waste, collected into a header, and pumped to the engine plants. After pre-treatment, the gas is used directly as a medium-energy-content fuel for a total of five reciprocating piston engines, which in turn drive generators with a combined total output of 5 MW. The power is sold into the grid.

Process Description

The gas is recovered from a network of approximately 200 gas wells, sunk to a depth of 12 to 18 metres into the buried waste, over an area of about 200 acres. The wells are connected to a header system equipped with a blower. The raw landfill gas is about 50% methane, and the balance is CO_2, with trace quantities of other gases including volatile organics and water vapour. Most contaminants are removed in a condensate trap. The gas is then fed to the engines without further treatment.

Newby Island 1 is equipped with four eight-cylinder, naturally aspirated Cooper superior reciprocating piston engines, each with a rated output of 500 kW. Newby Island 2 is equipped with three sixteen-cylinder, turbocharged Waukesha engines, each with a rated capacity of 1 MW. All seven engines drive generators and feed the grid.

History/Progress

The first plant was completed in 1984, and after initial start-up has run virtually non-stop ever since, except for maintenance shut-downs. The second plant was completed in 1990, and it too has run virtually trouble-free. It is necessary to constantly maintain the gas field, which means testing and replacing wells as they plug up or malfunction, and to be constantly alert for pipe fractures as the landfill settles. The only other threat to the long-term operation of the plant is the likelihood that regulations will change. For example, new laws were introduced which implied that the condensate would have to be disposed of as a hazardous waste. Laidlaw addressed this on two fronts. It challenged the way in which the law was being interpreted and applied, and at the same time it set about developing a technique to dramatically reduce the volume of condensate requiring disposal. The company developed a distillation technique using waste heat from the engines to reduce the volume of condensate requiring disposal by 97%, and it also won an exemption from the requirement to dispose of the raw condensate as a hazardous waste. Ironically, although the concentrated condensate is still a hazardous waste, it is nevertheless much cheaper to dispose of it this way than to dispose of it untreated as a non-hazardous waste. The next challenge was to meet the new regulations governing air emissions by 1996. Laidlaw is engaged in research in this area.

Performance/Results

Both Newby 1 and Newby 2 have parasitic loads which consume about 5% of the gross rated capacity. Maximum net output is therefore 95% of rated capacity. Newby 1 has operated, on average, in excess of 95% of gross rated output (90% sold to the grid, 5% parasitic load) for almost 10 years.

Newby 2 has operated at over 70% of rated capacity, but this is only because of the limit on the amount of power which PG&E is required to purchase under the contract, namely 4.5 MW. Furthermore, the agreement with the limited partners ensures that they get the maximum return from their investment in Newby 1 before Laidlaw generates and sells power from Newby 2.

All five engines are given a top-end overhaul every 30 months and a bottom-end overhaul every 60 months. The maintenance schedule is set up so that the work is staggered. Laidlaw performs all its own maintenance, using a team of specialists who travel from site to site for routine work and are on call 24 hours a day for emergencies.

Ownership/Financing/ Government Involvement

Newby Island 1 was designed and built by Laidlaw Gas Recovery Systems and sold to a limited partnership, who purchased 25% of the project. The remaining 75% was debt financed. The limited partnership was for ten years and three months (ending on December 31, 1994). At that time Laidlaw had an option to purchase the project outright at a value set by an independent appraiser. It exercised the option. Newby Island 2 was entirely financed by Laidlaw and is owned outright.

There are two basic contractual elements: a royalty to BFI for rights to the gas and a power sale agreement with PG&E. Laidlaw pays a royalty to BFI in two parts. Part one is 12.5% of net revenue and represents the minimum payable. Part two is based on a theoretical sharing of profit above a certain threshold but does not require Laidlaw to open its books.

The contract with PG&E is for 30 years. During the first 10 years, Laidlaw receives a capacity payment as a lump sum, which is based on achieving 85% of rated capacity during the high capacity period. This translates into 6 hours/day, 5 days/week, 6 months/year (in the summer). In addition, Laidlaw is paid a fixed rate per kWh sold. For the remaining 20 years it will continue to receive the capacity payment, but the rate per kWh will be based on the utility's avoided cost and will change from year to year. Laidlaw has depreciated the capital investment over 10 years so that the profitability of the operation is not expected to decrease with the lower power rates. In addition, the contract contains some fairly onerous repayment requirements should the facility cease to produce power. These repayment penalties actually increase year by year until about year 20, and then decline rapidly thereafter. This provision was included to protect PG&E against the possibility of the operator making high profits during the early years, then closing down when the rates decreased.

Program Cost

The construction cost for Newby 1, including the gas field and start-up, was about $2.6 million in 1984, or about $1.3 million/MW of generating capacity. Newby 2 cost about $4.6 million in 1990, or about $1.6 million/MW. By blending the capacity payment and the fixed rate, the revenues work out to about 8.5¢/kWh. Operating costs are not public information, but both plants have generated excellent profit margins and a good return on investment since initial start-up.

Problems/Modifications

Newby Island has been largely trouble-free since start-up. However, problems were encountered at other sites, and the lessons learned were applied to Newby. For example, the first turbocharged engines installed suffered from rapid deterioration of the second stage gas compressor, because of the corrosive nature of the condensate. This was fixed with a stainless steel retrofit.

At other sites, gas shortages have been a problem, and in the worst case the engines were actually pulled out and moved to another site. It is vital to co-ordinate the development of the gas field with the plans of the landfill operator to minimize damage to the wells and header pipes, and to maximize gas production. The nature and extent of the landfill cover plays an important role; if it is insufficient, it is possible that the blower will draw outside air into the site, killing the methanogens and temporarily causing a drastic fall in production. Much of the landfill gas business depends on operating experience, and most of the problems were resolved by trial and error.

In the longer term, new California laws may compel landfill gas operators to retrofit their engines with equipment to control NO_x, CO, and unburned hydrocarbons.

Expansion Plans

Although the site has lots of gas, new air permits are now impossible to obtain, so Laidlaw is discussing ways to meet some of BFI's on-site power needs for its recycling operation, which is a heavy power consumer.

4 Resources

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5 Summary Evaluation

Reasons for Success or Failure of Program

The Newby Island operation, and the landfill gas business in general, has been enormously successful. Although there are many reasons for the success, there are some major ones that should act as a guide to anyone interested in the field. First, the power sale contract has to ensure a revenue of not less than about 7.8¢/kWh over a 20-year contract. Second, the capital cost must be managed carefully; it should not get much above $1.3 million/MW, and a tight rein on overhead must be maintained. Laidlaw has a very high revenue per employee. The single most important factor has been consistently strong management. Since the business began in 1980, it was led by the same individual until three months ago.

Landfill gas cannot be exploited in commercial quantities unless there is at least 1 million tons of waste already in place. Landfills with porous walls do not make good projects; gas production is likely to be insufficient over the life of the project. Sites which are already closed are more risky and require much closer scrutiny to ensure that a long-term gas supply is available. Access to the grid, or access to an industrial customer that can use medium-energy gas, is necessary. Reciprocating piston engines are the most reliable and energy efficient. Gas turbines work well but have too high a parasitic load. Steam turbines are only economical for very large projects of 20 MW and up.

R&D Needs/Commercialization Potential

Techniques to upgrade landfill gas to pipeline quality are available but need to become more cost competitive. This would open up a much wider range of options for the use of the energy. All aspects of air emissions need more or less careful scrutiny, depending on the regulations in the specific jurisdiction; California has traditionally led the way in this area.

Landfill gas is a first-class business. It is environmentally responsible, with a significant net positive impact on the emissions of greenhouse gases, and it is commercially proven, requiring no financial support from government. There is, however, an important role which governments can fulfill: to find a way to compel the utilities to purchase power from projects which are environmentally beneficial, and to do so at a rate that will allow the developer to make a decent return.

Replicability of the Project

There is no technical reason why landfill gas projects should not proliferate in Canada; every well constructed site with more than a million tons (900,000 t) in place could have one. Only financial/institutional barriers stand in the way.

Case Study 15 Landfill Mining, Edinburg, New York

1 Abstract

The Edinburg landfill mining project was a demonstration project in rural upstate New York. The project tested the potential of landfill mining as a means of reducing the size of the landfill footprint and thus lowering the costs of closure. The original goal was to reduce the footprint from five to four acres. This goal was achieved and has since been exceeded.

The study was also designed to provide a blueprint for other landfill mining projects in New York State and the rest of the U.S. in the future. Excavated soil was declassified as solid waste and is now used in Department of Public Works subsurface backfill projects. Findings of this project showed that recovered materials are often too contaminated with soils and dirt to be reprocessed for recycling.

Landfill mining can be employed for a variety of reasons (e.g., to reduce landfill footprint, to reclaim problem sites, to regain lost airspace). Techniques, equipment and costs will vary according to the project objectives. This case study provides a basic understanding of the technique used at one site where the landfill footprint was reduced through mining.

2 Community Description

Location

- Edinburg (Adirondacks Region), Saratoga County in rural upstate New York.
- The community is primarily rural and residential, with limited IC&I activity.

Waste Management Context

- The Edinburg project was a pilot project.
- It began in 1988. Actual site work was conducted during three weeks in the fall of 1990 and three weeks in the spring of 1991.
- The project was part of a larger program announced by Governor Mario Cuomo to reclaim 10 landfill sites in the state. Pilot tests were initiated at six other N.Y. sites in the summer of 1993, and it was anticipated that the Edinburg site would serve as a model for other similar projects.

3 Program Description

Purpose and Sectors Involved

- The main purposes of the project were to create space in the landfill, to reduce the size of footprint to lower closure costs, and to extend the landfill life.
- The project was used to provide information regarding:
  - marketability of recovered recyclables,
  - potential for using recovered materials for refuse derived fuel (RDF), and
  - material toxicity.
- The Edinburg landfill had received mostly residential waste due to the limited IC&I sector in the area.
- Landfill mining can be undertaken for several reasons:
  - to establish a reusable landfill as part of an integrated plan for optimizing landfill operation by excavating the existing material, reusing or recycling this where viable, and creating more airspace in the process;
  - to consolidate a landfill site and to reduce the size of its footprint, to

upgrade existing sections, or to extend landfill life;
- to regain lost airspace by recovering soils that have decayed;
- to remove materials and re-line a landfill (i.e., to prevent or arrest ground water contamination) and to remediate a problem site; and
- to recover materials and energy.

Type/Method of Recovery

- Modified surface mining techniques were used. Refuse was excavated, screened and sorted in a one-acre portion of the five-acre rural Edinburg landfill.
- It is essential to match the type of equipment to the exact techniques that will be used (e.g., depth of mining and types of soils). Equipment used at Edinburg included:
  - dump truck,
  - one or more loaders sized to match the throughput of the screening equipment,
  - screens.
  - Shredders and balers may also be required for landfill mining.

Process Description

- The site was first evaluated in terms of potential for landfill mining (test pits were excavated) and to confirm that the top was stable enough to safely support the excavator.
- Material was sent through a series of processes:
  - Workers tested each load of incoming materials for hazardous substances (methane gas, hazardous materials, asbestos, volatile organic compounds).
  - A Mdi-Yutani excavator was used for digging.
  - A three-inch Read screener did primary screening.
  - A one-half-inch screen was used in 8 x 30-foot rotating trommel.
  - Screen Alls outfitted with 10- and 12-inch fingers were used to prod and sift the material. (A trommel screen had been used; while it produces cleaner material, it broke the glass.)
  - Workers were given respirators/Tyvek suits (tested for hazardous substances) for workers.
- Tires and bulk metals were removed and sent for recycling.
- Soil and mixed wastes were excavated and placed on landfill's existing footprint.

History/Progress

- A three-year process was undertaken (from fall of 1987 to the fall 1990) to build institutional support needed to demonstrate landfill reclamation in New York state. It involved three regulatory agencies as well as municipal agents and a state legislative commission.
- By comparison, only a few months were needed to design the technical plan.

Performance/Results

- 15,000 yd^3 of material were recovered (2,500 yd^3 in a December session and 12,500 yd^3 in a June session). The site size was reduced during this pilot phase from five to four acres.
- Approximately two-thirds of the material was soil (although this is not a prerequisite to conducting a landfill mining project).
- By weight, excavated material consisted of:
  - 66.1% soil,
  - 3.2% rock,
  - 5% metal (primarily cans),
  - 0.7% aluminum,
  - 2.7% glass,
  - 6.6% paper,
  - 6.2% plastics,
  - 1.4% wood,
  - 0.6% polystyrene,
  - 4.6% other material (rope, fabric, etc.), and
  - 2.9% unknown materials.

- Some materials were removed for recycling (e.g., lead from car batteries) although, due to high contamination levels, it was not economically viable to recycle most excavated materials.
- A project goal was to use soil for compost and landfill capping. Soil was tested for chemical, physical and biological properties. The soil passed U.S. Department of Environmental Conservation tests for Class I and II standards. Lead was the only constituent that showed a significant difference when measured against ambient levels. Soil is currently used for subsurface backfill in Public Works projects.
- A high energy value was expected in the test burn of materials (due to high plastic components). Tests showed that average values were lower than expected due to the high soil and rock content and moisture in the soils.
- By adding an air knife to remove stones, and by incinerating a blend of 100 tpd regular feedstock with 10 tpd reclaimed material, the calorific value was raised from 1,000 to 4,000 BTU/lb to 5,000 BTU/lb.
- Of the non-soil, potentially half the material was recyclable; however, it was heavily contaminated, and it was not economically feasible to recycle.

Ownership/Financing/Government Involvement

Several firms and agencies provided capital for the program. They benefited from participating in the research that was undertaken, including:

- The New York State Energy Research and Development Authority provided $570,000 (in 1991 when the footprint was reduced to 2.4 acres).
- The town of Edinburg funded the project for a final year after 1991.
- Schillinger, Salerni & Boyd of Albany (chief contractor) provided $32,000.
- The town of Edinburg provided $21,000.
- The U.S. EPA provided $96,000.
- Clough Harbor and Associates of Albany provided $21,000.
- Read Corporation of Middleboro, Mass. (screening expertise) provided $73,000.
- Environmental Products and Services (Albany company that operates the on-site equipment) provided $54,000).

Program Cost

- Factors that can affect landfill mining costs include:
  - the types of wastes landfilled,
  - the amount and characteristics of cover soils used,
  - the moisture content of the landfill,
  - the depth of fill,
  - the types of excavation and separation equipment required,
  - the required level of product quality control,
  - the level of environmental monitoring and health and safety programs,
  - weather patterns,
  - the sensitivity of the neighbouring community,
  - the age of the landfill, and
  - how long the material has been deposited (i.e., has the landfilled material stabilized or cooked out).
- Other costs such as planning, background analytical testing, and mobilization will be fixed.
- Cost modelling completed by the Edinburg team show that, under some conditions, the cost of landfill mining can be significantly less than closure of the original size landfill (i.e., before soil reclamation).
- The actual project costs of the Edinburg landfill mining operations were $866,000.
- At an estimated cost of $5/yd^3, reclaiming an eight-foot-deep acre costs approximately $88,000 while a 20 foot-deep acre costs

$222,000. A cost of $4/yd^3 is considered achievable.

Problems/Modifications

- Several steel drums were unearthed at the beginning of the project, raising concerns about a hazardous portion greater than had been expected.
- Although there was no real problem, Edinburg planners had prepared for potential liabilities associated with digging up a site. The plan included:
  - creating a $10,000 U.S. contingency fund to handle any unearthed hazardous wastes, and
  - selecting a qualified hazardous waste spill response and contractor.
- The first test burn was unsuccessful, due to soil, rocks and moisture.

Expansion Plans

- The first test burn was unsuccessful. The project therefore continued trying to perfect this element to further reduce the landfill footprint. Since completion of the pilot, the project has been expanded to the point that the footprint of the entire site has been reduced from the original total of five acres to little more than one acre (at present). This will substantially reduce closure costs (i.e., final cap).

Contractual Elements

- Several contractors involved in the study include:
  - Schillinger, Salerni and Boyd (project consultants),
  - Clough Harbor and Associates,
  - Read Corporation (screening),
  - Environmental Products and Services (on-site equipment operators), and
  - Privately owned Massachusetts resource recovery facility (incineration).

4 Resources

Contact

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Reports and Surveys

Morelli, J. *Municipal Solid Waste Landfills: Optimization, Integration and Reclamation.* New York State Energy Research and Development Authority, Albany, New York.

