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IMPORTANT NOTE TO THE READER

The content of this handbook should be considered a reference only. It combines knowledge and experience of the various contributors, combined with outcomes of the Getting to Net Zero Energy Wastewater Treatment workshop that was co-hosted on February 10th, 2020 by the Ontario Water Consortium and the Ontario Clean Water Agency.

Readers considering a co-digestion project at a municipal wastewater treatment plant should seek the appropriate professional services including legal, accounting, and engineering.

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A Handbook for Co-digestion Projects at Municipal Wastewater Treatment Facilities

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Objectives and Overview

Co-Digestion and its Benefits

Value generation from biosolids – minimizing volume, recovering resources, and unlocking trapped energy potential – is a major area of strength for Ontario. Combined with government priorities for reducing greenhouse gas emissions and recovering resources from all waste, there is a tremendous opportunity for Ontario municipalities to lead a major shift toward resource recovery and energy neutrality at wastewater treatment plants (WWTPs).

Anaerobic digestion (AD) is a natural process that consumes a portion of organic wastes and produces digestate and methane gas. Digestate can have beneficial uses such as fertilizer for agricultural applications or can be sent for disposal. Methane produced from AD is called biogas; it is a beneficial fuel that can be used to create compressed natural gas (CNG) to fuel vehicle fleets, for the production of electricity through a combined heat and power (CHP) process, or for cleanup and incorporation into the natural gas supply as renewable natural gas (RNG).

In Ontario, municipal wastewater treatment plants, large-scale farms, or occasionally stand-alone facilities use anaerobic digesters to process organic wastes. On-farm anaerobic digesters are typically used to process organic waste from farming operations, including agricultural plant waste or animal manure. Municipal wastewater treatment plants use anaerobic digestion to process waste sludge produced from treating wastewater. Co-digestion is a process whereby other organic waste, such as source separated organics (SSO) or commercially marketed organic slurry, is processed along with sludge in the anaerobic digesters at WWTPs.

Co-digestion is the key to taking a more integrated approach to managing all organic waste in Ontario and eliminating the disposal of organic waste in landfills.

Co-digestion at wastewater treatment plants will likely be a less costly, more efficient, and faster option to implement compared to building new stand-alone digestion capacity to process organics. It is a viable solution for municipalities across the province, and may be particularly relevant to small- and medium-sized municipalities. It is also an important model as the province implements new requirements on organics management and municipalities struggle to adapt and plan solutions to these new challenges. One path forward is to first optimize and next maximize the capacity of existing infrastructure through sound process control and the adoption of new technology. Co-digestion at existing WWTPs:

- Optimizes existing infrastructure (in many cases these facilities require upgrades, or are operating below rated capacity)
- Provides new local anaerobic digestion capacity to meet needs for diversion of organics from landfill
- Reduces the need to site expensive new greenfield projects or stand-alone digesters
- Transforms wastewater facilities into Resource Recovery Facilities
- Generates valuable renewable natural gas that can be a revenue stream for municipalities
- Provides a consistent and reliable source of local organic non-mineral fertilizer (which may meet requirements under the Federal Fertilizers Act and be marketed as a commercial fertilizer)
- Increases opportunities for new investment models, led by municipalities.

The Co-Digestion Landscape in Ontario

Demand Drivers

Political

Food and Organic Waste Framework

The Province of Ontario has articulated a strategic priority to be waste-free. The strategy includes the Food and Organic Waste Framework, which includes a vision of a circular economy that moves towards zero food and organic waste and zero greenhouse gas emissions from the waste sector. The Framework comprises of an Action Plan and a Policy Statement.

The role of co-digestion supports multiple commitments made in the Framework's Action Plan, including:

1. **Divert food and organic waste from landfill**
   Co-digestion utilizes existing infrastructure at WWTPs to process organic waste and create energy and a valuable soil amendment (digestate) providing an alternate destination for waste. Methane collection systems at landfills cannot capture all the methane produced.

2. **Support *resource recovery* infrastructure**
   Co-digestion requires upgrading of the existing WWTP infrastructure using innovative technologies, which extends the lifetime and increases the processing capacity of the facility. The additional food and organic waste processing capacity provided at co-digestion facilities is key to ensuring Ontario has sufficient infrastructure. Supporting co-digestion supports resource recovery infrastructure.

3. **Promote *beneficial uses* of recovered organic resources**
   One end-product of co-digestion is digestate, an organic residual with multiple beneficial uses: sold as a commercial fertilizer, applied to agricultural land as a soil amendment or used in mine reclamation or as a feedstock at composting facilities. Co-digestion facilities support *beneficial uses* that promote soil health, crop growth and enhance carbon storage.

4. **Reduce greenhouse gas emissions from food waste**
   Co-digestion facilities achieve significant GHG emission reductions through diversion of organics from landfill; the production of RNG, CNG or electricity that replace carbon-intensive fossil fuels; produce digestate that can replace mineral fertilizers.

The Framework's Policy Statement includes two statements that explicitly reference and support co-digestion and biosolids (6.15 and 6.16)

6.15 Existing wastewater treatment infrastructure may be considered for acceptance of source separated food waste, where there exists (or can be created, for example through approaches such as optimization, infrastructure upgrades or adoption of advanced technology) excess capacity to create high-value end products.

6.16 Municipalities are encouraged to plan for the management and beneficial use of biosolids, including considering new and enhanced biosolids processing technologies and co-management practices that support volume minimization and nutrient recovery.

The vision of the Food and Organic Waste Framework is well-aligned with the goal of transforming wastewater treatment plants (WWTPs) to water resource recovery facilities (WRRFs), moving towards energy neutrality through anaerobic digestion and the production and capture of biogas.

Made in Ontario Environment Plan

The role of co-digestion also supports multiple commitments made in the Made in Ontario Environment Plan including:

1. **Support RNG, including the uptake of renewable natural gas and the requirement for natural gas utilities to implement a voluntary RNG option for customers.**
   One end-product of co-digestion is biogas. Biogas can be upgraded to RNG, CNG or used to produce electricity. The biogas produced at co-digestion facilities can enable natural gas utilities to offer an RNG option for customers.

