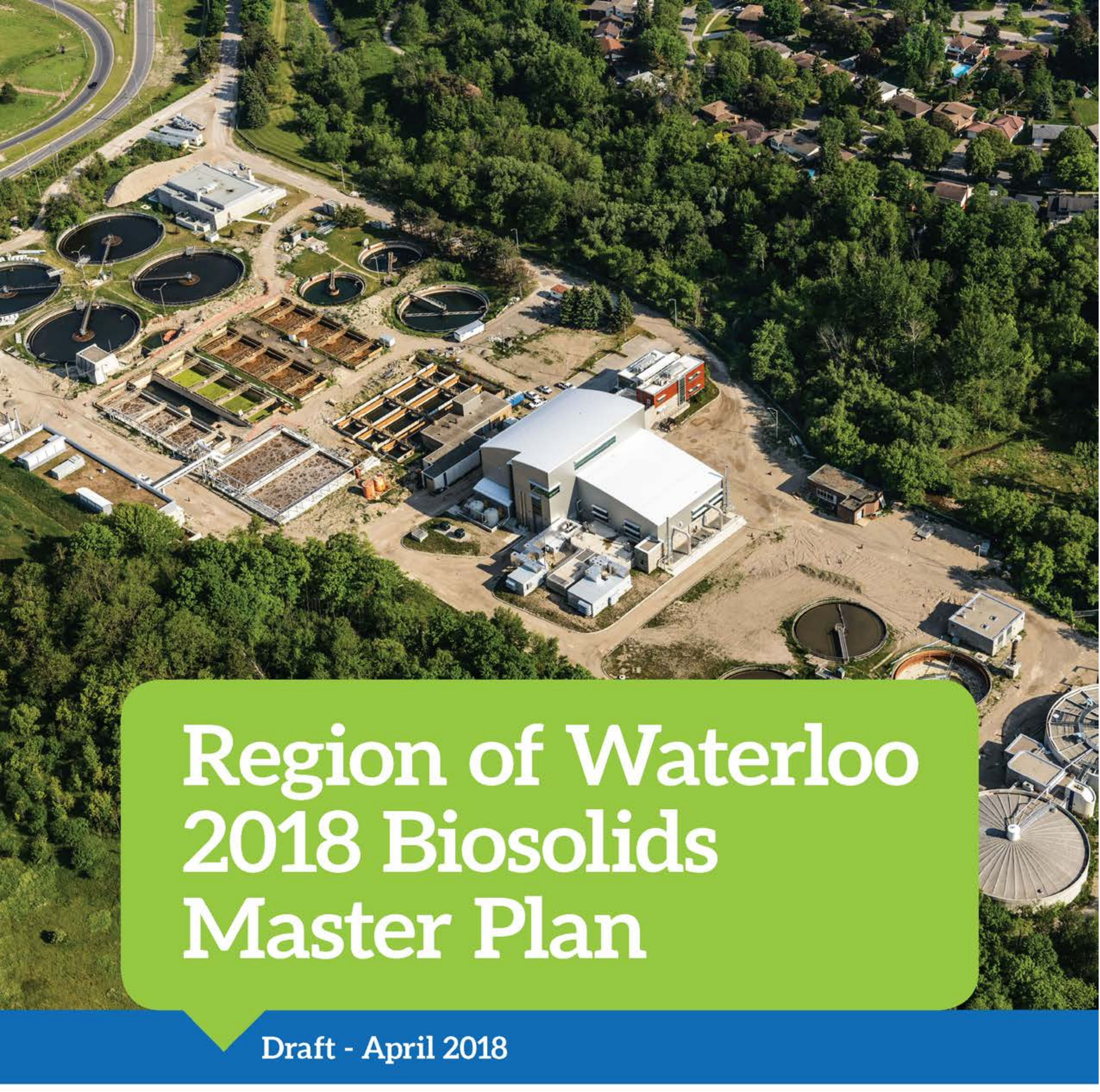

Region of Waterloo 2018 Biosolids Master Plan

Draft - April 2018

BIOSOLIDS Strategy

Region of Waterloo

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Acronyms

AS	Activated Sludge
ATAD	Autothermal Aerobic Digestion
BEAM	Biosolids Emissions Assessment Model
BMP	Biosolids Master Plan
CCME	Canadian Council of Ministers of the Environment
CFIA	Canadian Food Inspection Agency
CHP	Combined Heat and Power
EPA	Environmental Protection Act
GHG	Greenhouse Gas
GRCA	Grand River Conservation Authority
MLD	Million Litres / Day
LEED	Leadership in Energy and Environmental Design
MOECC	Ministry of Environment and Climate Change
MPQ	Minimum Performance Questions
NASM	Non-Agricultural Source Material
NMA	Ontario Nutrient Management Act, 2002, S.O. 2002, c. 4
OH&S	Ontario Health and Safety
PPE	Personal Protective Equipment
TM	Technical Memo
US EPA	United States Environmental Protection Agency
WAS	Waste Activated Sludge
WWTP	Wastewater Treatment Plant

Executive Summary

The **Region of Waterloo Strategic Plan (2015-2018)** identified the **Biosolids Master Plan** as a key component in its Environment and Sustainable Growth Focus Area. The Region embarked on a comprehensive process in its development, taking the interests of key stakeholders and the public to heart in order to identify the most suitable solutions for the whole community. The resulting **Biosolids Strategy** takes a critical look at today's practices, considers applicable technologies, and recommends means to manage biosolids within the Region to the year 2051.

The steps undertaken during the study to develop the Biosolids Strategy are outlined in this Executive Summary, along with the resulting recommendation to develop storage facilities to support current operations in the short term, and a new processing facility to be located in the Region to produce dried, low volume fertilizer in the long term.

Biosolids: An Overview

Biosolids are the processed organic material that remains after the treatment of our wastewater.

Within Waterloo Region, underground sewer pipes collect water and waste material we pour down our drains. The Region's 13 wastewater treatment plants processes over 180,000m^3 of wastewater every day. A series of processes are performed to separate and treat the wastewater, with the clean water being discharged into the environment. The separated material leftover after the clean water is removed results in over 15,000 tonnes of liquid biosolids daily. The settled solid material is treated in a large tank that utilizes microscopic organisms to digest it. The anaerobic digesters produce methane, which is a renewable resource to generate electricity. After digestion, the biosolids are processed in a centrifuge to remove excess liquid (much like the spin cycle on a clothes washer), making it easier to handle and transport. This dewatering process concentrates biosolids from the equivalent of 12 trucks initially to only one.

Trucking is an important part of biosolids management in the Region today. There are two types of trips: trips between wastewater treatment plants for further processing of biosolids, and trips out of the Region for end use or disposal of processed biosolids (see **Figure ES-1**). Currently, most biosolids are transported out of the Region for end use or disposal.

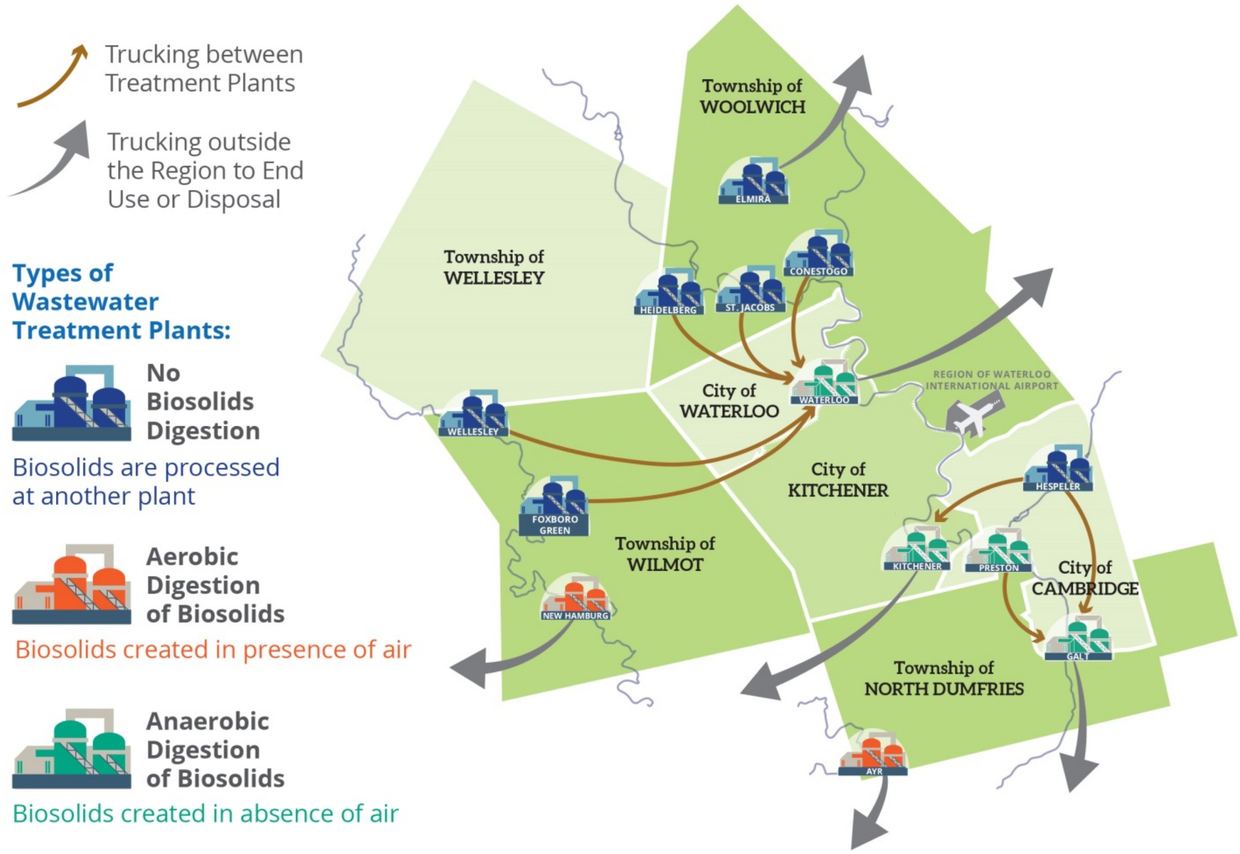


Figure ES-1 Current transportation of biosolids in Waterloo Region.

Biosolids can be used for a range of purposes. Generally, they are added to soil or used as an energy source. Uses resulting in direct economic or environmental benefit are common and can include:

- **Agricultural:** Biosolids that meet Provincial and Federal quality standards can be applied to crop lands as a nutrient source.
- **Non-agricultural:** This use includes biosolids application to forested areas to improve nutrient supply to the soil, enhancing degraded lands (such as mine tailings areas), and use a daily cover material for landfills.
- **Energy recovery:** Energy can be recovered by burning biosolids or burning biogas generated from biosolids processing. The energy recovered depends on many factors, including the processing method and the biosolids dryness.

Disposal resulting in no direct economic or environmental benefit can also occur:

- **Incineration:** Biosolids can be reduced to ash by incineration, which generates the smallest amount of material for disposal.

- **Landfill:** Biosolids can be disposed of in landfills that are allowed to accept this material. Landfilling has historically been used for managing biosolids when other end uses and disposal options are not available.

In 2016, 15% of biosolids produced in the Region were disposed of in approved landfills outside the Region, while 85% of the biosolids were used as a soil amendment to add nutrients, improve soil quality, and enhance crop growth on agricultural (45%) and non-agricultural (40%) lands.

New Biosolids Strategy

While biosolids management systems are currently keeping up with the Region's need, preparing for projected demand to 2051 and beyond requires planning for new biosolids management processes and infrastructure today. With that in mind, there are six main drivers in the development of this new Biosolids Strategy:

- **Growth:** The Region of Waterloo is expected to grow and this means more biosolids.

- **Environmental constraints:** Environmental and social constraints must be considered, including land availability, possible uses, climate change, and transportation routes.

- **Innovation:** The Region should consider feasible new technologies and scientific advances that present opportunities for innovation.

- **Security:** The Region needs flexibility and adaptability to plan for emergencies, manage risk, and tackle mid- to long-term biosolids storage needs.

- **Regulatory changes:** Updates to regulations can restrict how we use biosolids.

- **Increasing costs:** As the costs associated with trucking, storage and disposal of biosolids will continue to rise, it is important to consider the best value for the Region.

One of the main catalysts for the development of a new Strategy is a need for more storage. The Region currently does not have enough storage facilities for biosolids, and requires:

- **Operational storage (More immediate need):** This form of storage provides security during short-term emergencies and should be located at or near existing treatment plants. Having the operational storage allows for holding up to 10 days' worth of dewatered biosolids for final processing or end use/disposal.

- **Product storage (Future long-term need):** This form of storage provides security if inclement weather results in transportation challenges, and should be located along with a new processing facility, to hold approximately four months' worth of processed biosolids. These biosolids in this storage will await transportation to the final end use or disposal destination.

Methodology for Developing the Biosolids Strategy

The Biosolids Strategy follows the Municipal Class Environmental Assessment process for master plans, in order to develop the most suitable biosolids management approach for the Region. The Strategy was developed by the Region's Water Services division, along with an external consultant team. Committees supporting the development of the Strategy include the Steering, Stakeholder, and Project Technical Advisory Committees.

The project was broken down into six main phases, from the project launch to the presentation of the preferred strategy to Regional City Council (see **Figure ES-2**).

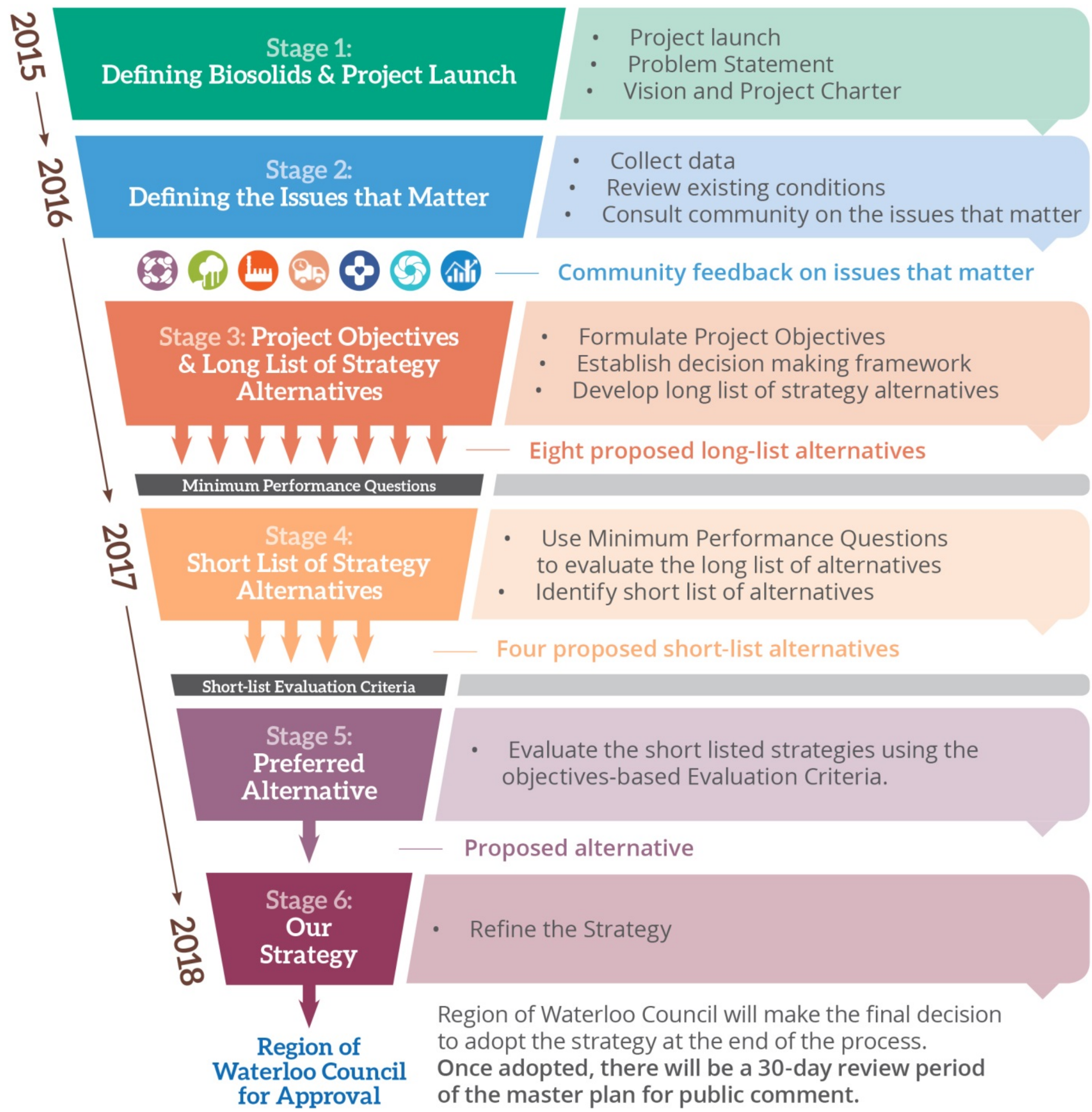


Figure ES-2 Key phases in the development of the Biosolids Strategy.

At the start of the project, a **Project Charter** was developed to act as a guiding document for the Strategy. It provides background information and serves as a reference tool for project team members and the public, describing the scope and intent of the project. Through the development of the Charter, three main principles guiding the project were developed:

- **Emphasize public engagement and participation from the community;**

- **Identify a long-term, flexible, secure, and sustainable strategy for the Region;** and,
- **Broadly consider all possible alternatives in developing the Strategy.**

These principles formulated the approach the Region took in developing the Strategy and Master Plan.

A Community-led Approach

Throughout the stages of the Strategy development, a key component was the active engagement of the public and key stakeholders. Groups invited to provide input, feedback, and direction included: community members; elected officials; regulatory bodies; technical experts; academic advisors; Indigenous communities; community-based organizations; business and industry experts; agricultural groups; health, environmental, and scientific experts; municipal staff; and students and youth. The Strategy development process emphasized community input and participation at multiple points to help identify values important to the public. Engagement opportunities included Biosolids Bulletin email updates, the Biosolids Project website, public consultation events and workshops, surveys (online, in-person, and by telephone), online and multimedia tools (Open Town Hall Tool, videos, webinars and educational materials), and social media (Facebook and Twitter).

Early and intensive engagement fundamentally shaped the course of the strategy and contributed to the development of the **Issues that Matter**, which became the **Strategy Objectives** and **Evaluation Criteria**. Issues that matter were identified through public consultations and helped establish objectives that all alternatives must align with, through an **objectives-based evaluation**[1] process.

[1] An objectives-based evaluation approach reflects a desire to achieve a particular vision or outcome defined by integrated environmental, social and economic objectives.

The Long List of Alternatives

After a review of all available technological options and with input received directly from biosolids technology providers through a Request for Information process, the Region developed eight alternatives[2] for managing biosolids.

- **Current approach with expanded capacity:** The current approach provides stable biosolids management. Biosolids are used for their nutrient value on fields or used for land reclamation, or landfilled when these options are not available.
- **Current approach with solids preparation before digestion:** This alternative can reduce the total solids by generating more biogas, and reduce the amount of liquid in the dewatered biosolids, with a similar end product.
- **Produce fertilizer:** This alternative would make a fertilizer product that can be sold. Different technologies produce fertilizer products with varying volumes.
- **Produce compost:** This alternative would add composting to the current process.
- **Produce dried, low volume fertilizer**: This alternative would add further drying to the current process to substantially reduce the total amount of product. The product is a fertilizer that can be sold or used as renewable fuel in certain applications.
- **Thermal reduction with energy recovery:** This alternative would 'burn' biosolids to ash and generate energy. Ash can be used as an industrial input, or disposed in landfill. This option requires enhanced dewatering that removes more water than the current approach and cannot be used in series with other energy recovery methods, such as the existing anaerobic digesters that generate biogas used to produce heat and electricity for use at wastewater treatment plants.
- **Thermal reduction to ash (no energy recovery)**: This alternative could use the current digested and dewatered biosolids as input and burn this to ash for use as an industrial input or disposal in landfill.

[2] All alternatives require operational storage to be implemented for contingency purposes.

- **Landfill all biosolids**: This alternative would send all biosolids produced in the Region to a Provincially-approved landfill. Existing infrastructure such as dewatering and digestion would need to be expanded with population growth.

Screening the Long List of Alternatives

To narrow down the long list, the Region applied a series of **Minimum Performance Questions,** built from the community's issues that matter, to each alternative based on the project objectives. For an alternative to pass this screening step, it had to produce a 'yes' to all the questions.

Not short listed:

- **Thermal reduction with energy recovery:** Did not align with the Region's existing infrastructure. Region is planning to recover energy from biosolids through biogas generation, leaving insufficient energy to make this alternative viable.

- **Landfill all biosolids:** Did not align with Canadian best practices policy in the area of biosolids management.

Continue in immediate future:

- **Current approach with expanded capacity:** Requires significant storage and the addition of a new facility.

- **Current approach with solids preparation before digestion:** Slightly reduces volume, but still requires significant storage and the addition of a new facility.

Short listed:

- **Produce fertilizer:** Produces a fertilizer product that could be sold. Focus would be on technologies that reduce the volume of biosolids.

- **Produce compost:** Produces compost, reducing volume of biosolids (but increases overall volume due to bulking amendment material) and resulting in an environmentally beneficial product.

- **Produce dried, low volume fertilizer:** Adds a drying process to substantially reduce total amount of biosolids. Product is a fertilizer that could be sold or used as fuel in certain applications.

- **Thermal reduction to ash:** Reduces the current digested biosolids to ash for use as an industrial input, or disposal in landfill.

Once the list of alternatives satisfied the Minimum Performance Questions, the remaining four short-listed alternatives were assessed using a series of **Short List Evaluation Criteria,** which were also developed from the issues that matter and with community input.

The Short List of Alternatives

Alternative 1 - Produce Fertilizer: The focus of this alternative would be creating a fertilizer product through technologies that reduce the volume of biosolids, such as stabilization or hydrolysis. The facility could store 4 months' of finished fertilizer product. This alternative could be built as either a single larger facility central in the Region (Option A) or four smaller decentralized facilities located throughout the Region (Option B).

Option A: Centralized facility

- Lifecycle cost: $187-241 million
- Trucking: 6 trucks in and approximately 7 trucks out per day
- End uses: Agricultural soil amendment, non-agricultural soil amendment, landfill

Option B: Four decentralized facilities

- Lifecycle cost: $285-336 million
- Trucking: Approximately 13 trucks in and 7 trucks out per day
- End uses: Agricultural soil amendment, non-agricultural soil amendment, landfill

Alternative 2 - Produce Compost: This alternative would transform biosolids into a Category A compost that consists of 25% biosolids mixed with other organic material such as wood chips. The centralized facility would have a compost processing and curing area. The facility could store four months' of compost product.

- Lifecycle cost: $291-342 million
- Trucking: 14 trucks in and 5 trucks out per day
- End uses: Agricultural soil amendment, non-agricultural soil amendment, landfill

Alternative 3 - Produce Dried, Low Volume Fertilizer: This alternative would add further drying to the Region's current biosolids management process to substantially reduce the total amount of product. The product would be a dried product that could be used as a fertilizer or fuel in certain applications. The facility could store 4 months' of dried product. This alternative could be built as either a single larger facility central in the Region (Option A) or four smaller decentralized facilities located throughout the Region (Option B).

Option A: Centralized facility

- Lifecycle cost: $155 million
- Trucking: 6 trucks in and 2 trucks out per day
- End uses: Agricultural soil amendment, non-agricultural soil amendment, landfill, energy from solids, incineration

Option B: Four decentralized facilities

- Lifecycle cost: $334 million
- Trucking: 13 trucks in and approximately 2 trucks out per day
- End uses: Agricultural soil amendment, non-agricultural soil amendment, landfill, energy from solids, incineration

Alternative 4 - Thermal Reduction to Ash: This alternative would reduce the current digested and dewatered biosolids to ash for use as an industrial input such as in cement, or disposal in landfill. A limited amount of storage would be needed for this alternative's centralized facility. In the Region, there is no current industrial use for the ash so the product would likely be landfilled.

- Lifecycle cost: $279 million
- Trucking: 6 trucks in and 2 trucks out per day
- End uses: Landfill

Figure ES-3 is a summary of each of the four alternatives when assessed using the Short List Evaluation Criteria that are based on the Objectives-based Evaluation approach.

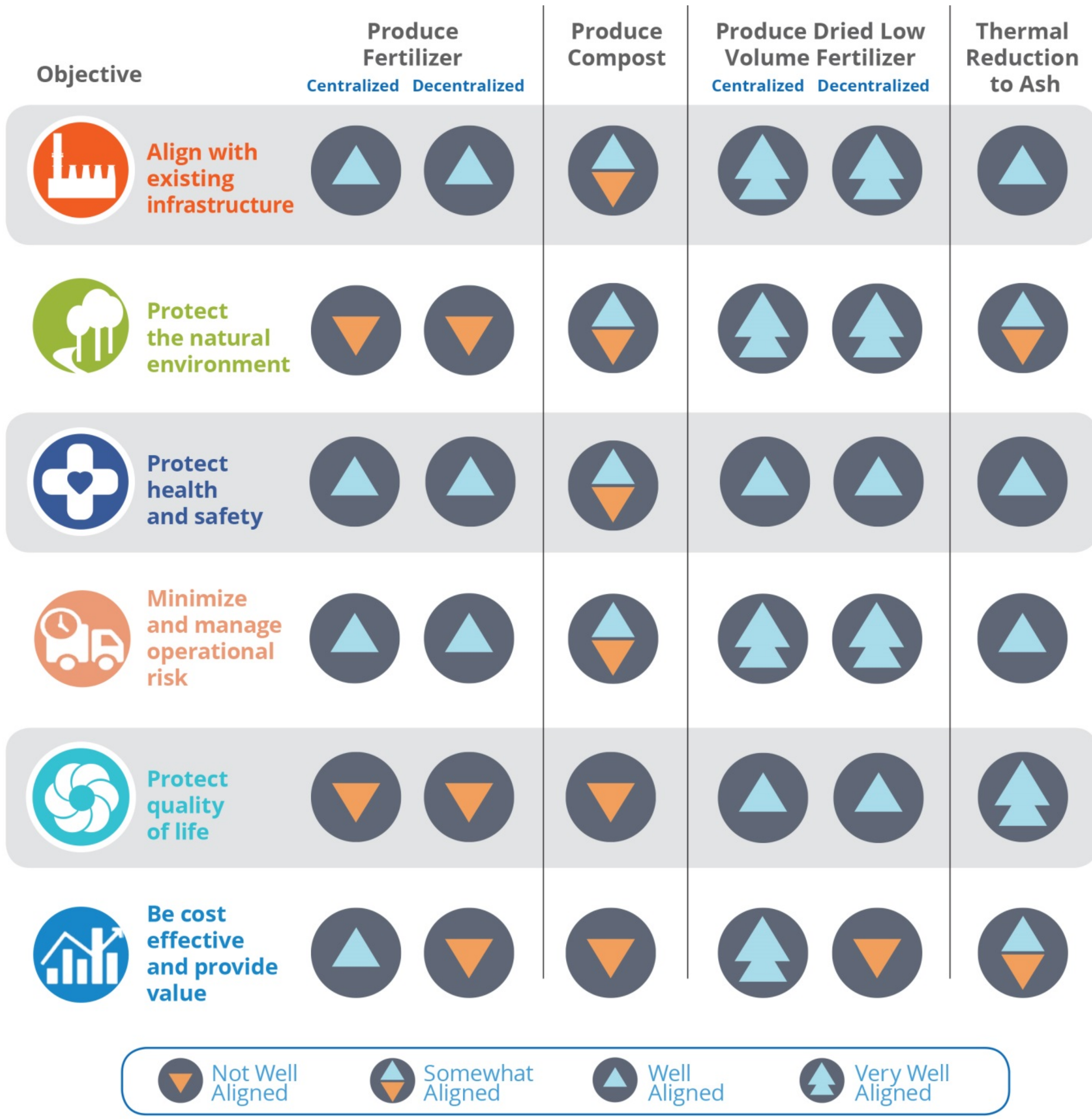


Figure ES-3 Overall evaluation summary of the four shortlisted alternatives.

The Preferred Alternative

The alternative to Produce Dried, Low Volume Fertilizer emerged as having the strongest alignment with the Strategy objectives.

The results of the detailed evaluation were presented to the community, and the feedback received was integrated with input from technical experts and Region staff. Based on the input obtained through the public engagement and consultation process and the results of the life cycle cost assessment, it was concluded that a centralized configuration for a new facility to produce dried, low volume fertilizer would be the preferred solution for managing biosolids in the Region in the long term. The end uses of this material would be agricultural and non-agricultural land application. The decentralized configuration could also be considered through the future implementation evaluation under the Municipal Class Environmental Assessment process.

The Preferred Strategy therefore consists of this alternative as the primary component. The Region may also consider adopting other technologies to manage biosolids at the smaller wastewater treatment plants on-site in order to reduce trucking requirements to a centralized facility.

Implementing the Strategy

The life cycle cost of implementing this alternative is very similar to the cost of continuing with the current approach to 2051, so the Region has the flexibility to move forward with implementation at any point in the future (**Figure ES-4**). The Region's current biosolids management approach is considered a best practice and can be continued for several years. Implementation will therefore take place in two phases:

- **Phase 1 (Immediate Term):** Implementation of storage at existing Regional wastewater treatment facilities, within the footprint of the existing sites. This will reduce the amount of biosolids currently going to landfill, by creating space to store biosolids during winter storm events that make trucking difficult.

- **Phase 2 (Mid to Long Term):** The Biosolids Strategy to be updated again in five to ten years to confirm that the Preferred Strategy is still the best route forward. Detailed planning for the preferred strategy would then proceed through the Municipal Class Environmental Assessment process, and the community engaged in future steps including site selection for the new facility(s).

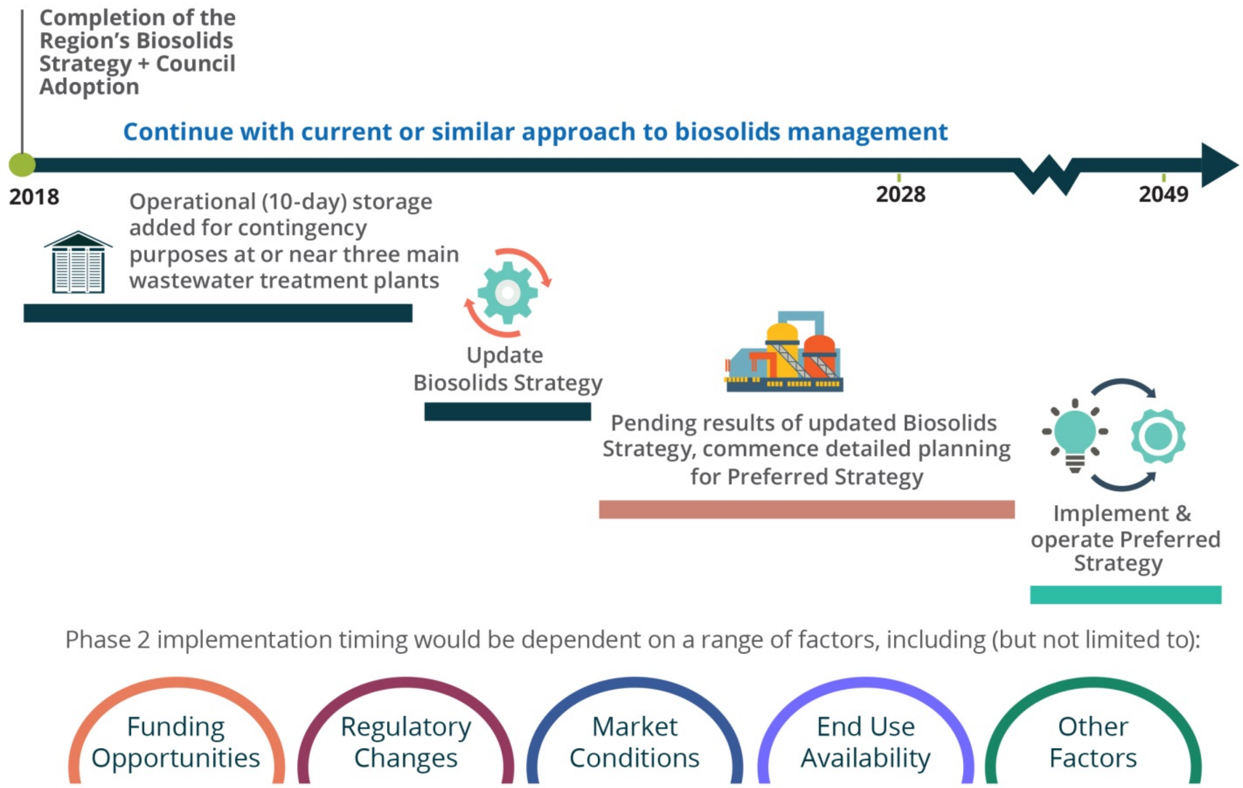


Figure ES-4 Proposed implementation timeline.

Conclusion

In developing the Biosolids Strategy, the Region conducted an in-depth objectives-based assessment of the alternatives for managing biosolids in the Region, integrating stakeholder, community, and technical feedback along each step of the process. The Biosolids Strategy is intended to form a supportive guide towards the long term management of biosolids in the Region to 2051, and will therefore be an important tool in communicating the Region's approach both for internal staff as well as for the wider community. With the Biosolids Strategy, the Region of Waterloo can implement a biosolids management process that retains the economic and environmental benefits of biosolids within the Region instead of trucking it elsewhere, actively reducing its economic and environmental footprint, while providing the necessary wastewater and biosolids infrastructure to support the Region's projected population growth.

1.0 Introduction

1.1 Project Purpose and Approach

The Region of Waterloo Biosolids Strategy Study (Biosolids Strategy) was initiated in 2015, to develop an approach to manage biosolids in the Region of Waterloo (Region) to the year 2051. The Biosolids Strategy took a critical look at current biosolids management practices in the Region, and considered available and relevant technologies for processing biosolids. Alternative ways to manage biosolids were evaluated against a range of criteria to develop a biosolids management strategy for the Region.