5 Summary Evaluation

Reasons for Success or Failure of Program

- The Edinburg study was considered a success in that the size of the landfill footprint was successfully reduced, costs of closure were significantly lowered, and excavated soil was declassified and used productively in another application.
- Project planning allowed time and budget for experimentation to ensure success.
- Part of the program's success may be attributed to the choice of a relatively benign site.
- Landfill mining must be conducted at a precise time related to decomposition of the material—either before it begins to decompose or after decomposition is completed. Odours and health risks are otherwise unmanageable.
- Type, number, order and size of screens must be considered in designing a project, as must the end use for the facility; e.g., if the soil is to

be reclaimed for cover material, the number of screens needed can be reduced. If the landfill is to be closed or soil used off-site, a finer screen will be required.

- Both trommel and finger screens do an acceptable job. The multi-tiered harmonic finger screens are relatively gentle and tend not to smash bottles or to pulverize other waste components. Trommels tend to break the glass and to shred waste. However, reject piles from finger screens contain a higher percentage of soil and fines than do reject piles from the trommel (i.e., the trommel tumbles waste and can effectively produce a soil-free reject pile).
- In most cases, markets will not be economically viable for recovered recyclable materials as they will be highly contaminated with soil.
- Refuse derived fuel (RDF) is a possibility, but not an easy option, due to soil contamination and potential moisture of materials recovered. Adding a stone removal process provides with materials higher calorific values.
- Project costs depend on the end use of excavated materials (i.e., type of soil and time of year).
- Under optimal conditions, assuming that excavated soil is used as landfill cover, a rate of 912 m^3 per day excavation is possible. On average, soil will be excavated at a rate of 456 to 608 m^3 per day.

R&D Needs/Commercialization Potential

- This approach has considerable commercial potential at existing or closed landfills for a number of reasons, depending on the local circumstances. These include:
  - reducing the footprint size to lower closure costs;
  - mining an unlined landfill to place a liner and to create a properly engineered landfill at an existing site;
  - mining to recover material useful as landfill cover; and
  - mining to recover air space by removing some of the landfilled material for other uses.

Replicability of the Project

- At the Solid Waste Association of North America Conference in June 1994, the issue of landfill mining was addressed. It is estimated that between 30 and 40 projects are on-going in the United States.
- Two similar studies are currently in operation in Ontario:
  - the Monaghan landfill site in Parry Sound (to remediate a problem site), and
  - the Metropolitan Toronto site (to rehabilitate land considered unusable, thus providing a productive development site for the future City of York Centre).

Landfill Mining

An extensive landfill mining project is in progress at the 20-year-old McDougall Landfill Site near Parry Sound, Ontario (200 miles north of Toronto). The project involves emptying the contents of the entire site and adding a new liner to remediate the landfill. In 1989, the Ontario Ministry of the Environment and Energy ordered the municipality to take control of the 18-acre site from a private firm after repeated and extensive contamination problems had been noted. Due to difficult soil conditions (rocky, lacking a natural waterproof barrier, with deep water-filled fractures), traditional remediation techniques were ruled out, and a plan was drawn up for landfill mining. To complete the project, the following steps were taken:

- From 250,000 to 300,000 t of waste (approximately 300,006 cubic metres) are being excavated over three years.
- Existing equipment (bulldozers, an excavator) is used where possible. Additional equipment (heavy-duty trommel screen, conveyor belts, a loader, Volvo rock truck and compactor) have been purchased or rented.
- From May to October, 1,800 t per day of waste are excavated, screened and stockpiled; incoming and old wastes are buried (or reburied) and compacted. Work is completed on the new liner and waste is placed in the containment cells.
- An estimated $8 million is needed. This is being generated through landfill tipping fees (at $120/t) and through a $3.7 million provincial grant.

Project representatives predict that due to decomposition, half the materials excavated will be available as daily cover as the site is filled or stockpiled for future use. However, recyclables will not be marketed due to distances from markets and low quality of materials. For further information contact John Langsford, Chief Administrative Officer of McDougall Township, at 705-342-5252.

Case Study 16 Mixed-Waste Processing Facility, Zoetermeer, the Netherlands

1 Abstract

The mixed-waste processing facility in Zoetermeer, the Netherlands, processes the fraction of waste remaining after source separation of organics and paper from the residential waste stream. The plant was originally constructed in 1980 but had never worked successfully. The municipality took over the plant, and redesigned it with the help of ESDEX, the original owners and operators. The new plant started operation in January 1994 and uses a hammermill, a trommel screen and magnetic separators to process the mixed-waste stream (remaining after organics and paper have been source separated) into a refuse-derived fuel (RDF) and an organic fraction. The organic fraction is stabilized and used as intermediate landfill cover. The RDF is currently baled and landfilled, as a market has not been found to date.

The plant has a capacity of 80,000 t/year, operating one shift per day, five days per week. Approximately half of this total comes from the local municipality. The remainder comes from other municipalities during plant upsets.

2 Community Description

Location

Zoetermeer is a municipality located about 20 km from The Hague. The waste received at the facility comes from Zoetermeer (110,000 population, 40,000 households) and some surrounding villages. The total population served is 150,000.

Waste Management Context

The facility, originally built in 1980, was not economical and was considered a financial failure. ESDEX (which designed and operated the plant) wanted to pull out. The municipality of Zoetermeer formed a company and was willing to take over and refurbish the facility if a long-term contract was secured. The municipality now has a 10-year contract with PROAV (Province of South Holland Waste Authority, which is responsible for handling all waste) for processing garbage remaining after organics have been source separated. There is now a requirement in the Netherlands that no unprocessed residential waste can go to landfill. As of January 1, 1994 it is also mandatory to source separate organics from household waste.

3 Program Description

Purpose and Sectors Involved

The facility processes garbage from residential sources. There is a source-separation program for residential paper and organics; however, the waste stream received at the plant still contains 35% organics. The plant capacity is 80,000 t/yr, operating 8:00 am to 4:30 pm, 5 days/week. The population of 150,000 feeding the plant generates only 40,000 t of organics per year. Additional waste is also sent from other residential sources (e.g., when the local incinerator breaks down).

Type/Method of Recovery

The municipality started source separating organics in 1988-89. All households are now on the system. Residents have 240-L grey bins for garbage and 120-L bins for source-separated organics. The source-separated organics go to an in-vessel composting facility located about 15 km away. It produces certified compost. Paper waste is collected separately once a month by charities. Householders are asked to separate paper, but it is not mandatory. Glass is recovered in bottle banks.

Household hazardous waste (HHW) and white goods are collected separately.

Process Description

Waste Processing

Waste is delivered to the tipping floor. Bulky items are removed by hand (stored and landfilled). The waste is then loaded onto a conveyor which feeds a hammermill with a 40-t/hr. limit (related to the specific gravity of the incoming waste). Conveyors deliver the waste to the trommel screen, which the plant manager feels is the core of system. The trommel screen produces three sizes of material:

- 60-mm diameter or smaller,
- 150-mm diameter or smaller, and
- greater than 150-mm diameter.

The system is designed on the basis of specific gravity and is more difficult to operate when the specific gravity of the incoming waste stream is lower. This is now a problem with source separation of organics from the waste, as the heavy fraction is gone, and the remaining plastics, etc. are lighter and lower the overall specific gravity of the remaining mixed-waste stream.

Organic Stream

The smallest (60 mm and smaller) fraction of the waste stream from the trommel screen is considered "organic". This is delivered to a facility in Amsterdam where it is "stabilized" over two to four weeks. (The plant manager did not know what process was used for stabilization.) The stabilized material is used as intermediate landfill cover, as it is too contaminated for any other purpose.

Refuse-derived Fuel Stream

The smaller-than-150-mm fraction is run past a magnet for recovery of metal (mostly cans), which are sent to a recycler. Two conveyors are required because of capacity limits (one existing conveyor from the old plant was used). The greater-than-150-mm stream is also run through an electromagnet to remove larger ferromagnetic metals. (Metals are 2% of the recovered stream and the plant finds markets for them through connections in the scrap market.) Both streams are then baled as RDF. A 40 yd^3 container is filled with bales by fork-lift. The bale size is designed to use the bin capacity most efficiently. The bales of RDF are currently landfilled, as PROAV cannot find a market. The company is looking at using it in cement or at electric generating stations, and incineration in Gibraltar or England. Domestic emission standards are too strict to incinerate the bales of RDF in the Netherlands.

General

All waste leaves the plant the same day that it arrives. There is an odour (not strong) of garbage inside the building, but none outside. The existing building is 22 m high because of the design of the previous operation. This allowed all equipment to be elevated and helps to keep the floor clean. One person is assigned full-time to sweeping the floor to keep the plant clean. The plant is located in an industrial area and surrounded with trees. Office buildings and low-rise residential housing are located nearby. The plant seems to be a good neighbour. The facility has 14 employees working, 1 shift/day, 5 days per week. There is a simple control room, and continuous records of any automatic equipment stoppages.

History/Progress

The old facility was shut down from 10 October 1993 to 1 January 1994 for refurbishing. Ninety percent of the existing conveyors were reused in the new design. The original building was also used. ESDEX (the original plant owners and operators) helped to design and to build the new facility. Prefabricated equipment was used for the new plant. Operation restarted on 3 January 1994.

Performance/Results

In the 20 weeks from January to April 1994, the plant handled 25,588 t of waste:

- 5,300 t bulky (to landfill),
- 13,457 t RDF (to landfill),
- 5,478 t organics (to stabilization),
- 368 t scrap metal,
- 985 t miscellaneous, untreated because of start-up problems.

Ownership/Financing/Government Involvement

No details on financing were available. The plant was originally owned and operated by ESDEX. It is now owned by a corporation of which the municipality of Zoetermeer is the major shareholder.

Program Cost

The local tipping fee was not known by the plant manager, he thought $12/t in South Holland, $156/t in North Holland. The plant originally cost $11 million in 1980. The retrofit in late 1993 cost an additional $3.5 million. Operating costs are about $40/t including the recent capital investment.

Problems/Modifications

The collection system is not suitable for separation of organics from high-rise waste. In some older areas of The Hague, separation of organics is not done (not enough space for bins). This stream also comes to the plant. It helps the operation because it is heavier.

Expansion Plans

None

Contractual Elements

PROAV pays a per-tonne rate (amount not provided) to the facility for processing and then takes the finished product. PROAV owns the waste after it leaves the plant: therefore PROAV—not the facility operator is responsible for disposing of it or finding markets.

4 Resources

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Reports and Surveys

None

5 Summary Evaluation

Reasons for Success or Failure of Program

The Netherlands must use this approach for residential waste because of new rules which require that all waste be processed prior to landfilling. Lack of markets for RDF limits the diversion potential of this approach; there is a need for development in this area. Processing of the organic fraction removed from a mixed-waste stream does not produce a clean compost; therefore, its use is currently limited to daily cover (which is an expensive approach).

R&D Needs/Commercial Potential

Design of the trommel screen depends on a waste stream in which the specific gravity of materials varies. Source separation of organics lowers the specific gravity of the waste stream. Therefore it is more difficult for the system to effectively separate the waste into different streams.

Replicability of the Project

This approach would have value in any area where the mixed waste compost could be used as landfill cover (i.e., where the cost of developing borrow pits is high) and also where a market for RDF is available.

Case Study 17 Lakeshore Village Multi-family Recycling, Etobicoke, Ontario

1 Abstract

This case study profiles a system which makes recycling more convenient to multi-family building residents.

Almost all multi-family buildings are equipped with a single chute for garbage disposal. In most cases, the buildings provide only a small chute room for the disposal of garbage. They require residents to carry recyclables to a central storage area, usually on the main floor of the building. This makes recycling less convenient for residents and is one reason for recovery and participation rates lower than in single-family dwellings.

The technology at Lakeshore Village is a three-chute system for collecting and separating waste and recyclables in high-rise buildings. In addition, a large chute room equipped with recycling bins was built on each floor to provide residents with a convenient method of disposing of their recyclables. Waste is disposed of by residents in one chute and collected in a stationary compactor located in the main-floor garbage room. After a check for contamination recyclables are sent down the chute by building staff or designated volunteers and fall into roll-out containers. The program targets ONP, OCC, old magazines, old telephone books, steel food and beverage containers, aluminum, glass and polyethylene/terephthalate(PET). Roll-out containers are set out at the curb for municipal collection.

A comparative analysis suggests that the capital cost of the three-chute system is higher than for other types of recycling systems for multi-family buildings. The level of recovery achieved by the three-chute system was found to be less than other multi-family systems (such as using a central storage area, or a carousel system); however it is anticipated that with a few simple modifications, diversion can be increased. The long-term advantage of a three-chute system is that it can easily be adapted to collect and store source-separated organics as well as dry recyclables and garbage.

2 Community Description

Location

- Lakeshore Village, in Etobicoke, Ontario is a residential redevelopment built by The Daniels Group and completed in September 1993. The project consists of five high-rise co-operatives with 612 units. Each high-rise was equipped with a three-chute recycling system. In addition, Lakeshore Village has 158 townhouses and 92 low-rise units (less than five storeys).

Waste Management Context

- New 3Rs regulations in Ontario affect all multi-family buildings with six or more units in municipalities with a population of 5,000 or more. The regulations require that source-separation programs collect ONP, food and beverage containers made of glass, aluminum, steel and PET. Any other materials included in the municipal program must also be collected. The 3Rs regulations were promulguted March, 1994, although a discussion paper was released in October, 1991.
- The city of Etobicoke requires that new developments submit a recycling plan which describes the type of waste material that will likely be generated, estimates quantities to be collected in a source-separation program, and identifies the methods of collecting and handling recyclables on site.

3 Program Description

Purpose and Sectors Involved

- The purpose of the three-chute system is to provide a convenient recycling system which can be adapted to include source-separated organics.
- Evaluation data for this case study was collected as part of a comparative analysis of multi-family recycling systems. The study involved one multi-family building at Lakeshore Village, which has a three-chute system, and two additional buildings which use different approaches to recycling (common storage area at ground level, and push-button carousel).

Type/Method of Recovery

- One chute is used to dispose of waste; the other two are for recyclables (one for fibres and one for mixed cans and plastic containers). Glass and old corrugated cardboard cannot be conveyed through the chutes; market specifications require minimal glass breakage, and cardboard may clog the chute. These materials are conveyed manually to the main storage area by building staff.
- Large chute rooms on each floor are designed to provide space for the storage of recyclables.
- The main-floor garbage room provides storage space for all required containers as well as the garbage compactor and three chutes.
- The kitchen of each unit is equipped with a special collection container for recyclables.
- Recyclables collected include ONP, OCC, OMG, old telephone books, food and beverage containers made of PET, glass, aluminum and steel.

Process Description

General Operation

- Residents can store recyclables in their apartments using the special storage bin located under the kitchen counter. Under-the-counter storage bins were selected because they do not require floor space.
- Residents take recyclables to a chute room (located on each floor) and separate materials into three streams: commingled fibres, commingled containers and glass containers. Each bin is labelled accordingly. Residents are asked not to place recyclables in the chutes (to minimize contamination in the main storage containers). As a safeguard, the two recycling chutes are locked. The garbage chute is unlocked and can be used by residents at any time. In one of the Lakeshore Village buildings, recycling chutes are not locked and can be accessed by residents at any time. Storage containers in the chute room are not required.
- Building staff control material quality by removing contaminants from the chute room storage bins. Once contaminants are removed, staff unlock the recycling chutes and send materials to the central collection area, where they end up in roll-out carts. Staff visit each chute room to drop recyclables down the chute at least once per week. On a small number of floors, volunteer residents sort contaminants from recyclables.
- When staff visit each chute room, they collect glass and OCC by hand in a roll-out cart. Once the cart is full, it is taken to the main-floor storage area.
- Once per week, building staff wheel the roll-out carts to the curb in preparation for municipal collection.
- OCC is not collected by the municipality. Instead, building staff arrange to have this material collected by a private hauler.

Technology

- Standard disposal chutes positioned side by side are used in the system.
- Each chute includes a chute hopper with a 1.5-hour fire rating.
- A key-lock system is used to restrict access.
- Compared to most chute rooms, these are relatively larger in order to provide space for storage containers for recyclables. A typical room is approximately 2.2 metres long and 1.6 metres wide.
- Shelving is installed in each chute room to hold the storage bins.
- The main-floor storage area is also larger than in most buildings, providing ample room for 10 to 12 340-L roll-out carts, the garbage compactor and three chutes.

History/Progress

- The three-chute system was developed between 1990-1991 during the design and planning stages of this residential project.
- An education package was prepared for all residents which provided instructions on how to recycle with a three-chute system.
- In one building, recycling monitors have been selected to sort recyclables on the chute rooms on three floors, thereby reducing the number of recycling tasks which staff need to complete.