2. **Collaborate to remove barriers to expanding 24/7 CNG refueling stations for trucks along the 400-series highways.**
   The biogas produced at co-digestion facilities, which can be located along this transportation corridor, can also be a local source of compressed natural gas (CNG) for use in refueling stations for trucks along the 400-series highways. CNG is recognized by the Province as a cost-effective option to lower emissions from on-road transportation.

3. **Improve the management of hauled sewage.**
   Co-digestion facilities can include hauled sewage reception thereby creating an improved management approach for hauled sewage.

4. **Achieve GHG emission reduction commitment (30% below 2005 levels by 2030)**
   Co-digestion facilities achieve significant GHG emission reductions through diversion of organics from landfill; the production of RNG, CNG or electricity that replace carbon-intensive fossil fuels; and produce digestate that can replace mineral fertilizers.

5. **Improve diversion of food and organic waste from landfills**
   Co-digestion utilizes existing infrastructure at WWTPs to process organic waste and create energy and a valuable soil amendment (digestate) providing an alternate destination for waste.

Economic

Reducing Energy Consumption

The Environmental Commissioner of Ontario noted, “Municipal water and wastewater systems are usually a municipal government’s largest energy users, consuming, on average, 38% of the energy [use].”[1] The trend is increasing energy costs with the opportunity to reduce the impact of increasing costs by offsetting energy consumption with energy generation.

Maximizing Use of Existing Infrastructure

The trend is towards more holistic examination of asset management, considering a wide variety of factors to maximize value from past and future investments, including various partnership structures.

[1] (Environmental Commissioner Ontario, 2017)

Maximizing the value of existing assets can produce long-term benefit for government and asset owners. By improving efficiency and leveraging new revenue streams it is possible to unlock new value from existing infrastructure while providing needed services.

Minimum Renewable Content in Natural Gas

Mandating a minimum renewable content for natural gas has been contemplated but not implemented in Ontario. Québec committed to setting minimum thresholds for renewable fuel content and renewable natural gas distributed in the province by 2020/21 and raise them over time.[2]
That province published a draft regulation in August 2019, requiring that deliveries of natural gas distributors contain at least 1% of renewable natural gas (RNG) by 2020 and 5% by 2025. British Columbia has implemented a revenue neutral carbon tax and specific greenhouse gas emissions limits, and imposed minimum requirement for 15% renewable content in natural gas by 2030.[3]

Greenhouse Gas Emission Reduction and Carbon Credit Markets

Carbon pricing is increasingly being deployed as a tool in cost-effective transitioning to a low-carbon economy. There are 57 carbon-pricing initiatives around the world, consisting of 28 emission trading systems and 29 carbon taxes[4]. Prices for carbon, depending on instrument and/or market, range from $1 to $127 USD/tCO2e. According to the UN Paris agreement the goal is for carbon pricing to reach from $50 - $100 USD/tCO2e by the year 2030[5]. It is anticipated that the trend will be for increasing creation of emission trading systems globally, increasing participation in existing markets, and increasing carbon prices. The resulting impact will be favorable for co-digestion and RNG projects.

Social

Climate Change and Action

There is increasing public knowledge and action, locally and globally, to reduce greenhouse gas emissions to mitigate further climate change impacts and global average temperature increases. In Ontario, more than 30 municipalities have declared “climate emergencies” and in Toronto alone, youth-led climate strikes had over 50,000 participants in 2019[6].

Landfill Pressure

In Ontario, approximately 70% of waste ends up in landfills. It is estimated that without at least 10 new landfills (which take on average 10 years to go through approvals) Southern Ontario’s existing landfills will be full by 2030[7]. According to Statistics Canada, from 2014 to 2016 total waste from all sources disposed of in Ontario has increased from 9,165,299 to 9,475,472 tonnes[8]. Governments, at all levels, are focusing on long-term waste management and reduction strategies to mitigate the pressures and challenges posed by reliance on landfills.

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[2] (Government of Quebec, 2019)
[3] (Province of British Columbia, no date)
[4] (The World Bank, 2019)
[5] (The World Bank, 2019)
[6] (Saxe, Rougeot, & Buchanan, 2019)
[7] (Ontario Waste Management Association, 2019)
[8] (Statistics Canada, n.d.)

Technological

Advanced AD Technology Development, Adoption

The Province of Ontario has academic expertise and an emerging ecosystem of technology companies with strengths in technologies to optimize and enhance anaerobic digestor performance to maximize capacity and the production and recovery of valuable resources. Technology solutions can be pre- or post- anaerobic digester and also within the anaerobic digester itself.

Strategic Position

Strengths

- Ontario is home to a robust wastewater and cleantech ecosystem with strengths in resource recovery, the circular economy, and biosolids treatment technology development and research.
- The Province of Ontario has policy initiatives that support the position of resource recovery.
- The Province of Ontario has policy initiatives that support the position of maximizing the use of existing infrastructure assets.
- There is at least one existing municipal anaerobic digester at a wastewater treatment plant in every MPAC region in the province. Allowing for a potential distributed hub and spoke organics management model.
- Regulatory landscape has been clarified through the Stratford project. There is no need for regulatory reform.

Weaknesses

- Ontario has many small and/or remote municipalities that produce small volumes of organics and create challenges for collection, transportation and consolidation.
- Lack of understanding and low profile of using existing wastewater treatment plant anaerobic digester infrastructure as an immediate option for co-digestion and diverting organics from landfills.
- Ontario does not have, or participate in, a carbon emission trading system. Future drivers of carbon emission reduction (and the applicability of the federal carbon tax to Ontario municipalities) are unclear.
- No specific driver for RNG (ex. British Columbia has implemented a minimum renewable content in fuels)
- Limited options for sites as approximately 70 of 486[9] wastewater treatment plants in Ontario use anaerobic digestion.
- Difficult for new technology vendors to enter the market with innovative solutions, leaving more established companies and fewer options.
- Most established technology vendors that have proven core process technologies will mainly pursue projects involving the large or medium municipalities, leaving the smaller municipalities under-served.
- Loss of targeted grant programs for municipal GHG reduction projects.

