2016 Excellence Award Entry

Category: Composting System
Entrant Organization: City of Toronto
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Title of Entry: City of Toronto Disco Road Organics Processing Facility
Jurisdiction: City of Toronto, Ontario, Canada
Population: Approximately 2.8 million
Cost per household for project: This metric is not tracked by the City of Toronto
Approximate budget: $56.2M, with an additional $19.7M for site-related items including waste removal
The City of Toronto is a world-leader in diverting food waste from landfill. Currently, the City collects approximately 130,000 tonnes per year of source-separated organics (SSO), much of which is processed within its urban limits.

This application is for a City-owned facility entitled the Disco Road Organics Processing Facility. Completed in summer of 2014, this facility processes 75,000 tonnes of the City’s SSO every year, using a state-of-the-art wet anaerobic digestion system that produces valuable products such as biogas and digestate. This digestate is used to make high-quality compost. This is a first-in-kind North American development that has been processing SSO in an urban setting without odour or operational issues through its 2-year history.

This showcase facility illustrates how it is possible to generate biogas and high-quality feedstock for composting from residential organics—even in proximity to neighbours—while demonstrating excellent sustainability metrics, including substantial reductions in greenhouse gases.
The City’s Disco Road Organics Processing Facility (DROPF) is North America’s first full-scale municipal source separated organic (SSO) / green bin waste processing operation to use anaerobic digestion. By processing organics with this technology, the City is now able to divert more waste from landfill disposal, generate and collect biogas as a recoverable resource, and supply digested nutrient-rich material for commercial compost—all of which takes place in an intensely urbanized segment of Canada’s largest city.

The DROPF is a key element of the City’s organics diversion program. Construction on the DROPF began in February 2011, and the start-up/commissioning period took place between June 2013 and June 2014. The DROPF has been operating for nearly two full years (as of April 2016), demonstrating a continuous record of uninterrupted performance, environmental sustainability, and the ability to function in a manner that is fully respectful of surrounding neighbours.

The City’s work with anaerobic digestion technology began in 2002, when it opened the Dufferin Organics Processing Facility. This positive experience with respect to digestion of SSO led to a 12-year process to site, define, and develop the DROPF—the largest and most sophisticated municipal SSO digestion system in North America.

The DROPF processes approximately 55% of the green bin material currently collected within the City, and the City will use this springboard project to ultimately process approximately 90% of the green bin material collected within the City, all using anaerobic digestion.

Note: This application by the City of Toronto (City) has been organized within the headings described in the Compost Systems application packet.
1. Design and Planning of the System

1.1 City of Toronto Green Bin Program

History

The broad history of the DROPF stems from the City’s long-standing practice of diverting materials from landfills through the use of innovative technologies. This pioneering approach has enabled the City to generate clean feedstock for the production of high-quality compost.

This success is rooted in the City’s history of separating organics at the source, and the nature of those organics given the large and diverse population base of the City.

The following timeline outlines the City’s activities since 1999:

- **1999** Toronto began construction of a mixed waste/organics pilot facility eventually becoming known as the Dufferin Organics Processing Facility (DOPF)
- **2001** The City closed its main landfill, began shipping waste to Michigan, and initiated an SSO collection program
- **2002-2005** Single-family SSO collection program rollout to approximately 450,000 homes. In order to make the SSO system convenient, and to capture more organics, residents were allowed to use plastic bags to collect the material
- **2004** DOPF began full operations
- **2007** SSO planning study was completed, recommending construction of two SSO processing facilities within the City of Toronto
- **2011** Construction began on the DROPF, with nominal processing capacity of 75,000 tonnes per year and approved capacity of 90,000 tonnes per year
- **July 2014** The DROPF achieved full-scale operations
- **2015** The City initiated a contract to expand the DOPF to 55,000 tonnes per year. At the conclusion of this project, the City will be able to process up to 130,000 tonnes per year of SSO within the City using City-owned SSO processing infrastructure

As noted, the City has allowed for a convenient SSO collection program in order to encourage participation. This has helped the City to achieve very high participation rates.