This Master Plan document is the result of work developed during the Biosolids Strategy, and represents the recommended implementation over the course of the planning period. Updates to this document will be undertaken approximately every five to ten years. Future projects will further refine the implementation details of the strategy including timing, sizing and location of any facilities.

A **sustainable strategy** is one that considers the future growth of the Region and looks to minimize potential landfill disposal requirements of biosolids.

The Region was committed to enhanced public engagement throughout the development of the strategy, as explained in the following sections.

1.2 Strategy Development

The Biosolids Strategy development process was led by the Project Team, consisting of Regional staff and consultant team led by Dillon Consulting Limited. It follows the Municipal Class Environmental Assessment (Class EA) process for developing master plans.

The siting of any new facility is not part of the Strategy, and would be the subject of a future phase of the Class EA process. The intent was to develop the Strategy under the Master Plan first. Upon thorough public consultation and finalization of the Master Plan, subsequent studies will be carried out for any new facilities identified. Those subsequent studies would include, if necessary, scoping for potential sites for placement of a facility.

The following key principles were used to guide the Strategy process:

- Emphasize public engagement and active participation from the community;

- Identify a long term, flexible, secure, and sustainable Strategy for Waterloo Region; and
- Broadly consider all possible alternatives in developing the Strategy.

1.3 Decision-Making Process

The Biosolids Strategy development process was completed in six stages. Each stage included a round of public engagement activities thereby providing an opportunity for public input and comment on the materials developed. Technical Memoranda related to each stage were developed, as appended to this Master Plan document.

1. **Stage 1: What are biosolids?** The kick-off stage of the Project focused on providing more information to the community on biosolids. This stage included preparing an overview of the Class EA process for Master Plans and a roadmap for how decisions till be made.
   Technical Report(s): TM1 - The Environmental Assessment Process (this document)

2. **Stage 2: Defining the problem:** The second stage included a background review of existing biosolids management approaches and data collection that was used in subsequent stages. This stage also included preparing an overview of existing conditions and forecasting the future needs based on population and employment growth in Waterloo Region.
   Technical Report(s): TM2 - Existing Conditions and TM6

3. **Stage 3: Alternative strategies and evaluation criteria:** This stage examined the technologies and strategies that are available for biosolids management and their applicability to the Region. Available technologies were documented, and a long list of biosolids strategy alternatives proposed along with criteria that were used to evaluate the alternatives. The evaluation will was conducted in two steps:
   - **a.** The first was a 'screening' step to identify the strategies that are applicable for the Region's context. To do this, a set of 'Minimum Performance Questions' was developed based on the Strategy Objectives, that highlight the core requirements for an eligible strategy. The outcome of this step was a short list of potential alternatives for the Region to consider.
   - **b.** The second step involved a detailed evaluation of the short listed alternatives, utilizing a list of criteria that were once again based on the

Strategy Objectives and capture the ‘Issues that Matter’ put forward by the community, stakeholders, and the project technical team.

Technical Report(s): TM 3- Evaluation Approach and Comparative Evaluation Criteria; TM4 - Biosolids Technologies, End Uses and Disposal; and TM #5 - Long List of Biosolids Management Alternatives

4. **Stage 4: Evaluating the long list of alternatives:** The long list of biosolids management alternatives identified in Stage 3 was assessed using the Minimum Performance Questions to identify a short list of strategy alternatives. *Technical Report(s): TM7 - Short List of Biosolids Management Alternatives*

5. **Stage 5: Evaluating the short list of alternatives:** The short list of alternatives identified in Stage 4 was analyzed in more detail in Stage 5. Comparative evaluation criteria were applied to assess the advantages and disadvantages of each of the short list alternatives for public review and input. *Technical Report(s): TM8 - Evaluation of Short Listed Alternatives*

6. **Stage 6: Recommended Strategy:** A preferred Strategy was identified to meet the Region’s needs to 2051. The Recommended Strategy is integrated into this Master Plan document, which will be submitted to the Region of Waterloo Council for consideration and approval in February 2018. The Biosolids Strategy will then be available for a minimum of a 30-day public review period before being finalized. *Technical Report(s): TM9 - Recommended Biosolids Strategy and Biosolids Strategy Document, Draft 2018 Biosolids Master Plan*

The completion of the Master Plan addresses phases 1 and 2 of the Class EA process. For any new facilities, phases 3 and 4 of the Class EA process would be initiated for each project (i.e. a separate study). A detailed process would follow to select a site for the facility based on the criteria laid out in this Master Plan, and a complete assessment of impacts and associated mitigation measures would be carried out. The community will be an important contributor to these later stages of implementing the Biosolids Master Plan.

A summary of the Project process to develop the Biosolids Strategy is shown on **Figure 1-1**.

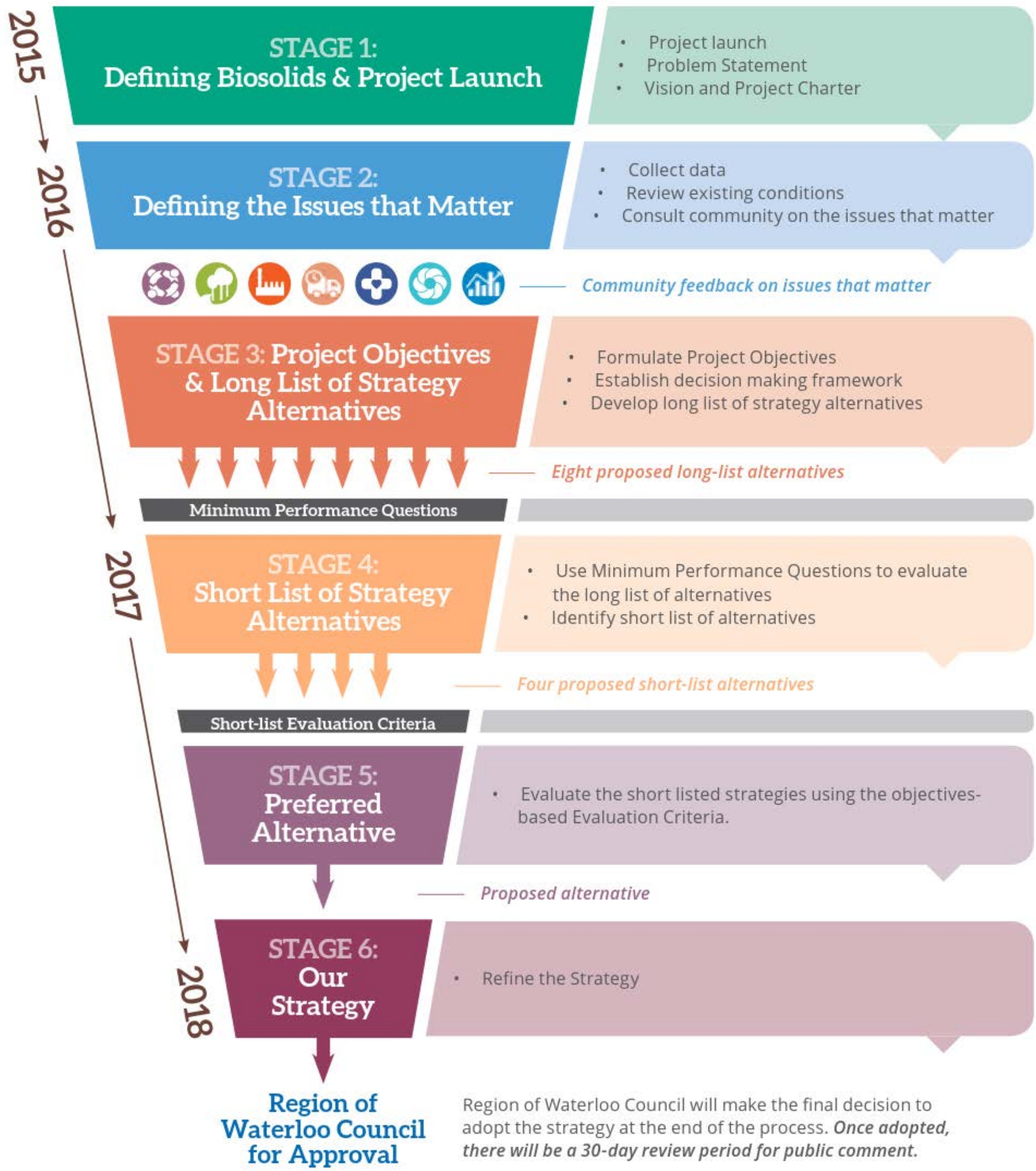
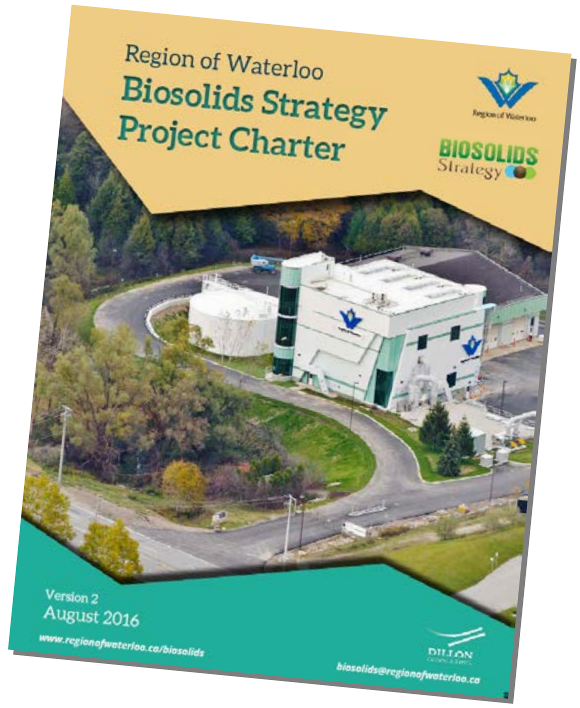


Figure 1-1 Roadmap to the Biosolids Strategy

1.4 Project Charter



At the outset of the Biosolids Strategy project, a Project Charter was developed to help guide the process and outline the mechanisms for communication and engagement with the community. The Charter covers the definition of biosolids, how they are managed in the Region, the roadmap to create the strategy, public engagement and timelines. The Biosolids Strategy is an integral component of developing environmental and sustainability programs in the Region, as noted in the Regional Council Strategic Plan (2015-2018):

"The Region will work in partnership with the community and area municipalities to manage growth in environmentally sustainable ways and create spaces and places that enhance living, working and travelling experiences for the community."

The Charter document was made available on the Region's website and copies provided at public events as the Biosolids Strategy was developed. A copy is included with this Master Plan as **Attachment #1**.

1.5 Report Structure

This Master Plan document is structured as follows:

- **Chapter 1: Introduction** provides an overview of the Master Plan development process.
- **Chapter 2: Project Context** describes the project purpose, history of biosolids management in Waterloo Region, and current planning for wastewater and biosolids management.
- **Chapter 3: Regulatory Framework** lays out the regulatory framework in Ontario that guided the development of the Master Plan
- **Chapter 4: Existing Conditions Background Study** summarizes the information from the Technical Memo developed to explore this topic

- **Chapter 5: Biosolids Quantity Forecast** provides the key conclusions of the population and biosolids quantity forecast to support biosolids management in the Region to 2051
- **Chapter 6: Evaluation Approach** explains the objectives-based approach that was used to evaluate the long and short lists of alternatives and identify the preferred alternative for the Strategy
- **Chapter 7: Biosolids Technologies, End Use, and Disposal** is a brief summary of the Technical Memo by the same name that highlights the key components in developing an alternative for managing biosolids
- **Chapter 8: Biosolids Alternatives Long List** identifies the key features of each of the eight alternatives for managing biosolids that were developed based on the components discussed in Chapter 7.
- **Chapter 9: Biosolids Alternatives Short List** highlights the results of the evaluation applied to the long list of alternatives, in order to screen out alternatives that would not work in Waterloo Region, and identifies the short list of alternatives.
- **Chapter 10: Evaluation of Short Listed Alternatives** describes the results of the detailed evaluation approach applied to each of the short listed alternatives, in order to identify the preferred alternative.
- **Chapter 11: Recommended Alternative** explains how the preferred alternative meets the project objectives laid out in Chapter 6 and summarizes the attributes of this alternative.
- **Chapter 12: Biosolids Strategy – Implementation Approach** describes the path forward and next steps to implement the recommendations of the Master Plan.
- **Chapter 13: Stakeholder Engagement** provides a description of the stakeholder engagement and public consultation process undertaken for the study and how the engagement feedback was integrated into the decision making framework to yield a long-term, sustainable solution for biosolids management for the Region.

2.0 Project Context

2.1 What Are Biosolids?

Municipal wastewater that enters the sanitary (wastewater) system consists of material from the toilets, sinks, bathtubs, dishwashers, laundry machines, and other water-based appliances located in homes and apartments, as well as wastewater from institutional, commercial and industrial activities across Waterloo Region. The wastewater is treated by the Region to meet Provincial Standards. Residual material from the processing is also treated and that material is referred to as biosolids.

2.2 Study Area and Strategy Horizon

The study area for this project is the Waterloo Region boundary, which includes the Cities of Kitchener, Waterloo, and Cambridge, and the Townships of Woolwich, Wilmot, Wellesley, and North Dumfries.

Given the rapid pace of technology change and the opportunities to explore innovative solutions to existing and future challenges, it is important that the strategy be forward thinking and be adaptable, flexible and sustainable. The planning horizon for this strategy is to the year 2051, thus assumptions made in forecasting future needs will be carried out with this timeframe in mind.

2.3 History of Biosolids Master Planning in the Region of Waterloo

The Region's first Biosolids Master Plan (BMP) was developed in 2003, and it directed biosolids management activities to the year 2021.

The objective of the 2003 BMP was to develop a biosolids management strategy that would be environmentally sound, cost effective and able to adapt to changing requirements and conditions over the next 20 years. A key recommendation from the 2003 BMP was the focus on volume reduction, which the Region implemented. Another recommendation from the 2003 BMP was the investigation into the potential for a storage facility for municipal biosolids in the Region. However, the Environmental Assessment (EA) for this facility was not completed due to issues related to identifying a site. As a result, in 2009, the Region initiated a study to update the 2003 BMP. Many factors drove the need for the update, including:

- Population growth;
- Changes to the regulatory environment;
- Climate change drivers for improved resource management;
- Newly available treatment technologies, end use and disposal alternatives;
- The adoption of a new Environmental Sustainability Strategy by the Region; and
- The 2003 BMP recommendation for regular reviews of the plan.

The update was completed in 2011. The new Region of Waterloo Biosolids Management Master Plan assessed the status of biosolids treatment, management and disposal facilities and developed a strategy to support the Region's needs. A number of technologies were evaluated and the preferred strategy for anaerobically digested biosolids, recommended by the 2011 Master Plan, was the development of a new biosolids heat drying facility. This was in line with the Region's continued desire to reduce biosolids volume, thereby addressing climate change. Also recommended in the 2011 Master Plan was the implementation of cogeneration at facilities with anaerobic digesters and an autothermal thermophilic aerobic digestion (ATAD) facility for smaller capacity facilities generating aerobically digested biosolids.

In 2013, the Region initiated a Municipal Class Environmental Assessment (MCEA) to determine the preferred location for the recommended facility. However, upon considering feedback from the public and stakeholders, it was determined that a review of this approach to implementation of the 2011 Master Plan be undertaken. In September 2013, Regional Council directed Regional Staff to step back and update the BMP with a focus on enhanced communications and public engagement, while looking at new advances in biofuels and greenhouse gas reduction opportunities. The current project to develop a new strategy was initiated in June 2015, and is expected to be complete in 2018.

Figure 2-1 outlines the history of biosolids master planning in the Region including some of the initiatives from the respective plans.

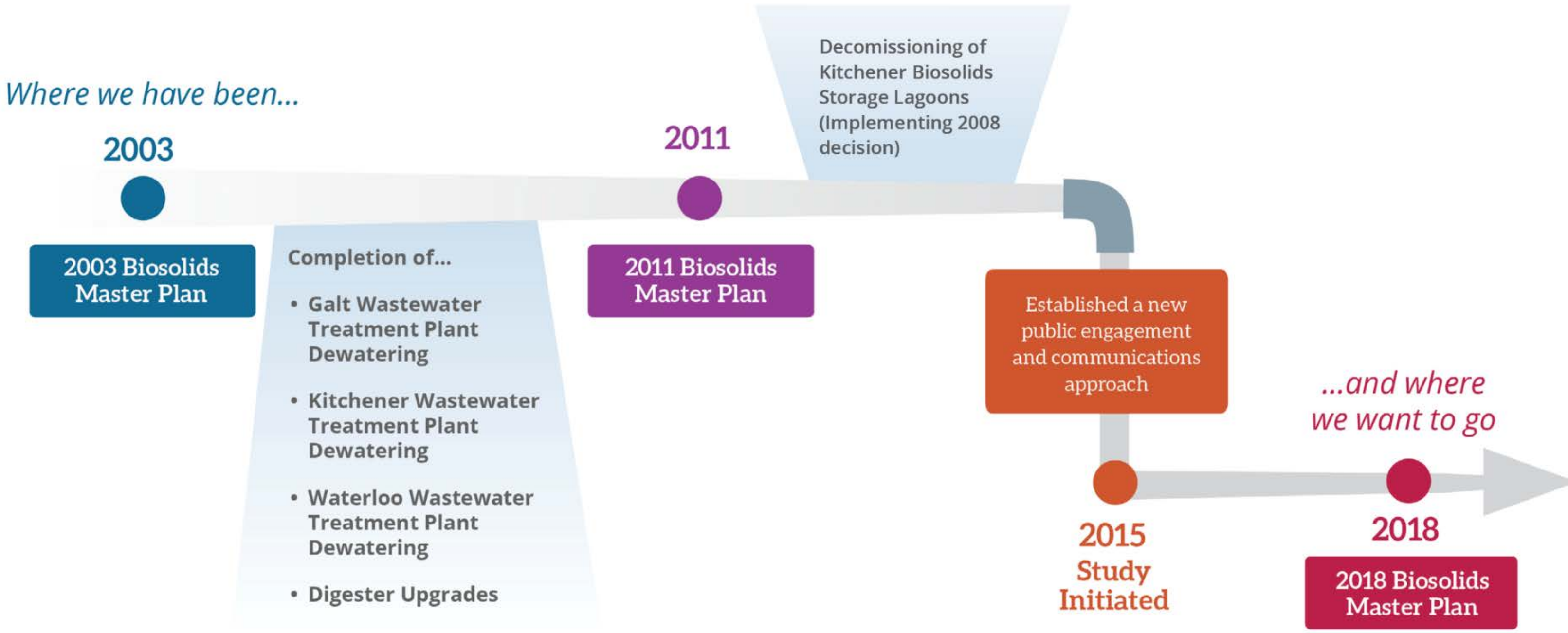


Figure 2-1 History of Biosolids Master Planning in Waterloo Region

2.4 Current Planning for Wastewater Management

The Region of Waterloo currently manages biosolids in two ways:

- **Land Application:** Land application refers to the management of the material as a resource. For biosolids in Waterloo Region, this involves the transportation of biosolids for application on accepting farmers' fields, and for use in remediation of mine tailings ponds. Where the biosolids are used varies throughout the year based on several factors, including demand from receivers and seasonal changes. For instance, agricultural land application is not possible in the winter.
- **Landfill Disposal:** When land application end uses are not available, biosolids are sent to provincially approved landfills for disposal, outside of the Region.

The current biosolids management system is based on the processing capacity of the wastewater systems to accommodate growing population needs. As processing demands evolve over time, it will be necessary to adopt a robust management approach to adequately plan for contingencies and emergencies to provide the best level of service, protection and value to residents.

2.4.1 Issues and Opportunities

The purpose of the Biosolids Strategy is to identify the preferred strategy for sustainably managing the biosolids produced in Waterloo Region. A number of different strategies will be considered and the preferred strategy selected based on a number of technical considerations as well as the community's input. Some of the important issues identified through early conversations with residents and key stakeholders include:

- Cost of various management approaches;
- Quality of life concerns, including noise and odour from facilities and traffic associated with trucking biosolids;
- Safety and human health considerations related to the treatment and use of biosolids;
- Community and economic impacts related to siting biosolids processing facilities;
- Infrastructure needs to support population growth, through either existing facilities or new ones;
- Environmental impacts related to the use and/or disposal of biosolids; and
- Logistics of transporting biosolids from processing facilities to sites selected for use or disposal.

In addition to the issues, some of the opportunities include:

- Emerging technologies for improving the quality of biosolids material;
- The changing regulatory framework related to biosolids use; and
- New avenues for biosolids use, for example in land reclamation projects or use as a biofuel.

The various issues and opportunities identified have been categorized into seven broad "issues that matter":

- Environment
- Health and Safety
- What the Community Values
- Infrastructure Needs
- Logistics
- Quality of Life
- Economic Impact

These broad "issues that matter" were used to develop the Biosolids Strategy objectives, which are discussed in **Chapter 6**. These objectives provide the aspirational goals against which the final recommended strategy will be measured.

2.4.2 Wastewater Treatment Master Plan

Concurrently with the Biosolids Strategy, the Region is developing a Wastewater Treatment Master Plan (WWTMP) that will address wastewater collection and processing needs for the Region to 2051. Coordination was undertaken with the WWTMP over the course of developing the Biosolids Strategy, and public events were co-hosted for both projects in the final stage of the Strategy process.

In general, the WWTMP covers planning for solids up to the digestion process at the Region's WWTP's. The Biosolids Strategy covers planning for solids after the digestion process (i.e. biosolids) up to ultimate disposal.

2.4.3 Co-generation Project

In 2017, the Region initiated a project to investigate the potential for energy recovery at the three largest WWTPs within its boundaries, at Kitchener, Waterloo, and Galt, based on recommendations in the 2011 Master Plan. The energy is to be recovered from the anaerobic digesters at these plants and routed towards supplying needs for the operations of the plants themselves. The study is designed to comply with and obtain Renewable Energy Approval (REA) through the MOECC, and is expected to conclude in 2018, with commissioning scheduled for 2020.

By integrating a co-generation component at the three WWTPs, the majority of energy is being recovered from biosolids at the digestion stage, thereby reducing the amount that is available in a final product that would be the output of a fertilizer or compost creation process.

3.0 Regulatory Framework

3.1 Purpose of Environmental Assessments

An Environmental Assessment (EA) is a planning and decision-making process used to ensure that relevant engineering and environmental features are considered in the planning and design of municipal infrastructure. It is an open and transparent process, with public and agency consultation integrated throughout.

The primary objective of an EA is to predict the impacts that can be expected, should the project proceed. EAs are used to identify the potential environmental impacts and mitigation associated with infrastructure proposals during the planning stages. Once the potential impacts are identified, there is an opportunity to make changes to the design, construction methods, and operational approach, to avoid or reduce negative effects prior to their occurrence and avoid expensive mitigation measures or controversial actions that might be associated with the project.

The EA process provides an opportunity for technical specialists, government agencies, local residents and other stakeholders to have input into the decision-making process. The EA process includes public involvement throughout and requires that feedback received be considered in the decision making process.

At the end of the process, a report is produced to document the planning and decision-making process. The report also summarizes the input received throughout. It is made available for a public review period, at which time any individual may object to or comment on a portion or all of the proposed works.

EAs are completed using two different approaches:

- **Project-by-project basis:** This is the most common approach to completing an EA. An individual infrastructure project is assessed, such as the construction of a new wastewater treatment plant, building a new bridge or widening an existing road.
- **Master Plans:** This approach begins the planning process by considering a group or related projects, or an overall system, such as a road network or wastewater system, prior to dealing with project specific issues. By using this approach, the need and justification for individual projects is better defined. The Biosolids Management Strategy is following this approach.

3.2 Ontario Environmental Assessment Act

In Ontario, EAs are governed by the Environmental Assessment Act (R.S.O. 1990), as well as a number of Regulations that outline the provincial rules related to such processes.

There are two types of assessments completed in Ontario:

- Individual EAs; and
- Streamlined EAs.

An Individual EA is required for large-scale, complex projects that have the potential for significant negative environmental effects. This type of assessment requires approval from the Ministry of the Environment and Climate Change (MOECC).

Streamlined EAs are generally used for routine projects that have predictable and manageable impacts. These projects follow a more simplified process compared to an Individual EA, and follow a self-assessment process. Part of the self-assessment includes a decision by the proponent to go above and beyond the requirements of the Class EA Process. The Municipal Class Environmental Assessment is one of the streamlined EA processes and covers most municipal infrastructure projects. Projects completed under the Municipal Class EA process are:

- Pre-approved, provided the process followed in the Class EA document is followed. MOECC approval is not required;
- Require a less extensive assessment process compared to an Individual EA; and
- At the completion of the project, there is an opportunity for anyone with significant environmental concerns regarding the project that cannot be resolved through discussions with the proponent (typically the Municipality), to request that the Minister consider elevating the project to an Individual EA.

What is meant by the "Environment"?

In general, the "environment" for the purposes of an EA includes the natural and man-made environment, as well as economic and cultural conditions. "Environment" is defined in the *Environmental Assessment Act* as:

"(a) air, land or water,

(b) plant and animal life, including human life,

(c) the social, economic and cultural conditions that influence the life of humans or a community,

(d) any building, structure, machine or other device or thing made by humans,

(e) any solid, liquid, gas, odour, heat, sound, vibration or radiation resulting directly or indirectly from human activities, or

(f) any part or combination of the foregoing and the interrelationships between any two or more of them, in or of Ontario".

Municipal Class Environmental Assessment

The Municipal Class EA (October 2000, as amended in 2007, 2011 and 2015), outlines requirements for assessing municipal infrastructure projects including:

- Public roads and highways;
- Waste management projects;
- Water and wastewater works; and
- Flood protection projects.

The planning process includes:

- Public, government agency and Aboriginal community consultation;
- Assessing potential environmental effects;
- Assessing alternatives; and
- Documentation.

The Municipal Class EA defines four schedules under which projects may be planned and the associated processes required for each. The four types of projects are referred to as "Schedules", with projects classed as Schedule A, A+, B or C, depending on the anticipated level of environmental impact, and for some projects, the anticipated construction costs. The Schedule that applies to a project determines the planning and design phases that must be followed.

- **Schedule A** projects are minor operational and upgrade activities and may go ahead without further assessment once Phase 1 of the Class EA process is complete (i.e., the problem is reviewed and a solution is confirmed).
- **Schedule A+** projects are limited in scale, have minimal adverse environmental impacts and require no documentation; however, the public is to be advised of the project prior to implementation.
- **Schedule B** projects must proceed through the first two phases of the process. Proponents must identify and assess alternative solutions to the problem, inventory impacts, and select a preferred solution. They must also contact relevant agencies and affected members of the public. Provided that no significant impacts are found and no requests are received to elevate the project to a Schedule C, or undertake the project as an Individual EA through a Part II Order request, the project may proceed to detailed design (Phase 5).
- **Schedule C** projects require more detailed study, public consultation and documentation, as they may have more significant impacts. Projects categorized as Schedule C must proceed through all five phases of assessment. Schedule C projects may potentially result in adverse impact(s), and as such, a public consultation program is needed to ensure that stakeholders and local residents within the Study Area are provided with the opportunity to contribute meaningful input.

There are five phases in the Municipal Class EA process, as disucssed in **Appendix A (TM#1 – The Environmental Assessment Process):**

- **Phase 1 – Problem/Opportunity**: What is the problem or opportunity being studied?
- **Phase 2 – Alternative Solutions**: What is the best strategy to address the problem/opportunity?
- **Phase 3 – Alternative Design Concepts for Preferred Solution:** What is the optimal design to implement the strategy identified in Phase 2?
- **Phase 4 – Environmental Study Report**: Document the process completed during Phase 1 through 3 in a report for public review.
- **Phase 5 – Implementation**: Confirm design details and proceed to implementation.

Often, municipalities take the route of developing a Master Plan that satisfies some or all of the requirements of Phases 1 and 2. The various types of Master Plans are discussed in the next section.

3.3 Master Plans: What are they?

Many EAs are completed on a project-by-project basis. However, in some cases, it is beneficial to start the planning process by considering the needs of an overall system, such as a wastewater or transportation network. This approach takes into account whether several different systems are working in the same location, and whether there is a group of related projects that can be planned together. Using a Master Plan approach involves a long-range view of integrating infrastructure requirements with existing and future land uses and EA planning principles.

At a minimum, Master Plans follow Phases 1 and 2 of the Class EA process. Master Plans differ from typical EA projects in two main ways:

1. They are completed at a high level, with broad analysis of the system to develop a framework for future work. Master Plans generally do not address a site-specific issue.

2. They typically recommend a set of works or projects that will be implemented over a number of years. The Master Plan provides the basis for future projects, providing the background and justification as well as the selected strategy for the projects moving forward.

The details of how the future projects will be designed and determination of specific impacts and mitigation measures are developed as part of the future implementation phase. Depending on the scale, nature and potential impacts of the future project, additional assessments following Phases 3 and 4 of the Class EA may be required.

The Master Plan is subject to the approval of Municipal Council, and does not require approval under the EA Act. During the stipulated review period members of the public may submit comments and/or objections only on the individual projects identified in the plan.

The Waterloo Biosolids Strategy is being completed as a Master Plan. At the end of Phase 2 of the process, the Master Plan may identify a number of infrastructure needs that, depending upon their nature, may require completion of Phases 3 and 4, as described in the next section.

3.4 Why is the Biosolids Strategy Being Completed as a Master Plan?

The Biosolids Strategy will focus on developing a sustainable biosolids management approach for Waterloo Region. A Master Plan provides a holistic, long-term view of the approach, and provides an avenue to explore opportunities for a range of mechanisms to use biosolids in the Region, including as a biofuel, towards reducing greenhouse gas emissions and ways to improve current processes to be more adaptable to future changes in regulations and innovations in the field of biosolids management.

The Master Plan will also identify potential criteria for selecting the location for a new facility (if required). Based on the strategy selected, additional environmental assessment(s) may be required for specific projects. The additional EAs would include:

- Schedule B "screening" for certain Schedule B projects. The screening would include completion of an impact assessment and outline of mitigation measures as part of the conceptual design of the project. A screening report would be prepared and available for public and agency review. Environmental Study Report for any Schedule C projects. This would involve completing Phases 3 (Alternative Design) and Phase 4 (Environmental Study Report) of the Class EA process.

Both processes will include public and agency consultation and provide an opportunity for any member of the public to request a "Part II Order" be issued by the MOECC, elevating the Schedule B project to a Schedule C project or elevating the Schedule C project to an Individual EA. Alternatively, the MOECC may require the fulfillment of specific conditions in relation to the proposed project in order to allow the proponent to proceed.

3.5 Legislative Framework

The Biosolids Strategy is guided by a number of important pieces of legislation and policy. The regulatory framework for agricultural land application is defined by:

- Ontario Nutrient Management Act, 2002, S.O. 2002, c. 4 (NMA);
    - Ontario Regulation 267/03 as amended (O.Reg. 267/03);
- Federal Fertilizers Act R.S.C., 1985, c. F-10 (Fertilizers Act);
    - Canadian Fertilizers Regulation (C.R.C., c. 666) (Fertilizers Regulation); and
- Ontario Compost Quality Standards.

Transportation and infrastructure implemented for biosolids management must satisfy the requirements of environmental protection legislation including:

- Environmental Assessment Act, R.S.O. 1990, c. E.18;
- Environmental Protection Act, R.S.O. 1990, c. E. 19;
  - O.Reg. 347: General Waste Management;
  - Ontario Regulation 419/05: Air Pollution – Local Air Quality;
  - Guideline A-7: Air Pollution Control, Design and Operation Guidelines for Municipal Waste Thermal Treatment Facilities;
- Ontario Water Resources Act, R.S.O. 1990, c. O.40;
- Green Energy Act;
- Safe Drinking Water Act; and
- Clean Water Act.

Biosolids and products incorporating biosolids that are used in non-agricultural applications, such as land reclamation, can be managed within the restrictions of the Environmental Protection Act (EPA).

The Safe Drinking Water Act requires communities in Ontario to develop source protection plans for municipal sources of drinking water. These plans may provide restrictions in addition to those identified by the Nutrient Management Act (NMA), such as set-backs from wells, surface water, and other reductions in the area available for biosolids application to land.

In addition, there are a number of plans developed by the Region of Waterloo that relate to the Biosolids Strategy. The Region completed a Hauled Waste study that was completed in 2016 and a Wastewater Treatment Master Plan that is scheduled for completion in 2018. These plans have an important impact on and contribute to the Biosolids Strategy.

3.6 Biosolids Management

The NMA, EPA, OWRA and the regulations made under the acts set the requirements for protection of the environment when managing biosolids. Municipalities and contractors that transport biosolids between wastewater treatment facilities, non-agricultural land application, and disposal sites require an Environmental Compliance Approval (ECA) under Section 27 of the EPA for a Waste Management System. Facilities that process biosolids require approval under Section 9 of the EPA for a plant or production process and Section 27 of the EPA for a Waste Management System or Waste Disposal Site. In addition, emissions to air from these processes must comply with the appropriate limits as defined by O.Reg 419/05 to protect local ambient air quality. Wastewater effluent discharged to receiving water requires an ECA under Section 53 of the OWRA. An approved Non-Agricultural Source Material (NASM) Plan under the NMA and O.Reg 267/03 is required for biosolids application to agricultural land.

Appendix B (Technical Memo #2: Existing Conditions) provides a detailed look at the legislative framework and quality metrics governing agricultural and non-agricultural uses of biosolids in Ontario.

3.6.1 Agricultural Land Application

A portion of the Region's biosolids are applied to agricultural land. The NMA provides the framework for biosolids use in agriculture. The Region's biosolids are considered a NASM under the NMA. All NASMs are categorized based on a language definition for Categories 1 – 3. O.Reg 267/03 includes specific restrictions, sampling, notification, and report requirements for each Category. Biosolids are considered a Category 3 NASM. Table 3 in Schedule 4 of O.Reg 267/03 provides clarification that when Category 3 NASMs are blended with other material, the new product remains a Category 3 material.

Storage Prior to Agricultural Use

A limitation of the NMA for sewage biosolids or materials that result from the processing of sewage biosolids is that these materials shall not be applied to land during the restricted period. This time restriction is accepted to be December 1st to March 31st, or when the ground is frozen or snow covered. The restricted period generates the need for substantial storage or alternate management over the winter period. In terms of storage at the site of application, the maximum duration allowed for dewatered biosolids is 10 days. Off-site storage capacity, and non-agricultural land reclamation uses are options in Ontario, as is disposal to landfill during the restricted period.