Performance/Results

- A study was conducted to compare the level of recycling achieved by a three-chute system and two other approaches. One of the other approaches is the centralized storage system in which residents are required to carry recyclables to a storage area, located on the sidewalk outside the building's front entrance. The third approach is a push-button carousel system; residents activate the recycling system by pushing a button in the chute room which corresponds with the type of material they wish to recycle (e.g. pushing the newspaper button positions the newspaper storage bin under the disposal chute). This system is also used to collect garbage.
- The results were:
  - The capital cost of the three-chute system was higher than for the other systems.
  - The level of recovery achieved by the three-chute system was less than for other recycling systems. Recovery rates for the three-chute system were 30.3 kg/capita/yr. This was 15 to 20% lower than in the other programs studied.
  - The rate of contamination with the three-chute system was much less than with the other systems. Contamination in the three-chute system was 3.4% of total recovery (6.8% and 10.7% for other programs studied).
- The study noted that the three-chute system was designed to provide a convenient household organics recovery system, which is not yet in place. Once in place, over-all diversion would likely increase significantly.
- Relatively low recovery may be, in part, due to the fact that residents had recently moved into the building. This would help explain why the recovery rates for OMG and old telephone books were lower in the three-chute building compared to the other buildings. The assumptions used to estimate the number of persons per unit could also have skewed recovery rates. As detailed figures for each building were not available, average occupancy rates from the local municipalities were used.
- The study suggested that recovery could be increased by implementing several basic changes to the building's waste handling system. These changes include:

- prohibiting OCC storage in the chute room (as this occasionally created a mess and restricted access to the recycling containers);
- staff visits to the chute rooms at least twice per week to ensure recycling containers do not overflow with material;
- providing on-going promotion and education.

Ownership/Financing/Government Involvement

- Funding assistance was provided by the federal and provincial governments for the following purposes:
  - to help offset the cost of the three-chute system,
  - to prepare an education package, and
  - to undertake an evaluation study.

Program Cost

- Capital cost (installed): $60,000 per building.
- Annual operating cost: $3,000 per building for the three-chute system.

Problems/Modifications

- In the large chute rooms, residents occasionally left bagged garbage and bulky items on the floor, which created a mess and physically prevented residents from recycling because it blocked access to the storage bins. Additional staff time was required to clean the chute rooms.
- Collection containers in the chute rooms are larger than the chute openings and were found by some building staff to be difficult to empty.
- Under-the-counter collection containers were reported by some residents to be too small for recyclables.
- In the main-floor garbage room, recyclables dropped down the chute would occasionally miss the container and spill on the floor. This was due to the gap between the end of the chute and the top of the collection container. This problem was corrected by fitting a metal box around the mouth of the chute so that it guided material into the roll-out carts.
- Potential changes could include:
  - collecting OCC somewhere other than the chute room to minimize clutter;
  - providing more promotion and education and using symbols rather than text on signage to reduce confusion because of language barriers;
  - training more volunteers to monitor/ operate the program; and
  - using larger storage containers in the main garbage room to reduce servicing requirements.

4 Resources

Contact

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Reports and Surveys

Resource Integration Systems Ltd., *Evaluation of a Three Chute Source Separation System for Multi-Family Buildings*. Prepared for The Daniels Group, May, 1994.

5 Summary Evaluation

Reasons for Success or Failure of Program

- As a new approach to recycling, the project is a success because it demonstrates that the three-chute concept is effective. Compared to other approaches, the level of recovery achieved by the three-chute system is lower than was originally expected. This may have been due to many factors such as language barriers, small containers in the kitchen units, and the fact that residents were new to the building.
- Although the three-chute system is 50% more expensive than other systems to build, and costs more to operate on an annual basis, the justification of this approach will ultimately depend on the successful implementation of an organics source-separation program.
- Although recovery was lower than in other programs, there are three contributing factors that may have affected this rate:
  - Fewer heavy materials (such as OMG and old telephone books) were recovered with the three-chute system, possibly due to people moving into the building and leaving old books and magazines behind.
  - New tenants may not have received the education package and therefore may not have been recycling materials.
  - Income and ethnicity influence consumption patterns and thus the types and amounts of waste produced, which in turn affect the amount available for recycling.
- Metal boxes have been placed around the mouths of the chutes in the main collection areas to prevent materials falling on the floor.
- This approach requires a relatively high capital outlay and requires more staff time to operate compared to some other systems.
- The three-chute configuration must be built into a building and is not appropriate for retrofits.

R&D Needs/Commercialization Potential

- means of increasing recovery in multi-family buildings;
- to evaluate methods to collect and store source-separated organics produced from multi-family buildings;
- to identify alternative collection containers (in-house, chute room, main collection area);
- systems for storing organics in a multi-family building (i.e., to eliminate potential for rodents or odour);
- promotion and education materials specific to multi-family buildings;
- in-house collection systems (i.e., containers or storage areas) for multi-family units;
- chute room design.

Replicability of the Project

- The three-chute system is replicable, although its high capital cost may discourage use in future buildings unless the implementation of a source-separated organics program demonstrates significant waste diversion.
- It is more likely to be used in urban, high-density settings.

Standard Multi-family Recycling

Increasing recovery from multi-family buildings is an essential element of achieving high diversion in large urban areas, where a significant proportion of residences are in multi-family units. Multi-family recycling projects generally fall into two categories: buildings with 10 units or fewer and buildings with more than 10 units. Studies in the Capital Region District (Victoria, British Columbia) and in Ottawa, North York, Mississauga and Etobicoke, in Ontario, point to the fact that, given the opportunity to participate in recycling, multi-family building residents typically divert between 35 and 55% of the waste of single-family units. Lower diversion rates are often attributed to a lack of convenience.

Some smaller buildings provide in-unit containers for collection that are set out at curbside by residents (much as in single-family residences). In others, recyclables are placed in a centralized collection area by the residents. The centralized container is maintained and set out as required by a superintendent or building supervisor.

Multi-family recycling in large buildings usually requires residents to carry recyclables to storage bins located at a central site in the apartment building or complex or distributed throughout the community. Some buildings provide in-house containers to residents. Centralized storage containers are usually located in on-floor garbage rooms, a central garbage room, near the front door of the building, or in a parking lot. Containers used for centralized storage include 90-gallon carts, bulk lift containers, garbage cans, steel drums (more applicable to small and mid-size buildings), and compartmentalized roll-off containers. Fire regulations, security, and convenience are the main issues in choosing bin type and location. Although some large buildings receive municipal collection, many hire private haulers for recyclables.

While dry recycling programs are gradually being introduced in many communities (particularly in Ontario, where this is now mandated by law), these programs are relatively new. Food waste diversion in multi-family buildings, either through three-stream source-separation systems or in community composters, is in its infancy.

A key factor influencing low diversion rates is the often transient nature of residents in multi-family dwellings; participation is reduced because people moving into buildings are not familiar with the recycling routine. Due to the lack of monitoring and easy public access, recyclable materials from multi-family buildings often suffer from high contamination rates. One important factor that inhibits multi-family buildings from providing convenient opportunities to recycle is limited storage space. To be effective, bins should be placed in a central location, which can often mean sacrificing usable or rentable space (e.g., parking lots or laundry rooms).

Case Study 18 Scarborough ReUze Building Centre, Scarborough, Ontario

1 Abstract

The Scarborough ReUze Building Centre is privately owned and operated. It has sold recovered building supplies since 1992. The Centre is the only one of its kind in the greater Toronto area. High-quality used building supplies are brought to the centre or picked up as far as 300 miles away from Toronto. Materials are stored and sold from a 10,000-square-foot retail facility, usually at a price approximately 25% of the original value. The ReUze Centre is successful. It has been holding its own financially for more than two years, with an estimated 20,000 customers in 1993. In addition to its success as a commercial enterprise, it offers an outlet for the reuse of materials that would otherwise be landfilled.

2 Community Description

Location

- The ReUze Centre is located within the greater Toronto area (GTA).
- It draws on a population of 2.3 million.
- The Centre is located in Scarborough, a densely populated urban area in the GTA that has a large IC&I sector.

Waste Management Context

- Under the Ontario 3R regulations, construction projects are required to source separate brick and portland cement, cardboard, drywall, steel and wood. Demolition projects are required to source separate brick and portland cement, steel and wood. Some of these can be difficult to recycle conveniently and cost effectively.
- Local landfill bans also prohibit disposal of drywall, OCC, scrap metal, surplus goods, off-specification goods and wood.
- Despite the regulations and landfill bans, the ReUze Centre has not planned to capitalize on the impacts of government regulation. In fact, staff report that little material has been provided to the centre as a result of these initiatives.
- Tipping fees in Metropolitan Toronto are currently $50/t (recently reduced from $150/t). Staff at the ReUze Centre believe that tipping fees are not a major factor in convincing suppliers to provide materials for sale in the store.
- Some of the materials collected and sold include pre-fab steps, slab doors, shelving units, bathroom fixtures, doors and door knobs, cabinets, fixtures, fittings, flooring, dimensional lumber and plywood off-cuts.

3 Program Description

Purpose and Sectors Involved

- The Scarborough ReUze Centre has received a major portion of its stock from projects in the residential sector. It is seeking to expand its network to access materials generated in IC&I projects.
- The ReUze Centre is a private-sector business venture.
- It accepts high-quality used building materials and resells them, often for do-it-yourself construction projects, for jobs where first-quality materials are not essential, and to homeowners, professional builders and landlords.

- The underlying philosophy is to recover and to distribute used materials as closely as possible to home.

Type/Method of Recovery

- Materials are collected by ReUze Scarborough staff free of charge (upon appointment) in a five-ton truck; they may also be dropped off by suppliers.
- In some cases, ReUze Centre staff assist in removing materials from a site to ensure that they are intact and undamaged.
- Materials received include carpet tiles, cabinets, doors, electrical supplies, floor coverings, hardware, heating supplies, plumbing fixtures, windows and a limited amount of lumber and plywood.

Process Description

- The operation is deliberately low-tech and simple to operate.
- High-quality construction, renovation and demolition materials are either dropped off (by residents or workers) or collected by company staff.
- Suppliers are not paid for materials donated. Charges are not levied for collection.
- Suppliers contact the centre to make an appointment for collection and to identify the material.
- ReUze Centre staff assess material value (by visual inspection or by telephone) to determine whether materials will be marketable.
- Incoming stock (from renovation jobs, surplus materials and demolition projects) is inspected, priced and shelved.
- Materials are sold to cottagers, do-it-yourself project workers and, increasingly, to IC&I construction and renovation projects.
- Equipment on site includes a forklift and a five-ton truck.

History/Progress

- The ReUze Centre was established by two former renovators in 1992.
- The Centre was originally located in a 15,000-square-foot warehouse, but this building was too large. A new 10,000-square-foot retail outlet has proven more satisfactory.
- The objective was to provide a business outlet for good-quality materials that had not completed their productive lives.
- The Centre was established as a business although, in the first year, a provincial grant was awarded to assist with start-up costs.

Performance/Results

- Materials are not weighed. Total waste diversion is estimated at approximately 300 t over 2.5 years (or approximately 120 t/year).
- Each tonne of material received generates approximately $1,500 to $2,000 in sales.
- Increased business (even through the recession) points to the success of the venture.
- The Centre is becoming more successful in penetrating the IC&I market as a supplier and a customer.
- Most materials accepted are eventually sold.
- 20,000 customers shopped at the ReUze Centre in 1993.

Ownership/Financing/Government Involvement

- $237,000 funding was provided for start-up by the Ontario Ministry of the Environment and Energy. The grant provided 50% of costs of specific items. Approximately $130,000 was used in its first year of development.

Program Cost

- The ReUze Centre is a private business; therefore, detailed cost estimates were not available.
- This is essentially a low-cost business venture.
- Main costs include rent on the building, a few items of equipment (e.g. truck or forklift), salaries for five staff, and transportation costs.
- Stock is supplied free of charge.

Problems/ Modifications

- Goods were originally overpriced. Prices have been reduced in line with customer expectations.
- Materials can be difficult to access. Removing materials intact requires more care by construction crews on IC&I jobs; therefore, material procurement requires considerable tenacity on the part of ReUze Centre staff.
- Staff at the Centre have conducted waste audits and/or reviewed waste composition and quantity analyses. Despite research that indicated availability of certain materials, some have been difficult to obtain because they are recycled (e.g., wood is often chipped in the GTA area).
- Identifying acceptable and sellable materials was difficult at the outset.

Expansion Plans

- There are no plans to expand the operation at this time.
- C&D projects are estimated to have fallen by about 20% in the GTA during the recession of the early 1990s. The Centre has sufficient inventory and plans to consolidate before expanding.
- The ReUze Centre would like to develop a stronger presence in IC&I projects for both recovery and sales. This requires developing a good network and having large enough supplies of standardized materials to cater to construction projects.
- The Centre may develop a guide on how to start up profitable construction and demolition materials reuse ventures.
- The Centre is moving toward more involvement in active demolition/renovation jobs (i.e., sending a crew in to remove materials for the store). This is a benefit to contractors (free labour and disposal) and to the centre (inventory procurement).

Contractual Elements

N/A

4 Resources

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Reports and Surveys

Association of Municipal Recycling Co-ordinators (AMRC). *Making the Most of Reuse Opportunities*. November, 1993.

5 Summary Evaluation

Reasons for Success or Failure of Program

- Program staff have always been clear about the purpose of the venture (i.e., that it is a business—for profit). One of the keys to success lies in having become self-sufficient at an early stage, outside funding has not been necessary. This approach has enhanced flexibility and market strength.

- The ReUze Centre has never made any environmental claims. Environmental claims are not seen by staff as likely to attract customers or suppliers for this product line.
- Staff do whatever they can to help suppliers get the materials to the ReUze Centre. ReUze Centre staff act quickly on any new sources of material.
- The program director has a background in construction and demolition. He knows the materials and their prices, and he maintains contacts in the industry, which is crucial in accessing stock.
- Good-quality materials are sold at low prices.
- The Centre is an idea whose time has come, it caters to an obvious industry need.
- Before any material is collected (free pick-up), staff conduct an informal cost-benefit analysis to ensure that cost of collection will be recovered in sales. Staff are willing to travel long distances to collect rare or especially high-quality (or large quantities of) materials.
- Staff are on the lookout for new materials, new sources of stock, quantity items and areas in which to expand.
- The operation has been kept low-tech, and all staff are capable of performing virtually any function on site.
- Some materials that were anticipated to be available (e.g., wood and some wood products) are sent to recycling rather than to reuse operations, thus reducing their productive life spans.
- Customers will not pay half-price for used goods, regardless of their condition.
- In the first year, more materials (some of inferior quality) were accepted due to staff concerns that these should be collected, and this contributed to a high level of residue waste that year.
- Centre staff were well versed in the construction and demolition industry. None of the staff were retail experts, and this expertise had to be learned on the job.
- The ReUze Centre now accepts only good-quality materials that can be sold.
- Pricing is usually conducted by committee, and prices have been reduced.

R&D Needs/Commercialization Potential

- ReUze Centre staff believe that significant amounts of good-quality (sellable) materials are being disposed of from projects in the IC&I sector. The intent is to penetrate the IC&I sector to access these materials. Research into current barriers and penetration points is under way.
- Because this is a low-tech approach, there is no apparent need for new equipment or processes.
- A computerized database to help track inventory movement would be useful, but it needs to be designed to specifically suit the needs of this type of operation.

Replicability of the Project

- This particular type of operation (e.g., C&D waste, high-value materials retail operation) appears to be most readily applicable in an urban area, where materials and market demand exist.
- This type of operation may also be applicable in areas where summer camps, hunting camps, cottages and other structures may provide demand for second-hand materials.

Case Study 19 The Habitat Re-Store, Winnipeg, Manitoba

1 Abstract

The Winnipeg Habitat Re-Store is a non-profit reuse centre for building materials that opened in 1991. It is linked with the Habitat for Humanity Project, which pools people's time and skills to build homes together with low-income families. The Winnipeg Re-Store is a retail outlet of surplus new and used building materials. Total sales in 1993 were $255,789, and revenues support Habitat's Home Building Program. Prices start at about 50% of the retail price for top-quality merchandise and drop to about 25% as an average price. Most materials presented come from homeowner renovation projects and are collected by Winnipeg Re-Store staff and volunteers or are dropped off by suppliers. Significant amounts of materials have also been obtained from manufacturers and from buildings being demolished. Primary project goals are to support the Habitat building program, to reduce the amount of waste sent to landfill from construction and demolition projects, and to maintain a stable revenue base.

This case study provides an example of a construction and demolition reuse opportunity that earns profits that can be applied to community projects.

2 Community Description

Location

- The store is located close to the city centre in Winnipeg, Manitoba.
- Due to the successes of the program in locating materials, the operation has moved twice since 1991 and is now in a 16,000 ft^2 retail location.