SSO within the City contains the following acceptable materials:

- food waste
- pet waste, cat litter
- diapers, sanitary items
- paper food packaging (soiled)
- tissues, napkins, paper towels
- houseplants, soil
- non-biodegradable plastics to house the organic materials

The following figure shows typical aspects of the City’s SSO—the material is complex, but allowance for this complexity has driven significant levels of participation from residents.

As a result of this collection program, the City has achieved a very high single family participation rate of approximately 89%, and is reputed to be the largest SSO collection program in North America.

One of the significant challenges of this collection system, however, is ensuring that the processing technology used for generating valuable final products (such as compost) are robust enough to accommodate the complexity of the feedstock. The City has managed to expertly develop these systems, culminating in the successful deployment of the DROPF.
1.2 Why Anaerobic Digestion (AD) as Part of a Composting System?

What is unique about the DROPF? Firstly, as it relates to generating compost, the City decided to process SSO within the City limits. As a densely-urbanized municipality and the largest city in Canada, this presented challenges, specifically in finding a location to undertake this activity without negatively impacting neighbours.

Part of the genesis of this decision was the City’s experience with contracted processors, which was highly variable and at times unreliable. In order to expand the Green Bin program, the City required reliable processing capacity, and thus decided that it would create its own capacity within City limits.

The City undertook a comprehensive siting process for this system, including consideration of a shortlist of four sites that included existing transfer stations and one plot of vacant land. Three of the prospective sites were all or partially located on closed landfill sites with municipal solid waste or incinerator ash.

The primary considerations for the City’s decision related to:

- owning its own processing assets to ensure reliability,
- undertaking processing within the City limits to reduce trucking costs,
- utilizing a technology that respected the urban landscape of the City by utilizing a technology that would not adversely affect neighbours, and took up a relatively small footprint, and
- ensuring that the technology was commensurate with the complexity of the incoming SSO.

Within this context, it was decided that aerobic composting as a first step for treating SSO would likely consume too much space to be a viable solution. As a result, the decision was made to pursue anaerobic digestion.

The criteria for siting and technology were confirmed during City public-consultation events and public open houses, where the main potential concerns with the development were identified as being odour, health effects, decrease in property value, truck traffic, compromises with respect to existing green space, and overall aesthetics. Additional considerations were raised with respect to greenhouse gas emissions.

As noted, anaerobic digestion has the benefit of requiring a smaller footprint. The 75,000 tonnes per year envisioned capacity for the DROPF could be delivered on less than a three-acre footprint; conversely, an aerobic primary composting activity would require an approximate ten-acre footprint for this capacity. Furthermore, anaerobic digestion (AD) does not produce process air (i.e. the air that passes through organic material and which then requires some measure of cleanup prior to release). In AD, air is simply collected from storage and processing areas for treatment, but the most high-strength odourous compounds are nested within the biogas, which is then combusted. Finally, the possibility of generating biogas for production of energy is unique to AD, which was seen as an important overall benefit to pursing AD on-site within the City limits, and then delivering final digestate to an external site for final composting.

1.3 The Selected Site: Challenges and Opportunities

The chosen site for development of the DROPF was the Disco Road Waste Management Facility (DRWMF), which is located at 120 Disco Road in the northwest corner of the City in an industrial area near Pearson Airport and the Woodbine Racetrack. Mimico Creek is located south of the Site and the City’s Disco Road Works Yard is located the west. This is a heavily-urbanized area in proximity to major highways, hotels, and industrial/commercial developments as well as churches, a large golf course, and as noted, the largest airport in Canada (see Figure 4).

The DRWMF has been a part of the City’s waste management operations since the mid-1980s and includes a transfer station for municipal solid waste and single stream recyclable material; leaf and yard material transfer area; and drop-off depot for municipal hazardous solid waste and waste electrical and electronic equipment.