Opportunities

- New and growing carbon markets and increasing price trends may offer the choice to develop partnerships to achieve premium value for renewable natural gas, improving return on investment (ROI) and revenue for Ontario based co-digestion projects.

[9] (Chao & Parker, 2018)

- 19 out of 27 MPAC regions could improve their digestion capacity by 30% through upgrading secondary digesters or implementing innovative technology thus creating capacity for off-site organics[10].
- Growing federal focus on climate change and greenhouse gas emissions spotlighting projects implementing innovative technology.
- Development, demonstration, and adoption of local technologies may result in greater export opportunities and enhance local economic development.
- Building unique clusters of collaborations among technology vendors centered around existing infrastructure.

Threats

- Competition among current and future processors for sources of organics including on-farm digesters and stand-alone anaerobic digestion facilities.
- Inconsistent feedstock supply and/or quality.
- Continued shipping of organics to the USA as the cheapest disposition option.
- Inconsistent, adverse, or lagging policy signals from government may generate confusion, risk aversion and slow adoption.
- Public perception and concern.

Tactical Options to Move Forward

- Stakeholders in Ontario must meet with purpose to spark collaborations, including pilot and demonstration projects, and work together to clear the path to enable these projects.
- Work with strategic partners in priority MPAC regions to develop regional plans for anaerobic digestion infrastructure, organics collection and processing, and digestate disposition.
- Promote resource recovery and the circular economy within the Province, reducing or eliminating out-of-province disposal options for organics.
- Build inroads to various emission trading markets to find opportunities to participate to create more options for business models and RNG price.
- The stakeholders in Ontario, including academia and technology companies, must work together to create common messaging and align goals to promote and enhance the profile of co-digestion at wastewater treatment plants using existing infrastructure. Key stakeholders support common messaging, build public awareness and broad support for the benefits of WRRFs.
- Support cluster building around established companies with later stage/proven process technologies and where applicable tie in the use of complimentary innovative non-core technology from Ontario small and medium enterprises (SMEs) to improve performance further. The goal is to open the door for small companies and/or new technology to grow this cleantech sector while reducing risk to municipalities by allowing them to work mainly with the established companies for major process operations.
- Engage early with “engineered organic slurry” manufacturers to assess opportunity for partnership in order to secure consistent and clean supply of organic slurry and avoid the need to de-package organic feedstocks at the WWTP. Using an “engineered organic slurry” can also reduce upfront capital costs at WWTPs.

[10] (Chao & Parker, 2018)

Technology Considerations

Feedstock

Types of feedstocks that may be used for co-digestion at a WWTP include those that are pre-processed or due to their source have little, if any contamination (e.g., plastic). Some waste management companies are also supplying organic slurries specifically designed as a feedstock for anaerobic digestion.

In the case of feedstocks that, like source separated organics, have significant contamination, pre-processing technologies are required to separate the organic matter that is suitable for the anaerobic digester from the contamination/garbage. There are a number of companies that offer this type of technology.

Figure 1 describes various technology considerations for advanced anaerobic digestion projects with mixed organics feedstock. In general, the site may need:

- Waste reception and pre-processing which could include:
    - tanks for receiving liquid feedstock
    - unloading bay for solid feedstock (typically the building is under negative pressure, doors only open for trucks to enter and leave)
    - separation technologies can create multiple streams: organics, waste (light and heavy fractions), wastewater
    - common de-packaging and separation techniques include: manual, extrusion, pulping, grinding/maceration, cyclone for grit removal
- Odour control;
- Pre-treatment prior to digestion (e.g. hydrolysis and pasteurization);
- Capacity increases in dewatering equipment and digestate storage;
- Digestate processing to address end-use market requirements;
- Enhanced digester mixing;
- Provisions to manage increased return streams to the liquid train of the WWTP;
- Biogas upgrading to Renewable Natural Gas (RNG);
- Expanded flaring capacity;
- Biogas storage;
- Cogeneration systems; and
- Management and disposal of residual waste resulting from pre-processing of the off-site organics.

Pre-treatment

In most cases, it may be most cost effective to incorporate pre-treatment technology, such as some type of hydrolysis, to increase the digestion efficiency of the plant. Similarly, pre-treatment like pasteurization may be required if the decision has been made to market the digestate as a commercial fertilizer.

Anaerobic Digester Technology

Most existing anaerobic digesters will require some type of optimization or retrofit to enable the co-digestion of new feedstocks. Typically, the solids concentration in the anaerobic digesters will increase

with the addition of non-sludge organic materials and as such improved mixing and possibly heating will be considered.

Digestate

There are two outputs from the anaerobic digester: gas and digestate. Digestate can be managed in a number of ways and the end use will determine any additional processes that maybe needed. End uses/disposal options include:

- Feedstock for compost
- Commercial fertilizer
- Liquid or dewatered non-agricultural source material
- Landfill