Application Rate

The application rate for biosolids is a critical aspect of land application. The application rate determines the inventory of agricultural land required to support the use of a given mass of biosolids. The maximum application rate for Category 3 NASMs is 22 dry tonnes per hectare per five year period (NMA, 2013). There are a number of criteria that may reduce the application rate below the maximum including:

- Crop nutrient requirements, mainly plant available nitrogen (PAN) and plant available phosphate (PAP)
- Metals content

In most cases phosphate limits the five year application rate for municipal biosolids. The available area for application is reduced by setbacks required for wells, surface waters and odour receptors.

Municipal By-law

The metals content in biosolids is a function of the wastewater quality influent to the WWTP. In the Region of Waterloo, wastewater quality is regulated using Sewer Use By-law 1-90, as amended by By-law 92-050 and By-law 14-012. The by-law includes concentration limits for all metals analyzed for biosolids quality. The limits in the by-law are comparable to the limits for metals in the CCME model by-law (CCME, 2009) and comparable jurisdictions (Hamilton and Toronto). The limits for certain metals are slightly higher in the Region of Waterloo by-law. Mercury is the exception where the Region of Waterloo limit is 0.1 mg/L compared with 0.01 mg/L in the other by-laws referenced.

3.6.2 Non-Agricultural Land Application and Landfill Disposal

The existing anaerobically digested and dewatered biosolids have historically been primarily applied to agricultural land. The current digested and dewatered product must be stored over winter at an off-site approved bulk storage facility, landfilled, or managed in a non-agricultural setting using a waste ECA.

In terms of non-agricultural use, the NMA does not apply. An ECA for a Waste Disposal Site is required under Part V of the EPA. For reclamation and rehabilitation sites, the application rates and other restrictions on the use of biosolids are based on site specific characteristics. The limitations on biosolids application rates and other restrictions are defined within an ECA (Waste Disposal Site) that is approved by the MOECC.

Characteristics of the site that affect biosolids application rate include the current soil and ground cover ranging from:

- Some vegetation
- Some topsoil with limited vegetation
- Exposed tailings
- Exposed sub soil
- Exposed rock

Site water management is also an important factor where sites with limited or no water management and potentially sensitive surface water cannot accept high biosolids applications rates. Conversely, sites with active water management and/or controls in place may accept much higher biosolids application rates.

The application rates vary based on existing soil conditions, where a rate similar to the NMA may be used to fertilize existing plant growth, ranging in application rates up to 150 dry tonnes per hectare to generate pseudo soil where topsoil has been completely removed. The highest biosolids application rates are appropriate in extreme conditions such are bare rock with no soil. In these situations, biosolids are often blended with a carbon substrate such as saw dust or leaf and yard waste. The combination of high carbon substrate and biosolids can support the establishment of vegetation on these degraded sites.

Biosolids that are sent for disposal in Ontario must be transported to a landfill site that has been approved under Section V of the EPA and operates under the conditions and restrictions defined within an ECA (Waste Disposal Site) that is approved by the MOECC. The quality and quantity of biosolids accepted at a landfill site must meet the conditions and restrictions identified on the ECA.

4.0 Existing Conditions Background Study

The current biosolids processing infrastructure and management approach in the Region of Waterloo provides the foundation for planning. This section provides a summary of the infrastructure in place at the wastewater treatment facilities, and the current approach to managing biosolids in the Region.

4.1 Existing Wastewater Treatment

Wastewater generated in the Region is collected by a complex network of sewers and pump stations. It is treated at 13 facilities across the Region of Waterloo as shown on **Figure 4-1**.

Appendix B contains detailed information on each of the facilities including; population served, the projected flow rate of wastewater treated for the 2015 operating year, and the uncommitted hydraulic reserve capacity.

Each treatment facility includes different infrastructure based upon the size or rated capacity of the treatment facility and the unique requirements of discharge. The mass and quality of residuals generated are affected by the technology utilized at each wastewater treatment facility. The treatment processes at each treatment facility are discussed in greater detail in **Appendix B.**

Wastewater treatment removes suspended and dissolved solids from wastewater, which generates residual material that must be managed. Residuals collected from preliminary treatment such as screenings and grit are typically managed as solid waste and do not become a component of biosolids. Primary and secondary treatment clarifiers are the main sources of sludge that contribute to biosolids, and are present at all of the larger and some mid-sized facilities in the Region, including Kitchener, Waterloo, Galt, Preston, and Elmira. Small and some midsized facilities in the Region, including Hespeler, New Hamburg, St. Jacobs, Ayr, Wellesley, Heidelberg and Conestogo, collect solids using secondary clarification only because of the extended aeration configuration.

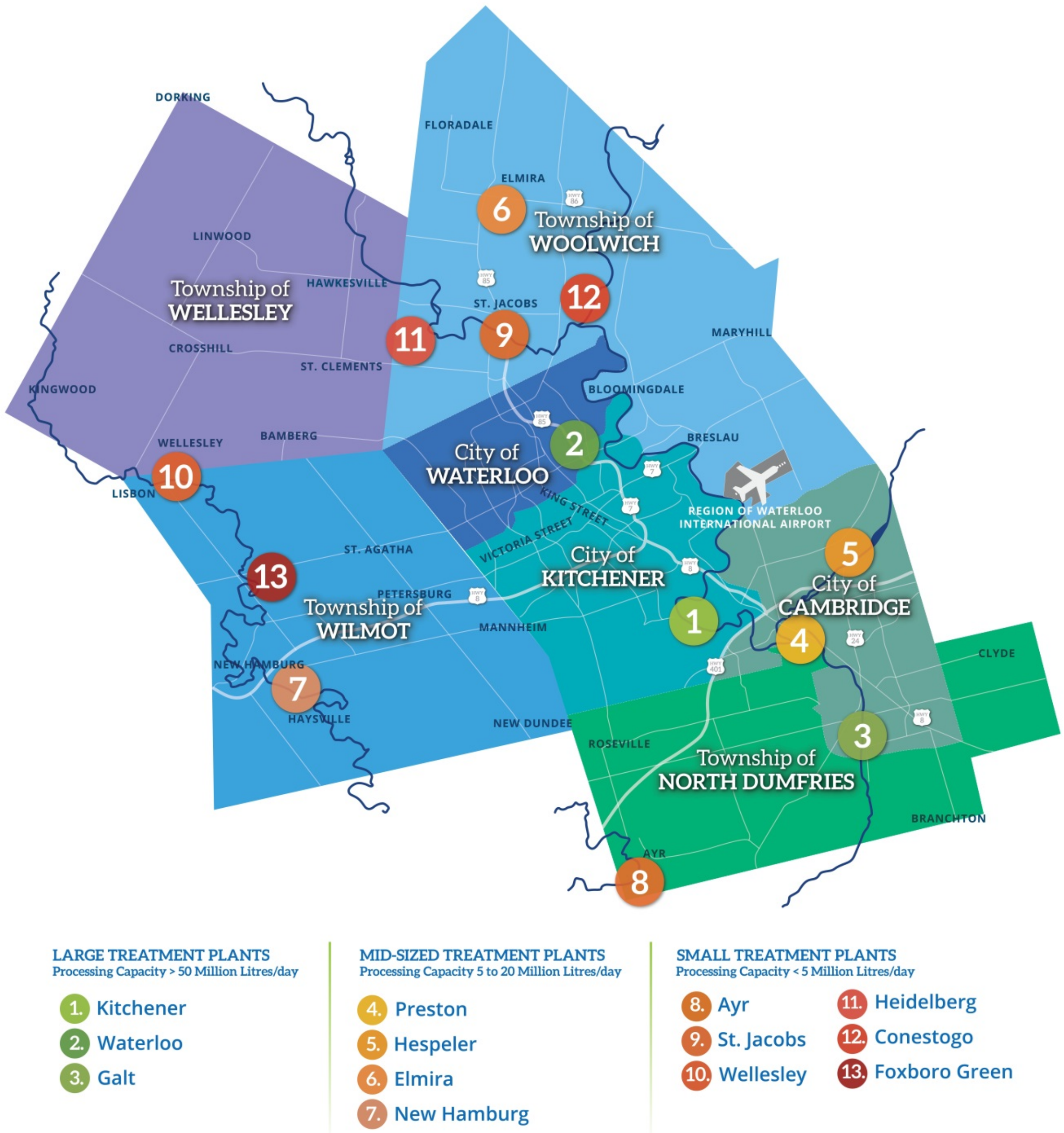


Figure 4-1 Location of Wastewater Treatment Facilities within the Region of Waterloo

Tertiary treatment will also contribute to biosolids. The objective of tertiary treatment at facilities in the Region is total suspended solids (TSS) and total phosphorus (TP) removal by filtration. The solids collected during tertiary treatment are returned to the beginning of the treatment process at the plant, and are removed from the system through primary and secondary clarifiers.

Sludge collected at the larger facilities is processed further to become biosolids. Sludge collected at the four largest wastewater treatment plants, Waterloo, Kitchener, Galt and Preston, are processed through anaerobic digesters. Digested solids are dewatered. Some mid-sized and smaller facilities, including New Hamburg, Ayr and Heidelberg, have aerobic digesters. Aerobically digested biosolids at the New Hamburg and Ayr WWTPs are stored in lagoons prior to use. The remaining facilities transfer residuals to larger facilities, because they do not have processing capacity on site to generate a stabilized biosolids product.

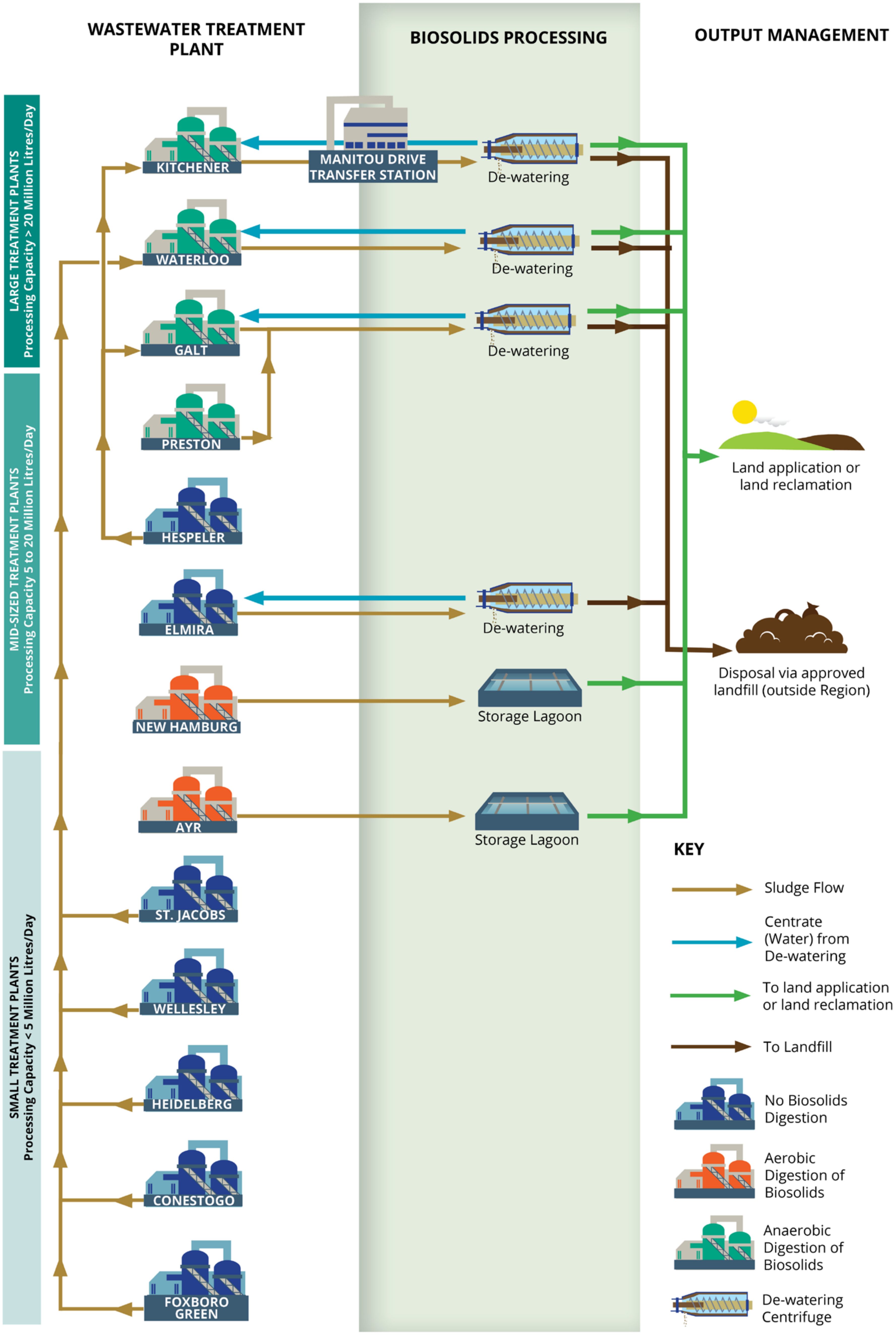
4.1.1 Current Biosolids Management Practices

The Region of Waterloo's current management approach for biosolids is dependent on the size of treatment plant and the related infrastructure for sludge processing. The majority of biosolids in the Region are handled at four facilities with anaerobic digesters: Kitchener, Waterloo, Galt and Preston WWTPs. Biosolids from these facilities are managed as dewatered cake and sent for use through land application / land reclamation, or sent to for disposal in a landfill. Each of the four plants has infrastructure available to allow truck transfer between plants as a contingency for biosolids management. The Preston WWTP transfers digested material to the Galt WWTP by truck for dewatering. The Kitchener WWTP digestate is transferred through a forcemain to the Manitou Drive facility for dewatering. Centrate from Manitou Drive is returned by sewer to the Kitchener WWTP. Dewatering infrastructure at these facilities was commissioned between 2009 and 2014, and is therefore relatively new. The Region's operating team has not identified any capacity or equipment issues related to dewatering for current operations. The load-out facilities for dewatered biosolids have storage capacity for approximately three days of operations. The Region does not control or have access to contingency storage capacity for dewatered cake in the event that trucking is disrupted. The operating team has identified the lack of Region controlled storage, or alternative contingency as a risk in the event that typical biosolids trucking is disrupted.

Solids at the Hespeler WWTP undergo partial aerobic digestion and are then sent to the Kitchener and Galt WWTPs for re-processing. A project is underway to allow complete aerobic digestion by the Region. Ayr and New Hamburg WWTPs have available aerobic digester capacity and available biosolids storage capacity in lagoons. Some transfers of biosolids from the New Hamburg WWTP to the Waterloo WWTP occurred in 2015 in specific instances to create additional capacity in the lagoons; however aerobically digested biosolids from the lagoons at both facilities are typically transferred directly for land application. The Conestogo, Heidelberg, St. Jacobs, and Wellesley WWTPs have transferred sludge to the New Hamburg WWTP over the last number of years; however in 2015 these facilities shifted the preferred transfer location to the Waterloo facility for re-processing. Sludge from the Elmira WWTP is dewatered and sent to a provincially approved landfill. The relatively low rated capacity combined with the wastewater treatment approach at Foxboro Green, including rotating biological contactors and subsequent anoxic tankage, generate sludge at a low rate. Solids are collected from this system once or twice per year and transferred to Waterloo. **Figure 4-2** presents the mass flows between facilities and end-uses.

The Region of Waterloo has contracts with vendors to remove biosolids from the wastewater treatment facilities. The contracts for final disposal of biosolids prioritize use of biosolids, with disposal in a landfill as a last option. **Figure 4-3** summarizes end uses of the biosolids produced from the Region's facilities in 2016.

Figure 4-2 Mass Flows of Biosolids within the Region



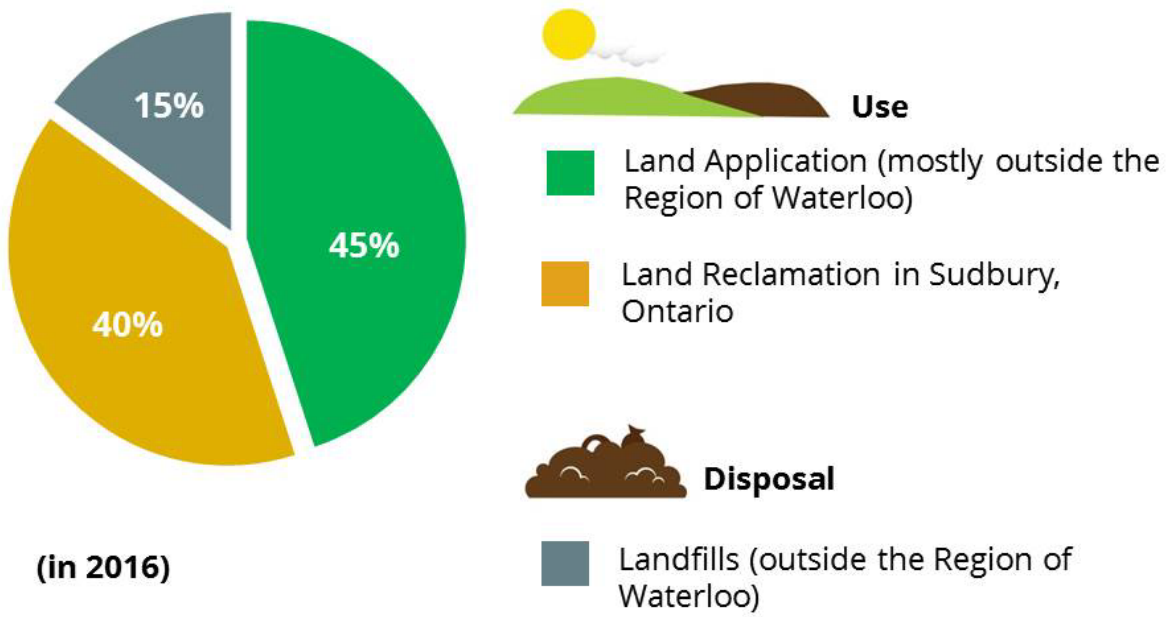


Figure 4-3 End Use and Disposal Breakdown of Biosolids for 2016

When necessary, provincially approved landfills outside the Region are used for disposal of biosolids. The Region of Waterloo's landfill is prohibited from accepting biosolids as a condition of their Provincial approval.

A mine tailings area reclamation program in Sudbury Ontario that was able to accept biosolids during the restricted period was identified in 2015. This approach allowed additional biosolids use when agricultural land application was not available during the restricted period, and provided an alternative to landfill. **Appendix B** contains more detailed information on the historical use of Biosolids in the Region.

4.2 Biosolids Quantity and Quality

The biosolids quantity and quality generated in the Region of Waterloo are presented in this section to identify the baseline conditions. The concentrations presented are compared to relevant standards for NASM. Characterization of the quantity and quality in this document will inform the technical assessment of alternatives during future steps in the development of the Biosolids Strategy.

4.2.1 Biosolids Quantity

The biosolids generation rate is related to the volume of wastewater treated at each facility. The sludge generation rate that forms the feedstock for each facility's biosolids processing is presented for the last five years in **Table 4-1** for facilities with anaerobic digesters, and **Table 4-2** to those without anaerobic digestion.

Table 4-1 Sludge Generation Rate (m3/year) 2011 – 2015 for Region of Waterloo Wastewater Treatment Plants with Anaerobic Digestion

Wastewater Treatment Plant	2011	2012	2013	2014	2015
Kitchener	209,460	195,889	189,536	218,747	203,633
Waterloo	88,639	109,276	108,411	80,115	77,674
Galt	82,357	82,836	87,867	96,405	109,320
Preston	25,534	24,465	26,950	26,296	28,220
Total	405,990	412,466	412,764	421,563	418,847

Table 4-2 Sludge Generation Rate 2011 – 2015 for Region of Waterloo Wastewater Treatment Plants without Anaerobic Digestion

Wastewater Treatment Plant	2011	2012	2013	2014	2015
Hespeler	72,359	88,064	74,036	103,874	92,346
Elmira	21,302	17,541	9,825	12,635	14,062
St. Jacobs	1,946	2,100	2,281	2,444	2,244
New Hamburg	17,568	18,259	15,022	14,931	15,081
Ayr	2,409	3,069	2,344	2,288	2,957
Wellesley	4,502	3,674	3,367	4,054	3,928
Heidelberg	458	701	312	375	354
Conestogo	162	285	181	215	204
Foxboro Green	1,037	1,313	352	0	0
Total	121,743	135,006	107,720	140,816	131,176

*Note: Sludge generated at Ayr and New Hamburg is reported as biosolids transferred from lagoon storage.

Sludge volumes have varied within a relatively consistent range over the last five years for each treatment facility, based on the above tables.

The majority of biosolids in the Region of Waterloo are generated at the Kitchener, Waterloo, Preston, Galt, and Hespeler WWTPs. Aerobically digested sludge at the Hespeler facility is reprocessed at the Galt and Kitchener facilities; therefore it is handled and accounted for twice in the data presented above.

4.3 Biosolids Quality

The biosolids quality was examined as it is measured prior to use or disposal at the Kitchener, Waterloo, Galt, Ayr, and New Hamburg facilities. **Appendix B** provides details on biosolids quality at each of these plants. The data presented in that Appendix is intended to set the baseline quality of biosolids for planning purposes, and demonstrate that biosolids used have value as a source of nitrogen and phosphorous and have been acceptable quality for use under the NMA as a Category 3 NASM over the period assessed.

5.0 Biosolids Quantity Forecast

A detailed discussion of the biosolids quantity forecast for the Region to the year 2051 is provided in **Appendix F (Technical Memo #6: Biosolids Forecast)**. This chapter provides a summary of the content in that technical memo.

5.1 Population Forecast

The quantity of biosolids that will require management in the future is a direct function of the number and type of users (residential and industrial) discharging to the Region's WWTPs as well as the wastewater treatment and biosolids management infrastructure in place. Establishing a population forecast is the first step of biosolids quantity forecasting. The forecast presented in this chapter is aligned with the information used as the basis for the Wastewater Treatment Master Plan (WWTMP) completed concurrently with the Biosolids Master Plan. **Appendix F** discusses the population projections available for the Region and the projections that inform the sensitivity analysis and the forecast quantities.

5.2 Biosolids Forecast

This section provides a summary of the biosolids forecast as developed through the WWTMP. The quantity of biosolids that requires management is a function of the load treated at the WWTPs, and the infrastructure available to treat the solids collected. The estimated quantity of dry solids that requires management now, and for future years, is a function of the loading to WWTPs based primarily on:

- Population;
- Per capita wastewater flow rate; and
- Concentration of TSS and BOD_5 in the wastewater.

The loading was characterized for the moderate population scenario presented in the WWTMP, and quantity of biosolids requiring management was estimated based upon:

- Solids collected at WWTPs;
- BOD_5 converted to solids collected as waste activated sludge (WAS); and

- Volatile solids removal in the WWTPs solids processing.

The biosolids quantities estimated for the WWTMP are presented in terms of dry solids requiring management in **Table 5-5**. These estimates considered the most appropriate for planning. As alternatives for biosolids management are developed in additional detail the quantity of biosolids will be used to size unit processes.

Table 5-1 Biosolids Quantity Projections (CIMA, 2016)

Wastewater Treatment Plant	Parameter	*Current Average Month*	*Current Peak Month*	*2051 Average Month*	*2051 Peak Month*
Kitchener	Raw Sludge	11,940	16,720	17,350	24,300
	WAS	8,300	11,620	12,060	16,890
	Sludge to Digesters	20,240	28,340	29,420	41,190
	Total Biosolids Produced	12,850	17,990	19,130	26,780
Waterloo	Raw Sludge	7,350	10,290	9,540	13,350
	WAS	6,000	8,400	7,790	10,900
	Sludge to Digesters	13,350	18,690	17,320	24,250
	Total Biosolids Produced	8,350	11,690	10,840	15,170
Galt	Raw Sludge (1)	7,440	9,670	10,350	13,450
	WAS	3,980	5,170	5,540	7,190
	Sludge to Digesters	11,420	14,850	15,890	20,660
	Total Biosolids Produced	7,140	9,280	9,930	12,910
Preston	Raw Sludge	1,030	1,440	1,360	1,900
	WAS	1,080	1,510	1,430	1,990
	Sludge to Digesters	2,110	2,950	2,790	3,900
	Total Biosolids Produced	1,320	1,850	1,740	2,440
Hespeler	WAS	-	-	1,300	1,810
	Sludge to Digesters	-	-	1,300	1,810
	Total Biosolids Produced	-	-	930	1,300
Ayr	WAS	210	320	450	680
	Sludge to Digesters	210	320	450	680
	Total Biosolids Produced	170	260	360	550
Baden / New Hamburg	WAS	510	770	950	1,430
	Sludge to Digesters	510	770	950	1,430

Wastewater Treatment Plant	Parameter	*Current Average Month*	*Current Peak Month*	*2051 Average Month*	*2051 Peak Month*
Baden / New Hamburg	Total Biosolids Produced	430	650	800	1,210
Wellesley	Total Sludge Produced	120	200	170	290
St. Jacobs	Total Sludge Produced	90	140	150	230
Elmira	Raw Sludge	630	950	1,350	2,040
	WAS	590	890	1,260	1,910
	Total Sludge Produced	1,220	1,830	2,620	3,920
Alt - Heidelberg	Total Sludge Produced	11	15	12	16
Foxboro Green	Raw Sludge	6	9	6	10
	WAS	9	14	9	15
	Total Sludge Produced	14	23	15	24
Conestogo	Total Sludge Produced	6	9	7	10
	Total Sludge/Total Biosolids Produced	**31,721**	**43,937**	**46,254**	**64,220**

*Current flow defined as (2012-2014) (kg/d)

The quantity forecast is sensitive to the factors presented above, and the estimates will vary linearly with changes to each parameter. The overall solids load influent to WWTPs in the future is considered most sensitive to the population forecast. The detailed evaluation of population projections presented demonstrates that a range of +/- 10 % would be prudent to consider particularly where the feasibility of an alternative is close to a size threshold.

Water conservation by individuals such as water efficient appliances, and low flow fixtures (e.g. faucets, toilets, showers) is likely to continue to reduce per capita wastewater flow rates; however it is considered less likely to impact loading at WWTPs. It is considered likely wastewater total solids concentrations will increase to offset per capita flow reductions, and therefore loading at WWTPs is likely to increase with population growth as presented.

The quantity of solids collected is anticipated to be relatively stable as a percentage of the influent load. Effluent water quality criteria are considered likely to remain the same or become more stringent and therefore an equal or higher percentage to the load influent to WWTPs must be removed from the liquid stream. More stringent effluent quality criteria will tend to increase the rate of biosolids production per capita; however current requirements are relatively stringent, and changes are not anticipated to generate more than a 10% increase in biosolids production.

The quantity of biosolids to be managed is also dependent on the amount of volatile solids removed during solids processing, primarily conversion to gas during digestion. Energy recovery as biogas is likely to incentivize volatile solids reduction, and reduce the per capita quantity requiring management in the future. Optimizing operations of the existing digestion infrastructure is considered unlikely to generate more than a 10% reduction in quantity. New technologies that substantially affect volatile solids reduction will be considered separately from the sensitivity analysis.

The biosolids quantity projected is sensitive to a number of factors related to the load influent, as well as solids collection and processing to the WWTPs. The parameters considered are unlikely to all act to increase or decrease quantity. For example, effluent quality criteria may tend to increase solids collected, while optimization of biogas generation will tend to decrease the amount of biosolids requiring management. Therefore the uncertainty band identified for population growth of +/- 10% is considered the appropriate range to consider for future projections. The total biosolids produced for the Region of Waterloo for the moderate population projection in the WWTMP was an average of 46,300 and a peak of 64,200 kg dry solids / day. Using 10% uncertainty, the range biosolids production projected for the year 2051 is 42,000 – 51,000 kg dry solids / day on average, and 58,000 – 71,000 kg dry solids / day for a peak month.

6.0 Evaluation Approach

At the outset of developing the Biosolids Strategy, it was determined that a community-led approach to developing the future direction of biosolids management in the Region was needed. The decision-making process discussed in **Chapter 1** was developed to integrate community feedback and input at every stage of the process. This chapter provides a discussion of the evaluation approach and decision-making process to select the preferred strategy for the Region. **Appendix C (TM#3 – Evaluation Criteria)** provides further description of the evaluation methodology and criteria.

6.1 Objectives Based Evaluation Methodology

An objectives-based evaluation approach was used to select the preferred strategy. This is a holistic, multi-disciplinary approach to completing the evaluation. It reflects a desire to develop a sustainable management strategy for biosolids by evaluating the alternatives against integrated environmental, social and economic objectives.

The objectives were developed based on initial consultation with key stakeholders (the “issues that matter”) and members of the community, alignment with the Region’s Strategic Plan and input from the project’s technical team. Public and stakeholder engagement was a guiding principle for the Biosolids Strategy. The initial phase of this project focused on education on biosolids and asking what issues should be considered in the decision making process. These issues then informed the development of the overarching objectives for the Biosolids Strategy.

Key consultation activities in Stage 1 and Stage 2 of the project that led to the development of the issues included:

- Steering Committee Meetings: The committee included technical, planning, and communications staff from the Region of Waterloo, as well as representatives from the Region of Waterloo Council
- Stakeholder Committee Meeting: The committee included representatives from a range of sectors, as well as community groups, farming community, academic experts, students and industry representatives
- Public Project Launch Event
- Online and telephone surveys (2)
- Pop-up Consultation Events (10)

Based on input received through all the above consultation opportunities as well as technical input from the Project team, a complete list of issues that matter was generated as shown in **Figure 6-1.**

Appendix M of this memo outlines how input received from various stakeholders during Stage 1 and Stage 2 of the project based on 'issues that matter' was collected and used to formulate the objectives and criteria for the Biosolids Strategy.

Figure 6-1 Biosolids Management - Issues that Matter Regarding Biosolids Management

6.1.1 The Strategy Objectives

The issues that matter were analysed by the project team, and a set of objectives identified for the Region's Biosolids Strategy:

Work collaboratively to find solutions. Stakeholders need to be involved in the decision making process, both now and as the biosolids strategy is implemented. Consistent with the Region's Strategic Plan, the decision making process should provide enhanced opportunities for public engagement, input and involvement in the decision making process beyond regulatory requirements.

Align with existing infrastructure. The Region has significant investment in wastewater and biosolids processing infrastructure based on the philosophy of volume reduction. A strategy that aligns with this philosophy is preferred.

Protect the natural environment. The preferred strategy should seek to make the natural environment better, not only focussing on minimizing negative impacts. This project provides an opportunity to examine both.

Protect health and safety. Consistent with the Region's Strategic Plan, the strategy should promote and support healthy living and prevent disease and injury, for both workers and the public.

Minimize and manage operational risk. The preferred strategy must be robust and limit the potential for complications during the operations that would compromise the Region's ability to provide on-going biosolids services.

Protect quality of life. The existing quality of life for citizens should be maintained, regardless of any recommended facility.

Objective: Work collaboratively to find solutions, was an overarching objective of the Biosolids Strategy and was used to shape the design of this project. The stakeholder engagement program for this study exceeds the minimum requirements of the Class EA process. As outlined in the Project Charter: *"The Region of Waterloo is committed to engaging citizens and collaborating with community partners to foster meaningful and open conversation about Regional programs and services. The project has an emphasis on community input and participation at multiple points throughout the development of the Strategy, to help identify values important to the community. Throughout the Strategy development process, the Region will endeavour to provide a wide range of event types and opportunities for public engagement and involvement."*

This objective was integrated into the strategy development process, and will carry forward during the implementation phase.

Be cost effective and provide value. The preferred strategy must be affordable to the Region, both now and in the future.

6.1.2 Developing Evaluation Criteria from the Objectives

To carry out the evaluation of alternatives developed in Stages 4 and 5 of the Biosolids Strategy, specific criteria were identified based on the objectives, as outlined in this section.

For each objective, a number of criteria were designed based on stakeholder and community input, as well as feedback from the technical team. These criteria served the purpose of clarifying the specific items that needed to be measured in considering an alternative for managing biosolids in the Region. Furthermore, each criterion was assigned a set of corresponding indicators to measure performance of the alternatives against the criteria, as a way to distinguish the preferred alternative. Both quantitative and qualitative indicators were selected, depending on the criteria. The criteria are described in this chapter, and the corresponding indicators defined in **Appendix H (TM#8 – Evaluation of Short Listed Alternatives).**

6.2 Evaluation Approach and Criteria

The following section outlines the evaluation approach and criteria that will be used to select the preferred alternative(s). Throughout the evaluation process, the intent is that each alternative will be assessed against the criteria indicators and the alternative(s) that best meet the defined objectives will be confirmed as the preferred strategy for addressing biosolids management in the Region.

Opportunities to mitigate negative impacts will be considered in the development and refinement of the strategies, so that an “optimized” alternative is evaluated. It is recognized none of the alternatives will be fully aligned with all of the objectives and some measure of trade-offs would likely be required, which will be discussed as part of the evaluation results.

6.2.1 Long List Evaluation

The long list of strategies will be screened against minimum performance questions identified for the objectives. Strategies that did not meet the minimum performance were screened out. The minimum performance questions were intended to screen out alternatives that are not feasible for the Region to consider further. The questions were also tied to the project objectives as laid out in **Appendix C (Technical Memo #3 – Evaluation Criteria)** and **Appendix G (TM#7 – Short List of Alternatives).**

The first objective, 'Work collaboratively to find solutions', did not have any Minimum Performance Questions assigned as it is meant to go beyond the minimum requirements and was therefore met through the study design. With respect to the 'Be cost effective and provide value' objective, the cost of the preferred strategy must be acceptable to the Region, both now and in the future. No specified Minimum Performance Questions related to costing were applied at the short listing stage as this objective was addressed through the specific criteria to evaluate the short-listed strategies.

The Minimum Performance Questions were:

Align with existing infrastructure

- Does the alternative build upon the Region's existing wastewater infrastructure?
- Is it based on commercially proven technology that provides a long term solution?

Protect the natural environment

- Does it meet current environmental regulations and is it capable of meeting permitting requirements?
- Does it align with best environmental practices in the field of biosolids management?

