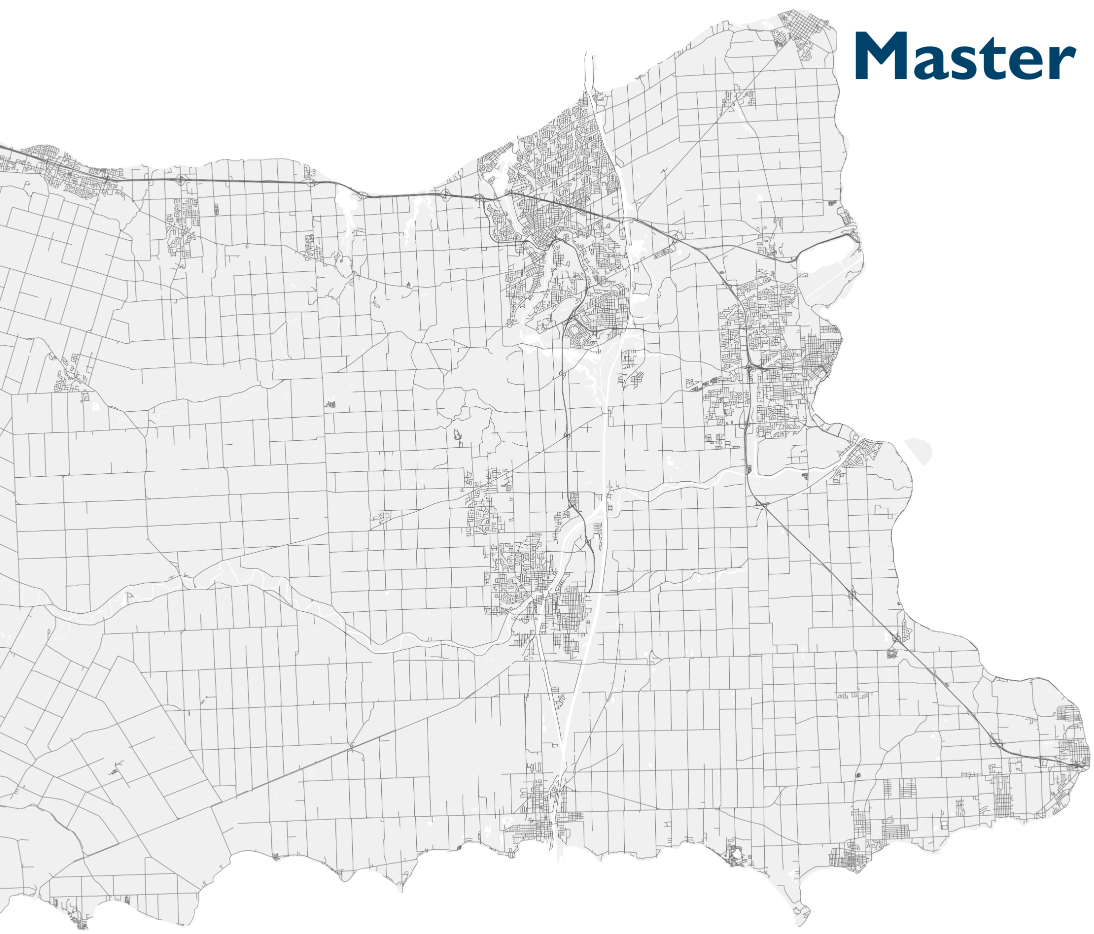
APPENDIX A9:
TM 9 – Long Term Market Strategies

Niagara Region

Technical Memorandum 9
Long Term Market Strategies

2021 Biosolids Management Master Plan Update

October 2022



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QA/QC - SIGN OFF SHEET

This report has been reviewed and approved by the undersigned.

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1.0 Introduction

1.1 Background and Purpose

In alignment with Niagara's Growth Management Strategy and under the legislative context of the Province's Place to Grow Plan and the Regional Policy Plan, growth in the Region of Niagara should occur in a sustainable manner addressing economic, social, and environmental considerations. The Region initiated the current Biosolids Management Master Plan (BMMP) Update to review the existing biosolids management strategy considering these Provincial and Regional growth targets, to identify limitations, develop and evaluate alternative management strategies, and recommend a preferred strategy for implementation. The study will follow Phases 1 and 2 of the Municipal Engineers Association Class Environmental Assessment Master Planning Process, while meeting the goals and objectives of the Region.