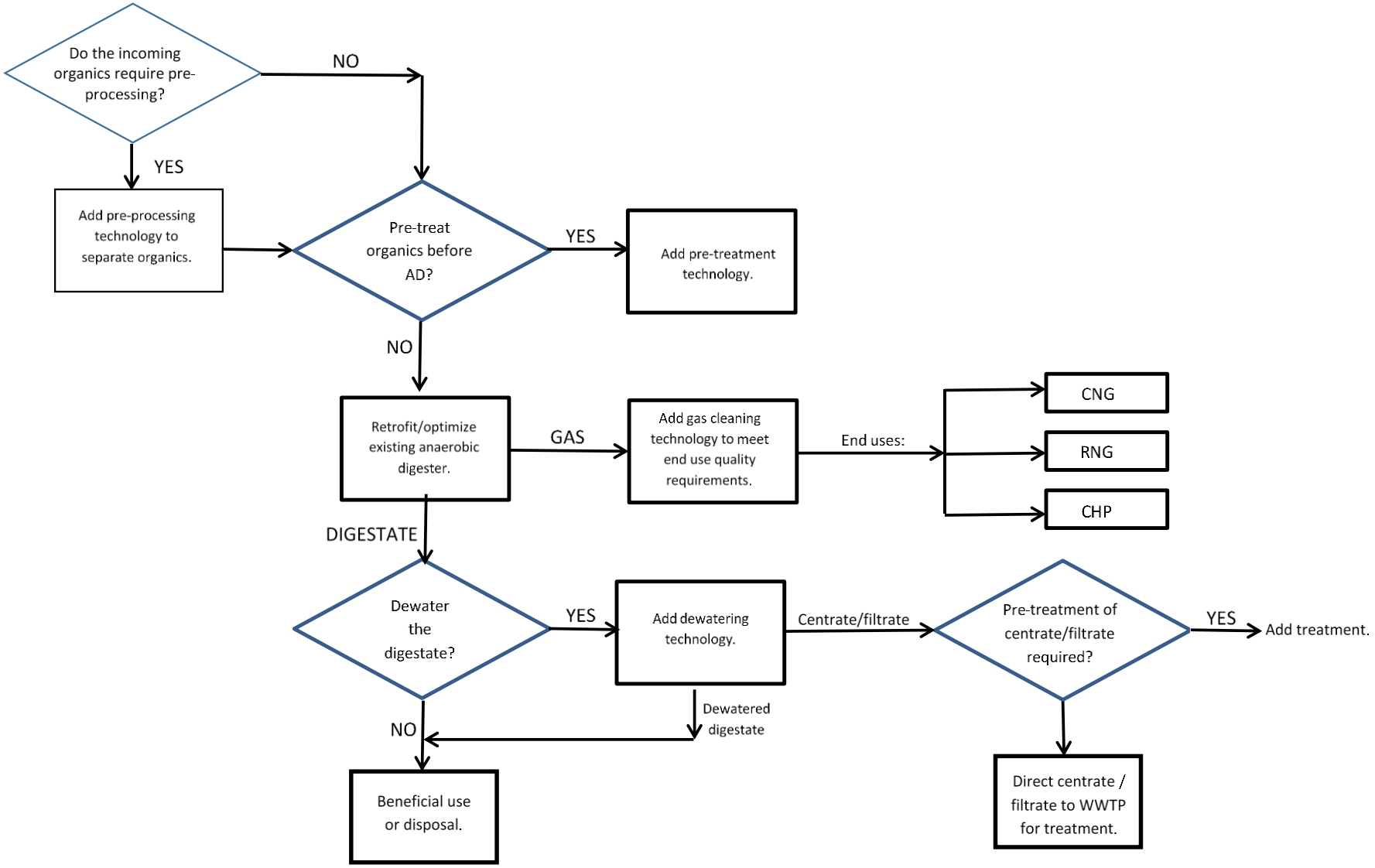
Dewatering equipment will be needed if the digestate will leave the site as a "cake". Digestate dewatering is similar to biosolids dewatering and the same types of equipment can be used. One consideration is the centrate or filtrate that is generated from dewatering. If the WWTP does not have available treatment capacity to accept and treat this stream, a separate treatment process may be required.

Clean Fuels

The biogas generated from the anaerobic digestion of organic matter contains a number of undesirable constituents (e.g., siloxanes) that will need to be removed prior to use. The extent to which the gas must be cleaned will be determined by its end use. End uses include:

- Compressed natural gas (CNG) for fueling vehicles
- Renewable natural gas (RNG) that is injected into a nearby natural gas pipeline
- Fuel for a Combined Heat and Power (CHP) unit for production of electricity

Figure 1: Anaerobic Digester Technology Considerations



Considerations on the Path to Co-Digestion at WWTPs

Business Model

Partnership Structures

Municipal Services Corporation

Under the Municipal Act (2001) Regulation 599/06 "Municipal Services Corporations" a municipality may establish a corporation on its own, or with one or more public entities. The municipality may transfer assets to the MSC if the municipality adopts and maintains policies on asset transfers to corporations. The corporation is prohibited from transferring to a private person any asset that is part or all of a municipal drinking water system or of a sewage works unless the board of directors of the corporation has declared, by resolution, that the asset is no longer needed for the purposes of the system.

The municipality can give or lend money to the corporation and can guarantee borrowing by the MSC.

In Ontario, a government business enterprise (GBE) is a government organization that[11]:

- Is a separate legal entity with the power to contract in its own name;
- Has the financial and operating authority to carry on a business;
- Is principally focused on the selling of goods and services to individuals and non-government organizations; and
- Is able to maintain its operations and meet its obligations through revenues generated outside the government reporting entity.

In certain circumstances the investment made by a municipality in the MSC, may not impact the municipality's debt limit. Advice from an accountant should be obtained.

Public – Private Partnerships

Co-digestion projects may present an opportunity for private sector joint ventures and partnerships.

A public-private partnership or P3 is an infrastructure procurement alternative, wherein the private sector assumes a share of project risk, which may encompass financing, project delivery, and performance. There are various models, generally including design and construction, and sometimes including operations, maintenance, and/or financing. A 2013 report evaluated the applicability of these models to the water and wastewater sector in Canada. It noted that Design-Build-Fund-Operate-Maintain (DBFOM) projects in particular are feasible only if they require a private finance amount of at least $100 million.[12]

Technology Partnership

Municipalities may partner directly with technology providers. Equipment contributions or investments can be made under various performance-based models.

[11] (Ontario Ministry of Finance, 2012)
[12] (PPP Canada, 2013)

Utility Financing

Gas or electric utilities have invested in energy generation projects traditionally as equity share or interest-based investment. This kind of model brings low cost capital and revenue security through off take agreements with the utility.

Concession Model

One mechanism for direct private sector financing of projects is the Concession Model. This model has not been previously used in Ontario but is currently being pursued by the Town of Mapleton as a mechanism for attracting private sector investment in wastewater assets. The Canadian Infrastructure Bank has supported the model (see below). Under the Concession Model, the municipality enters into a long-term lease of its infrastructure asset(s) to a third-party operator (the "Concessionaire") and risks are transferred to the Concessionaire. The municipality controls rates, performance standards, etc. and maintains ownership of the assets. The model is intended to allow for spreading the costs of paying for capital investments (through rates) over time. However, the model presumes that the capital costs are indeed paid by the ratepayers over time (as opposed to through public grants from provincial or federal governments). Moreover, to be financially viable, rates must fully cover the capital and operating costs (which is not the starting point for most municipalities). The Concessionaire is paid a return on its financial investment, and is compensated to operate the system (including customer service, billing and collecting, etc.).