Protect health and safety

- Does it meet current health and safety regulations?
- Does it align with best practices for the protection of public health in the field of biosolids management?

Minimize and manage operational risk

- Can the Region control all necessary elements of implementation?
- Can the storage requirements be met with a facility(s) located in the Region?

Protect quality of life

- Does the alternative protect the quality of life for citizens regardless of where it is built in the Region?

6.2.2 Short List Evaluation

Once the long list of alternatives was evaluated against the Minimum Performance Questions, a short list of “eligible” alternatives will be confirmed and evaluated in more detail based on the study objectives. The alternatives were further optimized prior to being evaluated so that the “best” form of the alternative is evaluated. The following tables provide the evaluation criteria that were used to provide an assessment of performance of each alternative against the objectives. As noted previously, Objective 1 to ‘Work collaboratively with the community to find solutions’ is not included in the evaluation criteria, as it this objective is being assessed as part of the development of the Strategy itself.

Consultation on the evaluation approach sought to obtain input on whether any of the objectives or criteria should be considered more important in the evaluation than others. Criteria were not weighted with any type of numerical or empirical measurement; rather weighting was qualitative, based on the input provided by the community and from the Region. The objectives-based approach applies a reasoned, holistic understanding to the assessment of alternatives, thus no scoring was applied to differentiate between the performances of alternatives. Instead, a four part scale was utilized to assign a performance level of alternatives against the criteria:

1. Not well aligned
2. Moderately aligned
3. Well aligned
4. Very well aligned

The criteria for the project objectives used in the evaluation were as follows:

Align with Existing Infrastructure

1. How compatible is the alternative with existing Regional wastewater and biosolids processing infrastructure?
2. How much new supporting municipal infrastructure is required (e.g. roads, power and water services, etc.)?
3. What is the potential for aligning with other municipal initiatives in the future?

4. How flexible is the alternative in adapting to changing government regulations, policies and market demands?

5. Does the alternative allow us to accommodate future population growth?

Protect and Enhance the Natural Environment

6. What are the environmental effects of the facility?

7. What are the environmental effects of transport of biosolids, processing materials, and products?

8. What are the environmental effects of the end uses?

9. What is the energy balance? Is it possible to recover energy?

10. Is the alternative adaptable to climate change impacts (e.g. extreme temperatures, weather events [frequency, intensity, duration, and magnitude])?

11. How much greenhouse gas emissions does the alternative produce? (Note: Greenhouse gases are any gas in the atmosphere that traps heat and contributes to global warming)

12. How much risk is there that material generated from the process will be landfilled?

Minimize and Manage Operational Risk

13. How do the end use or disposal options affect the risk of disruption to biosolids management services?

14. Does the alternative reduce the volume/mass of end product to be managed?

15. How susceptible is the alternative to disruption in maintenance and labour supply?

16. How susceptible is the alternative to a process disruption?

17. How susceptible is the alternative to disruption in end product quality, management or storage?

Protect Quality of Life

18. How will odour be managed?

19. How will dust from process or trucking be managed related to nuisance effects?

20. How will noise be managed?

21. How will visual effects be managed?
22. How will effects related to trucking be managed?
23. What are the potential impacts to source water protection?
24. Can all components of biosolids management, end uses and/or disposal be managed within Waterloo Region?

Protect Health and Safety

25. What are the relative health risks posed to the public for each alternative?
26. What are the relative health risks posed to workers for each alternative?
27. Does the alternative reduce or eliminate undesirable components in the biosolids?
28. What is the potential nature of an accident or adverse event?

Be Cost Effective and Provide Value

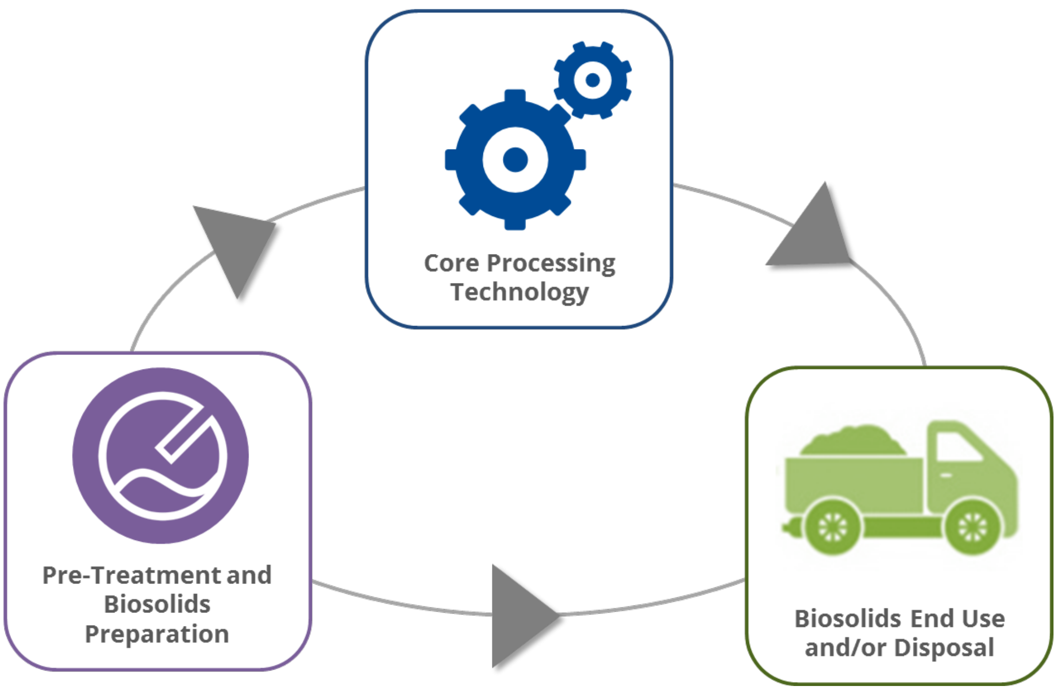
29. What is the relative capital cost?
30. What is the relative operating cost?
31. What is the relative life cycle cost including trucking?
32. How does life cycle cost vary based on implementation timing?
33. Is there an opportunity to apply for carbon credits? (Note: Carbon credits are given to municipalities by the province for making proven efforts to reduce the gas emissions created.)
34. What is the local economic benefit?
35. Is a biosolids end product created that has value? If yes, what is its value?
36. Would the alternative involve an innovative approach that demonstrates leadership in the area of biosolids management?

7.0 Biosolids Technologies, End Use, and Disposal

7.1 Introduction to Biosolids Technology

This chapter provides an overview of technologies, end uses and disposal options considered in the development of the Region's Biosolids Strategy. The technologies and processes associated with biosolids management can be grouped into three stages: core biosolids processing technologies; pre-treatment and biosolids preparation technologies; and biosolids end use and disposal options **(Figure 7-1).**

Figure 7-1 The Three Stages of Biosolids Management



More detailed summaries for each technology, including market maturity and technical attributes are provided in **Appendix D (TM#4 – Biosolids Technologies, End Use and Disposal)**. For core processing technologies, a table is provided identifying pre and post processing requirements. Pre-treatment and biosolids preparation technologies are presented along with a table identifying the associated core processing technologies for which they are required. Similarly, end use and disposal approaches are matched to corresponding core processing technologies.

Existing Region treatment facilities at Kitchener, Waterloo, Galt, and Preston employ anaerobic digestion as a core processing technology.

The technologies summarized in this chapter and detailed in **Appendix D** may form part of a process to supplant or enhance digestion as the existing method of biosolids management at these facilities, provide further processing of digested biosolids, or provide a means of onsite processing of biosolids at other Region facilities. Biosolids management prior to and including digestion is addressed under the Region's WWTMP update, and reference should be made to the WWTMP documents for those details. The Biosolids Strategy project thus addresses the biosolids produced after digestion at the Region's plants. The following section describes the potential core biosolids processing technologies that form the anchor for the strategy.

7.2 Overview of Core Biosolids Processing Technologies

The core processing technology is the main process designed to achieve the stabilization of biosolids. This may include physical transformation of biosolids following the end of the existing processing train at the Region's WWTPs, or modifications to the existing processes at these plants. Whether the technology is potentially suitable for the local area and compatible with existing infrastructure will be evaluated as part of a subsequent stage of the project.

The core processing technology would be designed to facilitate appropriate use or disposal of the end-product. Several options may be considered for core technologies depending on the intended goal of processing and the envisioned end-use.

Some core processing technologies feature opportunities for energy recovery, such as enhancements to potential biogas generation through digestion, or opportunities to recover heat as a source of energy. **Table 7-1** provides a summary of the key attributes of core processing technologies presented here. Further details of each technology are provided in **Appendix D**.

Table 7-1 Core Processing Technology Summary

	Stabilization Technologies		Digestion Technologies			Composting	Hydrolysis Technologies		Drying Technologies		Thermal Reduction/Incineration Technologies		
Key Attributes	Alkaline Stabilization	Thermal Stabilization	Anaerobic Digestion	Aerobic Digestion	Autothermal Thermophilic Aerobic Digestion	Composting	Thermal Hydrolysis	Combined Hydrolysis	Direct Drying	Indirect Drying	Multiple Hearth Incineration	Fluidized Bed Incineration	Pyrolysis and Gasification
Prior Dewatering	✔	✔			✔	✔	✔	✔	✔	✔	✔	✔	✔
Volume Reduction			✔	✔	✔	✔			✔	✔	✔	✔	✔
Biosolids Product	✔					✔			✔	✔	✔	✔	✔
Biogas By-product			✔										✔
Thermal By-product			✔								✔	✔	✔
Potential Biosolids Product Use	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔			✔

7.3 Overview of Pre-treatment, Preparation Technologies, and Storage

Pre-treatment and other preparation of biosolids may be required to facilitate the operation of many of the core biosolids processing technologies identified in this memo. This section describes the pre-treatment or other preparation technologies that may be required as part of a biosolids processing system.

Pre-treatment and preparation facilitate the interface between biosolids generating processes and downstream biosolids technologies. Technologies and options in this category also include biosolids storage alternatives. Biosolids storage is a critical component of most biosolids processing systems and is therefore addressed in this section.

Pre-treatment may simply consist of physical modifications to biosolids, such as dewatering or thickening. In some cases, more advanced pre-treatment processes may be selected such as thermal hydrolysis. Initial biosolids management infrastructure, specifically dewatering, is already implemented at the large WWTPs in the Region, based on the long-term philosophy of volume reduction. It is anticipated that continuing the process of dewatering, as well as the construction of storage will be a necessary component of the biosolids management strategy in the future.

Core processing technologies requiring dewatered biosolids may also employ one of several thickening technologies ahead of the dewatering stage. Each of these is described in further detail in **Appendix D.**

7.4 Overview of Biosolids End Uses and Disposal

Identifying the preferred end use or disposal option is one of the main goals of the Biosolids Strategy. A core processing technology is required in order to enable use of biosolids:

- for land application as a NASM;
- for land reclamation using an Environmental Compliance Approval (ECA)
- as a Canadian Food Inspection Agency (CFIA) regulated fertilizer;
- as a Compost as defined by the Compost Quality Standards (MOECC, 2012); or

- as a source of fuel / energy value in a manner considered beneficial by CCME.

Core processing technologies considered for use within the Region are presented with potential end use or disposal options in mind in **Appendix D**.

7.5 Collection of Technical Information

The Strategy aimed to consider the latest technologies in the development of alternatives for managing biosolids. To support this goal, the biosolids management vendor community was engaged through an open Request for Information (RFI) administered through the Region's procurement process. The RFI allowed any vendor to make a submission, and the information received was used to provide technical background for the development of the long list of alternatives for the Strategy. The process supplemented the team's knowledge with the latest information on viable technology options, their performance and site requirements.

8.0 Biosolids Alternatives Long List

The long list of alternatives for managing biosolids was developed based on publicly available information as well as a Vendor Request for Information process (**Appendix P**) that provided detailed information on potential technologies for processing biosolids to create new products (such as fertilizer or compost). **Appendix E (TM#5 – Long List of Alternatives)** provides an initial assessment of core processing technologies, including how they might integrate with existing infrastructure; the possible combinations of technologies; and possible core processing technologies with end use and disposal options.

8.1 Features of Biosolids Strategy Alternatives

The alternatives were developed to satisfy either a technical or operational objective. The elements of each strategy or management approach described in this section have features that have been presented consistently for each alternative and may include:

- **Mass and volume reduction:** to maintain or reduce the current amount of biosolids requiring transportation, end use or disposal;
- **Enhanced stability, or product quality:** biosolids conversion allowing additional end uses, and / or additional operational flexibility;
- **Energy Recovery:** a component of the management approach which generates fuel or electricity;
- **End use and disposal:** more diverse and or reliable management of biosolids within an alternative;
- **Centralized or decentralized implementation**: to facilitate future site selection and configuration; and
- **Region of Waterloo control**: to facilitate reliable operations over the planning period.

Each of the features is further discussed below.

8.1.1 Mass and Volume Reduction

The quantity of biosolids requiring management can be reduced by removing water, or converting volatile solids to dissolved solids or gases. Dissolved solids are typically returned to the WWTP and must be considered in terms of WWTP capacity and effluent quality.

Digesters and thermal reduction processes can be used to reduce volatile solids and therefore the total dry solids requiring management. Pre-treatment and preparation technologies as well as dryers can be used to remove water associated with solids requiring management.

This feature aligns with post biosolids at the Region that is based on the philosophy of volume reduction.

8.1.2 Enhanced Stabilization and Product Quality

Stabilization processes enhance biosolids product quality because they reduce pathogens, and/or volatile solids content in the solids. Processes such as pasteurization, hydrolysis, alkaline stabilization, advanced digestion (ATAD) and drying reduce pathogens such that the biosolids can be managed as a fertilizer, which generates additional opportunities for end uses. Composting also provides additional stabilization value, and increased flexibility of end uses compared with NASM where the end product meets the requirements of the Compost Quality Standards for Category A compost (MOECC, 2012).

The current NASM product generated by the Region meets all regulatory requirements for responsible use of the nutrients and organic content in biosolids. Compost and biosolids derived fertilizers, provide additional flexibility in terms of handling and storage because they have further reduced pathogen content, and lower nuisance potential which is mainly lower odour emission potential.

8.1.3 Energy Recovery

The potential to recover the energy content collected with solids at the wastewater treatment plant is also a feature associated with a number of core technologies. Production of biogas through the existing approach to anaerobic digestion is anticipated to continue for each alternative. Biogas use in a combined heat power process is already planned for Kitchener Waterloo and Galt WWTPs, therefore is included as planned infrastructure in each alternative presented. Alternatives that enhance biogas production, or generate other fuels and electricity are considered features of some alternatives. Energy products may take a number of forms including, biogas, renewable natural gas, syngas, and solid fuels such as pellets.

8.1.4 Use and Disposal

The existing management approach provides two alternatives for biosolids use (agricultural use as NASM, or mine tailings pond reclamation), and disposal to approved landfills. Facilitating increased use of biosolids and therefore avoiding disposal is considered a feature of alternatives. Although use is prioritized, reliable disposal options are considered a feature as well. Allowing for multiple end use and disposal options is considered a feature as it mitigates the risk associated with the reliability of any one use or disposal option included as part of the alternative.

8.1.5 Centralized or Decentralized Infrastructure

The approach to biosolids management can consist of a single centralized facility or decentralized infrastructure. A centralized process may be considered on an existing WWTP site, or at new site where biosolids would be transferred to a single new process implemented for a core technology.

In a decentralized approach, technology for biosolids processing is located either at the WWTPs, or at dedicated facilities serving one or more WWTPs similar to the Manitou Drive dewatering facility that serves the Kitchener WWTP.

The alternatives are presented with the relative potential to allow centralized or decentralized approach, but do not identify the approach at this level of alternative development.

8.1.6 Region Control

The level of control retained by the Region affects the level of financial and operational risk associated with biosolids management alternatives.

There are vendors that provide biosolids management services using their own facilities. In this way, the Region could choose to procure the services of a contractor to haul the current biosolids cake to an existing or new private facility for additional treatment, end use or disposal. This approach exposes the Region to a financial and operational risk by limiting the ability to ensure the contractor manages biosolids responsibly as agreed upon through the procurement contract. It also exposes the Region to an operational risk in the event that a contractor goes out of business or operations are otherwise disrupted by business decisions. These risks are not considered acceptable, and therefore the Region is pursuing alternatives where dedicated facilities would be constructed for the Region as necessary to support each alternative. The delivery method for new infrastructure would remain open at this stage of planning including the potential for alternative procurement methods such as public-private-partnerships, alternative project delivery with full Regional operation, or traditional design-bid-build with contracted operations.

Another alternative is a partnership where an industrial facility would use the current dewatered cake as an industrial input directly. An example is incorporating biosolids into cement production, where volatile solids provide fuel, and the ash is incorporated into the cement product. This approach relies directly on a partner facility with similar risks as described above, and therefore is not considered as a primary management approach as part of the alternatives described below. It is a strategy that could be incorporated as a management practice in parallel with the main alternatives described below.

8.2 Alternatives

As a result of the assessment in Section 8.1, and building on previous master planning, eight biosolids alternatives have been developed and are described in detail in this section:

- Current Approach with Expanded Capacity;
- Current Approach with Solids Preparation Before Digestion;
- Produce Fertilizer from Biosolids;
- Produce Compost from Biosolids;
- Produce Dry Low Volume Fertilizer from Biosolids;
- Thermal Reduction of Biosolids to Ash (No Energy Recovery);
- Thermal Reduction with Energy Recovery; and
- Landfill all Biosolids

Each alternative is presented in terms of the following components:

- **Part A: Solids preparation and modification** which involves technologies to prepare organic material to become biosolids and reduce volume.
- **Part B: Core biosolids processing technologies** to create a new product from biosolids, such as fertilizer or compost. The processing technologies are primarily focused on:
    - Reducing volume / mass of final product requiring management
    - Enhancing quality to allow access to new end use and disposal options
- **Part C: End uses and disposal options** for biosolids or processed end products.

The Region's current system incorporates components of Part A and C. The Alternatives considered therefore include technologies related to Part B.

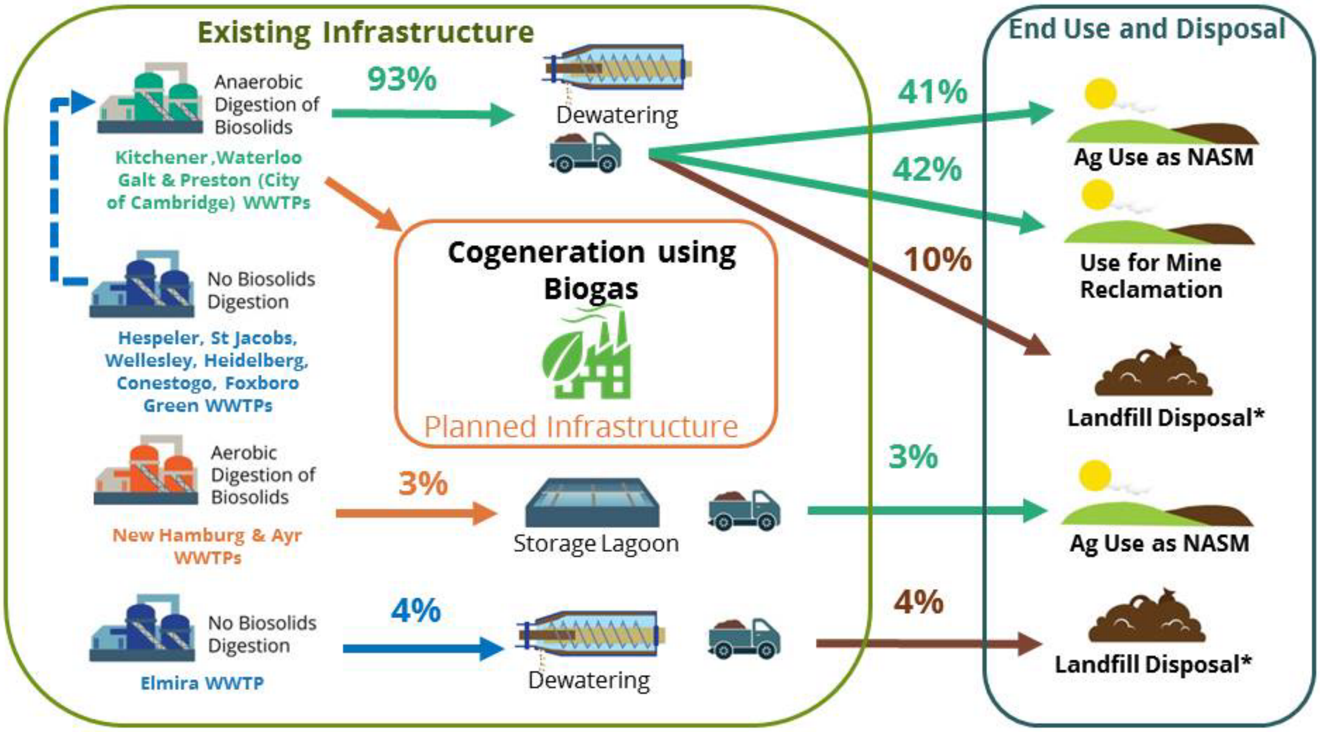
The completed strategy must consider all of the WWTPs that are generating solids for management; however the focus of these high level alternatives is the four largest facilities with anaerobic digestion and dewatering including: Kitchener, Waterloo, Galt and Preston. Facilities that currently have limited or no solids processing on site including: Hespeler, St. Jacobs, Wellesley, Heidelberg, Conestogo, and Foxboro Green WWTPs are envisioned to continue to be managed through the facilities with digestion and dewatering while New Hamburg, Ayr (which has aerobic digestion in place with on-site storage) and Elmira will continue to operate as they currently do.

8.2.1 Current Approach with Expanded Capacity Alternative

The current approach provides stable biosolids management that complies with applicable regulations. The majority of biosolids are anaerobically digested and dewatered, and all biosolids used or disposed using one of three options:

- Agricultural use as NASM;
- Mine tailings pond reclamation; or
- Landfill disposal.

Figure 8-1 presents the block flow diagram for the current approach to biosolids management. For this alternative digestion and dewatering would be expanded only as necessary to accommodate the population growth and the associated increase in solids generated at the wastewater treatment plants. Storage would be added to limit operational risk related to the existing just in time trucking approach, and facilitate additional use to limit disposal. Operational risk can be mitigated with new storage capacity (approximately 10 days of biosolids generation), while facilitating additional uses would require larger storage capacity (30 days or greater).



*** At approved sites outside the Region**

Note: Percentage values shown represent data from 2016 operations

Figure 8-1 Block Flow Diagram – Current Biosolids Management Operations

What are the Features?

The main features of this alternative include:

- Limited investment in new infrastructure; and
- Proven approach to biosolids management given existing regulations.

What is the end use or disposal method?

The quality of biosolids would remain the same and continue to be managed as a NASM. The end use and disposal methods would remain the same as those available now, including:

- Agricultural use as NASM;
- Mine tailings pond reclamation; or
- Landfill disposal.

It should be noted that a limitation with agricultural use as NASM is the maximum land application permission of the material to every five years.

Has it been done before and what are the considerations for the future?

The current approach is demonstrated to deliver appropriate biosolids management given current conditions, and the regulatory framework in Ontario. However, it should be recognized that the mass of biosolids requiring management will increase in the future. The current approach relies on end uses outside the Region and on the Provincial policy regarding biosolids related regulations.

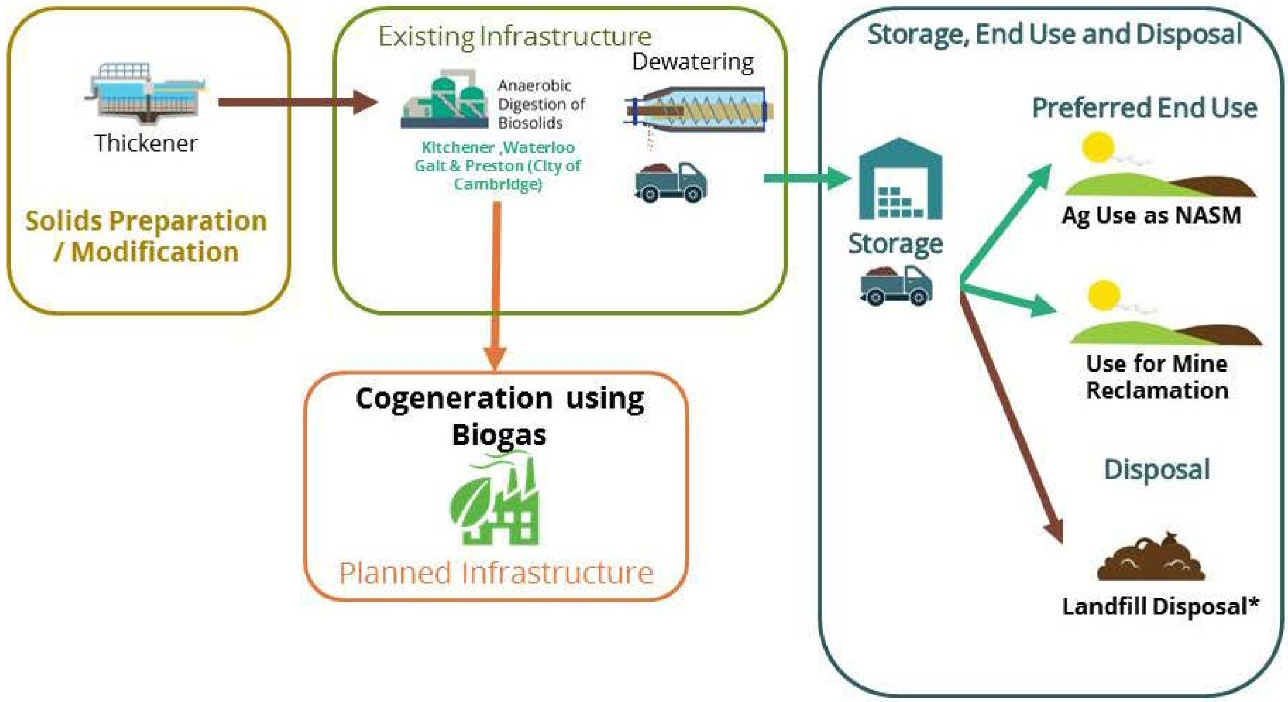
8.2.2 Current Approach with Solids Preparation before Digestion Alternative

This alternative would implement pre-treatment and preparation to accommodate the existing digestion approach for future solids production rates. Candidate technologies for thickening prior to digestion and dewatering include:

- Gravity;
- Gravity belt;
- Rotary drum;
- Dissolved air; and
- Recuperative thickening.

The approach has the potential to increase the conversion of volatile solids to biogas, and decrease the mass of biosolids requiring end use or disposal. However, the approach could also be used to expand the capacity of digestion with very similar rates of volatile solids conversion, and therefore similar biosolids quantity per person. This alternative has many more considerations that affect operations of the digesters and liquid train that must be considered as part of the wastewater treatment master plan. The focus of the information presented here are impacts on biosolids management. It would affect the majority of biosolids (93%) produced in the Region that are anaerobically digested and dewatered, and the quality of digestate is anticipated to remain NASM quality.

Figure 8-2 presents the block flow diagram showing that solids thickening infrastructure would be required ahead of anaerobic digestion. Thickeners are currently utilized at the Galt and Waterloo WWTPs in the Region.



*** At approved sites outside the Region**

Figure 8-2 Block Flow Diagram – Current Approach with Solids Preparation before Digestion

This alternative could be used to manage the footprint of new infrastructure to increase the capacity of digestion to accommodate future increases in solids generated at the wastewater treatment plants.

What are the features?

The main features of selecting this alternative include:

- Investment in additional mature thickening technologies may marginally increase biogas production, and reduce the quantity of biosolids produced per capita;
- Limited investment in new infrastructure related to digestion; and
- Continues existing proven approach to biosolids end use and disposal.

What is the end use or disposal method?

The quality of biosolids would remain the same and continue to be managed as a NASM. The end use and disposal methods would remain the same as those available now, including:

- Agricultural use as NASM;
- Mine tailings pond reclamation; or
- Landfill disposal.

What do we need to implement it?

Additional, new thickening infrastructure may be required at WWTPs ahead of anaerobic digestion.

The number of trucks would be similar per capita, as compared with the current management approach, and trucking would be anticipated to increase with time and the corresponding increase in mass of biosolids produced.

Has it been done before and what are the considerations for the future?

Thickening technologies are well established, and digestion at higher solids content is also a mature approach. Increasing the solids content for the digesters requires an assessment of the impact on operations such as:

- Mixing within digesters;
- Biogas production rate; and
- Impacts on dewatering.

This approach provides an option to manage footprint of new infrastructure and process performance where thickening is used with existing digester vessels to manage additional solids. The approach is anticipated to deliver similar biosolids quality. Concerns would remain including that increasing mass of biosolids requiring management in the future will place pressure on the system, requiring more trucks and more land area.

8.2.3 Produce Fertilizer from Biosolids Alternative

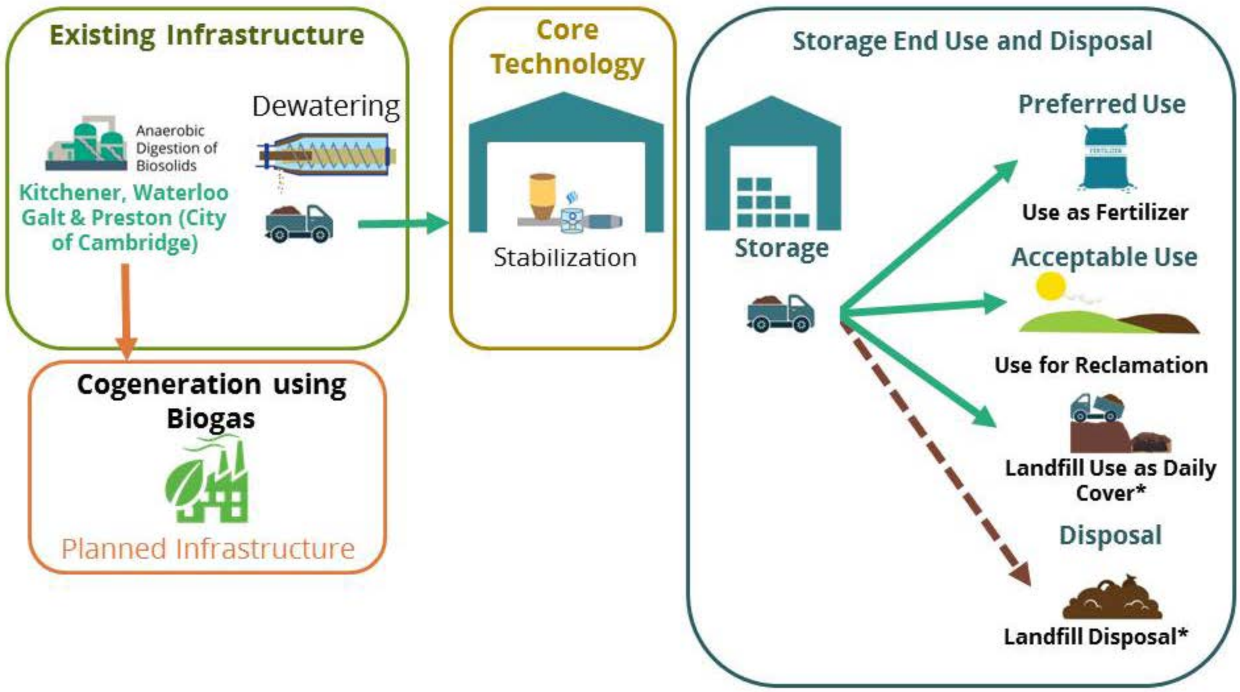
This alternative would implement a core stabilization technology before or after anaerobic digestion to generate a biosolids derived fertilizer product. Candidate technologies proposed in this category would produce biosolids derived fertilizer including:

- Thermal hydrolysis;
- Combined hydrolysis;
- Thermal stabilization (pasteurization); and
- Alkaline stabilization.

The quantity of biosolids generated is dependent on technology selected. Technologies implemented ahead of digestion can enhance conversion of volatile solids to biogas reducing the quantity of dry solids requiring management. These technologies affect the liquid train at WWTPs substantially and would be considered by the WWTMP. Technologies implemented after digestion would use the existing dewatering capacity with a new core technology to generate a biosolids derived fertilizer. The fertilizers generated can range in moisture content from 15 – 55% solids depending on technology implemented. Therefore the quantity of biosolids per capita would range from about 2/3 more than the current amount to about 1/3 less, given that the existing dewatered cake is typically about 25% solids.

Technologies considered would generate a product that would meet the US EPA definition of Class A biosolids. Processes in the proposed configuration have been demonstrated to meet the requirements of a fertilizer under the Fertilizers Act as administered by CFIA. Based upon the enhanced stability of the dewatered cake, additional biosolids storage options are available.

Figure 8-3 presents the block flow diagram showing the new core technology and storage required after anaerobic digestion.



*** At approved sites outside the Region**

Figure 8-3 Block Flow Diagram – Produce Fertilizer from Biosolids

What are the features?

The main feature of selecting this alternative is enhanced biosolids quality (produce fertilizer) to add end use options (Agricultural use as fertilizer and landfill use as daily cover (at landfills outside Region that will accept)), which provide operational flexibility. The fertilizer products also facilitate storage options as compared with the current NASM product.

The sale of the fertilizer product has potential to generate revenue to offset costs associated with biosolids management.

What is the end use or disposal method?

Technologies considered for this alternative would produce a fertilizer that meets the regulatory requirements under the Fertilizers Act administered by the Canadian Food Inspection Agency (CFIA). This alternative would provide the following end use or disposal options:

- Agricultural use as fertilizer;
- Non-agricultural soil amendment;
- Landfill use; or
- Landfill disposal.

A fertilizer product provides equal or greater opportunity for use in agriculture. Non-agricultural soil amendment options such as the existing mine tailings pond reclamation remains available, with additional bulk fertilizer uses available (e.g. landscaping / golf courses). Adding more flexibility to end uses is considered a valuable feature as it mitigates risk if any one end use or disposal method is unavailable in the short or long-term. It should be noted that a limitation with agricultural use as NASM is the maximum land application permission of the material to every five years.

What do we need to implement it?