The BMMP will be developed to:

- Meet future population growth needs to the year 2051,
- Consider future regulations,
- Educate stakeholders regarding the benefits of biosolids reuse,
- Address community expectations,
- Protect the environment,
- Provide greater flexibility, reliability and cost efficiency for biosolids management, and
- Provide a 'Made in Niagara' strategy that incorporate features unique to this area.

The purpose of this technical memorandum (TM9) is to review end use markets for biosolids produced in the Region, both under current conditions and to 2051.

1.2 Technical Memorandum Outline

This TM is organized into the following sections:

1. **Introduction:** This section describes the BMMP purpose and TM outline.
2. **Regulatory Framework**: This section summarizes provincial and federal regulations associated with biosolids management.
3. **Niagara Region Biosolids Quantity and Characteristics:** This section describes the Region of Niagara's biosolids characteristics and implications for various end users.
4. **Target Markets and Market Availability Assessment:** This section summaries potential end use markets for biosolids and residuals based on the processing strategy and market demand. It also describes current market trends that could affect the Region's biosolids program.

5. **Recommended Target Markets/Outlets:** This section describes the recommended end use markets and their availability in Niagara Region and southern Ontario for biosolids use.
6. **Summary and Next Step:** This section describes next steps to develop biosolids management strategies.

2.0 Regulatory Framework

2.1 Biosolids Regulations

2.1.1 Federal

At the national level, Environment Canada administers the Canadian Environmental Protection Act to protect the environment and human health. The Canadian Food Inspection Agency (CFIA) regulates the sale and import of biosolids intended for use as a fertilizer or supplement.

2.1.1.1 The Canadian Environmental Protection Act (CEPA)

The Canadian Environmental Protection Act (CEPA) was enacted in September of 1999 and provides the Canadian government the power to protect the environment and human health while contributing to sustainable development. The CEPA does not directly address biosolids products. It may, however, address new substances found in biosolids through the National Pollutant Release Inventory (NPRI). The NPRI is a program that requires the reporting of the release of 323 substances listed on the inventory based on an annual threshold. From a regulatory perspective, Environment Canada currently considers biosolids to be a waste product. As a result, biosolids may be impacted in the future if the substances on the inventory or the threshold quantities change.

2.1.1.2 The Canadian Food inspection Agency (CFIA) Fertilizers Act (FzA) and Fertilizers Regulations (FzR)

The Canadian Food Inspection Agency (CFIA) administers several Acts and Regulations including the *Fertilizers Act (FzA*) and *Fertilizers Regulations (FzR)*. These have been designed to protect the food supply along with animals and plants. As a result, they enhance Canada's environment, economy and the well-being of its citizens.

The Fertilizers Act and Regulations require that regulated fertilizers and soils supplements are safe for humans, animals, plants and the environment. The regulations require that the items are labeled for safety and their proper use. The products regulated include:

- Farm fertilizers
- Micronutrients
- Lawn and Garden products

- Supplements, including:
  - Water holding polymers
  - Microbial inoculants
  - Abiotic stress protectants
  - Liming materials
  - Waste derived material such as composts and municipal biosolids.

While CFIA regulates the fertilizers and supplements that are sold and imported into Canada, the manufacturer of the product, their use and disposal are controlled by provincial and municipal regulations. The CFIA performs pre-market assessments and label verification on fertilizer products. For supplements such as biosolids products and compost they provide marketplace monitoring to verify their compliance with prescribed standards which include pathogens, metals, and pesticide residue along with dioxins and furans.

The Fertilizer Trade Memoranda provides product specific information and requirements for fertilizers and supplements regulated under the *Fertilizers Act* Section T-4-93. The safety standards for fertilizers and supplements provide a series of metals concentrations that are acceptable in a fertilizer product. As noted on Table 1, the maximum acceptable product metal concentration (in milligrams per kilogram (mg/kg)) on a dry weight basis) is calculated based on an anticipated 45-year cumulative loading (in kg per hectare (kg/ha)).