Revenue and Funding Model

Figure 2: Financing Case 1 - Stratford, Ontario

Project cost: $22.5 million
ROI: 7.5 – 12.5 years (from start-up)
Estimated life period of new technology: 20 years
Financing structure: Municipal Services Corporation owned by the municipality and OCWA (a Crown Corporation). The municipality and OCWA are contributing cash, with a shared revenue model.

Revenue sources:

- Target GHG Fund (Ontario government through Ontario Centres of Excellence) investment of $5 million (program no longer exists)
- Municipality, OCWA and SUEZ Water Technologies & Solutions contributing $5 million matching for OCE funding).
- Ongoing revenue stream through RNG sales under contract with Fortis BC.
- Additional project financing from a public financier.

Figure 3: Financing Case 2 - Petawawa, Ontario

Petawawa is proceeding with the 30% design engineering for a proposed co-digestion project with OCWA. Existing anaerobic digesters will be upgraded with Anaergia's sludge screw thickeners and high solids SMART mixers. Captured biogas will be used to generate electricity and/or RNG.

Project cost: $7million
ROI: 9-12 years
Estimated life period of new technology: 20
Revenue sources:

- Low Carbon Economy Fund (Canada) grant of $2.7 million approved for capital installation
- Additional project financing currently being explored.

Revenue Models

Organics Tipping Fees

Organic wastes directed to landfill or compost usually carry both transportation as well as per tonne tipping fee costs. The tipping fees can vary from approximately $70 to more than $100 per tonne.

The tipping fees are set by the digester operator and are largely driven by regional factors such as the supply and demand of the organic feedstock, the transportation costs and availability of digester capacity, and the nutrient management requirement for the resulting digestate.

Tipping fee dynamics are discussed more in "Regional Planning" section below.

Selling RNG/Gas Contracts

An emerging revenue stream for waste-to-energy digesters is through upgrading the biogas to meet pipeline natural gas quality standards. This upgraded gas, called renewable natural gas (RNG) can be sold to the natural gas utility at a premium price. RNG contracting is expected to be similar to the long-term electricity Feed-in-tariff (FIT) contracts, although, the natural gas utilities may desire contract language that could allow a change in the price paid should their regulatory compliance needs change. For example, RNG, with its Renewable Identification Number (RIN) credits, can be sold to other parts of North America, such as Quebec or California, which is another green energy financial initiative.

With the end of the Ontario electrical FIT program, selling RNG at a premium price or monetizing the green attributes, can potentially replace FIT contracts as the primary financial incentive for digester projects.

Where a mandate or economic drivers exist to require or promote renewable content, utility companies are willing to pay more for RNG than the price they sell natural gas. Upgraded biogas is considered renewable because the methane captured would otherwise be released into the atmosphere through landfills or land application if they were not sent to digesters.

Currently, the province of British Columbia and Quebec have established an open-market price at which the local utility companies will purchase RNG from digesters. Digesters are also able to negotiate with the utilities directly on a price to sell their RNG, or sell their RNG to other markets such as California where the RIN credits are available to buyers that purchase RNG.

RNG sales prices are based on the receiver and are highly variable based on quality, quantity, and location; typically, they range from $13 to $26 per gigajoule (GJ). For example, Energir (Quebec) is offering between $10 and $22 per GJ of RNG based on production capacity with long term contracts from 15 to 20 years; FortisBC in British Columbia is offering up to $30 per GJ.

Grant Programs

Federation of Canadian Municipalities: Green Municipal Fund

FCM offers funding programs for municipal applicants to support pilot and capital projects. This includes[13]:

• Feasibility Studies: GMF has a "Study" stream for energy recovery or district energy projects that aim to reduce GHG emissions through the use of recovered or renewable thermal energy in new or existing facilities. The fund will support up to 50% of eligible costs to a maximum of $175,000.

• Pilot Projects: GMF now offers up to $500,000 to cover up to 50 per cent of eligible costs for pilot projects. Municipalities with a population of 20,000 or less may qualify to receive up to 80 per cent of eligible costs.

• Capital Projects: Funding may be provided for up to 80 per cent of eligible project costs. The loan maximum is $5 million, and the grant amount is 15 per cent of the loan.

• Capital Projects: Applicants with high-ranking projects may be eligible for a loan of up to $10 million, combined with a grant for 15 per cent of the loan amount, to a maximum of $1.5 million.

The deadline for energy, waste, water and transportation capital projects was August 1, 2019.

Federal/Provincial Infrastructure Funding Programs

The **Low Carbon Economy Challenge** was part of the federal government's Low Carbon Economy Fund for projects to reduce greenhouse gas (GHG) emissions and generate clean growth in support of Canada's clean growth and climate action plan. The $450 million Champions stream was open to municipalities, but has now closed.

Federally, Infrastructure Canada dedicated more than $500 million for Ontario (in 2016) through the **Clean Water and Wastewater Fund** (CWWF) to provide communities with more reliable water and wastewater systems so that both drinking water and effluent meet legislated standards. The CWWF will fund up to 50 per cent of eligible costs for projects through a bilateral agreement with the province. The provincial government has committed to provide up to $270 million (up to 25 per cent of total eligible project costs). This is currently inactive (under the current program all eligible costs must be incurred by March, 2020).

The **Investing in Canada Infrastructure Program** (ICIP) is a cost-shared infrastructure funding program with a total of $30 billion combined federal, provincial and other partner funding, under four priority areas, including green infrastructure. The "green stream" is intended to support the reduction of greenhouse gas emissions, enable greater adaptation and resilience to the impacts of climate change and climate-related disaster mitigation and ensure communities can provide clean air and safe drinking water. An intake for small (under 100,000 population) municipalities, focusing on improving water, wastewater and stormwater infrastructure, was launched in September, 2019 (application deadline is January 22, 2020). The maximum grant available is $3 million.