Waste Management Context

- This operation is supported by a population base of 670,000.
- Although two landfill sites have recently closed, landfill pressure is not a driving force; however, staff and volunteers feel that pressure is likely to grow over the coming years. Landfill tipping fees are approximately $35/t.
- Landfill bans on construction and demolition wastes are not yet a factor.

3 Program Description

Purpose and Sectors Involved

- Materials are recovered from the construction and demolition industry.
- The Re-Store provides a source of affordable building materials.
- Major customers include rental property owners, cottage owners, and do-it-yourselfers. Some materials are also used in IC&I construction projects.

Type/Method of Recovery

- An average of 3 to 4.5 t is received daily, although daily intakes of up to 22.5 t have occurred. There is considerable seasonal variation and unpredictability in the business.
- 80% of residential materials is collected by staff and volunteers at no charge; materials are also accepted from delivery. Only 2 to 5% is drawn from IC&I projects, and the remainder is generated from miscellaneous activities.
- A regular collection route has been established and is well publicized.

- Equipment reflects the types of materials recovered. A three-ton truck was originally used for collection, along with a large flatbed truck. The current preferred option is a one-ton cube van, which is smaller and more maneuverable. Such a van can serve up to 30 households/day.
- The Re-Store is contracted to salvage materials from renovation projects conducted by a local kitchen cabinet installation firm.
- Old paints collected from Manitoba Hazardous Waste Management Corporation depots are provided to Re-Store for resale. The range of products accepted has been limited to latex-based only.
- Start-up equipment includes (at minimum) a forklift, a half-ton truck, a pallet jack and a large warehouse area. Equipment is important in improving efficiency.
- Collection equipment includes:
  - one half- ton collection vehicle,
  - one one-ton cube truck, and
  - one 24-foot van.

Process Description

- Primary materials collected include cabinets, electrical equipment, hardware, heating equipment, cast iron tubs, paint, windows and doors, and plumbing fixtures.
- Stock is kept in Re-Store large (16,000 ft^2) warehouse retail facility.
- A total of 17,700 volunteer hours was logged in 1993 (up from 8,795 in 1992).

History/Progress

- In its fourth year of operation, the program continues to receive and sell large quantities of materials.
- In 1991, a total of 103.5 t of building materials and over 15,000 L of paints and solvents was diverted from landfill and other methods of disposal through the Re-Store.
- Total sales in 1991 were $84,857. Sales increased to an estimated $255,000 in 1993.
- The project employed four full-time staff and four full-time volunteers. The project currently employs five full-time staff, with a projected two more to be hired.
- Volunteers are an integral element of the organization. Volunteers help with stock control, accounting and driving trucks. Paid staff are usually selected from the volunteer network. They are chosen on the basis of familiarity/ expertise in required subject areas.

Performance/Results

- In 1993, an estimated 150 to 250 t of building materials was diverted from landfill, with 2,300 pick-ups and many on-site collections. Projections for 1994 were 3,000 pick-ups .

To put this initiative in context: in 1992, construction and demolition refuse in the city of Winnipeg was estimated at 13,870 t.

Ownership/Financing/Government Involvement

- Grants received from the Environmental Partners Fund ($62,000) were used for operational expansions.
- The Re-Store is now completely self-financing.

Program Cost

- Total operating and capital costs for 1993 were $275,000.
- Some of the major costs included $25,000 for rent; $10,000 for salvage and related costs; and $108,000 for payroll.

Problems/Modifications

A tighter system for inventory control and management is needed. Since intakes and sales fluctuate dramatically, a computerized data management system would be more efficient.

Expansion Plans

- The volunteer system, which was once very strong needs, to be revitalized.

Contractual Elements

N/A

4 Resources

Contact

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Reports and Surveys

A Guide for Establishing Building Material Recycling Centres, Environment Canada.

5 Summary Evaluation

Reasons for Success or Failure of Program

- A crucial element of success is making material collection easy for suppliers.
- The business is seasonal, and sales during winter months are approximately 50% of summer sales.
- Markets must be secured.
- Goods must be simple to access and easy to use.
- People will participate only if it is easy, quick, smooth and efficient.
- People will not pay the same for reused goods as for new.
- A good computer system is needed to help with product tracking (both within the store and to anticipate delivery), to monitor profitability, and to conduct product tests. The store is just like any other retail outlet, and customer satisfaction is the first concern. The computer system helps to provide the service quickly and efficiently.
- Trucks were taking too long for collection. Flatbeds were cumbersome (due to their size) and required too much time making turns in small areas. A new one-ton cube truck (which can serve approximately 30 households/day) has been purchased and, purchasing another is under consideration.

R&D Needs/Commercialization Identified

R&D is being conducted in-house on how to combine and reuse specific products (e.g., paint).

Replicability of the Project

- Additional building material recycling stores are currently operating in Canada, and several have been established throughout North America. Successful building material recycling stores are operating in cities as small as 40,000 people. Any size community can establish a recycling centre for used and surplus building materials, as long as the scale is matched to the community.

Case Study 20 Gold River Two-stream Wet/dry System, Gold River, British Columbia

1 Abstract

The Gold River Project is a full-scale, two-stream wet/dry waste diversion system. Dry recyclables and organic wastes are collected separately for processing in a municipal Material Recovery Facility (MRF) and composting facility. The project was established in 1993 with the objective of achieving the provincial target of 50% waste diversion from landfill. The system manages residential and IC&I wastes in a relatively affluent logging community on Vancouver Island. Although the program is costly on a per-tonne basis, a 58% diversion rate was achieved in the first year of the project. Although the project was successful in achieving the 50% diversion target there are a number of operational issues which could be improved. These include providing for greater promotion and education to help reduce material contamination (primarily with household hazardous waste), identifying stronger markets, and undertaking measures to reduce transportation costs.

2 Community Description

Location

- Gold River is approximately 375 kilometers from Victoria, near the geographic centre of Vancouver Island.
- The population is about 2,200 (1991 census) with 715 households.
- It is a relatively wealthy community.
- About 60% of workers are employed in the pulp and paper industry (tree harvesting and a pulp and paper mill), although the economic future of the community is uncertain (the mill laid off 150 workers in December, 1993).

Waste Management Context

- The village collects and disposes of solid waste generated in residential and IC&I sectors. The local mill disposes of non-industrial waste at the village landfill. The mill operates its own landfill for industrial waste disposal.
- There is no tipping fee for waste disposal at the village landfill.
- The wet/dry program was developed due to pressures when the existing landfill was estimated to have only 10 years' capacity remaining.
- The BC Ministry of Environment refused a permit to site a new landfill or to expand the current operation until the village implemented a waste diversion program that attempted to achieve the provincial 50% waste diversion target.
- At the same time, a citizen group was pressuring the local council to implement a waste diversion program.
- A two-stream separation system was implemented, because municipal staff and politicians believed that this was the most convenient system and that participation might be reduced if residents were required to separate waste into a greater number of fractions.

3 Program Description

Purpose and Sectors Involved

- The purpose of the wet/dry project was to increase waste diversion to more than 50%.

- The project focuses on the IC&I and residential sectors (excluding the pulp and paper mill, which manages its own industrial wastes).

Type/Method of Recovery

- The Gold River project is a two-stream wet/dry system involving separate collections of a dry recyclable stream (including papers, glass, metals, plastics, other materials) and a wet organics stream (which includes kitchen and yard waste).
- Residential materials (wet and dry) are recovered on different days, once per week, using the existing fleet of rear-packer trucks.
- IC&I materials are also collected once per week over the remaining three days.
- Residential dry recyclables are collected in a blue bag.
- Residential wet wastes are usually collected in a green or black bag. (Anything but blue can be used).
- All IC&I facilities are provided with separate two-cubic-yard lift bins for dry recyclables (blue bins) and organic wastes (green bins).

Process Description

- All materials (residential and IC&I, wet and dry) are processed in a single MRF and composting facility.
- The MRF is a 1,200-square-metre fully enclosed facility.
- All incoming waste is weighed at the MRF and at the landfill.
- A skid steer loads bagged materials onto a feed conveyor.
- Materials are passed along an inground conveyor to an incline conveyor.
- Large pieces of OCC are picked off at the front of the line.
- Materials are passed by the conveyors to a rotating carousel where two staff manually debag materials using electric cutters.
- A magnetic separator extracts ferrous materials; otherwise; material sorting is completed by hand.
- Glass, polyethylene/terephthatlate, newspaper, magazines, boxboard, natural high density polyethylene, other plastics, steel and aluminum containers (by brand name), and foil are sorted.
- Materials are baled, and a glass crusher is used where necessary.
- Organics are processed in the same manner as dry recyclables with a few added steps.
- A trommel screen (approximately 2 metres in length and 1.5 metres in diameter) with internal blades opens the bags. The materials are screened and sorted, with non-organic materials picked off for disposal or recycling. Organic material is collected for two weeks or until a sufficient pile has been amassed.
- A 1,200-square-metre covered compost pad is adjacent to the MRF. It is open, with a roof, and surrounded by a wire fence (to protect against bears). Material is composted in static piles with negative aeration. Leachate is collected and treated in the municipal sewer system.
- Compost is used by the Department of Public Works for municipal landscaping projects.

History/Progress

- In 1990, a 10-year potential landfill capacity was identified.
- The Gold River wet/dry recycling program has been running since July 1992.

Performance/Results

- In 1993, a total of 520 t of municipal and residential waste was recycled or composted.

- This represented 58% waste diversion, based on 1993 waste disposal figures.
- In 1993, 890 t of residential and IC&I wastes were collected (including non-industrial waste from a local mill). Of this, 265 t originating from areas not participating in the project, were immediately disposed of. The processing centre received 630t; this consisted of 380 t (60%) organic waste and 250 t (40%) dry recyclables. Of the 630 t sent to the centre, 110 were landfilled.

Ownership/Financing/Government Involvement

- A $300,000 provincial grant was received.
- Procter & Gamble also provided financial support for the compost component by hiring an engineer to conduct trials on different batches of compost over 18 months. Initial householder education was supported by Procter & Gamble, and capital financing for some labratory equipment to test finished compost was also provided.

Program Cost

- Total capital costs were $1.4 million.
- 1993 operating costs were $421,500, including $360,400 in operating costs and $96,300 in annual capital costs.
- Total costs are estimated at $473/t.
- Operating costs are estimated at $332/t.

Problems/Modifications

- Promotion and education was not sufficient, due to a lack of funds and insufficient understanding of their importance. This affected the level of sorting by residents and ultimately increased over-all processing costs.
- The program is not equipped to collect or to store household hazardous waste (HHW). In the absence of provincial collection programs, residents were asked to warehouse HHW. Contamination of materials by HHW was a problem.
- The community is located far from markets, and transportation costs are high. Also, the majority of plastics collected is not recyclable and contributed to higher costs.

Expansion Plans

The Comox/Strathcona regional district (which includes Gold River) is preparing a regional waste management plan. The two major options are to shut the Gold River landfill site, or to expand production at the wet/dry facility to process more material from neighbouring communities.

Contractual Elements

Not identified

4 Resources

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Reports and Surveys

- None available
- Site visit report, Spring 1994

5 Summary Evaluation

Reason for Success/Failure of Program

- The program is considered successful since it established waste diversion in a community where none had previously existed, and it achieved a 58% diversion rate in a short time.

- Success is partially due to the fact that the two-stream approach is relatively simple for residences and businesses to participate in.
- The composting process has been successful, partially due to its simplicity. Odours have not been a problem, and end uses have been found for the compost.
- Original compost piles were built after one week of storage; however they were too small to control temperatures and properly heat the core. Compostable materials are now accumulated over a two-week period prior to processing.
- Two compost techniques (positive and negative aeration) were tested. The negative aeration produced more homogeneous temperatures throughout the pile and effectively heated the core.
- MRF equipment was adequately sized to suit current community needs; extra shifts can be added if material throughput increases.
- Debagging materials by hand was time consuming and contributed to some staff injuries. Electric cutters have reduced injuries.
- All cardboard, aluminum, steel and some PET and natural HDPE have been successfully marketed. To address the problem of high shipping costs to distant markets, the village is looking into forming a markets co-operative for the whole of Vancouver Island.
- The approach is costly. A three-stream approach may reduce costs by engaging participants in further source separation, reducing processing costs, and potentially increasing quality of materials.
- Additional pre-education for system users would have been helpful. Intensive and on-going promotion and education is essential.
- Contamination should be anticipated with strategies for prevention. Gold River did not specifically address HHW, anticipating that government commitments to establish a collection system would be implemented. (They have not been to date.)
- The village is satisfied with the program.

R&D Needs/Commercialization Potential

- The Gold River wet/dry program demonstrates that small communities can divert over 50% of their waste from disposal. Further R&D should focus on systems and technologies which can achieve similar targets at a lower cost.

Replicability of the Project

- The Gold River project is replicable in many areas, assuming capital and expertise is available.
- The Gold River project was conducted in a political context where increasing waste diversion was essential. The community had an important stake in the success of the project; it proceeded despite high program costs, which residents were willing to pay as they are very committed to environmental issues. The economic conditions underlying development of the program are not likely to exist in all areas of the country.

Case Study 21 Waste Watch Demonstration Program, Prince Edward Island

1 Abstract

Waste Watch is a system of waste management introduced in Price Edward Island (PEI) in November 1992. Two demonstration areas were selected for the project (one in the Summerside/ Prince County area and the other in the Capital Region/Charlottetown). Under the program, compostables and garbage are collected every other week (in specially provided collection bins), and recyclables are collected monthly in blue bags. The project was initiated by a multi-stakeholder steering committee faced with the need to establish a new landfill in Prince County. The project's emphasis is on public awareness/education, maximizing the diversion of organic materials, using existing equipment/resources wherever possible, and enhancing the efficiency of the island's energy-from-waste (EFW) facility. The program has achieved an average diversion rate of 66% within the demonstration area. It is one of the most successful integrated waste reduction demonstration programs in Atlantic Canada.

2 Community Description

Location

- PEI's population is approximately 130,000. While the island is 1.3 million acres in size, only 40,000 acres are urban. Consequently, PEI is one of the most densely populated provinces in Canada.
- Prince County (pop. 27,000) and Charlottetown (pop. 15,500) are the locations of the two Waste Watch demonstration projects. The Prince County project started in November 1992 and the Capital Region project started in October 1993.

Waste Management Context

- In the 1970s, PEI had approximately 450 dumps and two "Tee-Pee" burners. An energy-from-waste facility was opened in 1983. As of June 1994, the island had an EFW facility operating at 66 t/day, 3 regional sanitary landfills, 12 roll-off container sites and 26 community disposal sites.
- The current landfill tip fee is $30/t.
- The Prince County Regional landfill closed in the fall of 1994. The energy from the waste plant is at or over capacity nine months of the year.

3 Program Description

Purpose and Sectors Involved

Waste Watch is focused on both residential and smaller IC&I generators; little effort has yet been made to incorporate large industrial generators into the program, although East Prince Hospital (100 beds) is an important exception.

The purpose of the project is:

- to encourage waste reduction through public education and to encourage widespread political/community support for the Waste Watch program;
- to reduce the amount (and environmental impact) of waste sent to landfill (e.g., to reduce quantity and quality of leachate by removing organic material);
- to maximize efficiency and performance of the existing EFW plant—e.g., to improve fuel quality, to reduce emissions, to reduce wear on plant, to reduce odour and to reduce ash destined for landfill by removing recyclable and

compostable materials from the waste stream; and

- to improve over-all the PEI waste management system.

Type/Method of Recovery

- Each household participating in the Waste Watch demonstration project is asked to separate its waste into three streams:
  - **recyclables**, including newsprint with non-glossy inserts, phone books, egg cartons, corrugated cardboard, glass bottles and jars, metal food and beverage cans, and soft clean plastic bags. Recyclables are placed in blue bags on the first Wednesday of each month and are collected by a private contractor using a dedicated vehicle. The contractor is responsible for marketing all recyclables collected. Householders are asked to place all recyclable paper and corrugated cardboard in one bag and all other recyclable materials in another.
  - **compostables**, including food waste (i.e., meat, bones, fish and dairy products), non-recyclable paper, boxboard, yard trimmings, sawdust, wood shavings, paper vacuum cleaner bags and contents, animal or human hair, cat litter and wood ash. Compostables are collected every other week . Each household is provided with a small, daily- use wet-waste kitchen bin and a 64-gal. wheeled green Compostainer (manufactured by Schaefer System International). In East Prince, compostables are transported and windrowed at a temporary site at Summerside Forces Base. (The initial site was inside an available hanger, but it has since been moved outside; the final site will be at the new regional landfill). In the Capital Region, compostables are transported to a private compost site approximately 20 minutes from the city centre. Both refuse and compostables are collected by a single operator in a standard Shupak side-loading garbage truck modified with the addition of a cart lifter ($4,000 cost).
  - **garbage,** which is collected every other week at the same time as the compost container is collected. Householders in the demonstration area are provided with a 64-gal. grey wheeled container for their "other waste" (including all rigid plastic containers, diapers and sanitary products, textiles, foil and aerosol containers). In East Prince, garbage is delivered to the regional landfill. In the Capital Region, residential waste is delivered to the EFW facility for incineration.
- Participating households post a Waste Watch sign in their yard to notify the collection contractor. In the summer of 1994, the project used householder feedback forms to advise households of any contamination/sorting mistakes made.