Table 1. CFIA Fertilizer and Supplements Metals Standards

METAL	MAXIMUM ACCEPTABLE CUMULATIVE METALS ADDITION TO SOIL OVER 45 YEARS (KG/HA)	EXAMPLES OF MAXIMUM ACCEPTABLE PRODUCT METAL CONCENTRATION BASED ON ANNUAL APPLICATION RATES (MG/KG) 4,400 KG/HA-YR	EXAMPLES OF MAXIMUM ACCEPTABLE PRODUCT METAL CONCENTRATION BASED ON ANNUAL APPLICATION RATES (MG/KG) 2,000 KG/HA-YR	EXAMPLES OF MAXIMUM ACCEPTABLE PRODUCT METAL CONCENTRATION BASED ON ANNUAL APPLICATION RATES (MG/KG) 500 KG/HA-YR
Arsenic (As)	15	75	166	666
Cadmium (Cd)	4	20	44	177
Chromium (Cr)	210	1,060	2,333	9,333
Cobalt (Co)	30	151	333	1,333
Copper (Cu)	150	757	1,666	6,666
Mercury (Hg)	1	5	11	44
Molybdenum (MO)	4	20	44	177
Nickel (Ni)	36	181	400	1,600

METAL	MAXIMUM ACCEPTABLE CUMULATIVE METALS ADDITION TO SOIL OVER 45 YEARS (KG/HA)	EXAMPLES OF MAXIMUM ACCEPTABLE PRODUCT METAL CONCENTRATION BASED ON ANNUAL APPLICATION RATES (MG/KG) 4,400 KG/HA-YR	EXAMPLES OF MAXIMUM ACCEPTABLE PRODUCT METAL CONCENTRATION BASED ON ANNUAL APPLICATION RATES (MG/KG) 2,000 KG/HA-YR	EXAMPLES OF MAXIMUM ACCEPTABLE PRODUCT METAL CONCENTRATION BASED ON ANNUAL APPLICATION RATES (MG/KG) 500 KG/HA-YR
Lead (Pb)	100	505	1,111	4,444
Selenium (SE)	2.8	14	31	124
Thallium (TI) (1)	1	5	11	44
Vanadium (V) (1)	130	656	1,444	5,777
Zinc (Z)	370	1,868	4,111	16,444

Note (1) Not all products require analysis for Thallium and Vanadium. Results may be requested on a case-by-case basis based on the type of product or material.

The number of samples to be collected is dependent on the number of “batches” or “lots” produced within the last three-year period. If greater than 26, the number of samples will be determined in conjunction with CFIA.

The maximum acceptable cumulative addition to soils of polychlorinated dibenzo-p-dioxins (dioxins; PCDD) and polychlorinated dibenzofurans (Fs) concentrations and the 45-year cumulative application product concentrations for dioxins and furans to soil is 5.355 toxic equivalents per hectare (TEQ/ha), is presented in Table 2. In addition, a maximum concentration of 100 nanograms (ng) TEQ/kg is being considered to protect workers.

Table 2. CFIA Fertilizer and Supplements Dioxin and Furan Standards

	MAXIMUM ACCEPTABLE CUMULATIVE PCDD/FS ADDITION TO SOIL OVER 45 YEARS (MG TEQ/HA)	EXAMPLE OF MAXIMUM ACCEPTABLE PCDD/FS CONCENTRATION BASED ON ANNUAL APPLICATION RATES (NG TEQ/HA) 4,400 KG/HA-YR	EXAMPLE OF MAXIMUM ACCEPTABLE PCDD/FS CONCENTRATION BASED ON ANNUAL APPLICATION RATES (NG TEQ/HA) 2,000 KG/HA-YR
PCDD/ Fs	5.355	27	59.5

Section T-4-93 of the *Fertilizers Act* also addresses pathogen reduction in biosolids using Salmonella and Faecal Coliforms as indicators. The section mentions that this approach is closely aligned with the US EPA's 40 Part 503 Regulations. The maximum level of these organisms in fertilizers and supplements is presented in Table 3. The Act includes further information regarding the acceptable tolerances for fertilizers that guarantee certain concentrations of micronutrients in their product.