[13] (Federation of Canadian Municipalities, 2020)

In budget 2019, the Federal Government commitment to municipal infrastructure investment in the form of a "top-up" to municipalities through the Gas Tax Fund, with a one-time transfer of $2.2 billion to address short-term priorities in municipalities. This may signal an end to cost-shared infrastructure grant programs, with a priority on direct transfers.

Loan Programs

All Ontario municipalities are eligible for loans from Infrastructure Ontario (IO) for any capital investments, including water, wastewater and sewage infrastructure. IO's lending rates provide equitable access to affordable financing for all clients. Municipalities may select repayment terms of 5 to 30 years, to match the life of the capital asset, with favourable loan terms for municipalities.

Info: https://www.infrastructureontario.ca/Infrastructure-Lending/

Equity/Debt Financing/Lending

The Atmospheric Fund (TAF)

The Atmospheric Fund is a not-for-profit that is able to provide financing or lending for projects that reduce greenhouse gas emissions and have potential to be applied in (or benefit) the Greater Toronto and Hamilton Area. Maximum investment available is approximately $2 million and TAF is also able bring in additional partners funding partners.

Canada Infrastructure Bank

Canada Infrastructure Bank (CIB) is a Federal Crown Corporation with a mandate to invest $35 billion in new, revenue generating public infrastructure. Priority areas for investment include green infrastructure (including water and wastewater infrastructure). To qualify, projects must attract private sector investment and transfer risk to private sector, and generally require amounts of $20 million or more. CIB is offering municipalities a standardized debt product for water projects using a Concession model, based on a project that been initiated for Ontario's first Design-Build-Finance-Operate-Maintain procurement. Because the CIB loan is secured against revenues (from water/wastewater rates) it is "non-recourse" to the municipality (does not affect debt limit). CIB provide further details in a recent Webinar offered by Canadian Water Network (Financing Water Systems: Green Bonds and the Canada Infrastructure Bank (available at http://cwn-rce.ca/events/webinars/cwn-webinars/).

Green Bonds

Municipalities can issue Green Bonds as a financing option. A few large Canadian cities have issued bonds, for very large amounts ($100m - $300m). The proceeds are allocated to eligible projects; the process, eligibility and accounting requirements are complex. RBC has been involved in many of these bond issuances; RBC experts provide an overview in a recent Webinar offered by Canadian Water Network (Financing Water Systems: Green Bonds and the Canada Infrastructure Bank (available at http://cwn-rce.ca/events/webinars/cwn-webinars/).

Approvals

Approvals Process and Engagement Strategy

It is very important to submit a complete ECA application. ECA applications will not be reviewed until a screening level review confirms that all required information is provided. MECP's Guide to Applying for ECAs, and other guidance, can be reviewed at https://www.ontario.ca/page/environmental-compliance-approval.

Proponents considering co-digesting organic materials with sewage sludge at their WWTP are strongly encouraged to meet with the ministry to discuss their proposed project. The meeting is an opportunity to clarify environmental approval requirements and is a chance to provide information that will support the application. The proponent will be asked to complete a pre-submission consultation form that provides information the ministry needs to prepare for the meeting. Pertinent information may include:

- A detailed description of the proposed project including conceptual design and general operational procedures/protocols;
- The location of the site where any buildings, tanks or equipment will be installed, and flow diagram of the process(es);
- A plan for the proposed installation of process(es) that includes the time frame, where it will be located on the site, and a monitoring plan;
- A description of the measures to mitigate odour, noise and other adverse impacts;
- A description of digestate management, including storage, transfer and intended end-use;
- If similar technologies are used elsewhere, providing the operational and performance data for those technologies will help ministry engineers evaluate the proposal;
- Extent and format of the intended public consultation; and
- Any questions for the Ministry to address at the pre-consultation meeting.

The co-digestion project in Stratford, Ontario will begin construction in 2020. All environmental approvals are site specific, but the municipality's experience with approvals and permissions provides an excellent template for the process and requirements that other municipalities can expect in undertaking similar projects. MECP Approvals Branch and the Innovations Unit within the Climate Change Partnerships and Programs Branch have worked closely with the proponents to support the approvals process for this precedent-setting project. It is important to note that a number of key clarifications have been made, and that projects of this type fit well with the current approvals' regime. If new projects such as this are treated similarly, and continue to be addressed in a timely way, there is no need for regulatory change.

Stratford was required to follow the Municipal Class Environmental Assessment (Class EA) and requires a comprehensive Environmental Compliance Approval (ECA) for the project. Details are outlined below.

Stratford project fundamentals: The receiving building will accept up to 20,900 wet tonnes per year of solid organic waste and 5,000 tonnes per year liquid waste. Pre-processed organics will be co-digested with up to 29,200 tonnes of wastewater sludge (which is already being generated at the site). The municipality anticipates production of over 2 million cubic metres of RNG per year, to be sold and utilized in the natural gas pipeline.

Environmental Assessment Act

The City of Stratford determined its project to be a **Schedule A Project** under the Municipal Class EA. MECP required Stratford to seek confirmation from the Municipal Engineers Association (the organization responsible for the Municipal Class EA). MEA agreed with Stratford's interpretation.

Under the Class EA, there is no requirement to give Public Notice of a Schedule A project, and therefore no mechanism for a Part II Order (or "bump-up" request from members of the public). Schedule A Projects are pre-approved and may proceed to implementation (subject to receiving Environmental Compliance Approval (ECA) and any requisite statutory approvals) without following the full Class EA planning process.

Although Schedule A projects do not require Public Notice, due to the nature of co-digestion it is highly recommended to hold public consultations early and often, especially if the project will be taking place near sensitive residential, commercial, or residential areas.