History/Progress

- The East Prince project has operated in two phases. In phase one, 100 families in ten East Prince communities were recruited (by local municipal politicians) to participate in the program. Phase one was extended for six months, until April 1993. Total diversion during phase one of the program was 27.67 tonnes of materials (46.6% was composted and 16.2% was recycled, producing a 62.8% diversion rate). In phase two, Waste Watch was expanded to 220 households in East Prince on June 15, 1993. In addition to the 120 new households, Prince County Hospital also joined the program at this point. In phase two of the East Prince demonstration, 16.47 t of residential material was diverted (13.65 t of organics and 2.81 t of recyclables). In addition, over 9 t of cafeteria and patient food waste was diverted from Prince County Hospital during the first six-month period of the project. Phase two of the East Prince project was extended to the fall of 1994, at which point a new regional landfill was opened. County-wide expansion plans were

also finalized at that time. The new landfill does not accept organic materials which could be composted or recyclable materials for which there are available markets.

- The Waste Watch demonstration program expanded to Charlottetown/Capital Region in October 1993. Under the first six months/phase one of the Capital Region program, 240 households were selected from four Charlottetown area municipalities (again using municipal politicians to identify and to select participants). Between October 1993 and March 1994, 68.7% of residential waste was diverted from the participating households. During phase two (launched in April 1994), five additional Capital Region communities agreed to participate in the program, bringing on an additional 160 households.
- In February 1993, a survey was conducted with 64 of the participants in the phase one program. The overall level of satisfaction with the demonstration program was very high: 94% of respondents said that the separation of wastes is easier than anticipated; 98% were pleased with the rate of waste reduction achieved in their homes; 94% would recommend Waste Watch to their neighbours.

Performance/Results

- Within the demonstration area, targeted and actual participation is 100% (participating householders are self selected). To date, the project has focussed strictly on single-family households.
- Diversion within the residential sector is 68%. The Department of Environmental Resources estimates that total annual Municipal Solid Waste (MSW) generated on the island is 102,808 t.
- Other than being a signatory to the National Packaging Protocol (NAPP) agreement (50% packaging diversion from disposal), and its commitments to the Canadian Council of Ministers of Environment (CCME) goals, Prince Edward Island has no established province-wide diversion targets. One of the purposes of the Waste Watch demonstration program was to determine the actual rate of diversion achievable through a comprehensive program.

Ownership/Financing/ Government Involvement

- Waste Watch has received demonstration funding from two primary sources: Environment Canada Environmental Partners Fund and the PEI Department of Environmental Resources. Additional support has been provided by Atlantic Canada Opportunities Agency (ACOA), the PEI Department of Agriculture, Fisheries and Forestry, and the local municipalities that have participants in the program.
- Provincial and municipal governments have been the primary initiators and (along with the federal government) funders for the Waste Watch demonstration project. The private sector is the primary service provider. The over-all project has been guided by a multi-stakeholder steering committee.

Program Cost

- Since this is still a demonstration project (with widely dispersed households participating in the program), it is difficult to precisely estimate current and future projected program costs.
- The PEI Department of Environmental Resources anticipates that Waste Watch will be comparable to the cost of current waste disposal in the province and has presented the following cost summary (on a per-household basis):
  - One contractor has projected that collection costs would be $35 per household per year for a full-scale regional program.
  - The cost of the carts is based on a lease purchase and rounded to $3.25 per month for five years. After this, the cost is zero per

year. The Schaefer carts are guaranteed for 10 years, and over 80% reportedly last 20 years or more. The average homeowner spends between $20 and $25 per year on garbage bags, which can be redirected to offset the cost of the carts.

- Stickers and miscellaneous costs are one-time/start-up costs only.
- Tipping fees are not included in this summary. They range from $30 to $50 per household per year.
- Recyclables handling and processing are projected at $1 per household per month for material collected. Revenues remain with the collection contractor.
- In the demonstration program, participating communities were asked to contribute $50 per household in phase one and $100 per household in phase two to the program costs.

Problems/Modifications

- As the program is fairly new, no significant problems have been identified.

Expansion Plans

- The most immediate plans are to expand the Waste Watch program to all 10,000 households in Prince County to coincide with the opening of the new landfill and regional composting facility. (Total estimated capital cost for this project is $3 million: $2 million for the landfill; $800,000 for the compost facility; and $200,000 for composting equipment.) Further expansion into the Capital Region, into the remainder of Queens County and eventually into Kings County (the east end of the island) will depend on the political and public acceptability of the program, the program's technical merits and success, and the overall program costs.

Contractual Elements

- All collection services are privately contracted. The Prince County compost facility is publicly owned and operated. The Charlottetown compost site is on private land (for which a fee is paid) but is publicly managed. The recyclables are also privately managed.
- At the time of this case study, Prince County was on the verge of tendering county-wide collection services for an expanded program. The area is divided into four regions, and it is anticipated that contractors will be invited to bid on one or all of the collection contracts.

Expanded Program 1 year - April 94 Start **Regional Program Long Term**

Item		YR1	YR2	YR3
Pick-up by contractor	$ 70	$35	$35	$35
Carts	39	39	39	0
Recycling bags	10	10	10	10
Stickers	5	5	0	0
Miscellaneous	2	2	0	0
Total	**$126**	**$91**	**$84**	**$45**

4 Resources

Contact

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Reports and Surveys

Limited published material is available on the program, although a variety of information brochures and guides used to educate consumers are available. In addition, in October 1990, PEI's Department of the Environment (as it was then known) prepared a brief "Waste Reduction Program" summary outline for Prince Edward Island.

5 Summary Evaluation

Reasons for Success or Failure of Program

There have been three main elements of success for the Waste Watch program.

- The program has been clearly focussed on what offers the largest and most cost-effective waste-reduction potential: compostable material. Although Waste Watch households also set out recyclable material, the most significant waste reduction (over 50% of potential waste) is through composting. The compost currently produced at the two sites on the island meets all provincial quality standards. Both sites are windrow facilities and accept a broad range of compostable material. They provide an opportunity to test the impact of broad-based material inclusion on compost quality.
- Waste Watch is focussed on using of existing equipment as much as possible. One of the objectives of the demonstration project is to contain over-all project costs at the same level as current waste management costs in the province.
- The program is also focussed on both public and political support for the project. Participating households were invited to take part in the program through door-to-door solicitation by their municipal councillors. Waste Watch is dependent on effective material separation at source and active participant education on waste reduction and recycling. Future expansion of the demonstration will depend directly on political support for the initiative.

R&D Needs/Commercialization Potential

The major research components of the Waste Watch project are:

- The technical impact of significantly less organics materials on the operation of the EFW facility (and on future landfills);
- The impact on compost quality of a highly mixed compost stream; and
- The technical, logistical and cost implications of potentially expanding the facilities to handle several separate waste streams island-wide.

The Department of Environmental Resources is examining the impact of significantly reduced levels of organic materials (and of recyclables) on fuel quality, emissions, plant wear, odour and ash production from the EFW facility. Similarly, the government will examine the same impact of reduced organics/recyclables in the waste stream on odours, quantity of leachate, quality of leachate and leachate treatment costs at landfills. The results of these research efforts are not available to date but are likely to identify a number of R&D needs. Mitigation measures to reduce (or to eliminate) the potential problems

associated with pest control and runoff from the outdoor composting facility for East Prince will need to be addressed. The composting facilities on the island are also initiating a project to compost disposable diapers.

The major commercial ingredient of the Waste Watch program is the Schaefer Compostainer. The container is popular with participating householders and makes the bi-weekly collection of both refuse and compost convenient for the householder.

Replicability of the Project

Although PEI is Canada's smallest province, it is also one of the most densely populated. PEI's size and population base are typical of many agriculturally based counties in the country. As such, Waste Watch's emphasis on organics recovery, use of existing equipment wherever possible, and public education and awareness are readily replicable in other parts of Canada.

Lunenberg Residential Organics Composting

There is one other "advanced" residential organics composting (and dry recycling) program under way in eastern Canada that is attracting attention.

The Municipality and District of Lunenberg (38,000 households in the region) in southeast Nova Scotia launched a 1000-household four-stream demonstration project in September 1992. Based on the results of the successful pilot program, the district initiated the construction of a separation program and in-vessel compost facility in March 1994 with the following objectives:

- The full regional program will separate residential and selected IC&I wastes into four streams: source-separated waste paper, source-separated recyclable containers, source-separated organics, and the remaining mixed waste.
- The compost/separation facility is designed to process 32,000 t of material/year (i.e., 180 t/day). Resource Recycling Technologies of New York designed and constructed the dry facility and supplied the recycling equipment. Convertit Miller Atlantic (representing EBARA Environmental in Japan) supplied the in-vessel compost technology (an agitated-channel technique).
- Total project costs are $8.9 million ($2.8 million for site services and building construction, $4.9 million for equipment and a contingency for engineering and financing of $1.2 million).
- Residents will be provided the same type of Compostainer that is used in the PEI's Waste Watch program for the collection of household organics. At the time this case study was prepared, collection frequency and methods had not yet been determined. Collection bids were being reviewed, with start-up expected for November, 1994.
- One-third of the project's capital costs (to a maximum of $3 million) is to be contributed by the province; the remaining two thirds of capital and operating costs will be covered by the four area municipalities. The project is designed to divert 55 to 60% of waste currently destined for landfill.

For more information on this program, contact Ray Halsey at the Municipality of the District of Lunenberg in Nova Scotia; phone (902)543-8181.

Case Study 22 Four-stream Collection System, Lemsterland, the Netherlands

1 Abstract

As a result of a landfill capacity crisis several years ago, OLAF (Openbaar Lichaam Afvalver Wijdering Friesland), the regional waste management authority, required all municipalities to source separate all residential organics. When Lemsterland evaluated how to meet this requirement, it decided on a two-stream (organics/garbage) collection system for household waste. It was approached by the province of Friesland to become a demonstration project for a four-stream collection system, and it agreed to participate as long as paticipation did not cost more than the collection system Lemsterland had chosen.

The initial three-year full-scale demonstration project involved 12,000 people (4,500 households) in July 1991. Each household was provided with two 240-L collection carts, each of which had an internal vertical wall to divide the cart into two compartments. The waste is source separated into four streams (plastic, metal, drink cartons (PMD); organics; paper fibres; and garbage). Each cart (and each of the four streams) is collected bi-weekly. Bulky wastes are collected monthly; household hazardous wastes are collected door-to-door six times per year, and glass is collected at 23 depots located in convenient areas. The program achieves 63% diversion of residential waste, and it could achieve a higher rate if methods of diverting bulky wastes could be found.

The demonstration project came to an end in July, 1994. The municipality has decided to continue with separate collection of organics and paper but will no longer collect PMD as a separate stream, as it has concluded that this is too expensive. However, as of 1998, all waste in The Netherlands will have to be processed prior to landfilling; therefore OLAF is considering mixed-waste processing and anaerobic digestion of the remaining garbage, as the cost of incineration is prohibitively expensive.

2 Community Description

Location

Lemsterland is one of 31 municipalites in the province of Friesland in the northern Netherlands. The province has 700,000 people and contains several small villages. Lemmer (population 9,000) is the largest and is a popular tourist town. The municipality is predominantly rural, with a population of 12,000 in 4,500 households, virtually all single-family, in low-density areas.

Waste Management Context

Landfilling became enormously expensive ($155/t) in Friesland (see History/Progress for explanation). Composting was only 30% of the cost of landfilling, at $46.50/t. This provided a strong incentive to compost as much waste as possible. OLAF required all municipalities in Friesland to source separate organics as a cost-saving measure. While the system was being redesigned to source separate organics, Lemsterland was approached by Friesland to initiate a demonstration project to test more material separation. They agreed to implement a four-stream collection system as long as it did not cost any more than the three-stream system they had been considering. The Dutch government, OLAF, ERRA and NOVEM provided funding for the project.

New regulations in the Netherlands ban the landfilling of unprocessed waste as of 1998. This will require additional processing of the garbage stream remaining after the current source-separation efforts. This presents OLAF with a new challenge, as all incinerators are privately owned, which can raise the cost of incineration. Options being

considered to meet the new regulations are mixed-waste processing of the garbage stream, and anaerobic digestion of the organic fraction.

3 Program Description

Purpose and Sectors Involved

The purpose of the program is to achieve maximum diversion of residential waste through more separation into different streams at the household level.

The system involves collecting waste from residential sources in four separate streams, which are source-separated by the householder. Glass is collected in depots, and door-to-door bulky waste and household hazardous waste (HHW) collections are provided less frequently.

Type/Method of Recovery

The collection system consists of:

- bi-weekly collection of four streams of waste;
- collection of glass in depots;
- door-to-door collection of household hazardous waste six times per year;
- monthly collection of bulky wastes; and
- collection of textiles in five textile banks.

Organics/PMD/Paper/Garbage

The four-stream system collects each of the following materials in a separate stream which is source separated by the householder:

• PMD	grey bin
• paper	grey bin
• organics	green bin
• garbage	green bin

Each household is provided with two bins (each 240 L). Each bin is vertically split into two compartments with a wall down the middle, thus allowing the waste stream to be separated into four streams. The grey bin is for paper and PMD. The green bin is for organics and garbage. The bins are collected on alternate weeks; therefore each stream is collected once every two weeks.

One special dual-compartment collection vehicle (manufactured by Geesink) collects the materials disposed of in the 240-L bins. The vehicle's collection chamber is horizontally split to match the wheeled bins. The upper compartment is 12 m^3 while the lower is 8 m^3. The truck can hoist and dump two bins at a time, discharging the contents of each compartment into its matching truck compartment. When the grey bins are collected, the paper fraction goes into the upper compartment while the PMD goes into the lower. When the green bins are collected, the organic fraction goes into the upper compartment and the garbage goes into the lower.

All 4,500 households are serviced in 4.5 days, Monday to Friday. In Lemmer (the largest town), up to 1,500 households are serviced each day. The truck crew consists of a driver and two loaders. Collected materials are lightly compacted.

Residents must bring bins to a yellow dot marked on the pavement for collection. The yellow dots are located so that no household has to bring a bin more than 50 m. Some collection points have as many as 12 bins at one location. When the truck stops, the driver and two loaders all help to load the bins onto the lifting arms. During the site visit (June 1994), 12 bins were emptied in about three minutes.

Glass

Glass is collected at 23 drop-off sites (41 igloos) located conveniently at a density of one per 500 inhabitants. A glass recycling company collects the material directly. Lemsterland officials estimate 95% recovery of non-refillable glass through this system.

Textiles

Textiles are collected in a series of five "textile banks". In addition, four to five different charitable organizations distribute plastic bags for annual door-to-door textile collection. This program is less successful and will probably be cancelled.

Household Hazardous Waste

Each household is supplied with a 27-L red HHW box. A "Chemocar" provides curbside collection of HHW six times per year. A yellow card placed in the window indicates that the household wants a pick-up (it is against Dutch law to put HHW outside). There is also a public HHW drop-off for one hour (1-2 pm, Monday), at the public works yard, for people who cannot be home when the Chemocar comes to collect.

Bulky Wastes

Bulky waste collections are provided separately for garden and non-garden wastes. Bulky garden wastes are collected monthly. The collected material is stored, shredded and sent for composting. Bulky non-garden wastes are also collected once a month. Most of this stream is landfilled except for refrigerators, whose CFCs are recovered prior to recycling. Bulky waste collection used to require 3 days/month before the four-stream bin system; now it requires 16 days/month, because bulky wastes will not fit in the 240 L bins. Lemsterland officials discovered that 50% of bulky non-garden wastes are from construction/ demolition. They have decided not to pick up C&D materials curbside any longer. These must be delivered to the transfer station by residents who may bring up to 100 kg free but they must pay for larger loads.

Process Description

All dry materials and source-separated organics are delivered to the VAM facility in Wijster (about a one-hour drive from the Lemsterland transfer station) where there are a landfill, a MRF, and a composting facility. Construction of an incinerator (400,000 t/year, at a cost of $775 million.) is scheduled for completion in 1996-97. Processing of source-separated materials is carried out by the VAM. No details were provided . VAM is a private company. Garbage is landfilled at the OLAF state-of-the-art landfill in Heerenveen. OLAF used to run its own composting operation, but closed the facility after numerous operating problems—which were eventually solved, but OLAF wanted no further involvement in processing and now sends everything to the VAM for processing.