A new process would be required, either at a number of new sites to serve WWTPs, or in a centralized facility. A building would be required to protect equipment, as well as controlling emissions such as odour and noise.

The quantity of biosolids generated per capita and the number of trucks required is dependent on the technology selected, and could increase by 2/3, or decrease by 1/3, as compared with the existing quantity per capita.

A storage building is envisioned to protect the product from weather, and control emission potential (e.g., particulate and odours) while facilitating multiple end uses. Allowing for inventory of the biosolids derived fertilizer provides flexibility to match seasonal demand from different users.

Has it been done before and what are the considerations for the future?

Stabilization after digestion has been implemented in Ontario at WWTPs, and at centralized facilities.

This approach would deliver a fertilizer product for sale. Agricultural use as the preferred end use of a biosolids derived fertilizer product means similar risks related to the land area required, and the distance of trucking; however more options are available, and storage to align with the markets mitigates some risk when compared with the existing approach.

8.2.4 Produce Compost from Biosolids (To Category A or B Quality) Alternative

This alternative would implement composting for stabilization that integrates with the current dewatering infrastructure that follows anaerobic digestion. There are two categories of compost available:

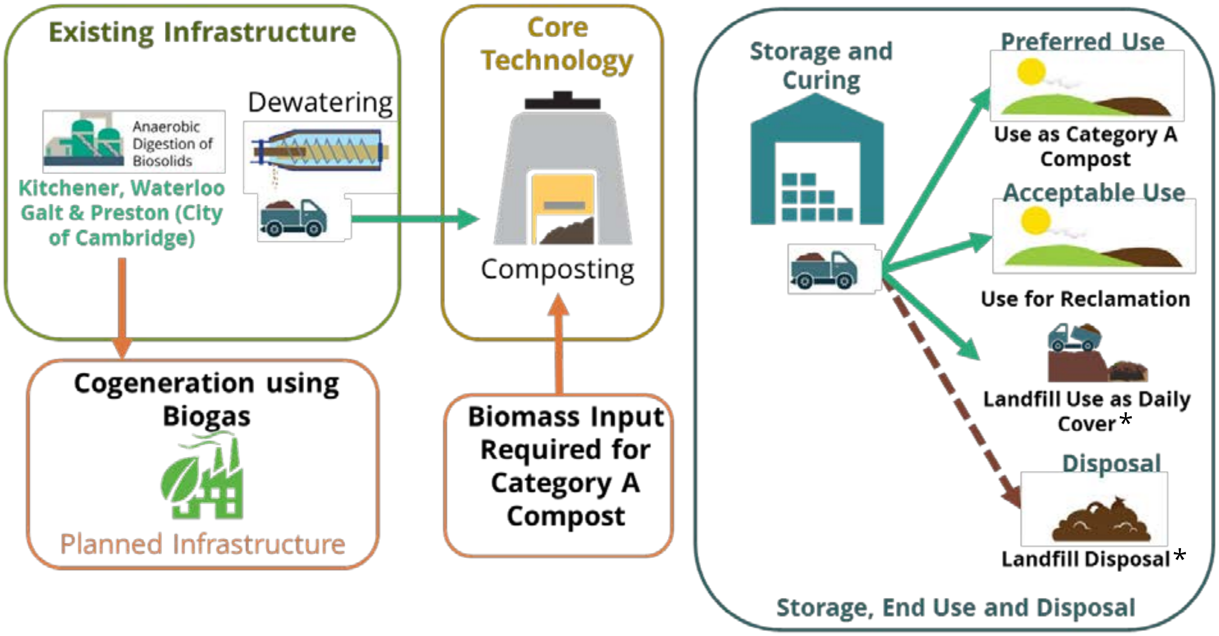
- Category A where biosolids are co-composted with other biomass (e.g. source separated organics, leaf and yard waste, purchased amendment like wood chips) in a mixture up to 25% biosolids, minimum 75% other biomass; and

- Category B where biosolids can be composted with amendment (typically woodchips) selected to maintain key properties for composting such as carbon to nitrogen ratio (C:N). The two different categories lead to different end uses and are discussed separately below. The Compost Quality Standard (2012) requires compost to be maintained at 40% moisture content (60% solids) during curing; therefore the quantity of biosolids per capita would be less than half the current amount, given that the existing dewatered cake is typically about 25% solids. However, other sources of organic material added as feedstock to the biosolids may increase the total quantity of finished compost.

8.2.4.1 Composting Digested Dewatered Biosolids to Category A Quality

* at approved sites outside the Region

Figure 8-4 presents the block flow diagram showing the new core technology and storage required to produce Category A compost.



* at approved sites outside the Region

Figure 8-4 Block Flow Diagram – Composting Digested Dewatered Biosolids – Category A

What are the features?

The main features of selecting this alternative are:

- Stabilization mitigates the odour emission potential of the final product compared with the existing NASM product, and facilitates storage (odour control facilities are still required);
- Compost that meets Compost Quality Standards for Category A is subject to fewer restrictions for use than NASM containing biosolids;
- Adding two new end use options (agricultural and non-agricultural use as compost and landfill use as daily cover (at landfills outside the Region that will accept)), which provide operational flexibility; and
- The compost product is acceptable for sale, and has potential to generate revenue to offset costs associated with biosolids management.

What is the end use or disposal method?

This alternative would provide the following end use or disposal options:

- Agricultural and non-agricultural use as compost;
- Non-agricultural soil amendment such as mine tailings pond reclamation;
- Landfill use; or
- Landfill disposal.

Adding more end uses is considered a feature as it mitigates risk where any one end use or disposal method is unavailable in the short or long-term. The stabilized product is anticipated to be more straightforward to handle, store and use.

What do we need to implement it?

A new composting processing facility would be required either at a number of distributed sites or at a centralized facility. The number and type of sites could be determined based upon supporting WWTP operations, limiting trucking distances, and limiting overall impact on communities with new infrastructure. It is not likely that a composting facility could be constructed in the space available at existing WWTPs. A building would be required to protect equipment, as well as controlling emissions such as odour and noise. As such, the site configuration that would be considered for a new composting facility as part of the long list of alternatives is that of a centralized facility.

Local trucking to transfer dewatered cake to the composting site or sites would be required, and the number of trucks at WWTPs would be similar to the current approach. Composting to Category A quality would also require transportation of additional biomass to the composting site. Depending on the current amount of trucking required for the biomass used in co-composting, the total amount of trucking related to the biomass may be equal or higher than it is currently. The number of trucks leaving the compost facility to deliver the Compost to end use or disposal would be lower per capita for the biosolids compared with the current approach; however, there will be other traffic for spent biomass.

A storage facility is required to protect compost from weather during storage and curing, as well as to control emission potential (e.g. particulate and odours) while facilitating multiple end uses. Allowing for inventory of the compost provides flexibility to match seasonal demand from different users.

Has it been done before and what are the considerations for the future?

Composting biosolids and other anaerobic digestate has been demonstrated in many jurisdictions. There were no facilities identified in Ontario that are permitted to compost biosolids to meet Category A standards. Halton Region has completed a pilot project with promising results, and a feasibility study to further develop the project is under way. Meeting the Compost Quality Standards (MOECC, 2012) for Category A compost is considered likely achievable, but has not been completed in Ontario at the commercial scale.

This approach is anticipated to deliver a compost product that is acceptable for sale. The Category A compost feedstock is limited to a maximum 25% biosolids (dry weight basis), which may generate more finished compost to manage when compared with other stabilization alternatives. The biomass that makes up 75% of the compost generated could be composted to Category AA quality if biosolids were not added, and therefore the broader organics management strategy must be considered before directing additional biomass to co-composting with biosolids.

8.2.5 Composting Digested Dewatered Biosolids to Category B Quality

Figure 8-5 presents the block flow diagram showing the new core technology and storage required for Category B compost.

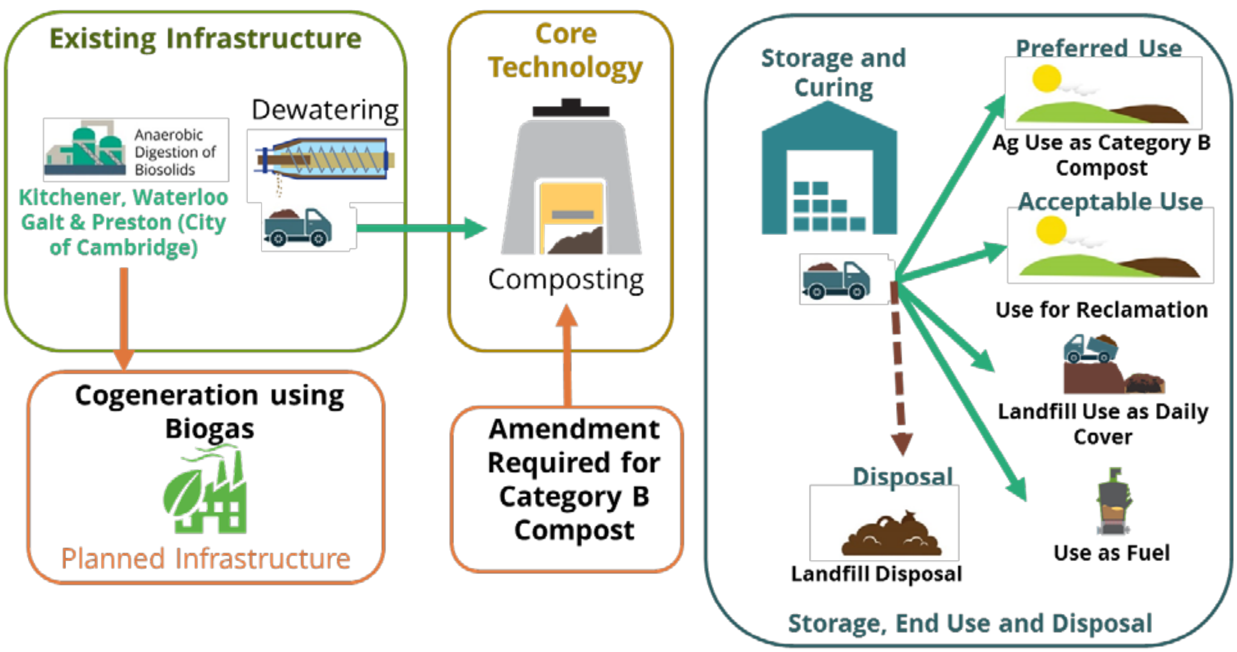


Figure 8-5 Block Flow Diagram – Composting Digested Dewatered Biosolids – Category B

*at approved sites outside the Region

What are the features?

The main features of selecting this alternative are:

- Stabilization mitigates the odour emission potential of the final product compared with the existing NASM product (odour control facilities are still required), and facilitates storage;
  Category B compost is acceptable for agricultural use and must meet the requirements of the NMA for a Category 3 NASM the same as the existing product;
- Reducing the volume / mass of biosolids that require transportation, end use or disposal by up to 60% compared with the existing biosolids product; and
- Adding two new end use options (Landfill use as daily cover (at landfills outside the Region that will accept), and use as fuel), which provide operational flexibility.

What is the end use or disposal method?

This alternative would provide the following end use or disposal options:

- Agricultural use as NASM;
- Non-agricultural soil conditioners such as mine tailings pond reclamation;
- Landfill use;
- Use as fuel; or
- Landfill disposal.

Category B compost would be considered renewable biomass under the Green Energy Act, and is anticipated to provide net energy for combustion; however this is considered an acceptable end use that has low probability of implementation. Adding more end uses is considered a feature as it mitigates risk where any one end use or disposal method is unavailable in the short or long-term.

What do we need to implement it?

A new composting facility would be considered at a centralized facility. Local trucking to transfer dewatered cake to the composting site would be required, and the number of trucks would be similar to the current approach. Composting to Category B quality would also require transportation of amendment to the composting site. The number of trucks leaving the compost facility to deliver the compost to end use or disposal would be lower per capita than for the biosolids alone; however, there will be other traffic for spent biomass.

A storage facility is required to protect compost from weather during storage and curing, as well as to control emission potential (e.g. particulate and odours) while facilitating multiple end uses. Allowing for inventory of the compost provides flexibility to match demand from different users.

Has it been done before and what are the considerations for the future?

Composting biosolids and other anaerobic digestate has been demonstrated in many jurisdictions. There were no facilities identified in Ontario that are permitted to compost biosolids to meet Category B standards. Meeting the Compost Quality Standards (MOECC, 2012) for Category B compost is considered likely achievable, but has not been completed in Ontario at the commercial scale.

The Category B compost is considered a waste and must be managed as a waste using an ECA; unless it is used as a NASM in accordance with the NMA. The new opportunities to use nutrients from the biosolids beyond those available for the existing NASM product are limited for Category B compost.

8.2.6 Produce Dry Low Volume Fertilizer from Biosolids Alternative

This alternative would implement a dryer technology after anaerobic digestion and dewatering to reduce the volume of dewatered cake and generate a biosolids derived fertilizer product.

The technologies proposed in this category would produce a substantially lower quantity of biosolids derived fertilizer per capita compared with the current approach (from 75% moisture content to 10% moisture content).

The product would meet the US EPA definition of Class A biosolids, and stabilization processes in this configuration have been demonstrated to meet the regulatory requirements of a fertilizer under the Fertilizers Act as administered by CFIA. Based upon the enhanced stability of the dry product, additional biosolids storage is considered feasible.

Figure 8-6 presents the block flow diagram showing the new core technology required for this alternative.

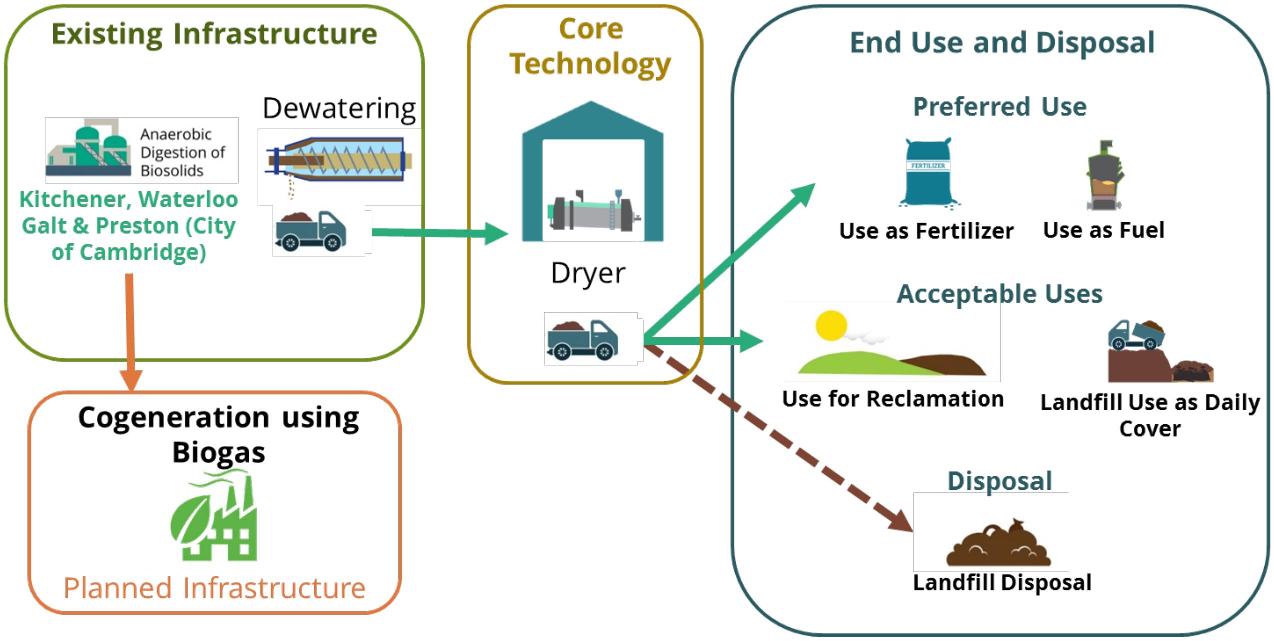


Figure 8-6 Block Flow Diagram - Produce Dry Low Volume Fertilizer from Biosolids
*at approved sites outside the Region

What are the features?

The main features of selecting this alternative are:

- Adding three new end use options (Agricultural Use as Fertilizer, Landfill use as daily cover, and use as fuel), which provide operational flexibility; and
- Reducing the volume / mass of biosolids that require transportation, end use or disposal.

What is the end use or disposal method?

This alternative would provide the following end use or disposal options:

- Agricultural use as fertilizer;
- Non-agricultural soil amendment such as mine tailings pond reclamation;
- Landfill use as daily cover;
- Use as a renewable fuel in combustion; or
- Landfill disposal.

Adding more end uses is considered a feature as it mitigates risk where any one end use or disposal method is unavailable in the short or long-term. The end product generated from this alternative has been used as a fuel in other jurisdictions, and presents an end use that does not rely on use as a soil amendment or fertilizer in agricultural or non-agricultural applications. It can be used directly as fuel in combustion processes that generate useful heat (steam) and electricity, or provide energy to an industrial process such as cement production. It is also anticipated to be appropriate feedstock for emerging pyrolysis processes being developed to use dry organic feedstock.

What do we need to implement it?

A new process would be required either at WWTPs, or in a centralized facility. A building would be required to protect equipment, as well as controlling emissions such as odour and noise.

For a central facility, there would be a similar number of trucks required to transport dewatered cake from WTTPs to the central facility when compared with the current amount of truck traffic at WWTPs. The number of trucks required to handle the dry product for delivery to end use or disposal would be substantially the lower per capita (up to 75% less) than the existing approach.

A storage system is required for the dry product; however the substantially lower quantity of material requires a much smaller footprint than the first four alternatives. Engineering controls to mitigate the risk of fires during storage is required for this dry product. Allowing for inventory of the biosolids derived fertilizer would provide flexibility to match demand from different users.

Has it been done before and what are the considerations for the future?

Stabilization with volume reduction using dryer technology has been implemented in Ontario at a number of facilities. All biosolids producing dry fertilizer in Ontario are currently used as agricultural fertilizers or land reclamation. Additional end uses for this product such as use as a fuel further mitigates the risk of losing access to any one end use or disposal option. The amount of land required would be similar to the existing approach when targeting agricultural use of a biosolids derived fertilizer product.

8.2.7 Thermal Reduction Alternative

This alternative would implement a core technology after anaerobic digestion and dewatering to reduce the volume of dewatered cake to ash for use as an industrial input, or disposal in landfill. Energy recovered from the process would be used to preheat or dry dewatered biosolids cake to reduce the amount of supplementary fuel required. The most promising technology is a fluidized bed incinerator. The technologies proposed in this category would produce the lowest mass and volume of end product.

Figure 8-7 presents the block flow diagram showing the new thermal reduction process after digestion and dewatering.

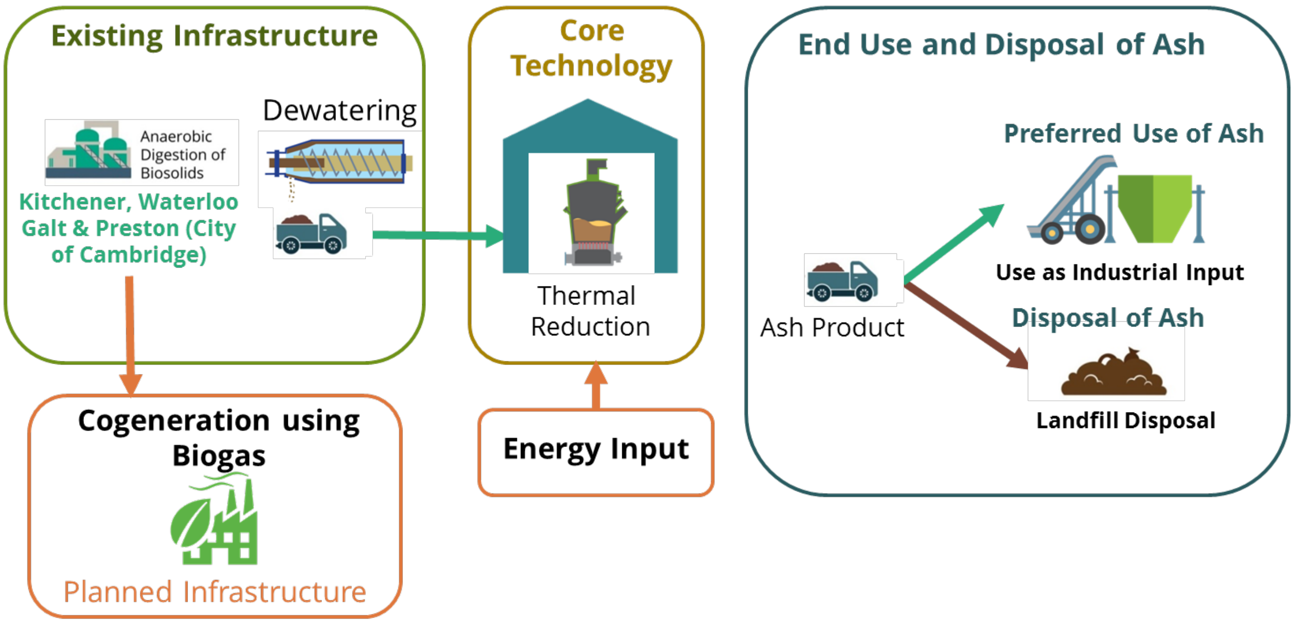


Figure 8-7 Block Flow Diagram – Thermal Reduction to Ash
*at approved sites outside the Region

What are the features?

The main features of selecting this alternative are:

- The largest reduction in quantity of product that requires management of all of the alternatives;
- Relies on industrial use of ash, or landfill disposal (at landfills outside the Region) of a low volume product with no organic matter; and
- The ash product is anticipated to be straightforward to handle, store and use.

What is the end use or disposal method?

This alternative would provide the following end use or disposal options:

- Use as an industrial input; or
- Landfill disposal.

This alternative does not take advantage of the nutrient value of biosolids. The energy content of biosolids is used in combustion, but supplementary fuel such as natural gas is also required to maintain combustion temperatures given the moisture and volatile solids content of the current biosolids product.

What do we need to implement it?

A new thermal reduction process would be required most likely as a centralized facility. A building would be required to protect equipment, as well as controlling emissions to air such as criteria air contaminants, odour and noise.

There would be a similar number of trucks required to transport dewatered cake from WWTPs to the central facility when compared with the current approach. The resulting ash product would have some liquid added to create ash slurry. The number of trucks required to handle this material would be the lowest of any alternative, up to 90% less than the existing approach per capita. Depending on the final destination for the ash, the vehicle kilometers travelled to truck the material is likely to be the lowest per capita of all the alternatives. A storage system is required for the ash product, which would likely consist of outdoor storage of the ash slurry in geobags. The substantially lower quantity of material requires a much smaller footprint than other alternatives.

Has it been done before and what are the considerations for the future?

Thermal reduction has been implemented in Ontario at a number of facilities, mainly in larger centres such as London and Toronto. This alternative is not sensitive to potential markets for biosolids products that take advantage of nutrients as the product is unsuitable for this use. It must comply with air quality restrictions for the combustion, and would generate a product that can be landfilled.

8.2.8 Thermal Reduction with Energy Recovery Alternative

This alternative would implement a core technology to reduce the volume of dewatered cake to ash for use as an industrial input, or disposal in landfill. Energy recovered from the process would be used to generate renewable electricity. In order to align with existing infrastructure, anaerobic digestion, and dewatering would be retained for this alternative which limits energy available for recovery through this alternative. It is anticipated that a supplementary energy source would be required either to reduce the moisture content of the dewatered cake prior to combustion, or co-combust with the current biosolids cake product. Renewable biomass such as low value by-products from the lumber industry would facilitate co-combustion as part of a renewable biomass to energy facility. The most promising technology for this application is a fluidized bed incinerator. The technologies proposed in this category would produce the lowest mass and volume of end product.

Figure 8-8 presents the block flow diagram showing the new thermal reduction process after digestion and dewatering.

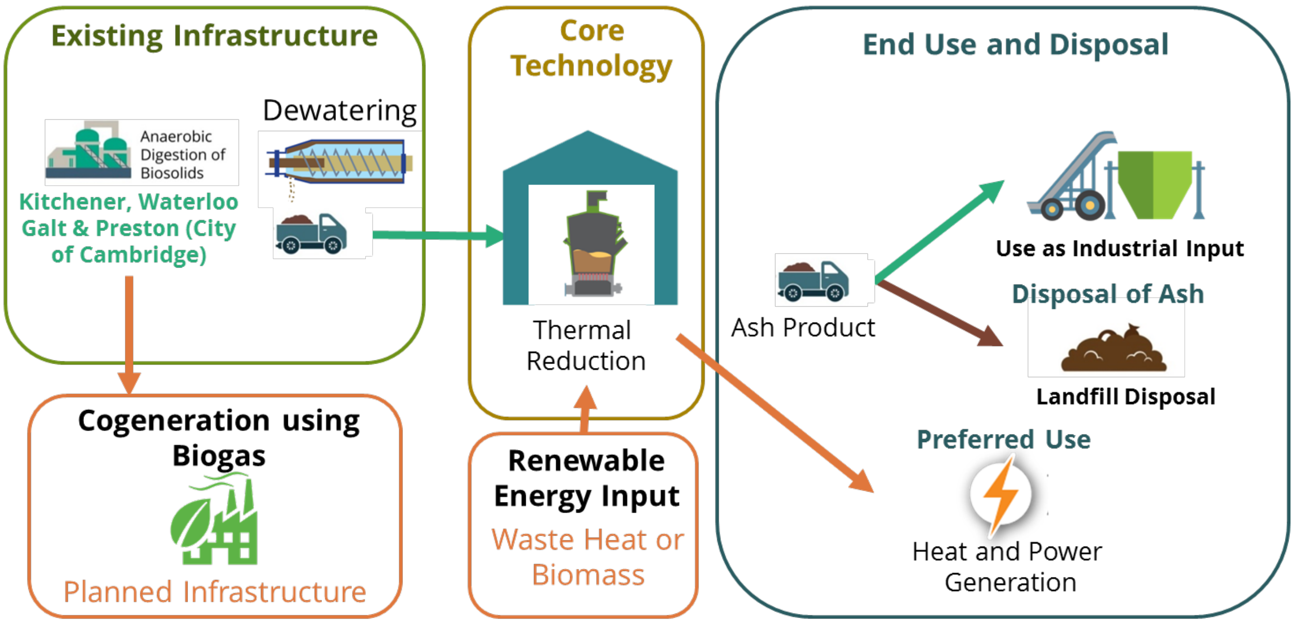


Figure 8-8 Block Flow Diagram – Thermal Reduction with Energy Recovery
*at approved sites outside the Region

What are the features?

The main features of selecting this alternative are:

- The largest reduction in quantity of product that requires management of all alternatives;
- Relies on industrial use of ash, or landfill disposal (at landfills outside the Region) of a low volume product with no organic matter;
- The ash product is anticipated to be straightforward to handle, store and use; and
- It contributes to renewable energy generation.

What is the end use or disposal method?

This alternative would provide the following end use or disposal options for ash:

- Use as an industrial input; or
- Landfill disposal.

In the event that there is net energy from the combustion of biosolids, renewable electricity, or heat recovery typically as steam are the main products. This alternative does not take advantage of the nutrient value of biosolids, and although energy content of biosolids is used to reduce the use of supplementary fuel, it would not export energy unless enhanced dewatering or drying of the biosolids was implemented ahead of the thermal process. The CCME guideline for use of the energy content of biosolids requires greater than 25% of the ash to be used (CCME, 2012).

What do we need to implement it?

A new thermal reduction process would be required most likely as a centralized facility. A building would be required to protect equipment, as well as controlling emissions to air such as criteria air contaminants, odour and noise. A source of supplement renewable energy input (waste heat or biomass) is likely required to dry the current biosolids product to allow meaningful amounts of net energy to be recovered from combustion. A partner industrial facility willing to use ash would be beneficial to diverting the final product from landfill, but is not required.

There would be a similar number of trucks required to transport dewatered cake from WWTPs to the central facility when compared with the current approach. The number of trucks required to handle the ash product would be the lowest of any alternative, up to 90% less than the existing approach per capita. . Depending on the final destination for ash the vehicle kilometers travelled to truck the ash is likely to be the lowest per capita of all the alternatives.

A storage system is required for the ash product; however the substantially lower quantity of material requires a much smaller footprint than other alternatives.

Has it been done before and what are the considerations for the future?

Thermal reduction has been implemented in Ontario at a number of facilities mainly in larger centres such as London and Toronto. There are also facilities operating in Ontario that generate electricity from municipal solids waste such as the Emerald Energy from Waste (EFW) facility; however it is not clear that there are any facilities in Ontario that are permitted to accept biosolids to generate renewable electricity under the Green Energy Act.

This alternative is not sensitive to potential markets for biosolids products that take advantage of nutrients as the product is not suitable for this use. It must comply with air quality restrictions for the combustion, and would generate a product that can be landfilled.

8.2.9 Landfill All Biosolids Alternative

This alternative would send all biosolids for disposal in regulated landfills outside the Region. For this alternative digestion and dewatering would be expanded only as necessary to accommodate the population growth and the associated increase in solids generated at the wastewater treatment plants. Storage would be added to limit operational risk related to the existing just in time trucking approach. Operational risk can be mitigated with a relatively small amount of new storage capacity at each WWTP. Facilities without dewatering would be required to transfer solids to WWTPs with dewatering capacity. This would continue the existing transfer approach with the exception of Ayr and New Hamburg which would add a new source of solids for transfer, or would require new dewatering equipment.

Figure 8-9 presents the block flow diagram showing the process for landfilling.

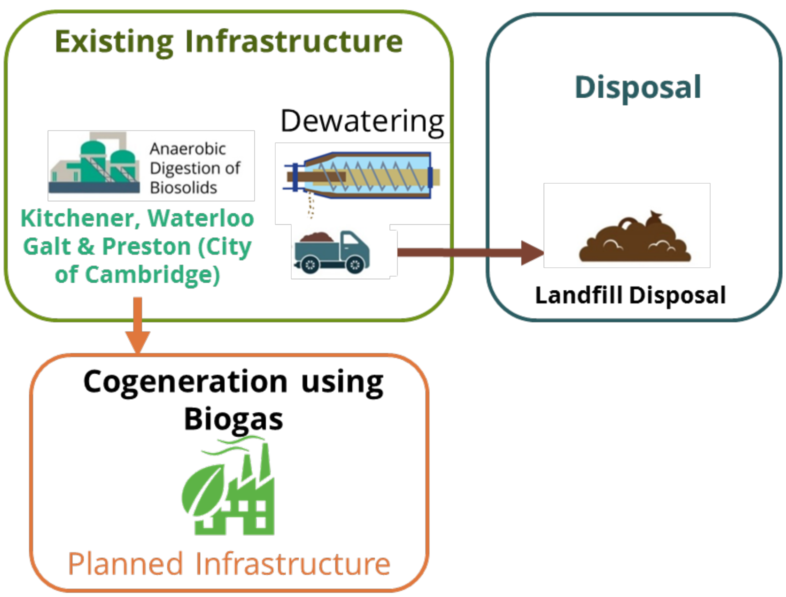


Figure 8-9 Block Flow Diagram - Landfill Disposal
*at approved sites outside the Region

What are the features?

The main feature of selecting this alternative is that it does not rely on a market for a biosolids product, and provides disposal that complies with regulations for all biosolids generated in the Region.

What is the end use or disposal method?

This alternative would send all biosolids generated in the Region to Landfill disposal outside the Region.

What do we need to implement it?

Operational storage systems to protect dewatered biosolids from weather, and control emission potential (e.g., particulate and odours) would be required to mitigate the risk of disruptions to trucking.

The number of trucks would be similar per capita, as compared with the current management approach, and trucking would be anticipated to increase with time and the corresponding increase in mass of biosolids produced.

Permitted landfills capable, and willing to accept the full quantity of biosolids generated by the Region would be required.

Has it been done before and what are the considerations for the future?

Many municipalities in Ontario use landfill disposal for a portion of their biosolids; however, no examples of municipalities in Ontario of similar scale to the Region of Waterloo were identified that rely solely on landfill disposal.

This alternative is not sensitive to potential markets for biosolids products that take advantage of nutrients, organic matter or energy value. However, a single end use or disposal method presents a risk, and landfill capacity may not be available or allocated to organic material like biosolids for the quantity required in the future.

9.0 Biosolids Alternatives Short List

9.1 Minimum Performance Questions Summary

As discussed in **Chapter 6**, **Section 6.2.1**, a set of Minimum Performance Questions (MPQs) was developed to assess the practicality of implementing each of the eight long list alternatives for managing biosolids in the Region. The MPQs were designed to allow for a pass/fail response, and each alternative would need to pass all the MPQs in order to proceed to being considered on a short list of alternatives for detailed evaluation. The following section describes in more detail how the MPQs were applied to the long list alternatives. Further details on the MPQs are provided in **Appendix G**.

9.2 Evaluation of Long List of Alternatives

Table 9-1 summarizes the evaluation of each alternative with respect to MPQ criteria. A detailed discussion of the evaluation for each of the alternatives is provided in **Appendix G**. Alternatives to be carried forward to the short list for further examination are identified.

Table 9-1 MPQ Summary – Evaluation of Long List of Alternatives

MPQ	Current Approach with Expanded Capacity	Current Approach with Solids Preparation Before Digestion	Produce Fertilizer from Biosolids	Produce Compost from Biosolids	Produce Dry Low Volume Fertilizer from Biosolids	Thermal reduction to Ash (No Energy Recovery)	Thermal Reduction With Energy Recovery	Landfill All Biosolids
Build upon Existing Infrastructure: Does the alternative build upon the Regions existing wastewater infrastructure?	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Build upon Existing Infrastructure: Is it based on commercially proven technology that provides a long term solution?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Protect the Natural Environment: Does it meet current environmental regulations and is it capable of meeting permitting requirements?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Protect the Natural Environment: Does it align with best environmental management practices in the field of biosolids?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Protect Health and Safety: Does it meet current health and safety regulations?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Protect Health and Safety: Does it align with best practices in the field of biosolids management?	Yes	Yes	Yes	Yes	Yes	Yes,	Yes	Yes
Minimize and Manage Operational Risk: Can the Region control all necessary elements of implementation?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Minimize and Manage Operational Risk: Can the storage requirements be met with a facility(s) located in the Region?	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Protect Quality of Life: Does the alternative protect the quality of life for citizens regardless of where it is built in the Region?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Carry forward to shortlist?	Carry forward as component of strategy	Carry forward as component of strategy	Yes	Yes	Yes	Yes	No	No

9.3 Discussion for Removal of Alternatives

Following a review of the facility and MPQ compatibility, the alternatives of Thermal Reduction with Energy Recovery and Landfill All Biosolids were proposed to be removed from further consideration. The two alternatives related to maintaining the Current Approach are also proposed to be removed from further consideration as stand-alone alternatives for implementation. However, these two alternatives may be combined with another alternative, or as part of the phased implementation of a biosolids management strategy. A discussion on removal of alternatives that did not pass all of the MPQs is provided below.