Table 3. CFIA Indicator Organisms in Fertilizers and Supplements

INDICATOR ORGANISM	MAXIMUM LEVEL	MINIMUM DETECTION LIMIT
Salmonella	Not Detectable	Less than 1 Colony Forming Unit (CFU) / 25 grams
Faecal Coliforms	1000 Most Probable Number (MPN) / gram	Less than 2 CFU / gram

The Fertilizer Trade Memoranda provides information on the requirements for compost under the *Fertilizers Act*. Section T-4-120, Regulation of Compost under the Fertilizers Act and Regulations, describes the safety and labelling requirements that must be met to sell compost in Canada. This Section is also intended to assist compost producers and facility operators in meeting the regulations administered by the CFIA.

Compost is classified as a supplement and is defined in schedule II of FzR. Compost products are exempt from registration and do not require a market reassessment by CFIA. The product must still meet all the standards and requirements outlined in the FzR. The requirements include:

<u>Labelling requirements</u>

- Nutrient information if guaranteed on the product labelling
- Net material weight
- Producer information
- Organic matter and moisture content
- Lot number (all supplements must include a lot number on the product label)
- Directions for use
- Cautionary Statements
- Product pH and sodium (Na) content are recommended but not required.
- Labels can be printed in English or in French. If printed in both, each language must contain the full level of detail as the other.

<u>Safety standards</u>

- Physical contaminants
- Chemical contaminants which include most of the metals outlined in Table 4.

- Biological contaminants which include the indicator organism information outlined in Table 3, above.
- Maturity. The sale of compost is restricted to mature product. It is the producer's responsibility to demonstrate the maturity using scientifically valid methods.
- Prohibited materials including Specified Risk Materials (SRM)

The requirements for compost products also include recall procedures, record keeping requirements and sampling procedures

The safety standards for fertilizers and supplements provide metal concentration limits that must be met for the product to be used as a fertilizer.

2.1.1.3 Canadian Council of Ministers of the Environment (CCME) Guidance Document for the Beneficial Use of Municipal Biosolids, Municipal Sludge and Treated Septage

The Guidance Document for the Beneficial Use of Municipal Biosolids, Municipal Sludge and Treated Septage was developed by the CCME Biosolids Task Group (BTG) and published in 2012. It was developed in support of a Canada-wide approach to the management of biosolids. The guidance supports the beneficial use of biosolids and the sound management of biosolids, wastewater treatment sludge and treated septage. The guidance "contains information to assist Canadian regulators and generators to manage these three categories of wastewater residuals in an environmentally beneficial and sustainable manner" (Canadian Council of Ministers of the Environment, 2012).

2.1.1.4 CCME Guidelines for Compost Quality

In the early 1990s the CCME, to support the composting industry in Canada, established a committee to develop quality guidelines for compost products. The CCME, the Bureau de normalization du Quebec (BNQ) and the CFIA agreed to coordinate and develop compost standards to provide consistency. This effort resulted in the first edition of the CCME Compost Quality Guidelines which were published in 1996. The growth in the composting industry since 1996 and the advances in science and technologies resulted in the need to update the guidelines. The revised guidelines published in 2005 are based on four criteria to ensure product safety and quality (Canadian Council of Ministers of the Environment, 2005):

- Foreign matter
- Maturity
- Pathogens and
- Trace Elements

The Guidelines established two grades of material:

- Category A – Unrestricted use and
- Category B – Restricted use

The Guidelines for Compost Quality are referenced in the CCME Guidance Document for the Beneficial Use of Municipal Biosolids, Municipal Sludge and Treated Septage.

2.1.2 Provincial

2.1.2.1 Environmental Protection Act (EPA), Ontario Water Resources Act (OWRA) and Nutrient Management Act (NMA)

Ontario regulates the maintenance and operation of wastewater treatment and biosolids processing facilities through the Ontario Water Resources Act (OWRA) and the Environmental Protection Act (EPA). Application of municipal biosolids on agricultural land, as well as any form of commercial fertilizer, is regulated under the Nutrient Management Act 2002 (NMA), Ontario Regulation (O. Reg. 267/03). Application on other lands in Canada is regulated under the EPA.