History/Progress

The province of Friesland had no landfill. The incinerator in Leeuwarden (80,000 t/yr) was closed because of emission problems. The old landfill had to be re-opened until a new landfill (in Heerenveen) was ready. Residents near the old landfill were not happy about the re-opening. They had had a party to celebrate the landfill closure, and had thrown away the landfill key . OLAF had to promise to take care of post-closure costs as part of the re-opening agreement. The cost per tonne for landfill became expensive: $155/t . The cost of composting organics was much less: $46.50/t. This situation provided a strong incentive to divert organics. All municipalities in Friesland started source separation of household organics. Lemsterland was the last municipality (of 31) to switch to a new system, as they had recently bought a new truck when the landfill crisis arose. Lemsterland had to decide which system to adopt in 1989–1990.

Performance/Results

The paper stream is only 2% contaminated, and is therefore sent directly to market without processing. Paper markets were flooded with material from Germany in 1994 and therefore charged 2 cents per kg to take paper, whereas before they took paper for nothing. The PMD fraction contains about 35% contaminants, and is sent to the VAM for processing. The organics stream contains about 4% contaminants , and is sent to the VAM for composting. The glass stream is 2% contaminated.

Ownership/Financing/ Government Involvement

Lemsterland is responsible for collection and deposit of the waste at the transfer station. Lemsterland received funding from a number of sources. The Dutch government contributed $2.3 to 3.1 million. NOVEM (private/public agency which funds research) also contributed funding. ERRA contributed $620,000.

Program Cost

- The collection cost using the double dual container is estimated at $101/t.
- Processing/disposal costs are estimated at:
  - **Organics** $100/t for transfer and composting;
  - **Garbage** $198/t for transfer plus landfill;
  - **PMD** $46.50/t for transfer (no processing cost during demonstration);
  - **Paper** $23.25/t for transfer (no processing cost during demonstration).
- Igloos for glass are rented at $543/year each (which includes the collection cost). OLAF is paid $35/t for clear glass, and $19/t for other glass collected in the igloos.

Recovery Rates for 1993

	Tonnes in 1993	Residential Waste Stream	Comments
Residential Material Waste			
Paper	680	14%	• no processing • taken by paper company as is, or costs 2 ¢ /kg
PMD	277	6%	• to VAM for separation • disposed of in garbage after July 1994
Organics	1131	24%	• to VAM for composting
Glass	354	7%	• to glass companies
Textiles	22	0.5%	• reused / recycled
Bulky	777	16%	• landfill, except for white goods
Bulky garden	584	12%	• shredded and composted
HHW	28	0.5%	• secure disposal
Garbage	981	20%	• landfill
Total	**4834**		
Diverted	3076		
Diversion Rate	63.6%		
Municipal Maintenance Waste			
Waste from markets	25		• landfill
Recreation	97		• landfill
Drains	25		• landfill
Street sweeping	20		• landfill
Sportgrounds	72		• composted
Parks	295		• composted
Sanitary	33		• composted
Total	**5486**		
Diverted	3476		
Diversion Rate	63.4%		

- The household hazardous waste (HHW) program cost $116,300 in 1993. There is concern that HHW management costs are increasing, and that this will discourage residents from participating. Lemsterland tried to cut the HHW collection program from six times to four times per year, but had to retain the level of service because of a public outcry.
- There is a large budget for education/promotion of $77,500/year), with $236,600 for the three-year program.
- Households were charged $135/household/year before the project, and $228/household/year after the project began. Most of the increase is related to increases in tipping fees. The project itself raised household costs by $23/household/year. Current costs are $276/household/year. This will increase to $369/household/year if incineration becomes part of the system.

Problems/Modifications

- Promotion/education is critical and must be on-going. The program spent a two-year promotion/education budget in one year but received additional funding. Lemsterland staff feel that low contamination rates are because of on-going promotion/education.
- Lemsterland did not add a backyard composting program because, along with the system change, it would be too confusing for homeowners
- Lemsterland discovered that half of all bulky waste was garden waste. This warranted separate collection and management, which was initiated in 1992/1993. This waste is stored, shredded and sent to composting.
- Lemsterland staff discovered that half of non-garden bulky waste was C&D waste. It was considered unfair to handle this waste stream at the curbside as only some households generate it; therefore, the system was changed so that bulky C&D waste is no longer collected at curbside. As of January 1994, C&D waste must be self-hauled by householders to the transfer station. Some people were not happy with this change, but on balance it was considered fair.
- People will use glass depots if bins are conveniently located. Lemsterland staff feel that on-going promotion/education also helped to double glass recovery. Glass recovery was 175 t annually prior to the program launch. This increased to 350 t in 1993 through addition of more igloos (making the system more convenient) and a strong promotion/education program, which reports to the public on the quantities recovered.
- Staff feel that it is essential to report the results of the program to the public on an on-going basis.
- Staff concluded that collection of PMD is too expensive and that contamination is too high (35%). This stream was no longer source-separated after the demonstration funding ran out (July 1994). The PMD material is disposed of in the garbage stream.
- One conclusion of the project is "Don't try to recycle plastic". The Dutch government estimates that it costs $2,326/t to recycle plastic and considers incineration a more appropriate management option. Incineration currently costs $247/t and will increase.
- Greater recovery of household hazardous waste increases costs. This concerns the public, who see that participation drives their costs up. The concern was that this information would discourage participation. However, when Lemsterland tried to cut back HHW collection services, there was a public outcry, and the program had to be retained. It cost $116,300 in 1993, $77,500 in 1991.
- Some people with small gardens complained about the space taken up by the two 240-L containers. It took residents about four months to get used to the system.

- The two-bin system works well in low-density housing. It is probably not applicable to high-rise housing.
- Any system must be as simple as possible, or it won't work.
- Wind-blown plastics escape when the bins are emptied. (Lemmer, the largest town, is located at the coast, where there are usually brisk winds.) Curtain barriers installed to solve the problem were not entirely successful.
- The dual- bin compartments are too narrow. Early in the program, paper frequently got stuck and the bins would not empty. Staff resolved the problem by increasing the emptying cycle to 14 seconds from 11 seconds; this allows for some shaking of the bin while airborne. Staff would recommend 280-L rather than 240-L containers if starting again.
- Cleaning of the bins is a problem. Staff would include the cleaning cost in the household charge if they were starting the program again.
- Odours from the household bins storing the organic fraction are a source of complaint which has not been resolved. Staff recommend that really odorous food waste (e.g., fish) be put in a plastic bag and disposed of with the garbage. Companies have developed odour-control products which stick to the inside of the bin lid; these have not been distributed to date. Aerated carts were tried by Youre, a neighbouring municipality, but did not work.
- One of the surprising results of the bin system was the enormous flow of bulky wastes which do not fit into the bins. Collection requirements for bulky wastes increased from three days/ month before the bin system to 16 days/month after the bin system was implemented.
- A private company was willing to build a plant to recycle bulky waste, but OLAF was not willing to fund it. They failed in their efforts to operate the composting plant, and did not want to get into other operations.
- If the organic waste fraction is too contaminated, the truck crew will not empty the bin, and the household is stuck with the waste for another two weeks.

Expansion Plans

Funding from ERRA and other sources ended on 1 July 1994. Lemsterland now pays for the collection system. Source separation of papers and organics continues. However, source separation of the PMD stream ceased. Reasons for this decision include the high contamination rate (35%), the high cost of recycling plastics ($2,326/t), and the lack of markets for plastics.

The system will be changed to collect papers in the grey bin once per month, and to collect the green bins (with garbage and organics) weekly.

By 1998, it will be forbidden to take untreated waste to landfill in the Netherlands. At a minimum, waste must be incinerated to meet this requirement. This will cause a problem for Friesland. The province has just spent $77.5 million on its new landfill, that it needs to recover, but waste is not allowed to go directly to landfill as of 1998. VAM is charging $247/t for incineration plus $15.50/t for transportation at this time, and can charge more when processing becomes mandatory.

OLAF is considering a mixed-waste facility at the landfill in Heerenveen which would remove metals and anaerobically treat the organic fraction. OLAF is also considering setting up an environmental centre in Leeuwarden, with a separation plant, anaerobic treatment Contractual Elements facility, and incineration for RDF. Lemsterland municipal staff collect material from the two-bin system.

OLAF is responsible for waste transfer, processing and disposal. Recyclables are processed, and organics are composted by the VAM under contract to OLAF. Contractual details are not available. OLAF owns and operates a state-of-the-art landfill at Heerenveen, where residuals are disposed of. The glass igloos are rented at $543/ year each (which includes the cost of collection by a separate glass recycling company). OLAF is paid

$35/t for clear glass, and $19/t for other glass collected in the igloos.

4 Resources

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5 Summary Evaluation

Reasons for Success or Failure of Program

The Lemsterland program achieves 63% diversion of household waste. It could be higher if methods of diverting bulky waste were identified. Staff consider that continuous promotion and education is the reason the program has been so successful. It took residents approximately four months to get used to the program, and on-going promotion/education and feedback have sustained its success.

R&D Needs/Commercialization Potential

Odours from household carts containing organics appear to be a chronic problem in this program. Recycling of plastics was considered unviable because of lack of markets for the end product, the high cost of collection and processing, and the high degree of contamination of the stream containing PMD. Methods for addressing all of these issues need to be identified. The program discovered that bulky wastes were approximately 20% of the residential waste stream. Methods of diverting bulky wastes also need to be identified. If the bulky waste stream could be diverted, the four-stream approach could divert up to 80% of the residential waste stream. The horizontally split collection vehicle has potential for any programs considering a four-stream collection. The four-stream Geesink truck was one of the first of this type of specialized vehicle.

Replicability of the Project

The four-stream system requires some commitment to source separation on the part of the householder. It has potential to divert over 60% of the residential waste stream. It is applicable to relatively-low-density areas but is not likely to be feasible in high-density housing, because of the space taken up by the two-wheeled carts needed by each household. Requiring householders to bring their carts to designated areas saves significantly on the time required for collection and is an approach with the potential to save considerable collection costs. Glass depots at a high density (one per 500 people) have a very high recovery rate. This approach to glass collection would avoid many of the problems associated with including glass in curbside programs.

Case Study 23 Waste Diversion and User-pay in the Capital Regional District Victoria, British Columbia

1 Abstract

The Capital Regional District (CRD) in British Columbia has some of the most progressive solid waste management programs in that province (if not Canada). In the past several years, numerous waste diversion activities have been initiated. In particular, since the late 1980s, the CRD has established curbside recycling, apartment tote recycling, recycling depots, education/recycling centres, and comprehensive backyard composting with centralized leaf and yard waste composting. Many of these activities are supported by an extensive education and promotion program, a diversion credit program for non-profit organizations, and landfill bans on specific materials.

One of the most innovative waste reduction measures introduced to date has involved a user-pay system whereby residents are required to pay for waste disposed of. The CRD began its user-pay program in January 1992 in four municipalities: Victoria, Saanich, Oak Bay and Esquimalt. The program features a partial, volume-based system in which residents are allotted one can of garbage (100 litres) per week as paid by for their municipal taxes. This cost of garbage collection and disposal is identified as a separate line item on the individual property owner's tax bill. Additional containers are charged a separate fee, between $1.50 and $3.00 depending on the jurisdiction. Since the introduction of user-pay, the participating municipalities have recorded an 18% reduction in the amount of residential waste collected (8% reduction of the municipal waste stream). The extent to which the reduction is directly attributed to user-pay remains unclear, although CRD attributes a good portion of it to user-pay.

The initial success of the program encouraged the CRD board to conduct two pilot projects for testing co-collection methods for recyclables and garbage in an effort to reduce the costs associated with the collection of waste and recyclables. Both programs tested the collection of recyclables and compacted garbage in separate compartments of the same collection vehicle. The second study expanded on the first by also including source-separated organics in the collection. In addition, the second study tested a weight-based user-pay approach to determine its feasibility. Although the weight-based study showed promise, the CRD has decided to focus in the immediate future on recycling and composting programs to maximize waste diversion.

2 Community Description

Location

- The Capital Regional District (CRD) is located on Vancouver Island in British Columbia and consists of several municipalities, including the city of Victoria.
- The CRD covers 2,441 km^2 with a total population of approximately 308,700 in 1993.
- The CRD consists of 4 electoral areas and 12 municipalities, of which four are considered core and the other are rural.

Waste Management Context

- Waste in the CRD is disposed of in the Hartland landfill, located in the municipality of Saanich. Funding for the solid waste division of the CRD's engineering department comes primarily on tipping fees charged at the Hartland landfill. The tipping fee for general refuse is $75/t and varies from $100 to $240/t for controlled wastes entering the landfill.

- Approximately 55% of the waste sent to landfill is IC&I, and 45% is residential.
- Since 1989 (the base year for waste generation rates), the CRD has experienced a 28% reduction in municipal wastes (including residential and IC&I) entering the landfill.
- Several measures have contributed to this reduction, including a comprehensive backyard composting program whereby householders are subsidized for half the cost of the composter, paying only $25. In 1992 and 1993, a total of 19,700 composter bins was distributed to residents.
- To increase the amount of leaf and yard waste sent to the regional composting facility, the tipping fee was set at $20/t. The finished compost is sold for $10 to $35/t.
- Since the introduction of user-pay, the participating municipalities have recorded an 18% reduction in the amount of residential waste collected (8% reduction of the municipal waste stream).

3 Program Description

Purpose and Sectors Involved

- In 1987, the CRD produced a solid waste management plan which called for a 15% reduction in solid waste by 1995. The plan was revisited in 1991 and was revised to 50% reduction of solid waste entering the landfill by 1995, with the understanding that this goal could be achieved only with a regional food-waste facility in place. This revised target surpasses the provincial targets of 50% reduction of solid waste by the year 2000.
- To help the region achieve its aggressive target, the CRD board introduced a number of progressive programs.
- Volume-based residential user-pay garbage collection was introduced in four of the largest communities. This program requires residents to assume direct responsibility for waste generation by paying for waste collected beyond the permitted one container per household per week.
- Eight municipalities and four electoral areas are served by private haulers, and each household is required to negotiate a volume-based user fee for garbage directly with the hauler.

Type/Method of Recovery

- The user-pay system employed throughout the four largest municipalities in the CRD is a partial system which permits a single container or bag (to a maximum of 100 litres) to be sent to curb without requiring direct payment. The householder is required to pay directly for the collection of each additional container/bag.
- The first 100-litre container is financed through municipal taxes at $120 per household per year, and each remaining container/bag of waste costs between $1.50 and $3.00 (depending on the community).
- Specially marked tags must be attached to the additional bags or containers of waste and may be purchased from the municipal hall or designated retail stores.
- The user-pay system was structured so that the size of the first container was small enough (100 litres) to ensure that additional tags would be required unless the resident actively participated in waste-diversion programs.
- An arbitrary maximum weight of 22 kg also was established to reduce compaction of the wastes. Deciding if that limit had been surpassed was left to the discretion of the collectors.

Process Description

The CRD has implemented a broad range of programs to achieve its 50% waste diversion target. The initiatives include:

- a blue box program collecting newspaper, glass and tin;

- a "blue box plus" pilot program to increase the types of materials collected, including corrugated cardboard, boxboard, "junk mail", egg cartons, brown bags, mixed paper, magazines, and PET/HDPE bottles (not currently operating at the time of study);
- 14 rural drop-off depots, each operated by a private-sector company;
- an apartment tote recycling program that diverts 10% of the total recyclables collected in the region;
- diversion credits to non-profit organizations that are involved in reusing or retailing second-hand goods;
- backyard composter and vermicomposter distribution and education programs;
- a composting education centre;
- a multi-material collection depot and salvage area at the Hartland landfill;
- landfill bans targetting tires, drywall, telephone directories, corrugated cardboard and white goods;
- a regional yard and garden-waste composting facility;
- a volume-based user-pay program in four municipalities; and
- five mobile plaza recycling depots (staffed) collecting OCC, mixed paper, # 1 and # 2 plastic bottles.

The user-pay program required the support of the comprehensive waste-diversion programs that offers options to residents to divert wastes from landfill. Many of the waste-diversion programs have been in operation since the early 1990s, with a proven capability of diverting wastes.