9.3.1 Discussion for the Removal of Current Approach Alternatives

The MOECC Design Guidelines for Sewage Works (2008) recommends a minimum of 240 days (8 months) of storage for biosolids management strategies that rely exclusively on land application. Given the Region's experience attempting to site this type of facility within the Region, this type of facility is not recommended. These large scale storage facilities for NASM have not commonly been sited in Ontario in the recent past, and there is a case of a previously permitted facility of this nature outside the Region becoming closed since the last Master Plan.

Although landfill should remain a contingency option, the preferred strategy must include infrastructure to decrease the likelihood of biosolids disposal in landfill. The current biosolids management strategy also uses biosolids for mine tailings reclamation. This mine application allows use during periods when agricultural land is not available, and allows diversion from landfill. Therefore the 240 day storage facility is not necessarily required to allow use when agricultural land is not available, but operational storage is required. The amount of biosolids transferred to landfill since the mine application has become available was: 3,044 wet tonnes in 2016 and 14,216 Wet tonnes in 2015. These masses represent 40 and 172 days of biosolids production respectively. It is understood that landfilling was required given that approximately 3 days of dewatered cake storage is currently available, not due to a lack of capacity for mine tailings rehabilitation or agricultural application. Operational storage on the order of 30 days of the 2051 biosolids production is required for the 2016 quantity of landfilled biosolids. Overall, siting the large scale storage required to address the limitations of the current 'just-in-time' strategy and avoid landfill disposal of NASM quality biosolids presents a substantial risk.

The rationale for removing the two alternatives related to maintaining the Current Approach is common to both. The technical differences these alternatives consist mainly of upstream solids preparation for anaerobic digestion, and do not meaningfully change biosolids product generated or management considerations for the Region.

9.3.2 Discussion for the Removal of Thermal Reduction with Energy Recovery Alternative

This alternative differs from the alternative of Thermal Reduction without Energy Recovery in terms of the assumed energy content of the biosolids product, and net energy balance from thermal reduction. Energy content of the current biosolids product must permit a net energy gain through combustion, and greater than 25% of the ash produced must be used rather than disposed to a landfill to meet best practices guidelines (CCME 2012). In general, energy recovery from solid residuals does not align with digestion, as a significant portion of the heat value of this material is removed through the digestion process.

A fluidized bed reactor is the most up to date technology that can accept biosolids with the lowest total solids content, while still generating net energy. The approximate cut-off of 28% solids approaches the quality produced by the Kitchener, Galt, and Waterloo facilities, but does not consider the additional reduction in heat value through upstream anaerobic digestion and biogas recovery. Implementation of an incineration and energy recovery approach may require additional infrastructure to remove the maximum amount of water from biosolids.

The planned initiative underway by the Region to implement combined heat and power engines to use biogas generated through anaerobic digestion aligns with a strategy of recovering energy at the treatment plant level, rather than optimizing processes for energy recovery from a new biosolids combustion process. Capital investment in the infrastructure necessary to recover heat or electricity from a second combustion process is not considered an efficient use of resources. Therefore, Alternative 7 is not considered to align with existing or planned infrastructure.

9.3.3 Discussion for the Removal of Landfill all Biosolids Alternative

The Canada-Wide approach for the management of wastewater biosolids (2012) represents a key resource in terms of defining best practices. The CCME policy statement promotes use of biosolids as a resource for nutrients, organic matter, and/or energy.

This alternative consists strictly of disposal and does not align with best practice principles for use the nutrients, organic matter or energy content of biosolids. The strategy does serve as an appropriate method of mitigating risk as modern landfills are considered an acceptable location for disposal in order to protect human health and the environment, as long as the landfill has a permit to accept municipal biosolids. Landfilling can be performed adhering to provincial and municipal standards; however it does not align with the Region of Waterloo 2015-2018 Strategic Focus, specifically:

- Strategic Objective 3.1 Increase the amount of waste diverted from landfill, and
- 3.1.3 Evaluate alternative waste (solids waste, biosolids, and any other) disposal technologies (energy from waste).

Therefore, while disposal of biosolids to landfills is an appropriate contingency for biosolids management, disposal of all biosolids to landfill does not align with national best practices presented by the CCME or the Region's strategic focus and, therefore, does not meet the minimum performance.

9.4 Short List of Alternatives

As noted in **Table 9-1**, the first two alternatives that consider a continuation of the Current Approach are proposed to be removed from further consideration as the primary alternative for biosolids management, but may form part of an overall strategy. Remaining alternatives that may be carried forward as a short list for further analysis include:

- **Produce Fertilizer:** Consider implementation of one of the range of technologies available to produce a CFIA fertilizer product, either through centralized or decentralized implementation, as long as the technology is compatible with volume reduction through dewatering. This alternative will be named **Alternative 1**.

- **Produce Compost:** Consider implementation of a composting process capable of meeting Category A or B compost standards, either through centralized or decentralized implementation, as long as the entire facility can be covered and provided with odour control. This alternative will be named **Alternative 2**.

- **Produce Low Volume, Dry Fertilizer:** Consider production of a CFIA fertilizer product through implementation of a drying process likely through a centralized implementation, but decentralized options can be considered. This alternative will be named **Alternative 3**.

- **Thermal Reduction to Ash:** Reduce biosolids to ash, producing the minimum volume of residual product and identify use opportunities for ash aligning with CCME best practices through centralized implementation. This alternative will be named **Alternative 4**.

The four biosolids management alternatives identified in this chapter represent a wide range of acceptable processing technologies and configurations. The following chapter presents an evaluation of the four alternatives against the Strategy objectives and associated criteria as described in Chapter 6.

10.0 Evaluation of Short Listed Alternatives

This chapter provides an overview of each shortlisted alternative and builds on the descriptions provided in **Chapter 8** and **Chapter 9**. Additional information on each alternative is included in **Appendix H (Technical Memo #8 – Evaluation of Short Listed Alternatives).** The facilities and associated renderings developed for this section include the following common elements: road access for trucking, an administration building, a process building that includes enclosed receiving, process equipment, 4 months of storage, and an odour control system.

10.1 Alternative 1 – Produce Fertilizer from Biosolids

This alternative would produce a fertilizer end product. Product volumes are estimated to range from 110% to 170% relative to current dewatered biosolids cake.

Technologies considered for this alternative would produce a fertilizer that meets the regulatory requirements under the Fertilizers Act administered by the Canadian Food Inspection Agency (CFIA). This alternative would provide the following end use or disposal options:

- Agricultural use as fertilizer;
- Non-agricultural soil amendment;
- Landfill use; or
- Landfill disposal.

A fertilizer product provides equal or greater opportunity for use in agriculture relative to existing practices, reduces restrictions on application, and improves the ability to store the product during periods when the preferred end use is not available. Storage configuration may differ however as the fertilizer storage can be in liquid or solid form, depending on the process. Non-agricultural soil amendment options such as use for mine tailings reclamation remain available, with additional bulk fertilizer uses available (e.g., landscaping, golf courses). Adding more flexibility to end uses is considered a valuable feature as it mitigates risk if any one end use or disposal method is unavailable in the short or long-term.

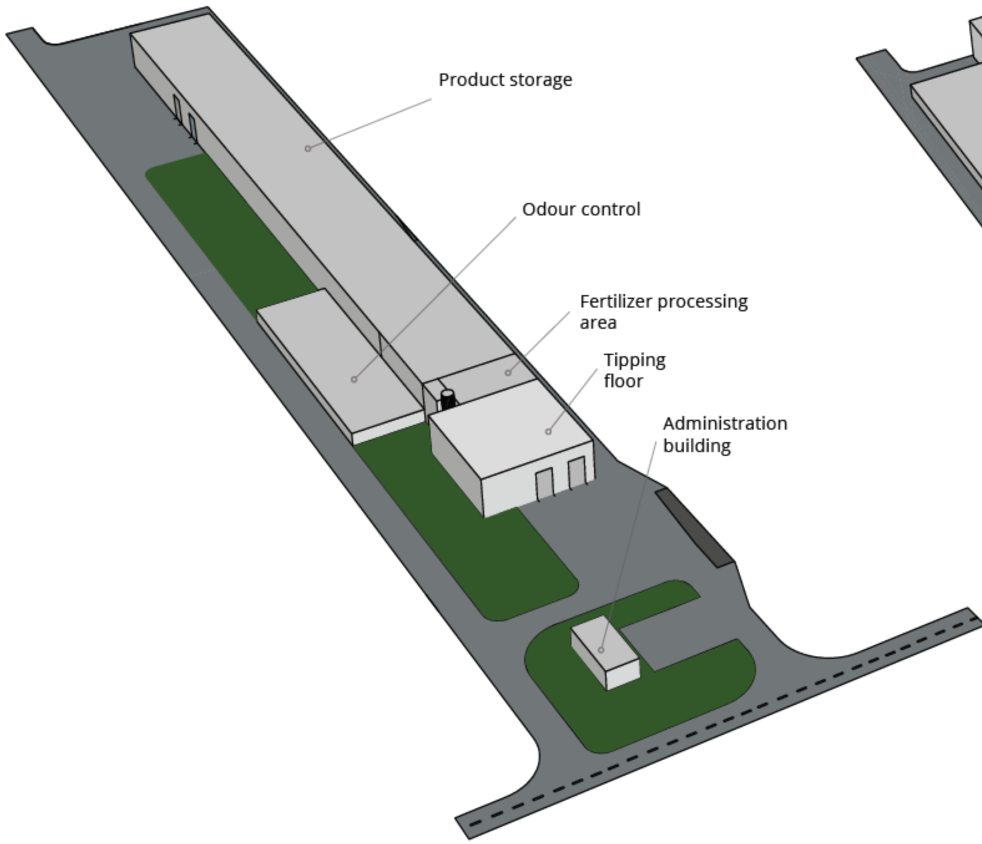
Implementation of the alternative may be considered at one (1) central location for processing all biosolids generated within the Region (the “Centralized Alternative”), or at up to four (4) smaller locations, each handling a portion of the overall production (the “Decentralized Alternative”). Decentralized implementation of the alternative may reduce local trucking of dewatered biosolids cake prior to processing, provide greater process redundancy and reduce the footprint of individual facilities, particularly product storage areas. Decentralized implementation is potentially more costly and complex to implement as construction of several small processes may be more expensive than a single large process. Facilities such as receiving and administration must be duplicated, and the challenges associated with facility siting must be addressed for a number of locations rather than one dedicated area. A layout rendering of the site indicating the relative size and location of buildings on a hypothetical “green field” construction site is provided in **Figure 10-1**.

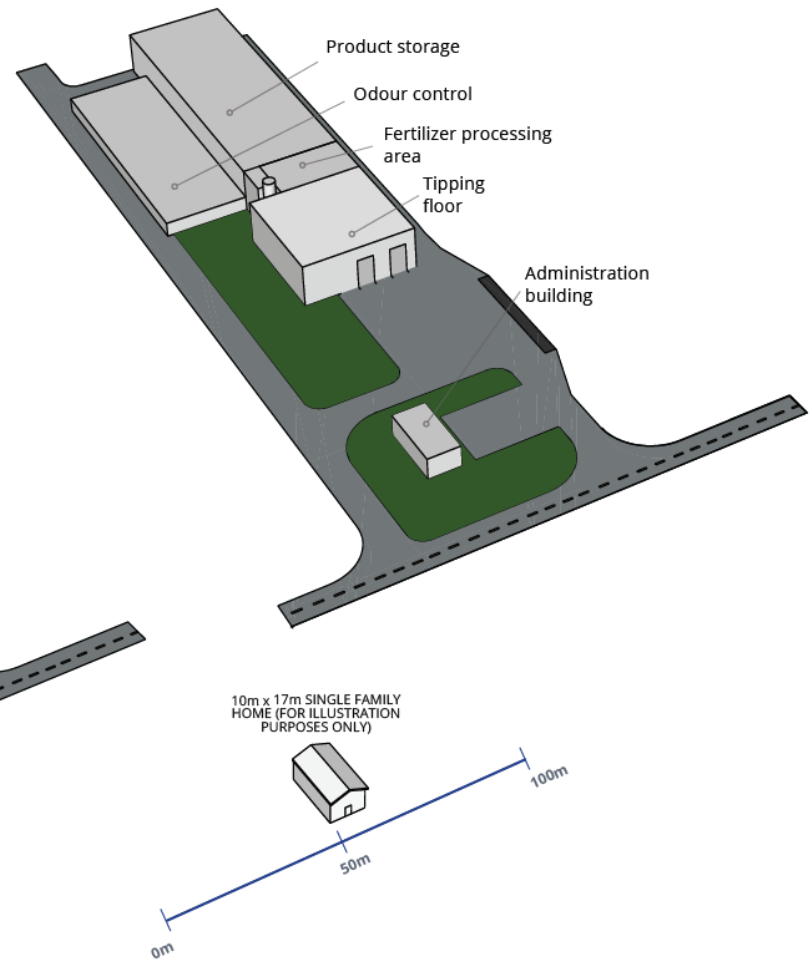
Construction of the new process may be considered with some or all components co-located with existing wastewater treatment plants (WWTPs) or located at new sites near the WWTPs. Site area constraints may limit the construction of storage at existing WWTPs, while co-location may allow some existing infrastructure, such as site access, servicing, administration, and product-receiving currently present, to be integrated with the new biosolids process. For the purposes of evaluating each alternative, we have considered construction of facilities for both the “Centralized Alternative” and “Decentralized Alternative” as stand-alone “green-field” sites with all components co-located on a single campus.

Figure 10-1 Schematic Representation of Site Layout Options for Alternative 1: Produce Fertilizer

OPTION B: Multiple Decentralized Facilities
(Only 1 Facility Shown)

OPTION A: Centralized Facility





10.2 Alternative 2 – Produce Compost from Biosolids

This alternative would utilize composting processes for stabilization. The alternative would consist of a single, centralized facility located downstream of the existing anaerobic digestion dewatering processes. The volume of product is anticipated to approximately double while the total mass of product is anticipated to be about 20% less than the current dewatered biosolids cake. Composting would be completed to a Category A quality standard, where biosolids are co-composted with other biomass (e.g., source separated organics, leaf and yard waste, purchased amendment like wood chips) in a mixture of up to 25% biosolids, minimum 75% amendment (dry mass basis). Category A compost has fewer restrictions associated with use than existing management processes in the Region.

This alternative would provide the following end use or disposal options:

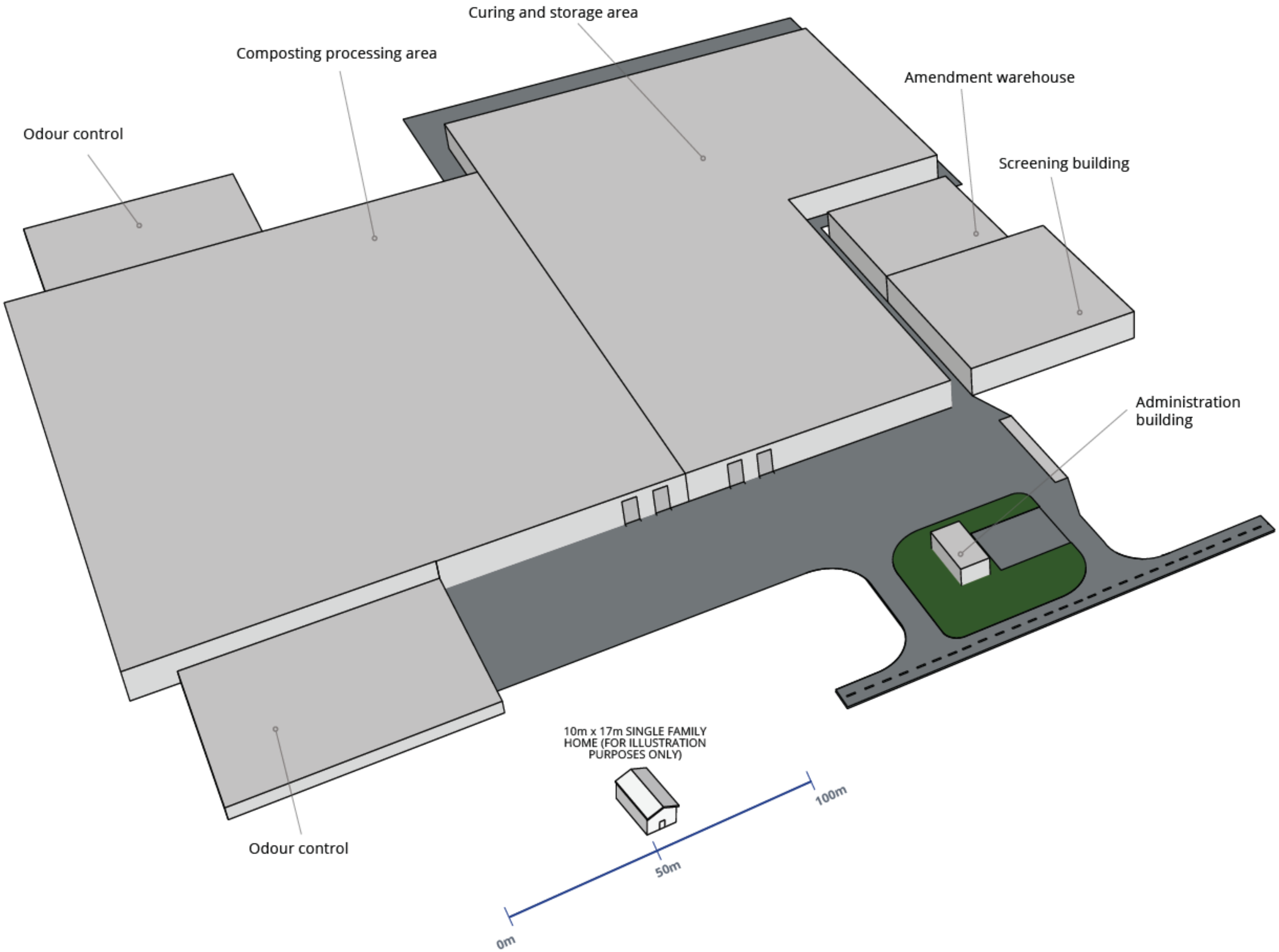
- Agricultural use as compost;
- Non-Agricultural Soil Amendment (NASM), such as mine tailings reclamation;
- Landfill use; or
- Landfill disposal.

It is not feasible that a composting facility could be constructed in the space available at the existing WWTPs, and due to the siting challenges anticipated with multiple large facilities, only a central facility alternative was developed in detail for composting. A large building would be required to protect equipment and store the processed compost, as well as for controlling emissions such as odour, dust, and noise. A layout rendering of the site indicating the relative size and location of buildings on a hypothetical "green field" construction is provided in **Figure 10-2**.

Local trucking to transfer dewatered cake to the composting site would be required, and the number of trucks at existing WWTPs would be similar to the current approach. Composting to Category A quality would require transportation of dewatered biosolids to the composting site, trucking of additional amendment required for the composting process, and use of compost product primarily on agricultural land. Trucking requirements are described in detail in the alternative evaluation in **Appendix H**.

A storage facility (assumed to provide a 4-month product inventory) is required to protect compost from weather during storage and curing, as well as to control emission potential (e.g., particulate and odours) while facilitating multiple end uses. Allowing for inventory of the compost provides flexibility to accommodate demand from different users.

Figure 10-2 Schematic Representation of Site Layout for Alternative 2: Produce Compost



10.3 Alternative 3 – Produce Dried, Low-Volume Fertilizer from Biosolids

This alternative would implement a dryer technology after anaerobic digestion and dewatering to reduce the volume of dewatered cake and generate a biosolids-derived fertilizer product such as a pellet or similarly granular material.

The technologies proposed in this category would produce a substantially lower quantity of biosolids-derived fertilizer per capita compared with the current approach through the removal of most of the liquid contained in the biosolids cake.

The product would meet the United States Environmental Protection Agency (US EPA) definition of Class A biosolids, and stabilization processes in this configuration have been demonstrated to meet the requirements of a fertilizer as administered by CFIA. Based upon the enhanced stability of the dry product, storage requirements for the specified 4-month period are relatively small.

This alternative would provide the following end use or disposal options:

- Agricultural use as fertilizer;
- NASM, such as mine tailings reclamation;
- Landfill;
- Use as a renewable fuel in combustion; or
- Landfill disposal.

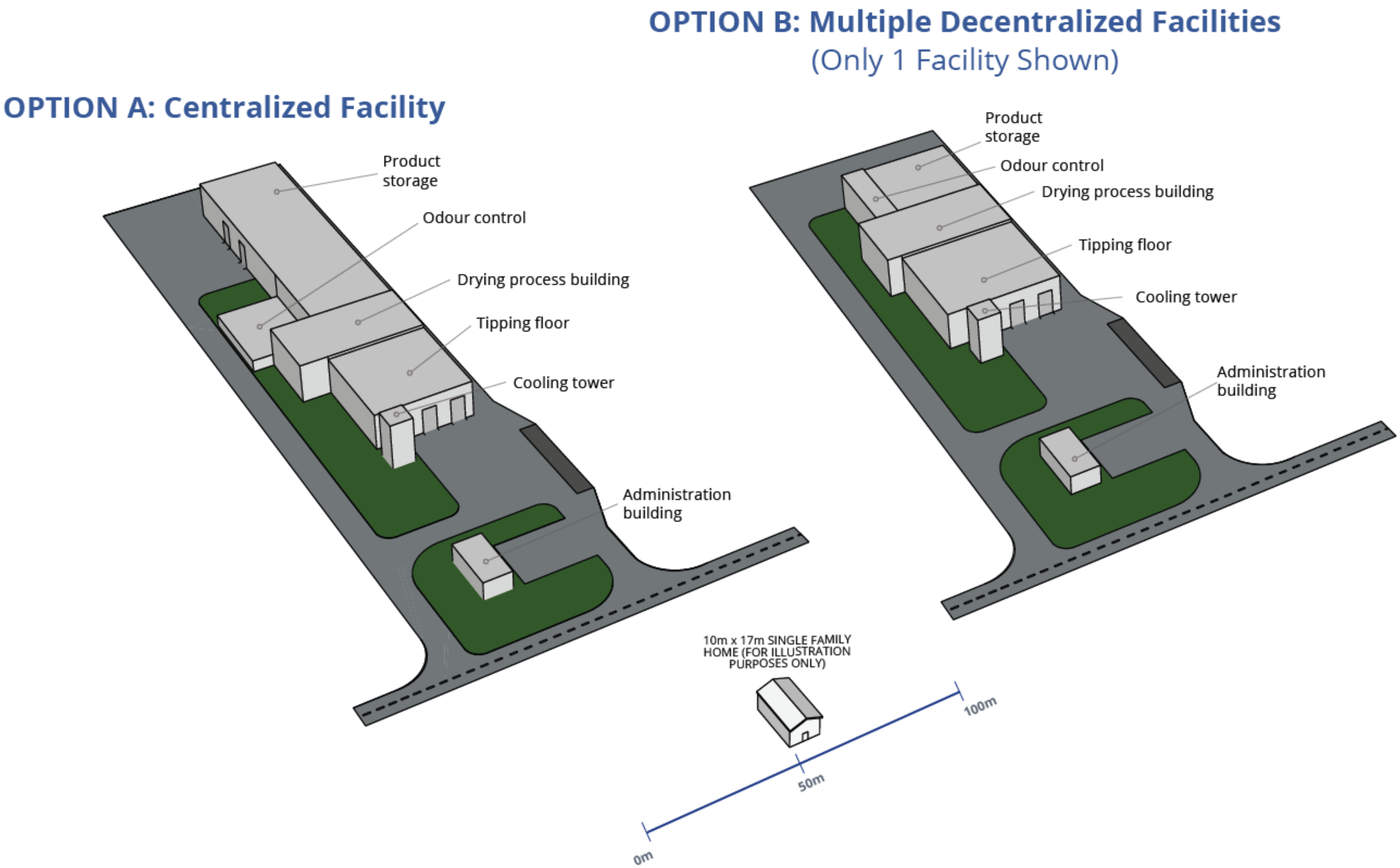
Multiple end uses would be beneficial as this mitigates risk and improves operational flexibility where any one end use or disposal method is unavailable in the short or long-term. The dried fertilizer generated from this alternative is suitable as a fuel for incineration or industry, and is commonly produced as an intermediate step as part of integrated drying/thermal reduction facilities. As a result, it produces an end product that does not strictly rely on use as a soil amendment in agricultural or non-agricultural applications. It can be used directly as fuel in combustion processes that generate useful heat (steam) and electricity, or to provide energy for an industrial process, such as cement production.

Dryer processing equipment would be required either at WWTPs, or in a centralized facility. A building would be required to protect equipment and stored product, as well as controlling emissions such as odour and noise.

For a central facility, there would be a similar number of trucks required to transport dewatered cake from WTTPs to the central facility when compared with the current amount of truck traffic at WWTPs. The number of trucks required for delivery of the end product to end use or disposal would be substantially lower than the existing approach, due to the dried nature of the finished product. A layout rendering of the site indicating the relative size and location of buildings on a hypothetical “green field” construction is provided in **Figure 10-3**.

A storage system is required for the dry product; however, the substantially lower quantity of material requires a small footprint. Engineering controls to mitigate the risk of fires during production and storage are required for this process. Allowing for storage of the biosolids-derived fertilizer would provide flexibility by accommodating demand from different users.

Figure 10-3 Schematic Representation of Site Layout Options for Alternative 3: Produce Dry, Low Volume Fertilizer



10.4 Alternative 4 – Thermal Reduction of Biosolids to Ash

This alternative would utilize a core technology after the existing processes of anaerobic digestion and dewatering to reduce the volume of dewatered cake to ash for disposal in an approved landfill outside the Region or potentially for use as an industrial input. The limited energy recovered from the process would be used to preheat or dry dewatered biosolids cake in order to decrease the amount of supplementary fuel required. The most promising technology is a fluidized bed incinerator. The technologies proposed in this category would produce the lowest mass and volume of end product.

This alternative would provide the following end use or disposal options:

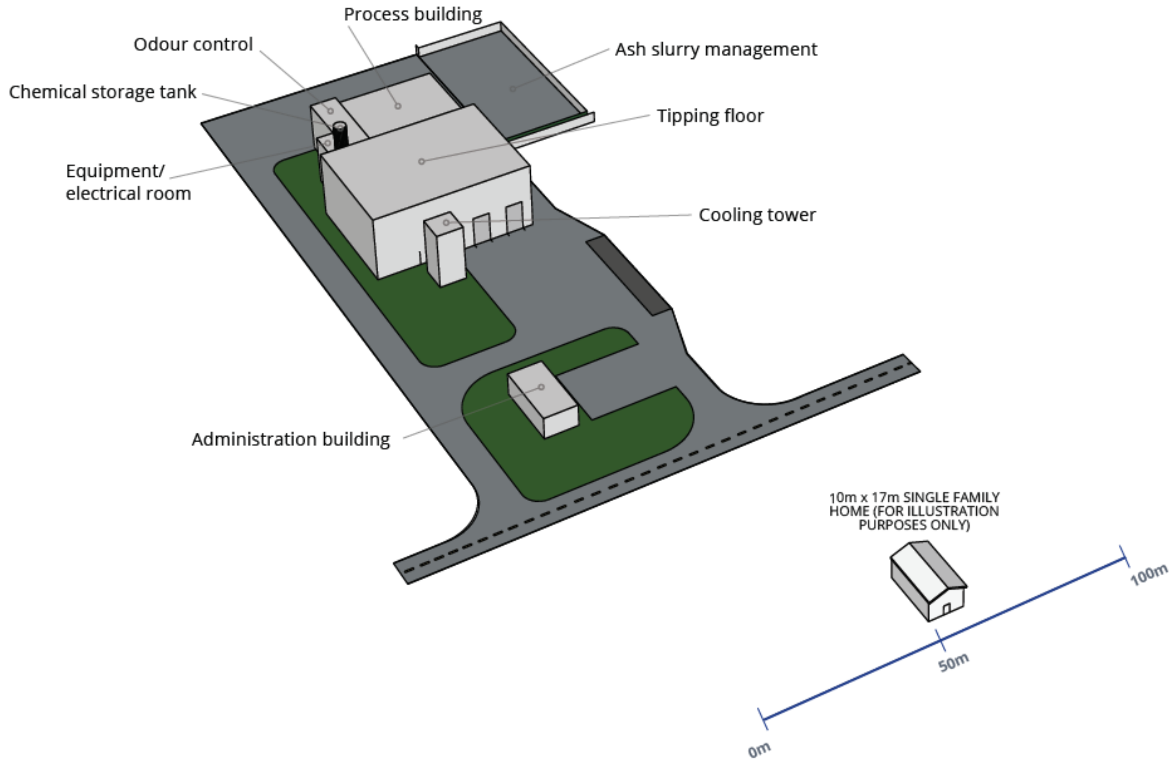
- Landfill disposal; or
- Use as an industrial input.

This alternative does not take advantage of the nutrient value of biosolids. The energy content of biosolids is used in combustion, but supplementary fuel such as natural gas is also required to maintain combustion temperatures given the moisture and volatile solids content of the current dewatered biosolids.

A new thermal reduction process would be implemented at a centralized facility. A building would be required to protect equipment, as well as controlling emissions to air such as air contaminants, odour and noise. A layout rendering of the site indicating the relative size and location of buildings on a hypothetical "green field" construction is provided in **Figure 10-4**.

There would be a similar number of trucks required to transport dewatered cake from the existing WWTPs to the central facility when compared with the current approach. The number of trucks required to handle the ash product would be the lowest of any alternative. Depending on the final destination for the ash, the vehicle kilometers travelled to truck the ash is likely to be the lowest per capita of all the alternatives. A storage system is required for the ash product; however, the substantially lower quantity of material requires a relatively small footprint. Ash slurry is directed to geomembrane containers, located in an impermeable concrete containment area. Filtrate from dewatering may be directed back to the thermal reduction process for reuse or collected for disposal. The geomembrane containers produce a semi-dry ash product with 50% dry solids. Additional thermal drying may be applied to increase solids content if required for specific applications. This approach to ash slurry management has been implemented at other Ontario thermal reduction facilities.

Figure 10-4 Schematic Representation of Site Layout for Alternative 4: Thermal Reduction to Ash



10.5 Evaluation of Short Listed Alternatives

The short listed alternatives were evaluated against the criteria related to each of the six project objectives. Each criterion had one or more indicators that were used to assess the performance of the alternative, as described in **Appendix H.**

10.5.1 Objective: Align with Existing Infrastructure

Alignment with existing infrastructure is central to a successful biosolids management strategy. Alignment would allow for continued utilization of the investments made by the Region to-date. All of the short listed alternatives would align with the use of existing infrastructure to some extent, in particular with dewatering equipment and the existing configuration of wastewater treatment plants across the Region. However, Alternative 1 (Produce Fertilizer) is less optimally designed to utilize dewatering equipment due to the need for a lower solids content in the product (water is added back in some processes). In addition, Alternative 2 (Produce Compost) occupies a large footprint, and would therefore present challenges to site within the Region.

Alternative 3 (Produce Dried, Low Volume Fertilizer) performs strongly with this objective due to the relatively smaller footprint and ability to integrate well with existing systems at the three main wastewater treatment plants (Kitchener, Waterloo, and Galt), if a decentralized approach is taken. Similarly, Alternative 4 (Thermal Reduction) occupies a very small footprint and is compatible with the Region's existing dewatering approach.

New supporting municipal infrastructure may be required for any new centralized processing facility for any of the alternatives, depending on the site selected. For purposes of this evaluation, it is assumed that a facility would be located in an existing serviced area within the Region, and as such there would be limited new infrastructure in the way of water, sanitation, natural gas, cooling infrastructure, solid waste management, or electricity required for any of the alternatives. The exception to this assumption is Alternative 2 (Produce Compost), which due to its large footprint would likely need to be sited in a less developed area and may therefore require a larger degree of new servicing infrastructure. Some roadway upgrades or access roads to existing wastewater treatment plants may be needed should a new decentralized processing facility for any of the alternatives be co-located near the existing WWTPs, in particular for the Waterloo and Galt treatment plants.

With respect to potential for aligning with other Regional waste management operations in the future, Alternative 2 (Composting) offers this possibility for its organic waste program, and Alternative 4 (Thermal Reduction to Ash) offers this possibility to integrate with solid waste management operations. In both instances, further discussion and assessment of alignment with waste management objectives would be required in the future.

All of the alternatives comply with current Provincial and Federal regulations, which generally are not anticipated to change in a way that would affect operations should any of the alternatives be implemented. However, the potential to reduce biosolids to ash under Alternative 4 could be limited by new regulations around air emissions for incineration of organic material. Policies that consider a landfill organics ban in Ontario currently are focussed on residential organic solid waste, and likely would not affect biosolids. There remains some risk that in the future a provincial policy could restrict the use of landfill as a contingency measure for Alternatives 1, 2 and 3. This would affect the Region's operations and make a stronger case for alternatives that reduce the volume of biosolids and offer improved flexibility in timing of land application and storage.

As the Region grows and the population expands, all of the alternatives, with the exception of Alternative 4 (Thermal Reduction to Ash), offer the potential to be phased and expanded over time to accommodate higher biosolids loads. Alternative 4 presents a challenge as an incinerator would need to be run at optimal capacity at all times for purposes of energy efficiency.

Alternatives 1, 2 and 3 create a product that can be sold and that has value for the Region. The value of the product and stability of the market for it varies across the alternatives, with the dried fertilizer product from Alternative 3 scoring highest due to quality and reduced volume. This is followed by the fertilizer from Alternative 1 and finally the compost product from Alternative 2.