Environmental Compliance Approval Requirements

There are several regulatory considerations when planning to import outside organic wastes for co-digestion at a municipal WWTP in Ontario. Imported organic wastes are regulated under Ontario's Regulation 347 (Waste Management, Reg. 347), unless they are exempt from this regulation, so compliance with Reg. 347 must be assessed by project proponents. If the project only involves upgrading biogas to RNG, the requirements of Reg. 347 still apply (and will be addressed in the ECA). Waste processing equipment and truck traffic at the site can create air, including but not limited to odour, and noise emissions, so project proponents must also assess compliance with Ontario Regulation 419 (Air Pollution – Local Air Quality), and compliance with the applicable sound level limits set out in Publication NPC-300. Proponents must apply for an ECA for all applicable media (wastewater, waste and air/noise).

Stratford required the following components, all of which were **included in a single comprehensive ECA**.

- Environmental Compliance Approval (Waste Disposal Site)
- Environmental Compliance Approval Amendment (Air & Noise)
- Environmental Compliance Approval Amendment (Industrial Sewage Works)

The following key plans and studies were completed:

- Odour Baseline Data and Management Plan
- Noise Assessment
- Geotechnical Report
- 30% design documents (drawing and reports).

Timelines:

- Submitted to MECP December, 2018
- Draft ECA received September, 2019
- MECP conditional approval to begin construction April 2020 (received September, 2019)
- Final ECA pending (as of March 3, 2020)

Key points of clarification:

- All requirements for environmental regulatory approvals have been addressed in the single comprehensive ECA, including Environmental Protection Act, Regulation 347 (Waste Management) under which biogas is considered a "waste."

Other studies or supporting Documentation that may be required as part of an ECA application include:

- An assessment of the capacity of solids treatment and handling systems with the additional organics to be processed, and an evaluation of the impact on the capacity of the liquid treatment train.
- A Design and Operations (D&O) Report that describes the waste handling process and how it will be operated.
- An Emission Summary and Dispersion Modeling (ESDM) report that describes equipment that has air emissions and provides an evaluation of air emissions, including odour from the site.
- An Acoustic Assessment Report that contains detailed information about the operation of the site and related equipment/sound and vibration sources.
- A hydrogeological assessment and geotechnical assessment may be required depending on the proposal and site-specific considerations.

Regional Planning

Pre-consumer Feedstock Sourcing

The main sources of pre-consumer organic feedstock for standalone digesters include food processing facility wastes, organic wastes from organic chemical facilities such as those that use fermentation or other processes (commercial ethanol, biodiesel, bioplastic and similar manufacturing, etc.), restaurant grease traps wastes, and off-spec, damaged, or surplus animal feed or other organic products.

Some organic wastes that are desirable feedstocks for anaerobic digestion find a higher and better use elsewhere and are not commonly available for AD. Two examples are food processing wastes and higher-quality waste oils.

Solid waste from food processing facilities has often found its highest and best use as animal feed. Area farmers often pay for transportation and accept the food waste at low tipping fee cost or may pay the generator for the animal feed inputs. The more desirable animal feed inputs are fruit and vegetable wastes; however, these are also desirable inputs for anaerobic digestion. One consequence of this traditional farming practice is that area farmers often have long-standing business relationships with local food processing facilities.

Similarly, clean waste fats, oils, and grease can be sold into the biodiesel or other commodity markets. Because a portion of pre-consumer organics may be available for other re-use opportunities, the leftover material directed to AD tends to be of inconsistent quality, higher nutrient loads, contain contamination, or possibly pose other challenges.

There is considerable elasticity in the supply of pre-consumer organics as the generator may be able to seasonally choose between animal feed, land application, composting, and AD. It is important to understand the current practices used by pre-consumer organic waste generators and recognize that any new AD project will be in competition with status quo disposal practices.

Post-consumer Feedstock Sourcing

Post-consumer feedstocks typically originate from municipal source separated organics collection programs. SSO consists of household wastes from curbside collection or community programs. The range and types of materials solicited into municipal SSO programs differs by municipality. There is the possibility of post-consumer feedstock from large generators such as large business cafeterias and other institutional programs.

The time and investment to initiate and operate a municipal curbside organics program is considerable, which means the supply is largely inelastic. Before an SSO collection program is launched, a consistent, reliable destination for the produced organics is required. Large municipalities can choose to manage their organics through a combination of AD, composting, and landfilling. These different destinations have differing degrees of flexibility in proportion to there need for consistent feedstock.

Digester Capacity

Historically, in southwestern Ontario several on-farm anaerobic digestion facilities have bene constructed as well as a small number of large, private, organic waste digesters. Almost a decade ago these early digesters were challenged to maintain full electrical production, requiring active solicitation of organic waste, and a corresponding price pressure on tipping fees.

As large-scale municipal SSO began to be directed to the large private digesters, their legacy clean feedstocks became available to be diverted to the agri-digesters. Currently, most agri-digesters in Ontario are operating near their capacity limits, however, these facilities are limited to 10,000 tonnes per annum (tpa) of off-farm feedstocks.

Recently, additional digester assets have become operational which will influence the local market for feedstocks. For example, the Stanton Brothers farm digester project near Ilderton, ON has an ECA that permits the receipt of a maximum of 60,000 tonnes of off-farm generated organic waste per year to be mixed and processed with on-farm generated materials. The StormFisher facility in London has an ECA that permits the receipt of a maximum 195,000 tpa and is currently commissioning their RNG upgrading facility.

In Ontario, when the Peel digester project comes on-line in the future, there will be a re-balancing of the destinations for different feedstocks and likely price pressure on the associated tipping fees. The same holds true for other municipal AD projects under consideration.

Due to the time and cost of permitting and constructing new AD assets, these facilities have only limited ability to increase their throughput through optimization projects.

Regional Tipping Fees

The organics waste processing capacity, availability, and tipping fees for SSO vary from region to region, and from time to time. The tipping fees for organics depend on not only the amount of SSO available, but also how many other destinations for these feedstocks are in the region and their current capacity—the usual market forces of supply and demand drive the cost of disposal.

This supply and demand relationship is dynamic and requires a consideration of the elasticity of supply. Not only is the elasticity of the supply of organics themselves important, but also the elasticity of the digester capacity, and the elasticity of the digestate management & disposal capacity.