History/Progress

- In 1991, a study was commissioned by the CRD to identify the most appropriate user-pay approach for solid waste in the CRD. The study involved testing several alternatives in the region.
- During the study, several workshops were conducted with local officials and waste haulers to gain a better understanding of waste management activities in the region and general attitudes towards waste management. The workshops also served to disseminate information about user-pay systems. Waste haulers responded favourably toward the user-pay system.
- Key recommendations from the study supported a user-pay system to promote waste reduction within the residential sector.
- In January 1992, the municipalities of Victoria, Saanich, Oak Bay and Esquimalt implemented volume-based, residential user-pay garbage collection.
- Press kits about user-pay were distributed to interested parties.
- To reduce illegal dumping, the CRD padlocked city garbage dumpsters and encouraged businesses and apartment buildings to do the same. Consequently, a small amount of illegal dumping was redirected to street litter bins, city parks, roadside ditches and vacant lots. Some burning also has occurred (e.g., residents burning waste paper and plastics in their wood stoves). However, this problem seems to have resolved itself.
- Response by some residents was negative until they realized that numerous programs were available to enable them to divert wastes. As a result, recycling and composting rates significantly increased when user-pay was implemented. Demand for backyard composters soared, with over 15,000 sold in the first year of the composter subsidy program (1992). In 1993, 200 vermicomposters were made available.
- In 1993, the CRD embarked on two pilot programs to study two and three-stream waste collection systems for residential waste as a means of reducing the costs associated with

collection of wastes and recyclables. In the second pilot program, all waste was collected in a tri-pack truck . Special equipment on the truck weighed and recorded each household's garbage, but residents were never charged by weight.

Performance/Results

- To achieve a 50% diversion rate, the CRD recognized the need to focus its energies on those materials which provide the greatest diversion opportunities, such as compostables and construction, demolition and landclearing wastes.
- The response to the user-pay system was immediate. While the CRD anticipated sales of over 40,000 tags within the first three months, the actual sales amounted to less than half that (17,000).
- Almost immediately after the introduction of the user-pay system, the volume of residential waste sent for disposal decreased by 18%.

Ownership/Financing/ Government Involvement

- The four core municipalities involved in user-pay systems provide residential waste collection services as well as service to some small commercial establishments. One town contracts out the collection of garbage to the private sector. The remaining 10 areas in the CRD are served by the private sector, and residents negotiate fees directly with the haulers. The blue box program, including collection and processing, is currently operated by the private sector on contract to the CRD.
- The CRD is responsible for planning and developing solid waste management programs in the region and increasingly has recognized the importance of working in partnership with the private sector.
- The CRD has established three multi-stakeholder task forces to develop waste management and diversion strategies on the following topics: commercial and retail; processing and marketing; and construction, demolition and landclearing wastes. The emphasis is to develop further strategies and partnerships between government and industry to achieve the greatest cost efficiency.
- The CRD was considering renewing a compost partnership with industry whereby the CRD will provide the land and zoning at the Hartland landfill for a food-waste composting facility, and a private-sector company will construct and operate the in-vessel compost facility for a fee less than the current tipping fee ($75/t).

Capital Region District Weight-based User-pay System

- A pilot program in Oak Bay (population 18,000) tested a weight-based user-pay system and collection of waste, recyclables and compostables in a tri-compartment vehicle. Oak Bay was selected for the pilot project as it is one of the highest per-capita income residential areas in the CRD and was considered very stable. If the weight-based system could work in Oak Bay, then it would work elsewhere.
- The compartmentalized vehicle was installed with three "weigh in motion" lifters. They enabled the collection crew to collect, to weigh, and to store information on each of the three collection bins containing waste, recyclables and compostables.
- While the weight-based pilot program indicated that weight-based collection was possible with further development to increase its accuracy, future implementation has been delayed at the political level; instead, a five-year program featuring a comprehensive blue box program has been developed.

Program Cost

- All solid-waste management capital and operating costs are funded through tipping fees. In 1993, the costs associated with solid-waste management in the CRD were $26/t to operate the landfill; $11/t to cover payment of an $8 million capital expenditure debt; and $38/t to pay for all waste diversion programs in the region. Waste diversion programs cost $3.8 million in 1993.
- The projected cost to provide recycling, composting, ban enforcement, grants and education associated with waste diversion was $43.56 per household per year in 1994.
- To help defray the fixed and variable solid waste management costs, the tipping fee was raised over the years from $22/t in 1990 to $75/t in 1993. These tipping fees are among the highest in the country.
- The $75/t fee charged for disposal of residential waste is recovered through municipal taxes (18%) and the user-pay system (82%).
- The partial user-pay approach (i.e., residents pay a fixed rate through their municipal taxes for the first container of waste and then pay a variable rate for every additional container of waste) helped to ensure that sufficient revenues would be raised to cover the fixed costs of operating the waste management / diversion programs even after significant waste diversion is achieved. Thirty to sixty percent of the CRD's waste management costs could be classified as fixed. Variable costs were estimated at $31/t in 1992 (40% of the total costs).
- The success of the various waste diversion programs and the volume-based user-pay program in the CRD is partly attributed to its progressive education program. In 1992, $650,000 was spent on education programs of which $105,000 was for salaries; $70,000 was for grant monies; $60,000 was for program development; $50,000 was for consultants; $105,000 was for internal allocation (administration, building overhead); $150,000 supported advertising and promotion; and $110,000 was for a hotline service, which averaged 200 calls per day.

Expansion Plans

The five-year program features several key strategies, including:

- A plan to separately re-tender blue box collection and processing/marketing and to require each bidder to determine the various costs associated with each additional blue box. The potential costs to collect and process packaging and fibres could potentially be reduced to $106/t.
- To register the private rural depots and to pay differentially rated diversion credits to the companies operating the depots, thus promoting maximum diversion of hard-to-recycle products. The diversion credits would be based on the volume of space saved for each tonne of materials diverted from the landfill; therefore, the diversion credit for plastics will be higher than the diversion credit for glass since, per tonne, uncompacted plastics take up more space than uncompacted glass. It is estimated that each cubic metre of space costs $29. Agreements have been reached that any residue from the depots will be sent to the Hartland landfill. Consultation is underway with industry to establish the differentially rated diversion credits.
- A user fee will be applied to recyclables collected at depots and through the blue box system. In 1995, vehicles paid $2.00 per drop-off at the depots. In 1996, residents will be charged 50% ($15-$20/single-family dwelling/year) of the costs for curbside blue box collection services, with full user-pay beginning in 1998.
- Proposed 1995 material bans include newspaper, concrete, asphalt, rubble, clean soil aggregates, ferrous and non-ferrous metal, yard waste, slash and stumps (at time of study).

This five-year strategy could save up to $1 million on the annual waste diversion costs.

4 Resources

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5 Summary Evaluation

Reasons for Success or Failure of Program

The volume-based user-pay program has had a significant impact on waste collected by municipal crews. The program has successfully achieved high waste-diversion rates by requiring that generators be directly responsible for their waste generation habits. CRD's comprehensive education program has kept residents aware of program developments and opportunities for household waste reduction.

One of the key components of the success of volume-based user-pay and waste-diversion systems in the CRD is the education and promotion programs which combine active demonstration with literature and displays. Also, the CRD has placed a great deal of emphasis on establishing partnerships with the private sector, taking advantage of their knowledge of the solid-waste business and experience in providing cost-effective services.

The CRD continues to explore new opportunities to encourage cost-effective waste reduction and diversion. User-pay has provided an opportunity to explore other initiatives that would not be considered feasible or acceptable without user-pay, such as user-pay applied to recyclables and programs targetting items that are difficult to recycle. The CRD also has recognized that the way for it to achieve maximum waste diversion is to focus on food waste, construction/demolition and land clearing wastes, and materials bans.

Case Study 24 Waste Diversion and User-pay in Kincardine, Ontario

1 Abstract

The town of Kincardine implemented a user-pay system in May 1993 to encourage waste reduction and to increase the life expectancy of their landfill. A range of services provides opportunities to divert waste from disposal: bi-weekly curbside residential recycling; a pick-up service for IC&I recyclables; seasonal collection of leaves; a drop-off site for various materials; and a backyard composting program. Residents purchase tags for their garbage bags at $2/tag. The user-pay program, along with a $70/t tipping fee at the landfill, offsets the costs of waste collection and disposal, the blue box program and capital expenses.

Program officials estimate that since implementing the user-pay program, the town is diverting some 50 to 60% of their waste from the landfill.

2 Community Description

Location

- The town of Kincardine is a small-sized town by Lake Huron.
- The town covers an area of 769 hectares with a population of 6,500 (about 2,700 households and 350 businesses).

Waste Management Context

- The town is served by one landfill located at the southern town limits. In 1992, the landfill expectancy was two to three years. A user-pay program was considered as a measure to extend the landfill life.
- The town implemented a tipping fee of $70/t. There is a minimum charge of $7.50 at the gate for material (e.g., boxes, furniture).
- The town received approval for a five-year landfill extension.
- The user-pay program has extended landfill use by two years.

3 Program Description

Purpose and Sectors Involved

Kincardine's goal is to divert as much waste as possible from the landfill. An informal goal is to reach 75% waste reduction by 1996.

User pay was introduced in May 1992 to create an incentive for waste reduction in the residential and IC&I sector. The program was needed to increase the life of the current landfill, to finance the landfill closure, and also to build a new site.

Type/Method of Recovery

User-pay Program

- The user-pay program requires householders to pay for the number of garbage bags set out on the curb. Residents purchase specially marked, self-adhesive tags at local grocery stores, municipal offices and about six convenience stores. Tags cost $2 each and are specially made and coded to avoid illegal replication. There is a 25 lbs/bag limit.
- The cost of garbage collection was eliminated from the tax base when the program was introduced. The user-pay program (including tipping fees) offsets the costs of waste collection and disposal as well as the blue box program and capital expenses.

Recycling Program

- A residential curbside recycling program was implemented during the fall of 1989. The blue

box program collects the following materials biweekly: newspaper, old magazines, PET, HDPE, glass, aluminum and steel cans. Corrugated cardboard is collected separately once per month.

- The same materials are also collected from the IC&I sector in roll-off containers once a week.
- A depot for scrap metal, construction and demolition material, lead acid batteries and recyclables is located at the landfill.

Organics

- Subsidized backyard composters are available at the town hall.
- Brush and leaves are accepted at the depot (at the landfill) free of charge at any time. The material is composted in windrows at the landfill.
- Leaves are collected by the municipality for composting during the fall.

Reuse

- An annual swap day is organized. Residents can place unwanted goods on their lawns a few days prior to garbage collection. A metal salvager is contracted to collect scrap metal from the community.

Process Description

- not available

History/Progress

- In 1989, the town councillors and waste management officials began to discuss the possibility of implementing a user-pay program.
- The decision to introduce a user-pay program was made in February 1992, and the program was implemented in May.
- A number of open houses were held to make residents aware of the program and to allow comment. Residents were informed of the rationale (i.e., costs of siting a landfill, current landfill expectancy, and costs savings) and the details of the new system (where to buy tags, schedule of collection, and other services provided by the town). The town also provided residents with a detailed taxation summary showing, through 1993 property assessments (in increments of $5,000), the relative costs of including and excluding garbage pick-up, disposal, recycling and landfill costs in taxes. For each property assessment, the total amount saved in taxes by going to a user-pay program was indicated. Other promotional materials included newspaper ads, flyers and brochures.
- Response was negative until residents realized that the cost of garbage collection was eliminated from the tax base, and that they now had an opportunity to reduce their costs. As a result, recycling rates and sales of backyard composters significantly increased.

Performance/Results

The town did not own a weigh scale when the user-pay program was implemented. The recycling coordinator reported a dramatic decrease in garbage and an increase in the amount of material recovered through the recycling program. An estimated 50 to 60% (by weight) is currently diverted from the landfill. The following figures are also estimates.

- Average garbage decreased from about 150 t/month to about 60 t/month after the user-pay program was implemented.
- Residents typically threw out three to four garbage bags/week prior to user-pay. They are currently throwing out an average of 0.9 bags/week. The average weight of a bag is 13 to 16 pounds.
- Old corrugated cardboard (OCC) collection has doubled since the implementation of user-pay. Prior to the program, the town collected one full 20-yard truck /week. It currently collects enough OCC to fill two20-yard trucks/week.

- The curbside blue box program initially served about 880 households/week. Currently, 1,800 blue boxes are collected each week.
- Commercial locations ordered more roll-off containers after the implementation of user-pay.
- The amount of leaves and brush dropped off at the landfill has doubled.
- Demand for backyard composters has increased significantly. Prior to user-pay, about 125 composters were sold every year. After the program was implemented, about 350 composters were sold within 10 weeks. Some residents purchased two units for their properties.
- Garbage pick-up was reduced from five to three days.

Ownership/Financing/Government Involvement

- The town of Kincardine provides residential waste collection, and Bruce Area Recycling provides recycling collection.
- Costs of all activities are financed through the user-pay program and landfill tipping fees.

Program Cost

- not available

Problems/Modifications

- Prior to implementing the program, the Solid Waste Office had to deal with many complaints from residents.
- Six cases of illegal dumping occurred after the program was implemented. Waste officials opened the bags and found envelopes which identified the generators. To avoid the repercussions of accusing people of illegal dumping, the recycling coordinator placed a "lost and found" column in the classified section of the local paper to "advertise" whose garbage had been "lost" (i.e., to identify the illegal dumpers). Residents who had "lost" their garbage were requested to pick it up. About 45 days after implementation, illegal dumping had subsided.

Expansion Plans

- The town is investigating a bar code scanning system to enable direct charging by weight. The town is hoping to implement a weight-based system within the next two years.
- The landfill is currently undergoing expansion. Current landfill expectancy is from 6 to 10 years.

Contractual Elements

- not available

4 Resources

Contacts

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Reports and Surveys

- None

5 Summary Evaluation

Reasons for Success or Failure of Program

- The success of the program is attributed to three main elements:
  - extensive promotion and education (Residents were made aware of the rationale of user-pay and the potential cost savings).

- distribution of tags at convenient locations;
- small size community (Promotion, education, and enforcement is easier in a smaller community).

- Public education and promotion is critical to the successful implementation of user-pay. Education and promotional material should focus on the fairness of the program and the services available for waste reduction (e.g., backyard composter sales, recycling program, and depots). Providing residents with a detailed taxation summary and indicating the savings they will accrue with a user-pay program was a worthwhile activity.
- More time was needed to organize the logistics of the system (i.e., to buy tags and to deliver them to retail outlets), to promote it and to educate the public. The program was implemented within four months. A number of public committees were formed (they included local businesses); however, there was some frustration because they did not have enough time to provide significant feedback on the proposed system. Another two to three months would have been ideal.
- The tags have caused problems and have been changed several times. The first set of tags was easily photocopied, and the second set could not withstand the weather (i.e., rain and snow).
- No studies were done prior to implementing the program. The approach was to implement the program as soon as possible and to work out any problems later. The approach worked; any problems identified were easily handled.
- Some retailers may initially be unwilling to sell tags for user-pay. However, some of the grocery and convenience stores that are selling tags reported an increase in total business and sales.

R&D Needs/Commercialization Potential

- Development and application of a technology for a weight-based user-pay system: The town is currently working with a company to test and run a pilot study of a computer-based approach using bar codes and wands.

Replicability of the Project

- User-pay programs are becoming increasingly common in all sizes of communities throughout Canada. This type of user-pay program is particularly suitable in smaller communities.

User-pay Programs in Ontario

User-pay programs are becoming more common in Canada. For instance, over the past few years, the number of user-pay programs in Ontario has risen from 1 to 23. The reasons municipalities are turning towards user-pay are:

- to offset significant cost increases in landfill closures and openings;
- to increase the life expectancy of current landfill;
- to provide waste generators the incentive to reduce their garbage, and to encourage maximum participation in waste reduction services; and
- to help finance current waste management services.

User-pay programs typically fall into two categories:

Pay-by-the-bag programs wherein the generator pays for the number of bags set out. Typically,this charge is in addition to residential taxes; however, Kincardine eliminated garbage disposal from the residential tax base. To identify garbage bags which have been paid for, either standard self-adhesive tags or standardized bags with a distinct colour are used. The cost per tag or bag in Ontario ranges from $1 to $5, with $1 to $2 being the most common rate. The majority of the programs implemented to date are "partial" user pay programs where residents may dispose of a certain number of bags at no charge (the cost is covered on municipal taxes), but pay directly for any additional bags.

A survey of Ontario user-pay programs shows that if a community allows two "free" bags per household, it will achieve about 15 to 20% diversion. Communities with no "free" bags achieve from 30 to 45% diversion. (Note: Numbers depend on diversion alternatives, current participation levels in waste reduction services, and local conditions).

Volume restriction whereby households are allowed only to leave a certain number of bags or containers (of a limited size) at the curb each week. Not all municipal officials consider volume restriction programs as associated with user-fee systems.