Overall, all the alternatives align well with this objective, with a higher performance from Alternative 3 (Produce Dried, Low Volume Fertilizer) due to compatibility with existing infrastructure systems, scalability of the technology, and flexibility conferred by the reduced volume of the final product. **Table 10-1** provides a summary of the evaluation result for all alternatives based on the criteria under this objective.

Table 10-1 Align with Existing Infrastructure: Alternatives Assessment

Criteria	Centralized Produce Fertilizer	Decentralized Produce Fertilizer	Produce Compost	Centralized Produce Dried, Low-Volume Fertilizer	Decentralized Produce Dried, Low-Volume Fertilizer	Thermal Reduction to Ash
How compatible is the alternative with existing Regional wastewater and biosolids processing infrastructure?	WELL ALIGNED	WELL ALIGNED	SOMEWHAT ALIGNED	VERY WELL ALIGNED	VERY WELL ALIGNED	VERY WELL ALIGNED
How much new supporting municipal infrastructure is required (e.g. roads, power and water services, etc.)?	WELL ALIGNED	VERY WELL ALIGNED	NOT WELL ALIGNED	WELL ALIGNED	VERY WELL ALIGNED	WELL ALIGNED
What is the potential for aligning with other municipal initiatives in the future?	NOT WELL ALIGNED	NOT WELL ALIGNED	WELL ALIGNED	WELL ALIGNED	WELL ALIGNED	VERY WELL ALIGNED
How flexible is the alternative in adapting to changing government regulations, policies and market demands?	WELL ALIGNED	WELL ALIGNED	SOMEWHAT ALIGNED	VERY WELL ALIGNED	VERY WELL ALIGNED	WELL ALIGNED
Does the alternative allow us to accommodate future population growth?	WELL ALIGNED	WELL ALIGNED	VERY WELL ALIGNED	VERY WELL ALIGNED	VERY WELL ALIGNED	NOT WELL ALIGNED

NOT WELL ALIGNED SOMEWHAT ALIGNED WELL ALIGNED VERY WELL ALIGNED

10.5.2 Objective: Protect the Natural Environment

Protection of the natural environment is one of the key issues that mattered to the public as informed by early consultation on the development of the Biosolids Strategy. For each of the alternatives, the effects of the processing, transportation, and end use stages were assessed, in order to determine the risks and potential effects of the alternative on the environment. Soil, groundwater, surface water, and the atmosphere were considered as the main receptors of any impacts from the various stages of the alternatives.

At the processing stage, Alternative 1 (Produce Fertilizer) involves the use of process vessels that hold liquid content and require addition of chemicals to aid processing, which could potentially leak out of the vessel and present a risk of contamination of environmental receptors, particularly soil and groundwater. This risk can be effectively mitigated through secondary containment. The relatively large site footprint of for this alternative could have additional impacts for surrounding ecology depending on the location of siting.

Alternative 2 (Produce Compost) involves collecting water that may drain from the composting material, depending on the technology adopted, and therefore presents a risk of contamination of soil and groundwater, which can be mitigated through collection systems and containment. This alternative has a potentially very large site footprint that may have impacts to the environment, although, as with Alternative 1, this would depend on siting.

Alternative 3 (Produce Dried, Low Volume Fertilizer) presents a low potential for risk to the environment at the processing stage, as the primary function of the process is the removal of water and pathogens and there are no chemical inputs to the process.

Alternative 4 (Thermal Reduction to Ash) creates a potential for release of emissions of gases to the atmosphere. This risk can be partially mitigated through the use of scrubbers and other air quality control measures; however GHG emissions are not likely to be reduced for this alternative.

At the transportation stage, the alternatives with the largest volumes of output would create a relatively higher risk for potential accidents and accompanying spills.

At the end use stage, Alternatives 1, 2, and 3 create a product that is intended for land application. Although concentrations would be reduced below the regulatory limits for the type of fertilizer or compost, there is a potential risk of the presence of residual pathogens or other compounds in the material. Runoff from lands where the material is applied would need to be avoided in order to limit the potential risk to water quality and aquatic ecology as a result of the high organic and nutrient content material entering into adjacent water bodies or leaching to ground water. However, Alternative 3 has the flexibility to be used as an energy source, should this become an issue in the future. Alternative 4 creates an ash product with no organic matter but a potentially high concentration of metals. Monitoring of the final product would need to be carried out and the material would need to be disposed of at an appropriate landfill.

The detailed climate change impacts and adaptation analysis for all alternatives are included in **Appendix H**. In general, the findings indicate that processing infrastructure for all alternatives is not anticipated to be vulnerable to climate change impacts. Potential increased flooding considerations can be addressed through siting and design. Power outages from increased freezing rain, ice storms and wind are not anticipated to be substantive and can also be mitigated through design of back-up power systems. The decentralized layout approach for Alternative 1 and Alternative 3 could present additional vulnerabilities to climate change risk if located within floodplain zones at the existing WWTP's.

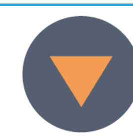
For Alternatives 1, 2 and 3, the availability of agricultural land for end use may be impacted by climate change, depending on year-to-year variation in growing season length. There is potential for increased demand due to overall longer growing seasons into the future. Trucking of products from for all four alternatives to end use or disposal destinations may experience increased disruption from flooding, freezing rain and ice storms, though this is not anticipated to have a significant impact on operations.

With respect to greenhouse gas emissions, Alternative 1 has a moderate level of emissions as a result of the chemical nature of the process and heat and energy requirements. As a primarily biological process, Alternative 2 presents low levels of greenhouse gas (GHG) emissions, which would result mostly from trucking and some heating of the facility. Similarly, Alternative 3 would result in low levels of emissions due to efficiency of the process and reduced trucking requirements for the end product. Alternatives 1, 2 and 3 all have the potential to offset GHG emissions by displacing commercial fertilizer through agricultural land application, although this has not been quantitatively assessed at this stage. Alternative 4 has a moderate level of associated GHG emissions as a result of the incineration process, energy demand, and off-gases from the process. Greenhouse gas emissions were estimated using the Region's BEAM model. The results were not able to be validated as it is a proprietary model.

Overall, Alternative 1 is not well aligned with the objective to protect the natural environment due to site footprint, potential for contamination from chemicals involved in the process, and GHG emissions. Alternative 2 is somewhat aligned. Although the footprint is large and significant trucking would be needed to deliver amendment material to the processing facility, impacts would depend on site configuration. Alternative 3 is very well aligned, due to very limited potential for environmental impacts, an efficient process that produces low levels of GHGs, a reduced volume of material and pathogens within it, low levels of trucking, and a broader range of end use options. Alternative 4 is somewhat aligned, with limitations due to the potential for fugitive emissions from the processing stage and no currently identified end users for the resulting ash, which requires landfilling. **Table 10-2** provides a summary of the evaluation result for all alternatives based on the criteria under this objective.

Evaluation of Short Listed Alternatives

Table 10-2 Protect the Natural Environment: Alternatives Assessment

Criteria	Centralized Produce Fertilizer	Decentralized Produce Fertilizer	Produce Compost	Centralized Produce Dried, Low-Volume Fertilizer	Decentralized Produce Dried, Low-Volume Fertilizer	Thermal Reduction to Ash
What are the environmental effects of the facility?						
What are the environmental effects of transport?						
What are the environmental effects of the end uses?						
What is the energy balance? Is it possible to recover energy?						
Is the alternative adaptable to climate change impacts (extreme temperatures and weather events (frequency, intensity, duration, and magnitude))?						

Evaluation of Short Listed Alternatives

Criteria	Produce Fertilizer		Produce Compost	Produce Dried, Low-Volume Fertilizer		Thermal Reduction to Ash
	Centralized	Decentralized		Centralized	Decentralized	
How much greenhouse gas emissions does the alternative produce?	SOMEWHAT ALIGNED	SOMEWHAT ALIGNED	VERY WELL ALIGNED	WELL ALIGNED	WELL ALIGNED	SOMEWHAT ALIGNED
How much risk is there that material generated from the process will be landfilled?	VERY WELL ALIGNED	VERY WELL ALIGNED	WELL ALIGNED	VERY WELL ALIGNED	VERY WELL ALIGNED	NOT WELL ALIGNED

NOT WELL ALIGNED

SOMEWHAT ALIGNED

WELL ALIGNED

VERY WELL ALIGNED

10.5.3 Objective: Minimize and Manage Operational Risk

The ability to offer continual biosolids management service with built-in resiliency to manage potential disruptions is an important consideration in the selection of a preferred alternative.

In terms of foreseeable changes to relevant regulations, Alternative 1 (Produce Fertilizer), Alternative 2 (Produce Compost), and Alternative 3 (Produce Dried, Low-Volume Fertilizer) all offer primary end uses that are unlikely to be disrupted by regulatory changes and which represent best practice in the area of biosolids management. Although Alternative 4 (Thermal Reduction to Ash) offers limited end uses, it also offers operational resilience, with no foreseeable changes to policy or regulations that would alter the potential to implement this approach.

Alternatives that significantly reduce volume of the end product would aid in the operational flexibility and security of the Region's Strategy, allowing for reduced areas for storage of processed biosolids and lower trucking requirements. As such, Alternatives 3 and 4 are particularly well aligned with this objective, while Alternatives 1 and 2 result in an increased volume of final product over the dewatered cake, and are therefore less well aligned with the objective.

All alternatives have a low level of susceptibility to consequences of disruption in maintenance, end product quality, management or transfer to a storage facility, and to limitations in storage capacity, as the amount of storage provided meets with policy and best practices in the field of biosolids management.

Alternative 1 is highly adaptable to disruptions in maintenance and labour supply as the process could be shut down temporarily if needed, and lower staffing levels can be maintained. Alternative 2 requires high levels of staff to maintain continuous trucking and facility management and is therefore somewhat susceptible to disruptions. However, this alternative requires relatively low maintenance levels. Alternative 4 requires continuous staffing and supervision of the processing facility, with operation of processes such as boilers, and would require complete shutdown for maintenance, and is therefore very susceptible to disruptions. Alternative 3 would also potentially require boiler operations.

All alternatives offer high levels of product reliability and constitute established technologies in the industry. They are therefore well aligned with the objective in terms of low susceptibility to process disruptions.

Overall, Alternative 1 is well aligned with this objective, with some limitations due to potentially larger volume of the final product. Alternative 2 is somewhat aligned, due to volume of the compost product and risk presented by the large volume of amendment required to supplement the biosolids material as well as the larger staffing levels for the processing and transportation stages of management. Alternative 3 is very well aligned, with significantly reduced volume of end product and a well-established range of technologies that offer reliability and require fairly low staffing levels. The dry state of Alternative 3 allows slightly easier handling during land application. Alternative 4 is well aligned with this objective, with a relatively small volume of end product produced, although the process requires full-time staffing and has the highest sensitivity to start-up and shut, and therefore the greatest risk related to process disruption. **Table 10-3** provides a summary of the evaluation result for all alternatives based on the criteria under this objective.

Table 10-3 Minimize and Manage Operational Risk: Alternatives Assessment

Criteria	Centralized Produce Fertilizer	Decentralized Produce Fertilizer	Produce Compost	Centralized Produce Dried, Low-Volume Fertilizer	Decentralized Produce Dried, Low-Volume Fertilizer	Thermal Reduction to Ash
How do the end use or disposal options affect the risk of disruption to biosolids management services?	▲	▲	▲▼	▲	▲	▲
Does the alternative reduce the volume/mass of end product to be managed?	▲▼	▲▼	▼	▲▲	▲▲	▲▲
How susceptible is the alternative to disruption in maintenance and labour supply?	▲	▲	▲	▲▼	▲▼	▼
How susceptible is the alternative to a process disruption?	▲	▲	▲▲	▲	▲	▲
How susceptible is the alternative to disruption in end product quality, management or storage?	▲	▲	▲▲	▲	▲	▲▲

▼ NOT WELL ALIGNED   ▲▼ SOMEWHAT ALIGNED   ▲ WELL ALIGNED   ▲▲ VERY WELL ALIGNED

10.5.4 Objective: Protect Quality of Life

Maintaining the existing quality of life for residents of the Region is important when planning for biosolids management infrastructure. The various stages of managing biosolids, from processing to end use, would have varying potential impacts on the surrounding community. These are captured by the criteria under this objective.

Odour is an important issue to the community, and is addressed in all alternatives through containment and design of any potential facilities through enclosure of all processing and material handling with odour treatment to limit the potential for fugitive emissions. Alternative 1 (Produce Fertilizer) and Alternative 2 (Produce Compost) have the potential for some odour release given the type of end product and size of facility involved. Alternatives 3 (Produce Dry, Low-Volume Fertilizer) and Alternative 4 (Thermal Reduction to Ash) have a limited potential for odour release.

With respect to dust, Alternative 1 has limited potential for dust release, because the product has higher moisture content and Alternative 2 has some potential depending on the type of organic amendment that is utilized for creating the compost product. Alternative 3 also has some potential given the dry nature of the end product. Alternative 4 has a very low potential for dust release due to collection of ash using a wet scrubber and management as a slurry.

Noise is another key consideration in facility design, and for purposes of this master planning exercise it is assumed that any noise impacts will be mitigated using enclosures, barriers, and / or low noise equipment to control noise to acceptable levels at the property line. Noise dampening would be installed to reduce effects on surrounding receptors for all alternatives. The primary source of noise disturbance would therefore come from trucking associated with the alternative. Alternatives 1 and 2 require a fairly high volume of trucking, while Alternatives 3 and 4 require a fairly low volume of trucking and would therefore be better aligned with the objective in terms of managing noise.

Visual impacts would need to be determined based on a site selected for construction of a processing facility. In general, the alternatives with lower footprints are assumed to have a correspondingly lower potential visual impact. Impacts related to the height of infrastructure are considered similar for each alternative. Alternative 2 and the centralized layout for Alternative 1 would have a the greatest impact on vistas, with the decentralized layout for Alternative 1 as well as the configuration of Alternatives 3 and 4 having a fairly low potential for visual impacts.

Source water impacts are also dependent on siting. For the decentralized layouts for Alternatives 1 and 3, should these be sited in proximity to the Kitchener, Waterloo, Galt, and Ayr Treatment Plants, there would be considerations for protection of source water based policies in the Region' Official Plan and on flood plain mapping retrieved from the Grand River Conservation Authority (GRCA) for these locations.

Restricting biosolids management operations within the Region would likely not allow for alternatives with a land application end use since locations for both agricultural and non-agricultural uses would be at the discretion of the contracted haulage company and may include sites outside the Region.

Overall, Alternatives 1 and 2 are not well aligned due to their potentially large footprint and trucking noise associated with the end use stage, as well as the potential for fugitive odours. Alternative 3 is well aligned, as a result of reduced volume of end product, which allows for a high degree of containment and less trucking that may impact surrounding communities. Alternative 4 is very well aligned, also due to volume reduction and the resulting limited trucking associated with the alternatives, as well as the ability to contain processing and limit odours and noise. **Table 10-4** provides a summary of the evaluation result for all alternatives based on the criteria under this Objective.

Table 10-4 Protect Quality of Life: Alternatives Assessment

Criteria	Centralized Produce Fertilizer	Decentralized Produce Fertilizer	Produce Compost	Centralized Produce Dried, Low-Volume Fertilizer	Decentralized Produce Dried, Low-Volume Fertilizer	Thermal Reduction to Ash
How will odour be managed?	▲▼	▲▼	▲▼	▲	▲	▲
How will dust from process or trucking be managed related to nuisance effects?	▲	▲	▲▼	▲	▲	▲▲
How will noise be managed?	▼	▼	▼	▲	▲	▲▲
How will visual effects be managed?	▲▼	▲	▼	▲	▲	▲
How will effects related to trucking be managed?	▼	▼	▼	▲	▲▼	▲

Evaluation of Short Listed Alternatives

Criteria	Centralized Produce Fertilizer	Decentralized Produce Fertilizer	Produce Compost	Centralized Produce Dried, Low-Volume Fertilizer	Decentralized Produce Dried, Low-Volume Fertilizer	Thermal Reduction to Ash
What are the potential impacts to source water protection?	Site dependent*	▲▼	Site dependent*	Site dependent*	▲▼	▲
Can all components of biosolids management, end uses and/or disposal be managed within Waterloo Region?	▼	▼	▼	▲▼	▲▼	▲

▼ NOT WELL ALIGNED ▲▼ SOMEWHAT ALIGNED ▲ WELL ALIGNED ▲▲ VERY WELL ALIGNED

* Site selection criteria would include source water protection risk reduction and engineering controls would be used to mitigate risks identified for individual sites

10.5.5 Objective: Protect Health and Safety

All four alternatives short listed for detailed evaluation meet regulatory and industry best practice standards regarding health and safety. Each of the alternatives involves varying processing components and levels of trucking as well as types of end products, which would affect the relative risks associated with implementation.

Potential safety risks to the public for Alternative 1 (Produce Fertilizer) would be related to potential fugitive emissions from the processing facility, which would be mitigated through containment measures. At the transportation stage, a traffic accident could result in the potential accidental spill of fuel or, if transporting raw materials, spill of chemicals such as lime used as amendment for the process. A spill of the fertilizer product is not anticipated to have negative impacts on human health and safety, although clear up will depend on whether the product is in solid, moist or liquid form. For Alternative 2 (Produce Compost), the health and safety risks would be associated with release of emissions from the facility. The relatively higher level of trucking associated with this alternative would mean a moderate increase in potential for traffic incidents. Alternative 3 (Produce Dried, Low Volume Fertilizer) and Alternative 4 (Thermal Reduction to Ash) both involve relatively low levels of trucking and reduced potential for fugitive emissions. Although both of these alternatives also involve emissions from combustion of natural gas, this would be managed through containment and air scrubbers.

Health risks to workers under normal operating conditions for Alternative 1 include exposure to corrosive chemicals and dust, as well as high temperature and pressure systems. These risks are mitigated through appropriate operator training, Personal Protective Equipment (PPE) worn by workers, as well as engineering controls and ventilation appropriate for area classifications and for odour and dust control. The processing stage for Alternative 2 does not involve chemicals and therefore the main risks are from odour, dust, and emissions from stored dewatered biosolids. As with Alternative 1, these risks are controlled with measures including the use of PPE worn by workers, the forced ventilation of odour, and dust control. Alternative 3 features both high temperature and high pressure processes, along with hot liquids emerging from the dryer vessel, which require more advanced engineering controls, appropriately trained and qualified operations staff, monitoring of processing for fire risk, and appropriate PPE worn by workers. No chemicals are involved in the process. Alternative 4 involves extreme heat as part of the processing stage, which presents a risk that is managed by appropriate monitoring of the process and safety procedures and may require specialized PPE to be worn. No chemicals are involved in this alternative.

Undesirable constituents such as pathogens are largely reduced in the case of all the short listed alternatives, as the final product is designed to meet regulatory standards and reduces pathogens below existing levels and below detection limits for indicator pathogens. In the case of Alternative 4, they are removed entirely. Safe handling practices if applied correctly will manage any risk associated with land application of the product for Alternatives 1, 2, and 3. Metal concentrations for these three alternatives are expected to be approximately the same (mg/kg dry solids), but may increase in the case of Alternative 4 where the ash product retains only the inorganic fraction of the dewatered biosolids.

The likelihood of a major accident or adverse effect across all alternatives is very low provided standard operating procedures are followed and the appropriate safety procedures are followed. The type of adverse events that could occur includes chemical spills, for Alternative 1, and fire or combustion, for Alternatives 2, 3, and 4. Mitigation of these risks would be achieved through facility and equipment design to separate process and staff areas, and adequate cooling and fire isolation measures.

Overall, Alternative 1 is well aligned with the intent of this objective due to limited risks and simple containment and safety procedures. Alternative 2 is somewhat aligned with this objective, as there is a risk of combustion of dry compost material that is stored. Alternatives 3 and 4 are well aligned, as the processing technology has a proven track record for safety and there are no chemicals involved in the process.

Table 10-5 provides a summary of the evaluation result for all alternatives based on the criteria under this objective.

Evaluation of Short Listed Alternatives

Table 10-5 Protect Health and Safety: Alternatives Assessment

Criteria	Centralized Produce Fertilizer	Decentralized Produce Fertilizer	Produce Compost	Centralized Produce Dried, Low-Volume Fertilizer	Decentralized Produce Dried, Low-Volume Fertilizer	Thermal Reduction to Ash
What are the relative health risks posed to the public?	WELL ALIGNED	WELL ALIGNED	SOMEWHAT ALIGNED	VERY WELL ALIGNED	VERY WELL ALIGNED	WELL ALIGNED
What are the relative health risks posed to workers?	WELL ALIGNED	WELL ALIGNED	WELL ALIGNED	SOMEWHAT ALIGNED	SOMEWHAT ALIGNED	SOMEWHAT ALIGNED
Does the alternative reduce or eliminate undesirable components in the biosolids?	WELL ALIGNED	WELL ALIGNED	WELL ALIGNED	WELL ALIGNED	WELL ALIGNED	VERY WELL ALIGNED
What is the potential nature of an accident or adverse event?	WELL ALIGNED	WELL ALIGNED	SOMEWHAT ALIGNED	SOMEWHAT ALIGNED	SOMEWHAT ALIGNED	SOMEWHAT ALIGNED

NOT WELL ALIGNED
SOMEWHAT ALIGNED
WELL ALIGNED
VERY WELL ALIGNED

10.5.6 Objective: Be Cost Effective and Provide Value

The long term economic sustainability of the alternative is an important element of the evaluation. The life cycle cost of the alternatives was assessed based on capital construction cost, operating cost with utilities, maintenance, and staffing. Construction of any new facility was assumed to take place in 2023, operating for the full planning horizon to 2051.

Alternative 1 (Produce Fertilizer) has a range of life cycle costs depending on the type of technology employed. A centralized layout has a lower cost than a decentralized layout, given the reduced construction, operating, and maintenance costs. Alternative 2 (Produce Compost) has a fairly high life cycle cost, associated with the construction of the large facility and the cost of ongoing staffing. The centralized layout for Alternative 3 (Produce Dried, Low Volume Fertilizer) performs very well on cost, given the efficiency of the dryer technology options available and the potential for partial automation of the system which reduces staffing costs. The decentralized layout does not perform as well, due to the cost of multiple dryers and associated construction for multiple facilities. Alternative 4 (Thermal Reduction to Ash) has a moderately high life cycle cost, as the technology requires 24/7 staffing and must be run at full efficiency at all times, which may raise the cost of electricity supply to the process.

The cost of implementing an alternative at different points across the planning horizon was also considered. With Alternatives 1, 2, and 4, a significant amount of investment can be saved by the Region over the planning period by delaying the implementation of the alternative and continuing with the current biosolids management process. This is primarily due to a substantial up-front capital cost, where overall project cost is reduced if capital expenditure is delayed. For Alternative 3, however, the annualized cost is very similar to the existing biosolids management process as savings through the delay of capital investment are largely offset by an escalation in trucking costs for the present approach compared with lower trucking costs for dry product produced through this alternative. As such, the cost of managing biosolids in the Region with this alternative is not dependent upon timing of implementation, and the Region can expect a consistent annual cost over the planning period. **Figure 10-5** illustrates the costs that could be anticipated to be expended by the Region depending upon the timing of implementation of each of the alternatives.

The potential to obtain carbon credits for each alternative was also assessed. Currently, there is no protocol available within the Cap and Trade framework to facilitate this. Should this option become available in the future, carbon credits may be possible to obtain for Alternatives 1 and 2 where energy consumption could be offset by the resulting displacement of commercial fertilizer. Alternatives 3 and 4 rely on natural gas as a heat and energy source and would likely not be eligible for carbon credits in the long run.

The local economic benefit of each alternative was assessed based on the number of potential jobs created by implementation of the alternative. For this criterion, the centralized layout of Alternative 1 performed less well than the decentralized layout, as the latter with multiple sites has the potential for higher local job creation. Alternative 2 would have a fairly high number of jobs created, including for the transportation stage of the management process. With a single facility, the centralized layout for Alternative 3 would create fewer jobs than the decentralized layout. Alternative 4 requires relatively few staff, although they would need to be well-trained.

The end product of Alternatives 1, 2, and 3 has value as a high organic matter product, and could potentially be sold to recoup some of the cost of processing and transportation. While the value of alternative 1 and 2 is primarily through agricultural use, alternative 3 has a potential use as a fuel which may increase its overall desirability. The commercial value of the product would depend on a variety of factors, including market conditions at the time of sale, distance from facility, and the timing of implementation of the alternative. These factors are difficult to predict for the planning horizon and may benefit from a market study as part of subsequent planning studies. The ash from Alternative 4 could potentially be transferred to a cement kiln as an input, although no such opportunities currently exist within the Region. As such, it is assumed that this material would be landfilled. Given the volatility and uncertainty of the value of the end product material the cost analysis did not include any remuneration to the Region for its sale in this assessment.

Depending on the design of the facilities and the operating approach, all of the alternatives offer an opportunity for leadership and innovation in sustainability and best practice management of biosolids. There are a number of green building and green infrastructure standards that could be adopted at the time of detailed design as the Region moves forward with implementation of the Strategy.

Overall, the centralized layout under Alternative 1 well aligned due to the lower life cycle cost, while the decentralized layout with a higher life cycle cost is not well aligned. Alternative 2 is not well aligned due to the cost associated with a larger footprint site and higher trucking requirements. The centralized layout for Alternative 3 is very well aligned, due to the life cycle cost and value of the end product. The decentralized layout involves a much higher cost is therefore not as well aligned; however, this layout may be preferred to allow for greater flexibility and incremental implementation of Alternative 3. Alternative 4 is only somewhat aligned, based on life cycle costs and the lack of value in the end product of ash which would likely be landfilled.

Table 10-6 provides a summary of the evaluation result for all alternatives based on the criteria under this objective.

Figure 10-5 Life Cycle Cost Variation Based on Implementation Timing

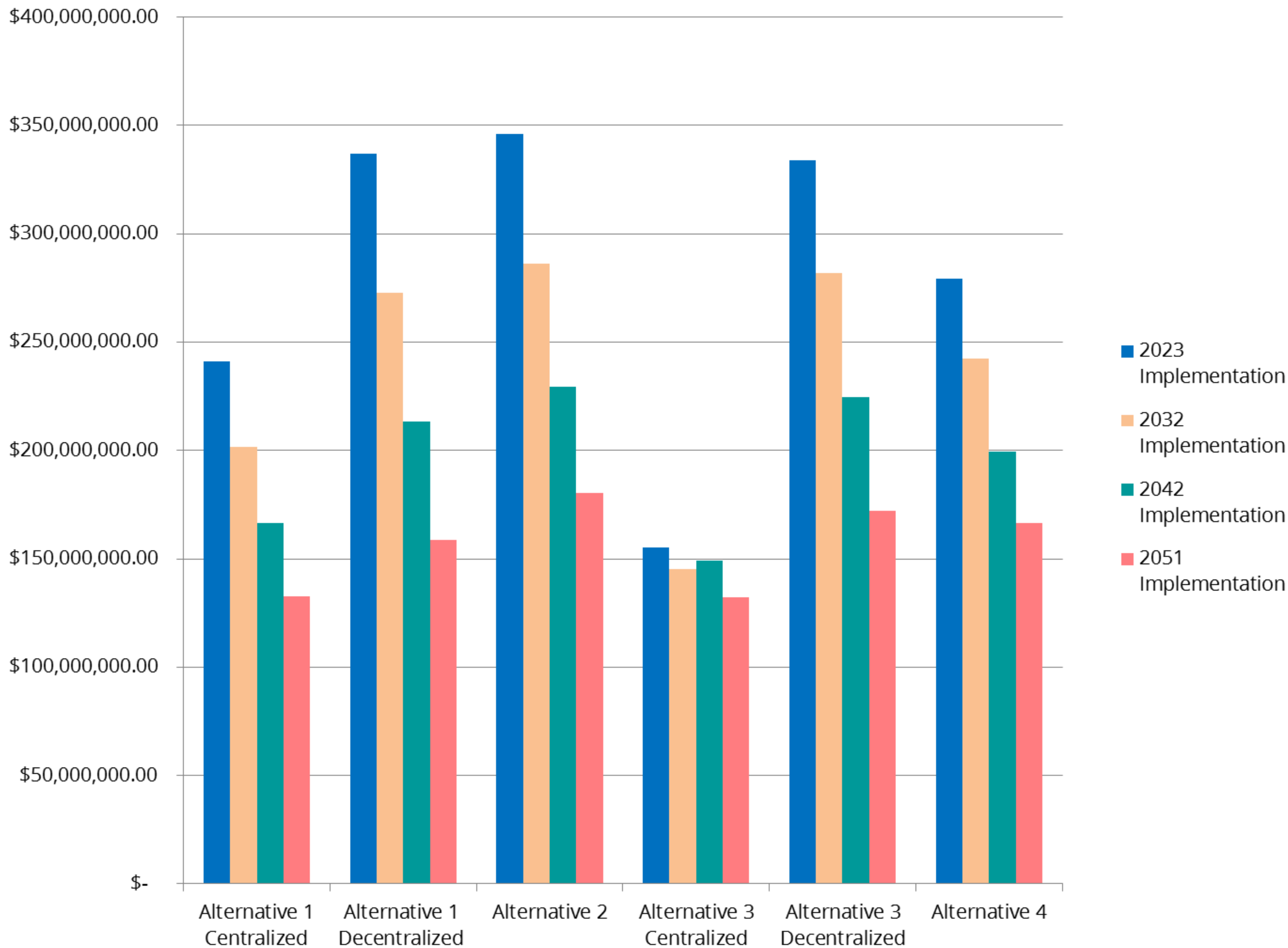


Table 10-6 Be Cost Effective and Provide Value: Alternatives Assessment

Criteria	Centralized Produce Fertilizer	Decentralized Produce Fertilizer	Produce Compost	Centralized Produce Dried, Low-Volume Fertilizer	Decentralized Produce Dried, Low-Volume Fertilizer	Thermal Reduction to Ash
What is the relative life cycle cost?	▲	▼	▼	▲▲	▼	▲▼
How does life cycle cost vary based on timing of implementation within the planning period?	▼	▼	▼	▲▲	▼	▼
Is there an opportunity to apply for carbon credits?	▲	▲	▲	▼	▼	▼
What is the local economic benefit?	▲▼	▲	▲	▲▼	▲	▲▼
Is a biosolids end product created that has value? If yes, what is its value?	▲	▲	▲	▲▲	▲▲	N/A

Evaluation of Short Listed Alternatives

Criteria	Centralized Produce Fertilizer	Decentralized Produce Fertilizer	Produce Compost	Centralized Produce Dried, Low-Volume Fertilizer	Decentralized Produce Dried, Low-Volume Fertilizer	Thermal Reduction to Ash
Would the alternative involve an innovative approach that demonstrates leadership in the area of biosolids management?						

 NOT WELL ALIGNED
 SOMEWHAT ALIGNED
 WELL ALIGNED
 VERY WELL ALIGNED

10.6 Overall Summary of Evaluation

The objective-by-objective evaluation outlined in the preceding sections of this Chapter provides a summary of the performance of each of the alternatives relative to each of the objectives. Based on the evaluation, this section summarizes some of the key strengths and areas of concern for each of the alternatives.

Alternative 1 (Produce Fertilizer) provides a mechanism for recovering the nutrient value of biosolids by turning this material into a marketable product that is lower in pathogens and meets the quality standards set by the Canadian Food Inspection Agency. In a centralized layout, this alternative is very expensive to construct due to the size of the facility footprint, which includes a very large storage area. The size of the footprint may also result in siting challenges in the Region. This alternative does involve chemical and moisture inputs and would likely result in a product that is greater in volume than the current dewatered biosolids. It also involves relatively higher storage and trucking requirements, with resulting impacts to the natural environment and quality of life for the surrounding community.

Alternative 2 (Produce Compost) has a very large footprint associated with the facility. It is also characterized by relatively high trucking requirements due to the introduction of a large volume of amendment material that would need to be transported, stored and added to the biosolids composting process. The compost material would require some direct handling within the facility by workers, with resulting exposure to odours and dust, depending on the type of mechanical equipment used. The capital and operating costs of implementing Alternative 2 are also quite high based on facility and storage size, amount of land and staffing requirements.

Alternative 3 (Produce Dried, Low Volume Fertilizer) provides a mechanism to reduce the volume of biosolids, reduce pathogens, and meet the requirements of the CFIA fertilizer end product through drying and without the input of chemicals. The significant reduction in trucking and ability to utilize the end product for a variety of end uses provides improved operational flexibility and security in the long term. The centralized facility size results in reasonably low costs and the configuration allows for good management of any impacts to quality of life or the natural environment. Extensive engineering controls are required as part of Standard Operating Procedures. The dryer technology is highly reliable, common in North America, and reasonably cost effective to operate in a centralized layout, although the cost (both capital and operating) would be relatively high in a decentralized configuration.

Alternative 4 (Thermal Reduction to Ash) allows for the significant reduction in volume of biosolids to an end product that would likely be disposed of at a landfill. There is no potential to recover the nutrient value of biosolids. There is, however, the potential that the ash may be classified as a hazardous waste, depending on the concentration of heavy metals within it. The emissions from the incinerator process could be controlled, although the GHG emissions associated with operating the incinerator would be relatively high. There would also be reduced flexibility in modifying operations in the short term as the incinerator would need to be built to a large capacity and then run at that capacity from the start of implementation. The very low levels of trucking and containment of the facility within a small site footprint allow for good management of impacts to quality of life.

Table 10-7 provides a summary of the evaluation result for all alternatives against each of the Strategy objectives.