Currently, in Ontario most private waste-to-energy anaerobic digesters also receive tipping fees for the organic materials they receive. The waste generator usually pays both the transportation and tipping fee costs. However, in some instances the digester operator accepts the material at zero tipping fee (the generator pays trucking), or, in rare instances the digester operator pays the trucking and accepts the material at zero tipping fee.

In Europe it is not unusual for digester operators to pay for raw material. Paying for raw material has been reported in Ontario in very rare instances. In the USA, a small number (approximately 10) WRRFs are paying for a pre-processed, clean, organic slurry product marketed by Waste Management as "Engineered Bioslurry" or EBS. EBS shipments include a certificate of analysis stating both fuel value and metals content.

In Ontario, digester operators evaluate the opportunity presented by different raw materials, the cost to manage those materials, and then make a business decision as to the materials desirability and the tipping fee they are willing to accept.

The tipping fees are usually paid on a per-wet tonne and per load basis, not on a per cubic meter biogas or methane-equivalent basis. The amount of the tipping fee paid to digesters varies significantly from region to region and from time to time. Several of the factors the digester operators consider, positive, negative, and time-varying, are shown in the following table:

Table 1: Factors Influencing Disposal Costs for Organic Wastes

Positives	Negatives
• High fuel value • Impact on gas quality (high CH4/CO2 ratio, low sulfur, no siloxanes or other negative gas qualities) • Low nitrogen content • Ease of handling (liquid/slurry/solid, not acidic or caustic, low plugging solids, low physical contamination, low foaming potential) • Time of day for receipt of waste loads • Consistent quality • Long-term supply contract	• Toxic or inhibitory inputs • Poor gas quality (high H2S or high CO2) • Physical contamination (amount and ease of depacking and/or treatment) • Odour or potential storage issues, including foaming in raw material storage tanks • Nutrient management needs post-digestion • One-off or irregular shipments
Time-Varying	
Depending on the individual digester's performance: • Unused capacity of the biogas utilization system & power purchase contract • Nutritional value of the inputs if desired from a Total Mixed Ration viewpoint • Unused capacity to stockpile raw materials Potential for odour; Weather dependent considerations (i.e. odour, vectors, vermin); and Distance and capacity of competitor destinations for the waste (market factors & pricing).	

Because of these various factors, the tipping fee paid to a digester operator can be volatile.

Tipping fees provide an extra financial incentive for digester operators. While the organic wastes often provide fuel value which through anaerobic digestion provides the biogas that is vital to digester

operation, this fuel value can also vary greatly from material to material. In addition, materials with high fuel value (i.e. high FOG content) can often cause operational challenges that can negatively impact the normal operation of the digester.

Additionally, some materials by nature of their origin or transport method might contain more foreign contaminants, which can also increase operating cost to remove these materials. Thus, it is beneficial for digester administrators to consider the business case of whether to accept an organic load at a certain tipping fee that can cause an associated increase in cost or loss of revenue.

Feedstock Quality Control

The fuel value of the feedstocks, either pre- or post-consumer, varies greatly and is influenced by the type of product the waste came from, the process of which produced the waste, and the phase or dilution level of the waste. There is currently no standard for feedstock quality, other than heavy metal contamination.

Disposition of Waste Products

Consideration should be given to two categories of materials in this section:

1. Packaging, screenings, and inorganic rejects: These materials will require special handling for storage, delivery, and recycling or disposal. Storage of these materials prior to shipping may need to occur in an odour-controlled environment. Disposal arrangements should be contracted to ensure both capacity and pricing.

2. Digestate: The digestate volume will increase appreciably with the addition of SSO material to the AD facility. The quality and character of the resultant material will also change and should be given due consideration in the facility planning stage. There may be opportunity to utilize available heat from the installed process(es) to achieve a reduction in pathogens that would allow for a broader utilization of the material or even the marketing of the end product as a registered fertilizer under the Fertilizers Act. In any case, a market evaluation should be completed to understand and match up with the needs and special conditions that may affect utilization of the digestate within the region of the facility. If agricultural utilization is intended, provisions will need to be made for seasonal storage, transportation, and application technology. Consultation with end users should occur early in the process to understand both farming practice and nutrient requirements.

Stakeholder Buy-In

Public buy-in for co-digestion projects at municipal wastewater treatment plants is essential. One of the major considerations are potential negative impacts to neighbours that are sensitive to odours or other impacts (e.g. homes, hospitals, community centres, office buildings, recreational areas, schools, churches, commercial plazas, etc.). Adjacent property owners must be notified under the waste disposal site approval requirement to ensure these neighbours are able to play a role in the establishment of any new processes, and potential negative impacts are mitigated. Based on project and site-specific considerations, the notification area may be expanded and/or additional forms of public notification may be needed. It is a good idea to carry out extensive public consultation even if the project is deemed a Schedule A proposal under the Class EA process. Public consultation establishes good relations with the community, gathers comments and concerns so the feasibility of the proposal can be established or confirmed, and community input can improve a proposal. Public consultation with the First Nations

must also be included, as applicable to the selected location. It is a good idea to carry out public consultation early in the project, even before submission of the ECA application so a final version of application materials is submitted to the MECP to minimize post-submission changes and delays.

Although it does not specifically address co-digestion at WWTPs, helpful information on siting and planning, odours, and other issues arising from anaerobic digestion facilities can be found in guidance "Canadian Anaerobic Digestion Guideline" by the Canadian Biogas Association, currently available at the Association's website in the draft form.

For the co-digestion project with the City of Stratford, engagement with the public early and often was critical. Stratford's public engagement and notification included development of an extensive contact list, which included the public with 1 km of the site, government agencies, school boards and First Nations. As important to frequency of engaging is knowing who you are engaging with. This means using simple and clear language the general public can understand while staying away from technical or industry specific jargon. If the public hasn't been engaged recently, it might be necessary to start from the basics, e.g. "what does a wastewater treatment plant do?". For Stratford, it was important to remind the public that their local wastewater treatment plant already produces and flares biogas and that the community already experiences increased truck traffic for sludge transportation during the spring and summer months. Consideration should be given to hiring communication consultants to work with municipal staff at all levels to help create and execute community engagement plans.

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