The NMA was developed by the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA), and the Ministry of the Environment, Conservation and Parks (MECP). OMAFRA is responsible for the approvals, training, certification and education activities required for the safe application of non-agricultural source material (NASM). They will also notify the local municipality (lower or single tier) when any NASM Plan within its jurisdiction is approved. MECP is responsible for enforcing compliance with the O. Reg. 267/03 of the NMA. They will also carry out proactive inspections and respond to complaints of NASM land application activities to ensure compliance with the regulatory standards and protection of the environment.

Regulation 347 under the EPA provides details on the regulation of organic soil conditioning sites and the standards applied, such as distance from watercourses, points of access to water, and distance from residences. Environmental quality, food safety, and human health issues and concerns are addressed in both Regulations and supporting land application publications of the OMAFRA and the MECP.

The NMA regulates biosolids as NASM intended for application to agricultural land as nutrients. NASM categories include yard waste, fruit and vegetable peels, food processing waste, pulp and paper biosolids and municipal sewage biosolids. O. Reg. 267/03 under the NMA prohibits application of these materials to land that is unsuitably close to adjacent surface waters and sensitive areas; sets out criteria regarding heavy metal concentrations and suitable soil types and topography; and outlines the amount, method and timing of application. Before being approved for application on farmland, biosolids must be tested for pH, available nitrogen, potassium and phosphorus, pathogens, 11 regulated heavy metals, and meet sampling requirements set out in the regulation.

NASM is categorized into three categories (1, 2, and 3) under the NMA, based on material quality. These categories set requirements for material and soil testing and level of approval. Biosolids are a Category 3 NASM. In addition, materials are further sub-categorized into pathogen (CP1 and CP2), odour (OC1, OC2, and OC3), and metal (CM 1 and CM2) categories. Metal and pathogen categories determine setbacks from wells, surface water, groundwater and bedrock. Setback distances to residential, commercial, community or institutional properties are determined by odour category. The standards for biosolids under each of these categories are described as follows:

- Pathogen Category: Biosolids that meet the CP1 standard must meet levels of E.coli ≤1,000 colony forming units (CFU)/g dry weight or 100 ml, Salmonella < 3 CFU or Most Probable Number (MPN)/4 g or 100 ml, and Viable Helminth Ova & total culturable Enteric Virus < 1 organism per 4g or 100 ml. Sewage biosolids categorized as CP2 must meet the E.coli < 2 x 10^6 CFU/g of total solids dry weight standard.
- Odour Category: Biosolids must have an odour detection threshold of less than 500 odour units (ou) per cubic meter (m^3) to be categorized as OC1. OC2 biosolids are between 500-1,500 ou/m^3 and OC3 biosolids are between 1,500 and 4,500 ou/m^3. O.Reg 267/03 does not allow NASM materials to be applied to agricultural land if they exceed 4,500 ou/m^3.
- Metal Category: Biosolids are classified as CM1 if they do not exceed the metal concentrations laid out in the middle column of Table 4 and CM2 if they fall between CM1 concentrations and the right-most column.

Table 4. Biosolids Categories CM1 and CM2 Metal Concentrations

(O. Reg 267/03 (2002))

REGULATED METAL	CM1 CONCENTRATION IN NON-AQUEOUS MATERIAL (CONTAINING 1% OR MORE TOTAL SOLIDS, WET WEIGHT), EXPRESSED AS MG PER KG OF TOTAL SOLIDS, DRY WEIGHT	CM2 CONCENTRATION IN NON-AQUEOUS MATERIAL (CONTAINING 1% OR MORE TOTAL SOLIDS, WET WEIGHT), EXPRESSED AS MG PER KG OF TOTAL SOLIDS, DRY WEIGHT
Arsenic	13	170
Cadmium	3	34
Cobalt	34	340
Chromium	210	2,800
Copper	100	1,700
Lead	150	1,100
Mercury	0.8	11
Molybdenum	5	94
Nickel	62	420
Selenium	2	34
Zinc	500	4,200

Updates to the NMA were published in July 2021. Part IX, Sampling, Analysis, and Quality Standards and Application Rates, Category 3, section 98.0.7, 98.0.8 and 98.0.9 set the criteria for determining the maximum biosolids application rates based on crop Nitrogen and Phosphorus requirements. In addition to these nutrient restrictions, new approvals for land application (NASM Plans) must meet beneficial use criteria (demonstrate beneficial use for either organic matter content, nutrients, increase soil pH or irrigation) as well as regulated metals and dry matter.