As noted in Figure 5 (see area to west of shown transfer station), the site is also a former municipal landfill, which has challenged both the construction of the existing transfer station and the intended DROPF. Despite these challenges, the City elected to develop the landfill mound shown to the west of the transfer station, excavating and removing approximately 100,000 tonnes of waste over a period of three months. Significant quantities of waste below-grade were left in place, and an extensive foundation piling program (approximately 13 km of total pile length) was used to support the DROPF on the existing waste-in place. A passive venting system and protective layer was also installed beneath the foundation to vent any landfill gas. This is very much a positive example of utilizing historic landfill properties to develop modern facilities, rather than using green fields.
1.4 Project Development
The DROPF went into full-scale operations in early 2014. Figure 9 shows an overhead figure of the DROPF at the Disco Waste Management Facility.

The following provides the main steps and timelines in the development of the project:

- Toronto retains Owner’s Engineer in 2008 (GHD Limited, then known as Conestoga-Rovers & Associates)
- Design-Build-Operate Agreement signed with AECOM Canada Limited in October 2010
- Waste mound removal and construction of DROPF from 2011 through 2013
- First waste receipt in November 2013, and initiation of commissioning
- Full-scale waste receipt January 2014
- Substantial Performance July 2014
As part of the DROPF procurement process, a Request-for-Qualifications process for AD pre-processing technologies was undertaken. This resulted in the prequalification of two different systems: the BTA hydropulping system™ and a similar system supplied by a second vendor. In the subsequent RFP for a design, build, and operate (DBO) contractor that would be required to utilize one of the prequalified systems, the BTA hydropulping system™ was selected. This system was already in-place at the City’s Dufferin Organics Processing Facility and had been in operation since 2002, providing reliable service.

A particular and important part of the search for technologies was the demonstrated ability to accommodate the particular characteristics of the City’s SSO. Given the quantities of film plastics and sanitary products in the SSO, it was vitally important to ensure that a pre-processing system could remove these contaminants and isolate the organic fraction for anaerobic digestion.

2.1 Process Overview

The basics of AD are long-established and in use at multiple wastewater treatment plants for stabilization of wastewater sludge. In the DROPF, processing of SSO uses the following steps:

- SSO is received on a tip floor fitted with steel plates and a specialized abrasion- and chemical-resistant tip floor coating to withstand vehicle traffic and liquids from SSO
• SSO is then exposed to the BTA pre-processing system™, which opens plastic bags, solubilizes organics into a slurry, skims plastics from the surface of the 3 – 30 m³ hydropulping tanks, and settles heavy materials to the bottom of the tank where they can be removed.

• Pulp is then exposed to a hydrocyclone for removal of grit (small inerts such as sand, eggshells, glass shards, etc.)

• The cleaned pulp is stored in a buffer tank that is filled during the week and depleted over the weekend. This is especially important given that the City does not collect SSO over the weekend, but the digesters must be continually fed in order to support the biological operation.

• The pulp is digested in 2 – 5,400 m³ anaerobic digesters (20 m tall and 20 m in diameter) that are mixed using biogas that is injected at pressure through a lance system integral to the tanks.

• Spent liquid from the digesters is sent to a centrifuge system that achieves liquid-solid separation.

• Solids from the centrifuges are inserted into trailers via screw conveyor, and then sent off-site for composting.

• Liquids from the centrifuges are treated on-site in a wastewater treatment plant whose objective is to discharge the treated liquid to the sanitary sewer system.

• Biogas from the digesters is used in a dual-fired boiler system that provides heat for the DROPF and for the process, in particular to keep the anaerobic digesters in a mesophilic temperature range of approximately 37°C at all times of year. Excess biogas is flared but will soon be utilized as a source of renewable energy through a system that is currently under development by the City.

• All air from the DROPF is collected in order to maintain negative pressure to prevent fugitive emissions, and this air is exposed to an inorganic media biofilter for treatment, with final release via a 40 m stack.
2.2 Process Technology and Design

Description

The following provides a design narrative and additional design details for the DROPF.