A few communities across Canada are experimenting with a weight-based user-pay system, (refer to th Victoria case study) in which residents pay by the weight of garbage they generate, rather than by the number of bags they place at the curb. In this system, householders attach self-adhesive bar code labels to containers placed at the curb. The garbage collection truck is equipped with weighing equipment and bar code scanning devices. Garbage weights are then automatically billed to household accounts. This is a fair system that also allows other materials (such as organics and recyclables) to be weighed at the curb. However, it requires more administration than a simple pay-by-the-bag or tag system.

Appendix

N.B. Values are in Canadian dollars unless noted otherwise.

Composting Facilities

Location

Corner Brook, Newfoundland

Description

Genesis Organics Inc. Composting collects wood bark, fish offal and chicken manure generated by local industries and creates high-quality compost. The low-tech composting procedure requires six weeks to ten months to complete. The operation employs five staff on-site and has diverted 2 million cubic yards of bark, 45,000 tonnes of fish offal and 13,000 tonnes of chicken manure since 1993.

Significance

The process relies on simple technology and is particularly effective in diverting waste in areas where local industries send large quantities of organic material to landfill.

Location

Aldergrove, British Columbia

Description

The Answer Garden Products facility is a successful combined in-vessel/open-windrow composting operation owned by Envirowaste. The operation accepts a wide range of organic material including waste from local food processing plants (fruit, vegetables and fish), leaf and yard waste from the Greater Vancouver Regional District (GVRD), and residential organics from a local wet/dry recycling program. The plant combines a high- and a relatively low-tech approach to composting (in-vessel and open-windrow). It has been successful in developing a variety of marketable products. The plant currently receives and processes approximately 50,000 tonnes per year and is expected to expand to 100,000 tonnes per year.

Significance

This system is replicable for organic waste streams in other parts of Canada that exceed 2,500 tonnes/yr. It produces high-quality compost that can be marketed in bags or bulk.

Anaerobic Digestion

Location

Brecht, Belgium

Description

The DRANCO facility in Brecht, Belgium opened in July 1992. It has a capacity of 10,000 tonnes/year of wet organic waste which is anaerobically digested for 20 days and aerobically cured for 10 days. The feedstock to the facility is source-separated household organics (food and yard waste), along with non-recyclable paper, from a population of 75,000 (26,000 households, all single-family). All households are provided with a 120-L brown bin for organics separation. Bins are collected bi-weekly.

Significance

The anaerobic technology works well to process source-separated household organics. It produces a useful end-product (Humotex), generates power, is energy self-sufficient, and has low space requirements.

Comprehensive Source Separation

Location

District of Giessen, Germany

Description

The Giessen program uses a three-stream collection system for approximately half the district. The remainder will be served by three-stream collection in the future. Blue bins are

provided for fibres (collected once a month), grey bins are for garbage (collected twice a month), and green bins are for organics (collected twice a month). Green Dot (packaging) material is collected in yellow bags once a month, and depots are provided for glass collection. Household hazardous waste is collected through a mobile depot, and a central depot collects additional materials such as clothes, C&D materials, batteries, etc. The composting site is owned and operated by the municipality and experiences on-going odour problems. These were temporarily resolved by carrying out the first-stage composting of kitchen organics (for about six weeks) at a more remote site, several kilometers from the city. The program achieves over 36% diversion of waste through collection of fibres and organics. Data are not available for glass and packaging. Each home pays $100/person/year on its tax bill for the collection program. The total annual cost for the program in 1991 was $16.6 million.

Significance

The collection program provides a viable example of a comprehensive source-separation program with centralized composting of organics. The on-going composting problems indicate the need to consider different technologies (in-vessel aerobic, or anaerobic) for initial stabilization of kitchen organics.

Construction/Demolition Recycling Facility

Location

Boston, Massachusetts

Description

Jet-A-Way operates a construction and demolition (C&D) waste-processing facility which is fully enclosed and uses both mechanical and manual separation systems to recover metals, wood waste and different-sized aggregates. The facility is licensed to process between 205 to 405 tonnes per day and achieves a 61% recovery rate for incoming C&D waste. Total capital costs are estimated to be $5.2 million.

Significance

This type of facility would be appropriate for large urban areas which experience higher disposal costs and where limited C&D waste disposal options are available.

Drop-off Depot System

Location

Calgary, Alberta

Description

In 1989, the city of Calgary initiated a study to determine the most appropriate recycling system for the city. Following a full year of monitoring, it was determined that, from both cost and diversion perspectives, the establishment of a city-side drop-off depot program was most appropriate. Implementation of the program began in 1992. On average, one depot serves one square mile; 29 depots were in place by the end of 1993. The program costs $127/tonne for collection and marketing of recyclables (excludes capital costs and material revenues). Typical locations for drop-off depots include shopping malls and community centres.

Significance

An example of a large urban centre which has chosen to create an extensive, convenient depot system as opposed to implementing curbside recycling.

Location

Pictou County, Nova Scotia

Description

The county has been operating a unique mobile depot system for three years. The program offers a cost-effective recycling service to households that are widely dispersed over a large area. Roll-off containers are dropped by a tandem trailer at 63 different locations. In 1993, the annual operating costs were $119,450 (excludes capital costs and material revenues). Extrapolated over the number of households that have access to the depot program, the annual diversion rate is approximately 52 kg per household.

Significance

This is an example of an innovative and cost-effective recycling program that offers service to large land areas with a low population density.

Energy-From Waste Project

Location

Burnaby, British Columbia

Description

The Burnaby energy-from-waste facility (EFW) is a state-of-the-art plant with a 720-tonne-per-day capacity. It currently operates at 94% capacity, processing waste generated in the Greater Vancouver Regional District (GVRD). The capital costs of construction were $70 million in 1988, and annual net operating costs were $39 per tonne in 1993 (not including depot amortization).

Significance

The plant uses state-of-the-art pollution control devices such as a vaporous mercury removal system (first of its kind in North America) yet maintains its cost effectiveness. The Burnaby facility has served as a prototype for other EFW facilities (including the Peel incinerator) in Canada and works in conjunction with the region's recycling programs.

Expanded Blue Box

Location

Seattle, Washington

Description

The Seattle program provides several services, including single-family dwelling and apartment collection of recyclables, yard waste collection and composting, backyard composting, and household hazardous waste collection. All are promoted extensively. A variable can rate encourages waste reduction and diversion and funds the programs. Average recovery for single-family households in the curbside recycling program was 350 kg/hhld/yr. in 1993, and the cost of curbside collection of recyclables averaged $133.79 per tonne in 1993.

Significance

This is an example of a large urban program with several elements. The Seattle program also demonstrates the viability of a user-pay system and the importance of promotion and education activities.

Location

Centre & South Hastings, Ontario

Description

The Blue Box 2000 program, established in 1991, greatly expanded the range of dry materials collected and added other services such as household hazardous waste and a household organics collection. The program relies on extensive source separation of material, high participation, and conventional and inexpensive processing technology to meet its waste-diversion goals cost effectively. It has achieved an estimated diversion rate of 40% at an estimated net cost of $126 per tonne (before grants and subsidies) or $23 per household.

Significance

The program demonstrates that a cost-effective program can be developed which achieves high rates of diversion. The program also successfully demonstrates the potential for relatively inexpensive, conventional, unsophisticated technology as a means of meeting recycling program objectives.

Location

Drummondville, Quebec

Description

The city has implemented a garbage and recyclables collection system based on the use of roll-out carts. A wide spectrum of recyclables is collected (18 materials including a range of fibres), and observed participation rates have been high (95% estimated). However, commingled collection creates the need for more processing of recovered recyclables and causes a greater degree of contamination. Waste diversion rates have been lower than projected (11.5% diversion rate for 1993). The average cost per household for garbage and recycling is $72.98.

Significance

This is an example of a cart-based system with a high participation rate.

Four-stream Wet/Dry Collection Program

Location

Lemsterland, the Netherlands

Description

The Lemsterland program provides each household with two bins; each bin is vertically split in the middle, allowing the collection of four different streams. A grey bin is used for paper and PMD (plastic/metal/drink cartons); a green bin is used for organics and garbage. Glass is collected in depots; bulky waste is collected door-to-door once a month; and household hazardous waste is collected door-to-door six times per year. The program achieves a 63% diversion rate for residential waste. Householders are asked to leave their bins at specially designated spots on the curb; the gathering of bins in one location reduces the collection time substantially. A specially-designed Geesink vehicle is used to collect the bins; the vehicle's collection chamber is horizontally split to match the bin's divided sections. Current costs are $276/household/year for diversion and disposal.

Significance

The Lemsterland program achieves a high rate of diversion and demonstrates the viability of an extensive source-separation program. The program also demonstrates the use of glass depots in complementing a curbside program. The practice of having householders bring their collection bins to a common designated location could also be replicated in Canadian curbside programs to reduce collection time and costs.

In-vessel Composting Facility

Location

Beilstein, Germany

Description

This is the most automated in-vessel composting facility in Europe, requiring only three staff members to operate. The plant can process 10,000 tonnes per year in a completely enclosed system; 20,000 tonnes per year can be processed using a combined in-vessel/open-windrow curing

approach. A sophisticated computerized control system is used to monitor process parameters and also to document wind directions in case of future odour complaints. The finished compost is blended with humus, topsoil and fines from an adjacent quarry to produce 13 different blends of soil conditioner. Carbon dioxide from the composting vessels is directed to greenhouses on-site to enhance plant growth. Operating costs for the facility are estimated to range between $135 and $200 per tonne.

Significance

The Beilstein facility is an example of a successful in-vessel composting operation.

Landfill Bans

Location

Regional municipality of Peel, Ontario

Description

Materials banned at Peel's landfill include old corrugated cardboard, drywall, wood, tires, paper fibres, cleanfill and rubber, container glass, ferrous and non-ferrous metal. The region estimates that, in 1990, bans placed on drywall, tires, OCC and wood diverted 100,000 tonnes of material (13% of the municipal solid waste stream). The region works closely with the IC&I sector to help them avoid violating the bans. Violations results in fines.

Significance

The program offers a cost-effective method for municipalities of diverting waste from landfill. The ban has been supported with waste diversion programs targeting the IC&I sector (e.g., on-site waste assessments, information hotline, recycling directories, and a yearly waste-reduction seminar). The bans have also encouraged the development or relocation of recycling companies in the area, providing a stable supply of recyclable material.

Landfill Gas Recovery

Location

Newby Island Landfill, San Jose, California

Description

Landfill gas is recovered through two plants at the landfill site using seven reciprocating piston engines driving generators with a total output of 5 MW. Maximum net output is 95% of rated capacity. The energy is sold to Pacific Gas and Electric. The first plant, constructed in 1984, cost $2.6 million; the second plant was constructed for $4.6 million in 1990. Operating costs are not made public but both plants have generated excellent profit margins and a good return on investment since the initial start-up.

Significance

Landfill gas projects are suitable for large landfill sites (over a million tons). Harnessing landfill gas has a net positive impact on greenhouse gas emissions and is commercially proven.

Landfill Mining

Location

Edinburg, New York

Description

The Edinburg landfill mining project was initiated to test the potential of landfill mining for reducing the size of the landfill and the cost of closure. Refuse was excavated, screened and sorted; recovered soil was used as backfill for public works projects and, after process modifications, some recovered materials were incinerated. Recyclables were found to be too contaminated to be sold. Project costs were $866,000 or an estimated $6.90/cubic yard.

Significance

Landfill mining projects may significantly extend the life of a landfill, reduce the costs of landfill

closure, and allow the reuse of soil and other materials.

Mixed-waste Processing Facility

Location

Zoetermeer, the Netherlands

Description

This mixed-waste facility processes the portion of the residential waste stream remaining after the source separation of organics and paper. The plant was constructed in 1980 and had never worked successfully; the municipality took over the plant from the original owners (ESDEX) and re-opened it in January 1994. The plant now processes the waste into a refuse derived fuel (RDF) stream and an organic stream. The organic fraction is stabilized and used as intermediate landfill cover; no market for the RDF has yet been found. The plant has a capacity of 80,000 t/y. The plant originally cost $11 million to construct in 1980. The retrofit in 1993 cost $3.5 million, and operating costs are $40/t.

Significance

This project demonstrates the difficulties associated with establishing a successful municipal solid waste (MSW) processing facility. This approach could be used in any area where mixed-waste compost could be used as landfill cover, or where a market could be found for the RDF.

Multi-family Dwelling Recyclin

Location

Etobicoke, Ontario

Description

Lakeshore Village, constructed by The Daniels Group, incorporated a recycling system into the initial apartment building design. A three-chute system collects and separates recyclables in the building. Waste is disposed of by residents in one chute and is collected in a stationary compactor in the main-floor garbage room. Recyclables are sent down the other chutes by building staff after the material is checked for contamination, and it is collected in roll-off containers. The program targets ONP, OCC, OMG, food and beverage containers made of steel, aluminum, glass and PET. Recovery rates for the three-chute system were found to be 30.3 kg/capita/year. Capital costs were $60,000 per building, and annual operating costs were $3,000 per building.

Significance

This project demonstrates an innovative method for recovering recyclables from multi-family dwellings. The system may also be expanded to include the collection of household organics from apartment dwellers.

Re-use Centres

Location

Scarborough, Ontario

Description

The Scarborough ReUze Building Centre is privately owned and operated and has been in operation since 1992. High-quality used building supplies are brought to the centre or are picked up by staff for resale at the centre. Customers typically include do-it-yourselfers and people renovating cottages, who do not require retail-quality materials. The centre has proven financially viable with over 20,000 customers in 1993. Total waste diversion over the 2.5-year period of operation is estimated to be 300 tonnes (120 tonnes/year). Each tonne of material

received generates approximately $1,500 to $2,000 in sales. The centre employs five staff.

Significance

This facility is an example of a relatively successful for-profit business which provides jobs and also has a waste diversion benefit.

Location

Winnipeg, Manitoba

Description

The Habitat Re-store is a non-profit reuse centre for building materials established in 1991. Total sales in 1993 were approximately $260,000, and revenues were used to support Habitat's home building program. An average of 3 to 4.5 tonnes of material is received daily; in 1993, an estimated 150 to 250 tonnes of material was diverted from landfill. The project currently employs five full-time staff. Total operating and capital costs for 1993 were $275,000.

Significance

This project is an example of a reuse centre which uses its profits to fund community projects. While actual waste diversion is limited, Re-store exemplifies a useful approach for recovering construction and demolition waste for productive reuse.

Two-stream Wet/Dry Collection Programs

Location

Gold River, British Columbia

Description

The Gold River project is a comprehensive two-stream wet/dry collection program established in 1993. Dry wastes and wet wastes are collected separately and processed in a municipal material recycling facility (MRF). Although the program is costly on a per-tonne basis, a 58% diversion rate was achieved in the first year of the program. (Total costs were calculated to be $473/tonne).

Significance

The program established a waste-diversion system in a community where it had not existed before and achieved a 58% diversion rate in a relatively short period. Success is partially due to the fact that the program is relatively easy for householders and businesses to participate in; the relatively simple processing has also been successful.

Location

Prince Edward Island

Description

The Waste Watch demonstration project was established by a multi-stakeholder steering committee in two communities in 1992. Under the program, compostables and garbage are collected every other week (in specially provided bins) and recyclables are collected monthly in blue bags. The project's emphasis is on high public awareness and education, maximizing the diversion of organic materials, using existing equipment and resources wherever possible, and enhancing the efficiency of the province's EFW facility. The demonstration project has achieved an average diversion rate of 66%.

Significance

This program successfully demonstrates the impact of an integrated approach to waste diversion. It is one of the most successful integrated waste reduction programs in Atlantic Canada.

User-pay System

Location

Capital Regional District, British Columbia

Description

One of the most innovative waste reduction measures introduced to date in the region has been a user-pay system. Householders are permitted one 100-L can per week funded through the municipal tax base. Additional containers are charged a separate fee. Since the introduction of user-pay, the municipalities have experienced an 18% reduction in the amount of residential waste collected. A pilot project testing a weight-based user-pay system was also undertaken in Oak Bay, with promising results.

Significance

This is an example of a comparatively large user-pay program in Canada. It takes a hybrid approach by allowing residents to put out one container without charge.

Location

Kincardine, Ontario

Description

A user-pay system has been in operation since 1992 to encourage waste diversion and to extend the life of the area's landfill. A range of services is provided, including bi-weekly curbside residential recycling, a pick-up service for IC&I recyclables, backyard composting, a drop-off site for various materials and seasonal collection of leaves. Officials estimate that the program is diverting between 50 to 60% of the area's waste from landfill.

Significance

This is an example of a successful user-pay program in a small community where landfill space is limited. The program also demonstrates the importance of promotion and education to support the introduction and implementation of a user-pay system.

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