Evaluation of Short Listed Alternatives

Table 10-7 Evaluation Summary

Criteria	Centralized Produce Fertilizer	Decentralized Produce Fertilizer	Produce Compost	Centralized Produce Dried, Low-Volume Fertilizer	Decentralized Produce Dried, Low-Volume Fertilizer	Thermal Reduction to Ash
Align with existing infrastructure	WELL ALIGNED	WELL ALIGNED	SOMEWHAT ALIGNED	VERY WELL ALIGNED	VERY WELL ALIGNED	WELL ALIGNED
Protect the Natural Environment	NOT WELL ALIGNED	NOT WELL ALIGNED	SOMEWHAT ALIGNED	VERY WELL ALIGNED	VERY WELL ALIGNED	SOMEWHAT ALIGNED
Protect Health and Safety	WELL ALIGNED	WELL ALIGNED	SOMEWHAT ALIGNED	WELL ALIGNED	WELL ALIGNED	WELL ALIGNED
Minimize and Manage Operational Risk	WELL ALIGNED	WELL ALIGNED	WELL ALIGNED	VERY WELL ALIGNED	VERY WELL ALIGNED	WELL ALIGNED
Protect Quality of Life	NOT WELL ALIGNED	NOT WELL ALIGNED	NOT WELL ALIGNED	WELL ALIGNED	WELL ALIGNED	VERY WELL ALIGNED
Be Cost Effective and Provide Value	WELL ALIGNED	NOT WELL ALIGNED	NOT WELL ALIGNED	VERY WELL ALIGNED	NOT WELL ALIGNED	SOMEWHAT ALIGNED

NOT WELL ALIGNED   SOMEWHAT ALIGNED   WELL ALIGNED   VERY WELL ALIGNED

10.7 Preferred Alternative and Recommendations

In selecting the preferred alternative for the Region, the complete evaluation was taken into consideration. This included the key issues of concern, in particular those related to quality of life and environmental effects of the alternatives, which were developed based on direct input from the community. As noted in **Chapter 6**, the objectives-based evaluation is not a scoring system but rather a reasoned approach to considering each alternative from a variety of angles, allowing for consideration of how well each alternative independently meets the project objectives. The evaluation summary provided in **Section 10.5** and **Section 10.6** consider each of the alternatives in terms of their performance against these Strategy objectives. This section now provides a relative comparison of the alternatives, to identify the alternative or group of alternatives that will be carried forward for inclusion in the proposed Strategy for the Region.

As presented in **Section 10.5**, each of the alternatives was assessed for performance against the Strategy's objectives.

Alternative 3 (Produce Dried, Low Volume Fertilizer) offers the ability to significantly reduce volume and accordingly reduce trucking and potential environmental impacts while creating a high-value fertilizer product with a broad range of end uses. This alternative aligns very well with the "align with existing infrastructure" and "protect the natural environment" objectives in both a centralized and decentralized layout. Alternative 3 performs the strongest against these two objectives compared to all the other alternatives, although Alternative 4 is also well aligned with the existing infrastructure objective.

Alternative 3 offers a reliable set of technologies with safety controls that would be operated by trained staff. Similar to Alternative 1 and 4, it is therefore well aligned with the "protect health and safety" objective. The ability to substantially reduce volume and storage requirements and be less susceptible to disruptions to processing or end product quality without significant impacts to operational risk allows Alternative 3 to be very well aligned on the "minimize and manage operational risk" objective. It performs the strongest on this factor compared to all other alternatives.

The reduced trucking and ability to control noise, odour, and other impacts to the community associated with Alternative 3 aligns well with the "protect quality of life" objective, although Alternative 4 performs better due to greater trucking reduction and control of odours and noise from operations. The cost of implementing the centralized version of Alternative 3 is the lowest of all the alternatives by a considerable margin and is therefore very well aligned with the “be cost effective and provide value” objective. The cost associated with a decentralized layout may be much higher depending upon how each decentralized facility is associated with an existing wastewater plant and the amount of new infrastructure and features required.

In reviewing the evaluation for each alternative and the comparative analysis completed in **Table 10-7**, Alternative 3 stands out as the alternative with the strongest alignment with the Strategy objectives. Characteristics of Alternative 3 provide long term security and flexibility in operations and allow for continuation of the current approach (with the implementation of short term storage at existing facilities) or early implementation (if that route is preferred). The volume reduction conferred through the drying process, the limited impacts to the environment, and protection of quality of life for the surrounding community are also key advantages of this alternative. Although the centralized version of Alternative 3 has the lowest life cycle cost, based on public feedback received, the Region could consider constructing decentralized facilities when the project moves forward to take advantage of existing infrastructure.

The smaller facilities that do not currently have anaerobic digestion, and dewatering have unique considerations, including smaller quantities of biosolids generated, and more flexibility with respect to storage and removal of material from the sites. The existing approach may be more viable for a longer period than those WWTP with anaerobic digestion and dewatering. The smaller facilities may be well served by inclusion in the centralized version of Alternative 3 as described above, or with a decentralized plant to serve these plants more locally.. Serving a group of smaller WWTP with a new facility would reduce the site footprint requirements and allow for a smaller scale, localized solution. Alternative 2 would not be considered as a preferred alternative due to the large site and trucking requirements, resulting in siting difficulties and high cost of implementation. Alternative 4 has benefits in terms of volume reduction and efficiency of management, but would not be preferred due to the loss of nutrient value of biosolids. However, this alternative may be considered at the time of implementation if there is an opportunity to capitalize on synergies with other waste management streams at the Region, in particular solid waste.

11.0 Recommended Alternative

In reviewing the evaluation for each alternative and the comparative analysis completed in **Chapter 10**, Alternative 3 stands out as the alternative with the strongest alignment with the Strategy objectives. Characteristics of Alternative 3 provide long term security and flexibility in operations and allow for continuation of the current approach (with the implementation of short term storage at existing facilities) or early implementation (if that route is preferred). The volume reduction conferred through the drying process, the limited impacts to the environment, and protection of quality of life for the surrounding community are also key advantages of this alternative. Both the centralized and decentralized layouts may be considered as the Region moves forward with future implementation under Phase 3 of the Municipal Class Environmental Assessment process. A further discussion of the recommended alternative is provided in **Appendix I (TM#9 – Preferred Alternative and Implementation).**

Alternative 1 may be examined as a potential alternative to be considered on a case-by-case basis for the smaller, aerobic plants in the Region in the future, along with other potential technologies that do not require dewatering of biosolids prior to treatment. At the present time however, the need to create a fertilizer has not been identified. Alternative 2 would not be considered as a preferred alternative due to the large site and trucking requirements, resulting in siting difficulties and high cost of implementation. Alternative 4 has benefits in terms of volume reduction and efficiency of management, but would not be preferred due to the loss of nutrient value of biosolids. However, this alternative may be considered at the time of implementation if there is an opportunity to capitalize on synergies with other waste management streams at the Region, in particular solid waste.

11.1 Recommended Alternative: Centralized Facility - Produce Dried, Low-Volume Fertilizer from Biosolids

This alternative would implement a dryer technology after anaerobic digestion and dewatering to reduce the volume of dewatered cake and generate a biosolids-derived fertilizer product such as a pellet or similarly granular material. The technologies proposed in this category would produce a substantially lower quantity of biosolids end product per capita compared with the current approach through the removal of most of the liquid contained in the biosolids cake.

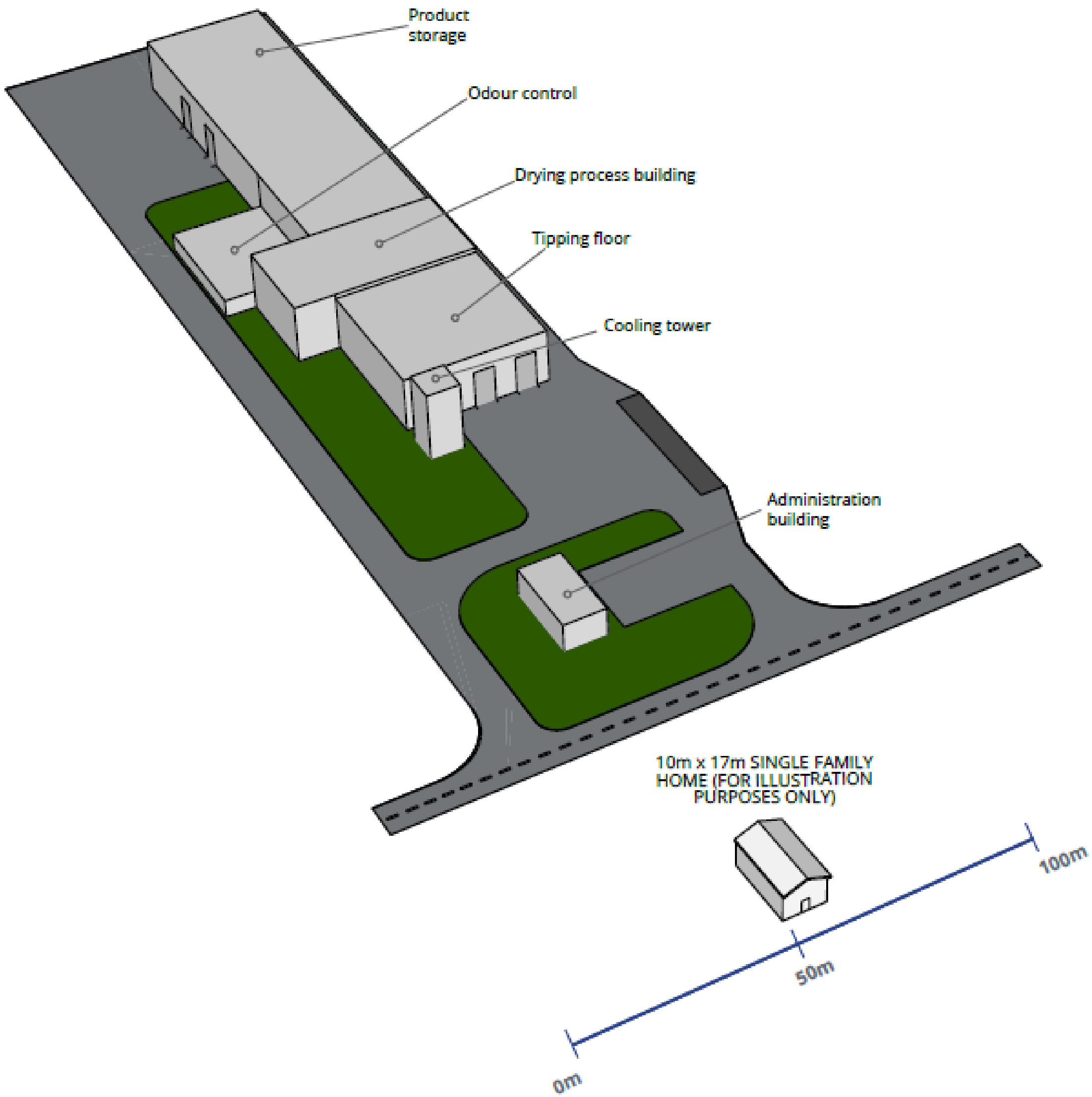
The product would meet the United States Environmental Protection Agency (US EPA) definition of Class A biosolids, and stabilization processes in this configuration have been demonstrated to meet the requirements of a fertilizer as administered by CFIA. Based upon the enhanced stability of the dry product, storage requirements for the specified 4-month period are relatively small. The schematic layout of the centralized facility is again provided for ease of reference in **Figure 11-1**.

This alternative would provide the following end use or disposal options:

- Agricultural use as fertilizer;
- NASM, such as mine tailings pond reclamation;
- Landfill daily cover (at approved sites);
- Use as a renewable fuel in combustion; or
- Landfill disposal (at approved sites).

The decentralized layout for Alternative 3 that is described in Chapter 10 may also be maintained as an option for consideration due to the potential benefits from locating adjacent to existing WWTPs and potential for incremental implementation of the drying facility.

Figure 11-1 Schematic Representation of Centralized Site Layout for Alternative SL3: Produce Dry, Low Volume Fertilizer



12.0 Biosolids Strategy - Implementation Approach

This chapter provides an overview of the approach to implementing the Biosolids Strategy, as discussed in Appendix I.

12.1 Overview of Implementation Considerations for Producing Dried, Low Volume Fertilizer

The existing approach for end-use of biosolids in the Region works well and incorporates best management practice. Biosolids are currently used as a soil amendment in agricultural land in Southwestern Ontario and in the rehabilitation of mine tailings areas in Sudbury. Whenever these two options are not available, then the Region must send the biosolids to a landfill for disposal. Landfilling of biosolids should be the last resort as it does not follow best management practices. The addition of short term (up to 10 days) storage at the three major wastewater plants (Kitchener, Galt and Waterloo) would provide operational security and flexibility to the current system and would minimize the need for landfilling of biosolids.

The current system is cost effective and provides value to the Region; however, there are long term risks associated with it as well. For example, the current agricultural use can only be applied periodically to the agronomic limit. The possibility of sudden refusal for land application by the land owner is also a risk.

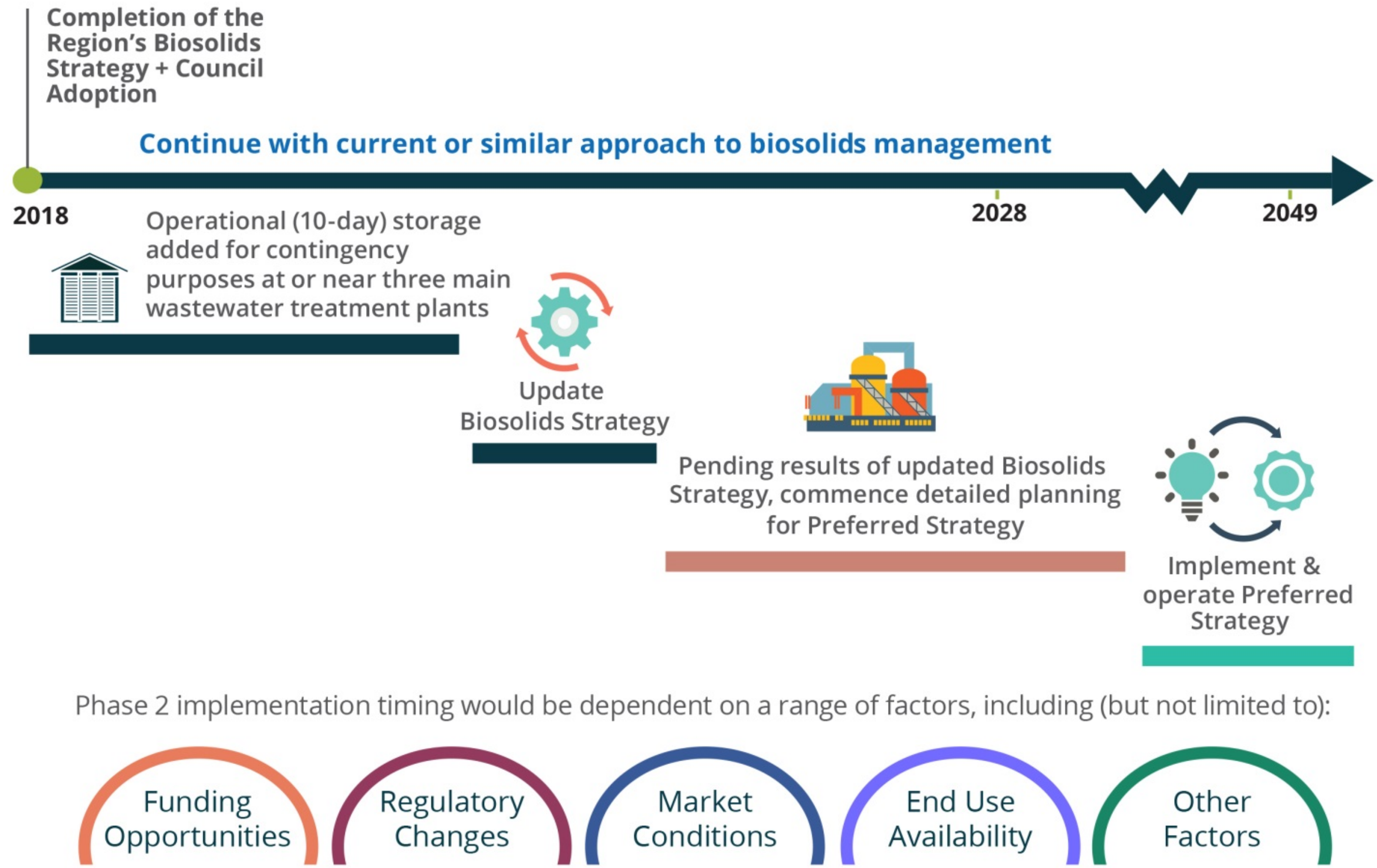
While the proposed processing alternative of producing dry fertilizer product also provides value to the Region, it does require the investment of a large amount of capital and necessitates the need to select a site. It is recommended that the Region immediately install short term storage at the three major wastewater plants and continue to explore methods for extending the current end-use options available to the Region.

Implementation of the processing alternative of constructing a facility or facilities to produce low volume dried fertilizer should occur in the future when internal Region factors such as contract extension and short term storage needs and external factors such as regulation changes dictate the need for this facility. The timing of the implementation should be such that it is initiated well in advance of the need recognizing the extended timeline required to site, design, obtain approvals and construct such a facility or facilities.

It is not possible to propose a date to start to implement the new facility(s) at this time as these factors controlling the timing are either unknown or out of the control of the Region. The Region should continually review the assumptions and considerations documented in the final 2018 Biosolids Master Plan and monitor the factors that will dictate the need to initiate the process to develop the new processing facility.

The Biosolids Strategy therefore consists of two phases: maintaining the current approach with implementation of short term storage to support operational needs, and future implementation of a centralized drying facility(s) located within the Region to support long term biosolids management needs, as illustrated on **Figure 12-1.**

Figure 12-1 Implementation Approach for the Biosolids Strategy



The two phases are further described in the following sections.

12.1.1 Phase 1: Integration of Operational Storage at Existing WWTP Facilities

The addition of short term (up to 10 days) storage at the three major wastewater plants (Kitchener, Galt and Waterloo) would provide operational security and flexibility to the current system and would minimize the need for landfilling of biosolids.

Operational storage is an integral part of the strategy, and is intended to be part of the development of the new centralized processing facility. However, if implementation of this facility is not undertaken immediately, there would be a need to develop operational storage at existing facilities to improve flexibility and mitigate challenges associated with everyday situations where biosolids cannot be transported immediately to end-uses.

Operational storage of the biosolids produced at the three largest facilities (Kitchener, Waterloo and Galt WWTPs) in the Region is a key aspect of continuing the current biosolids end use and disposal approach, lowering operational risk with the potential to facilitate use of biosolids in order to avoid landfill disposal. New storage will also be useful infrastructure between WWTP biosolids production, and any proposed processing technology. The focus of discussion at this stage is storage of dewatered cake at Kitchener (Manitou Drive), Waterloo, and Galt dewatering facilities. Compact footprint has been considered a priority in order to facilitate siting.

The storage approach discussed in this document is intended to provide storage for the existing NASM quality cake only on an interim basis when due to operational issues the material cannot be transported off-site under the current just in time schedule. Storage requirements for products generated by the short list of proposed alternatives are addressed as part of the detailed process description for each short list alternative in **Appendix H**.

This short term storage at the plants would offset the need for short term storage at a new centralized processing facility. Short term storage at the centralized plant could be decreased in size considerably.

Short term operational storage at the existing plants will have the following features:

- Location at the three facilities (Kitchener, Galt and Waterloo) presently producing dewatered cake. We have assumed that liquid sludge produced at small facilities may be managed for short periods of time onsite if required and that the primary risk to operations is end-use management interruptions rather than transport between facilities.

- Operational storage will consist of bunker-type cake storage with the following features:
  - Enclosed fixed roof building structure
  - Bunker constructed with 3m concrete push walls on three sides for containment of cake
  - Appropriate ventilation and air quality control measures

The following supportive studies are currently anticipated to be required towards implementing operational storage:

- Schedule A Class EA (preliminary design and detailed design).

Table 12-1 provides a summary of the estimated construction cost of operational storage at each of the main existing wastewater treatment plants in the Region.

Table 12-1 Summary of Operational Storage Implementation Assessment

Wastewater Treatment Plant	2016 Total Biosolids Production (Dry Tonnes / day)	Cake Volume m^3/day	Volume generated in 10 days (m^3)	Estimated Construction Cost (Low End)	Estimated Construction Cost (High End)
Kitchener	13	53	532	$1,100,000	$2,500,000
Waterloo	8	33	334	$900,000	$2,100,000
Galt + Preston	9	35	349	$900,000	$2,200,000

Values presented in **Table 12-1** are order of magnitude opinion of probable cost (Class V, Level 1, Class D Cost Estimate). Engineering is estimated as 15% of the total construction cost and a contingency of 20% of the total cost has been included in this estimate.

12.1.2 Phase 2: Implementation of a Centralized Processing Facility to Produce Dried, Low Volume Fertilizer

Implementation of a centralized facility (or decentralized facilities, as the need is determined) to produce low volume dried fertilizer should occur in the future when internal Region factors, such as greater risks related to maintaining existing methods and short term storage needs, and external factors such as regulation changes or funding opportunities (through Federal or Provincial programs) dictate the need for the facility(s). The timing of the implementation should be such that it is initiated well in advance of the need recognizing the extended timeline required to site, design, obtain approvals and construct the facility(s).

A date to start to implement the new facility(s) is not being proposed at this time as the factors controlling the timing are either unknown or out of the control of the Region. The Region should continually review the assumptions and considerations documented in the final 2018 Biosolids Master Plan and monitor the factors that will dictate the need to initiate the process to develop the new processing facility(s).

As noted in **Appendix H**, the smaller wastewater treatment facilities that do not currently have anaerobic digestion and dewatering have unique considerations, including smaller quantities of biosolids generated, and more flexibility with respect to storage and removal of material from sites. The existing approach may therefore be continued for the smaller plants even after the implementation of the new centralized facility; alternatively, other localized processing solutions for these smaller plants may be considered at the time of implementation.

Based on the feedback received from the community on the “issues that matter” and the implementation approach, the following are some preliminary recommendations for the Region to consider in the siting of the new processing facility through future phases of the Environmental Assessment process. The following supportive studies are currently anticipated to be required towards implementing the recommended strategy:

- Update to Biosolids Strategy
- Schedule C Class EA (preliminary design and detailed design).

Zoning

The selected site for placement of the new processing facility(s) should be located in an appropriately industrially zoned area, in line with the local and Regional official plans, municipal standards, and design criteria.

Access and Traffic Management

Mitigation of truck traffic impacts to the surrounding community will be essential to the long term success of the Strategy. Placement and selection of truck access points to the facility(s) should be situated to reduce noise and traffic impacts. Appropriate access will be required for emergency vehicles as well.

Site Footprint & Growth Potential

The site footprint provided in this strategy provides a high-level overview of the potential space that would be required to accommodate all components of the processing facility(s) and associated storage. However, this will be further refined through subsequent studies including a Schedule C Class EA. The selection of potential sites for consideration should also take into account long-term growth and expansion needs for the facility(s).

Proximity to Sensitive Environmental Receptors

Protection of the natural environment is a key part of the Strategy and will provide a set of considerations in selection of a site for a new facility(s). Proximity to sensitive environmental receptors as well as hazard areas such as floodplains should be considered in the selection of appropriate sites for consideration.

Proximity to Non-Industrial Development

Should the need arise for a new facility, protecting quality of life for any non-industrial neighbours such as residential communities would need to be considered as an integral component of the Strategy objectives. In addition to reducing traffic and associated noise impacts to the community, overall noise, odour, and nuisance disturbances to the facility(s) neighbours should be mitigated at the fence line of the facility(s) to limit exposure to these elements.

12.2 Conclusion

In developing the Biosolids Strategy, the Region has conducted an in-depth objectives-based assessment of the alternatives for managing biosolids in the Region, integrating stakeholder, community, and technical feedback along each step of the process. As the Region moves forward with the Environmental Assessment process to implement the Master Plan, the following key steps should be integrated:

- Ongoing regular review of the assumptions and considerations in the Master Plan to check for consistency with the evolving needs of the Region and latest state of technology options;
- Consideration of community concerns received through the process of developing the Master Plan in the selection of potential sites for the new processing facility(s);
- Continuation of enhanced community engagement through subsequent phases of the Municipal Class Environmental Assessment process to provide the community with opportunities to be involved in providing input towards future decisions related to implementation of the Master Plan; and
- Consideration of potential funding opportunities for the new processing facility through Public-Private Partnerships (P3s) or other federal/provincial infrastructure grant/incentive programs.

This Master Plan is intended to form a supportive guide towards the long term management of biosolids in the Region to 2051, and will therefore be an important tool in communicating the Region’s approach both for internal staff as well as for the wider community. An update to the Master Plan should be considered at around the 10-year mark to maintain relevancy with the most contemporary technologies and alternatives available at that time to carry the Region through the next long term planning horizon.

13.0 Stakeholder Engagement

13.1 Engagement Approach

The Biosolids Strategy was developed through an entensive public engagement and communications approach, designed to reach out to residents across the Region and offer opportunities to provide input into the decision-making process. Appendices J to P contain the engagement and communications related materials developed as part of the Biosolids Strategy process.

Early public engagement and engagement throughout the process is an important part of an environmental assessment. As outlined in the Class EA document, *"Consultation is a two-way communications process between the proponent and affected or interested stakeholders that provides opportunities for information exchange and for those consulted to influence decision-making*" (Page A-56). Stakeholder engagement was therefore a key component in developing the Strategy and was considered alongside technical aspects of the Project, and best practices relevant to Waterloo Region.

The overall goal of the stakeholder engagement process was to integrate the community's concerns, feedback, and vision for how biosolids will be managed in the Region into the future, by incorporating these into the objectives-based evaluation of alternatives for the Strategy.

13.2 Engagement Objectives

Engagement for the Strategy development process was designed to meet five key objectives. The success of the engagement program can be measured by how well it met these stated objectives. The following section provides an assessment of the success of the engagement program.

1. Meet and where possible exceed the consultation requirements of the Municipal Class EA process

The program included five rounds of community engagement to obtain input on each aspect of the Class EA Master Plan process including the need for a biosolids strategy, alternatives to be considered, the process and criteria for evaluating alternatives, the preliminary results and the final strategy. The level of engagement went well beyond what is required and what is typical for a master plan under the Municipal Class EA process.

2. Increase overall awareness of the project

Through the various communication and consultation activities this project reached out to over 3000 participants, as show on **Figure 13-1**. While there may be some overlap with participants attending more than one activity; this number does not include those who might have chosen not to participate in project events but become aware of the project through newspaper notices and articles in the EnviroNews distributed to all Region residents. It is not possible to definitively say whether this reflects an increase in awareness but it is clear that participation was high for a project of this type.

3. Provide a variety of ways for stakeholders to participate

The stakeholder engagement program provided 12 different ways for people to learn about the project and provide input - newspaper notification, direct mail/email, website, video, public consultation centre events, webinars, surveys, guest speaker presentations, pop-ups and local fairs and venues, children's coloring books, science fair participation, and teaching resources available on the project website.

4. Incorporate community perspectives into the evaluation of biosolids management strategies

Early in the project participants were asked to help the team understand the kinds of things that were important to them when they thought about the development of a biosolids strategy. All the input received through discussions and survey results on the issues that mattered to the community, local municipalities and the Region became the six objectives of the biosolids strategy. These six objectives, based directly on engagement input were used as the foundational elements for the evaluation of biosolids management alternatives. Community perspectives provided a fundamental guide for the decision making process that developed the final strategy.

5. Clearly document how input received was considered in the project

Section 13.3 of this document presents the input received and demonstrates how input was considered in the project.

6. Follow these key principles in implementing the engagement program:

- Accountability;
- Transparency;
- Respect;
- Inclusivity and Accessibility;
- Responsiveness; and
- Clarity and Simplicity.

These key principles were integrated into the Project Charter developed for the project and integrated into the design of programming and consultation materials for the project, which were intended to help translate complex technical complex for a broad public audience. Programming was developed for a range of demographic groups, including youth.

13.3 Engagement Activities

The section summarizes the consultation activities undertaken for this project. Each stage of the project was accompanied by a series of engagement opportunities designed to gather input that would be useful to the specific stage of the project.

Seeking Advice on Engagement Materials

Feedback on the engagement materials was sought regularly from the Steering Committee and Stakeholder Committee. Both were very helpful sounding boards providing valuable ways to improve materials prior to going out to the public. In addition to specific suggestions on graphic and text improvements, advice included:

- Make sure all technical words are defined and that explanations are provided where needed.

- Think about the emotions that might be evoked by the words and images used (e.g. pile of biosolids might be negative). People will be quick to interpret information negatively so be as neutral as possible.

- Reflect the different way people learn (reading words, seeing graphic images, talking to the team).

- Have engaging speakers, include prize draws and use humor as a way to attract attention and interest.

- Make sure venues are transit friendly; go to where people are (e.g. Ecofest, World Water Day events, Science Fairs).
- Include a variety of notification techniques (social media, animation and video, networking).

Notification Approach

Increasing overall awareness has been an important objective for this project and as such notification was designed to catch the community's attention. Colourful, eye-catching notices were used to encourage people to participate at events or online. Notification for this project included:

- Newspaper advertisements
- EnviroNews articles
- The Biosolids Bulletin distributed to all on the project contact list
- Project E-Newsletters with more detailed information than the Bulletin, for those looking for a more in-depth update
- Direct mail to key stakeholders to notify them of upcoming events

Notification material is included in **Appendix J (Notices and Communication).**

Public Events and Workshops

A series of public events were held over the course of developing the Biosolids Strategy. The following sections summarize the key events and participation numbers for each of the six stages of the Strategy process. Event materials are included in **Appendix K (Public Consultation Event Panels/Workshop Materials).**

Stage 1: Defining Biosolids and Project Launch

Telephone Survey

502 Responses

Gauging public knowledge of the project, and opinions on biosolids management, and how the project should engage the community.

Online Survey

50+ Responses

Online version of the Telephone Survey questions.

Public Consultation Centre: Launch Event

112 attendees

Public event to kick off the project, featuring guest speaker Bob McDonald.

November 10th, 2015, Waterloo Region Museum

Stage 2: Defining the Issues that Matter

Webinar

15 Participants, 50+ Video Views

Providing an overview of the Region's existing management approach and issues related to developing a sustainable Biosolids Strategy

Online Survey

340 Responses

Online survey on the 'issues that matter' to the community when it comes to biosolids management

Community Pop-up Events

10 Events 570+ adults, 560+ children engaged

A booth set up at community events across the Region over spring and summer 2016 to encourage participation in the online survey, raise awareness about the project and gather input on issues that matter

Science Fair

200+ 7th and 8th Grade Students

Activity hosted at the Waterloo Wellington Science Fair to encourage student attendees to think creatively about biosolids management

In Stage 2 a Request for Information (RFI) process was launched to collect information from biosolids management vendors on current technology options and their features, towards developing the long list of biosolids alternatives. The RFI process was an open call to vendors across North America, and allowed the Project Team to collect information directly sourced from vendors, thereby improving the transparency of the research process. The RFI documents are provided in **Appendix P (Vendor Request for Information Forms).**

Stage 3: Project Objectives and Long List of Strategy Objectives

Online Survey	Public Consultation Centres: Three Events	Community Pop-up Event	Science Fair
78 Responses	**117 attendees**	**World Water Day Booth at Wilfrid Laurier University**	**200+ 7th and 8th Grade Students**
Online survey on the long list of biosolids management alternatives and the criteria for short-listing those to be carried forward for detailed consideration	An event was hosted in each of Waterloo, Kitchener, and Cambridge to present the long list of alternatives, the project objectives, and the criteria for short-listing the alternatives March 23-April 12 2017	A booth was set up to provide information on the project at the World Water Day symposium hosted at Wilfrid Laurier University on March 22, 2017	Activity hosted at the Waterloo Wellington Science Fair to encourage student attendees to think creatively about biosolids management

Stage 4: Short List of Strategy Alternatives

Online Survey

24 Responses

Online survey on the short list of biosolids management alternatives and the criteria for detailed evaluation to select the preferred alternative

Public Workshop

27 attendees

Workshop to bring together the Project Stakeholder Committee and interested members of the community to provide in-depth input towards the detailed evaluation criteria
June 21, 2017

Community Pop-up Events

3 Events
250 Adults, 300+ Children Engaged

A booth set up at community events across the Region over summer 2017 to encourage participation in the online survey and raise awareness about the project

Stage 5: Preferred Alternative

Public Consultation Centres: Three Events

117 attendees

An event was hosted in each of Waterloo, Kitchener, and Cambridge to present the short-list of alternatives, the results of the detailed evaluation, and the direction being considered for the preferred alternative.
December 2017

Stage 6: Our Strategy

30-Day Public Review

The Master Plan along with a visual summary document entitled 'Biosolids Strategy 2018 at a Glance' was uploaded to the Region's website and following presentation to Council

Additional information on the feedback received over the course of the Strategy process is provided in **Appendix L (Comments Register)** and **Appendix M (Correspondence Register).** A number of articles in the media related to the Biosolids Strategy are contained in **Appendix N (News Articles).** Copies of the education materials developed to help reach a youth and student audience are included in **Appendix O (Biosolids Education Materials)**. The videos prepared for the Biosolids Strategy included:

- Let's Talk about Biosolids, a call to community participation featuring Bob McDonald;
- Region of Waterloo Biosolids, a follow-up video that provides a snapshot of the wastewater treatment and biosolids management process in the Region today;
- Region of Waterloo Biosolids Strategy Webinar Recording (Parts 1-6) from the activity in Stage 2 of the Strategy process; and
- Waterloo Region Biosolids Strategy: Deciding on Future Options, an explainer video summarizing the process of arriving at the short list of alternatives.

Summary: How Feedback Mattered

Throughout the public engagement process, the feedback was brought forward and used to inform subsequent steps in the development of the Biosolids Strategy. To summarize, the following highlights the main mechanisms by which feedback directly impacted decision-making:

1) Formulating the decision-making framework: From the development of' issues that matter' (Stage 1), to the Minimum Performance Questions used to screen the long list of alternatives and create a short list, to the detailed evaluation criteria applied to the short list, community feedback was directly integrated into decision-making in selecting among the alternatives and getting to the final strategy.

2) Developing the long list of alternatives: Through the RFI process conducted in Stage 2, the long list of alternatives for biosolids management was developed based on information provided directly by industry vendors, creating greater transparency and legitimacy to the research process and allowing for an improves level of reliability in the assumptions related to facility sizing and site requirements.

3) Confirming the short list and preferred strategy: The public events and survey held in Stage 4 of the project to confirm the short list, and subsequently the results of the detailed evaluation in Stage 5 to get to the preferred alternative were mechanisms to confirm the results of applying the decision-making framework and provide the community with an opportunity to see how the final strategy came together in a step-by-step process.

Figure 13-1 provides a "by the numbers" summary of the level of participation achieved through the engagement program.

Figure 13-1 Summary of Consultation Activities