The DROPF provides two tip lanes for waste deliveries (shown in Figure 7). The Tip Floor layout permits a front loader to pick up organics from either the truck unloading area or the Storage Area. Pulper loading is accomplished by feeding either of the two waste hoppers at the side of the tip floor (shown in Figure 8). Enclosed belt conveyors with dip trays transports organics from the loading hoppers to the Pulpers (shown in Figure 9 and 10). The Pulpers run an automated cycle to separate the light fraction (plastic) and heavy fraction (bone, stone, glass) from the organic matter to transform the material into a homogenized suspension.

There are three main processing lines at the DROPF, and three hydropulpers in total. The entire 75,000 tonnes per year capacity can be accommodated by two processing trains, running on two shifts. As a result, there is significant redundancy in the system for additional capacity should the City require additional processing up to the approved capacity of 90,000 tonnes per year. Further, an entire line can be under service and yet still achieve the 75,000 tonnes per year nominal capacity. Given the criticality of the DROPF to the City’s overall waste management system, this redundancy was important. There are also cross-connections between the processing units, allowing for elements from one processing train to be used as part of a different train.

Liquids used for pulping are recirculated through the system to minimize the use of potable water. Additionally, rainwater from the DROPF and the adjacent transfer station roofs is harvested for process water needs, further reducing the use of potable water. Another feature of the DROPF is that it is equipped with a white roof utilizing a specialized membrane, in order to reflect sunlight and mitigate urban heat island effects.
2.3 Other Features

Screw classifiers and presses are used to dewater the residues. The residue is transferred from the Process Area via conveyors to the Residue Management Area, where it is loaded into trailers by a second stage press. This residue is largely film plastic and is currently landfilled.

The organic suspension is pumped to the Grit Removal System (GRS) for grit separation (shown in Figure 10) using a hydrocyclone. The de-gritted organic suspension is transferred and stored to the Suspension Buffer Tank (SBT) located outside (shown in Figure 11), prior to being fed to the digesters. Here, the organic matter is kept in suspension by a direct air injection system.

The organic suspension is pumped from the suspension tank to the digesters, 24 hours per day, 7 days per week. The digesters are mixed by a system of digester gas reinjection and heated by external hot water via tube in tube heat exchangers connected to the dual-fired boilers. The digesters are sized to achieve between 14 to 21 days residence time and are shown as the larger tanks in Figure 11 and 15. The tanks are glass-lined to provide resistance against the internal liquids and gases. As a result, the tanks are steel-bolted rather than welded, and were assembled in layers. The tanks are finished with insulation and external cladding.

The biogas produced by the digestion process escapes the liquid phase into the digester headspace. A portion of the biogas is recycled to mix the digester (shown on Figure 12). The net gas production is boosted and fed first to the dual-fired boilers and secondly to the on-site flare; as noted, the City is engaging in a project to utilize this excess biogas. Overall digestion efficiency of the digesters are 75% with biogas production of 110 m3/tonne of organics. Methane content of the biogas is over 65%.

Following the digestion of the organic matter, the digestate is pumped to the solids management area for dewatering by the centrifuges. The dewatered digestate is conveyed into one of the two trailers on the floor level beneath. Centrate is pumped to the on-site Wastewater Treatment Plant (WWTP) to meet sewer discharge requirement. The WWTP technology is comprised of a sequencing batch reactor system.

The odour control system (OCS) is designed to contain, convey, and treat odourous air produced within the buildings, tanks, and WWTP. The Biofilter is equipped to treat 75,000 m3/hr of air; this odourous air is collected from selected points within the treatment facility, and transported to the odour control system. Odourous air is passed through a humidification stage before being treated in a biofilter system.
3. Regulatory Compliance

There are many unique aspects to the DROPF, but one in particular is its compliance with local regulations.

In the entire operating history of the DROPF (late 2013 to present), there have been zero odour complaints from neighbours. For a facility of this size, processing capacity, and proximity to neighbours, this is a truly remarkable attribute, and speaks to a highly-balanced development framework that marries appropriate technology to siting.

In terms of performance at the discharge stack, the DROPF has been tested yearly since it began operations, to ensure that the nearest sensitive receptors are not impacted by treated air emissions. The DROPF has achieved compliance with Ontario Ministry of the Environment and Climate Change standards for all tests to date. Coupled with stellar performance related to odour complaints (none), this indicates the clear success of the development.

Additionally, while the DROPF is equipped with a full sprinkler system to protect against fire, there has never been a fire issue at this plant. In part, this is because the main processing is undertaken anaerobically, in a wet solution that cannot produce fire conditions. As a result, most of the energy of the incoming SSO is removed in the liquid phase. The final digestate that is sent off-site for composting is thus relatively benign, has minimal odour, and has not in the history of the DROPF created any fire issues during the final off-site composting stage.

The DROPF has been operating so successfully within the City bounds that the City has elected to expand its other SSO processing facility (the Dufferin Organics Processing Facility) from a nominal design capacity of 25,000 tonnes per year to 55,000 tonnes per year, also using an AD platform. This project is currently underway.

4. Worker Health and Safety

The fact that the overall safety metrics are so favourable for a construction project on this ‘tight’ of a site speaks to the significant attention and follow-through on ensuring that worker health and safety was at the forefront at all times.

The total number of person-hours involved in the construction of the DROPF was 304,102, during the construction period from March 2011 to August 2013 (including waste removal and piling) as recorded by the constructor. On-site health and safety was the responsibility of a general contractor named ES Fox. During the entire construction period, there were 0 Lost-Time Accidents and 0 Work Days Lost. The Ontario Ministry of Labour was not involved on-site during the construction program. There were approximately 250 safety inspections conducted during the course of the 2-year construction program.

Given that the entire DROPF occupies an area of a little more than two acres—and incorporates significant deep foundational elements, as well as mechanical and electrical systems, and structural components that range from main and ancillary buildings through to complex process elements, including the erection of eight large process tanks—there were numerous contractors on-site at any one time during construction, but no worker health and safety issues whatsoever.

The fact that the overall safety metrics are so favourable for a construction project on this ‘tight’ of a site speaks highly to the attention, focus, and follow-through involving health and safety considerations.
The DROPF achieved substantial performance in July 2014. During its first partial year of operation in 2014, the DROPF processed just over 66,000 tonnes of SSO, a span that included ramp-up and commissioning. In the subsequent years, the DROPF has performed at its capacity of 75,000 tonnes per year with no operational downtime during that period. Given the biological nature of AD, it is vitally important to provide continuous operation, and in this respect the DROPF has provided the City with precisely the reliable, ongoing service that it sought by developing its own facility. There have been no interruptions whatsoever to processing.

Generally, the DROPF receives roughly 2,800 trucks per year, with about half of these being transfer trailers from other City transfer stations, and the other half being local curbside collection vehicles. There have been no interruptions in receiving loads since the DROPF began operations. Given that the single most important goal for the City is to reliably service its residential customers and provide a sustainable means of diverting material from landfill, continuous operation of the DROPF has eminently achieved the City’s main goals and provided a successful conclusion to a process that began in 2007.

In terms of performance metrics, the figure to the right provides a snapshot of the overall mass balance of the DROPF for every one (1) tonne of incoming SSO.

In addition to the above, about 4% (by mass) of the incoming SSO is exported as grit. While this quantity of material is relatively small from a mass perspective, the DROPF has an advanced grit removal system to prevent this material from accumulating in the digestion tanks, where it could interfere with mixing and biological conversion of organics to methane.

One of the significant achievements of the DROPF is the diversion of SSO from landfill disposal, and doing so without excessive trucking to off-site processors. For a facility operating at 75,000 tonnes per year, the corresponding reduction in greenhouse gas emission would amount to approximately 50,000 tonnes per year. For context, this is about the same effect as removing 10,000 cars from roadways. Once the planned utilization project is implemented, the overall greenhouse gas emissions reduction will be further amplified due to the displacement of purchasing grid-supplied electricity.

With respect to economic performance, the City released the project under a design-build-operate scenario where the operating term was for up to 5 years. At this point, the project has been delivered within the design-build budget, and operations have proceeded according to the fixed price per tonne for processing, as submitted by the private sector operator. Coupled with the environmental and operational success of the project, this establishes the DROPF as a facility that has met with resounding success from both a technical and economic standpoint, and cements its position as a first-in-kind and state-of-the-art development in North America - and the flagship of the City’s waste management operations.
6. Public Acceptance, Appearance and Aesthetics

The City has developed a facility that has been exemplary in terms of being a good neighbour in the community, as demonstrated by environmental performance. As the photos in this submission have demonstrated, the DROPF is a modern facility with a number of architectural finishes that align it with the adjacent transfer station and the surrounding community but that establishes it as a one-of-a-kind facility in North America.

Most importantly, the DROPF has been developed to be respectful and beneficial for the City’s customer base — namely, its residents. The inclusion of plastic bags and sanitary products in the SSO stream has allowed the residents of the City to actively and significantly engage in the SSO program, making the City’s program the most widely-adopted in North America. The technology suite and protective measures at the DROPF enable the City to effectively process this material while meeting environmental performance standards. This is an excellent marriage of technology to social and environmental goals.

Although the DROPF is in full-scale operations and has been for quite some time, the City has adopted a culture of continuous improvement. Two significant projects are envisioned for the DROPF. In the near future, the biogas excess to what is required for heating needs at the DROPF will be utilized to generate electricity that will take the DROPF and the adjacent transfer station “off-the-grid”. This will be the final step in maximizing the sustainability profile of the project. A future project relates to the use of the residue generated by the DROPF. As noted, the DROPF receives SSO in plastic bags, in order to facilitate participation in the program. This material is separated and dewatered, and represents a potential source of energy for off-site facilities that may generate electricity and/or liquid fuels. This aspect of the DROPF will be investigated in the future.

As a testament to the uniqueness of the DROPF, there has been significant attention to it from the municipal and private community. Since the DROPF began operations, it has attracted almost 60 tours from various parties with an interest in innovative SSO processing, from across North America.
7. Closing

We hope that this application conveys the unique excellence of the DROPF and its contributions to Toronto’s integrated waste management system. There are a number of elements that have been spoken to in this document, but we would like to summarize the main points:

- This is North America’s first full-scale municipal source separated organic (SSO)/green bin waste processing operation to use anaerobic digestion for the production of biogas and high-quality feedstock for use in composting.
- The DROPF has been in uninterrupted operation since completion in mid-2014 and has generated zero off-site odour issues during that time despite being in a densely populated portion of the City and in proximity to Canada’s largest airport.
- The DROPF has consistently generated a clean feedstock for off-site composting while also producing biogas at a rate that would support approximately 2.5 MW of electrical generation.
- The entire 75,000 tonnes per year operation including receiving, pre-processing, residue and digestate management, wastewater treatment and odour control occupies a space of less than 3 acres.
- The development is an excellent example of using brownfields, in that the DROPF is constructed on a historical landfill. To our knowledge, this is the only such facility constructed in North America on a landfill.
- The DROPF incorporates positive environmental features, such as rainwater harvesting to offset the use of potable water, and biogas usage in dual-fired boilers to satisfy heating demands for the building and the process. In the future, the DROPF will generate sufficient electricity to not only satisfy its own demands, but also those of the adjacent City-owned transfer station.

Given the successes noted above, the City is now actively engaged in building additional SSO AD capacity at a second site within the city bounds, and will eventually be able to process the vast majority of its SSO in its own facilities, while generating biogas for energy production and feedstock for high quality compost.