Plant available nitrogen applied cannot exceed crop requirement or nitrogen removed by crop harvesting and must be less than 200 kg/ha in any 12-month period. Plant available phosphate over a five-year period cannot exceed the phosphate removed by crop harvesting plus 390 kg/ha.

The maximum application rates of regulated metals are presented in Table 5. The application of regulated metals through biosolids application must be limited to the listed amounts per hectare (ha) over a five-year period. The MECP must be satisfied that the application of CM2 materials will not result in a measurable increase in soils whose concentrations exceed those listed in the third column of Table 5.

Table 5. Maximum Application Rates of Regulated Metals

O. Reg 267/03 (2002)

REGULATED METAL	MAXIMUM ADDITION TO SOIL (IN KILOGRAMS OF REGULATED METAL PER HECTARE/PER FIVE YEARS)	MAXIMUM CONCENTRATION IN SOIL (IN MILLIGRAMS PER KILOGRAM OF SOIL, DRY WEIGHT)
Arsenic	1.4	14
Cadmium	0.27	1.6
Cobalt	2.7	20
Chromium	23.3	120
Copper	13.6	100
Lead	9	60
Mercury	0.09	0.5
Molybdenum	0.8	4
Nickel	3.56	32
Selenium	0.27	1.6
Zinc	33	220

Category 3 NASM must also meet the application limits listed in Table 6 for sodium and fats, oils and greases for each soil hydrologic group. Soil hydrologic groups are defined and described in the Drainage Guide for Ontario, Publication 29, published by the OMAFRA (2007).

Table 6. Maximum Application Limits for Sodium, Fats, Oils and Greases

O. Reg 267/03 (2002)

HYDROLOGIC SOIL GROUP	MAXIMUM ADDITION TO SOIL (IN KILOGRAMS OF SODIUM PER HECTARE/YEAR)	MAXIMUM ADDITION TO SOIL (IN KILOGRAMS OF FATS, OILS AND GREASE PER HECTARE/YEAR)
A	200	5,000
B	200	5,000
C	500	2,500
D	500	2,500

Ontario also has land application requirements that specify waiting periods for harvesting tree fruits and grapes, vegetables, hay and haulage, and sod as well as grazing horses, cattle, swine, sheep and goats.

A NASM Plan is like a Nutrient Management Plan (NMP) but deals only with the area where NASM is applied and not the whole farm. The NASM must be prepared by a certified Individual. Under the NMA, for land application of material, copies of the NASM Plan, annual update and summary, site characterization, and records of the NASM application area, quantity applied, source of material, dates on which it was applied, and sampling and analysis results must be kept for two (2) years.

Haulers need to have a System Environmental Compliance Approval (ECA) issued by the MECP or register their operations to the Environmental Activity and Sector Registry, where eligible, but it must be revised to allow the transport of NASM to sites operating under a NASM Plan. Land appliers need to have a Prescribed Materials Application Business License and the person applying the NASM must be trained and have a license.

For application on non-agricultural land, the ECA sets out the maximum acceptable metal limits in the biosolids and soil of the receiving site on a case-by-case basis. There are no regulations on the inclusion of biosolids in topsoil and manufactured soil blends. If the blends are applied to agricultural land, a NASM plan under O.Reg. 267/03 is required; if the blends are applied on non-agricultural land, then an ECA under EPA is required.

O. Reg. 267/03 sets out storage capacity requirements for biosolids to be applied to agricultural land. NASM, including biosolids, cannot be land applied during the period beginning on December 1 of one year and ending on March 31 of the following year or at any other time when the soil is snow-covered or frozen. The Design Guidelines for Sewage Works, published by the MECP, indicate that a minimum 240 days of storage should be provided for biosolids unless a different period is justified based on site-specific conditions. The Design Guidelines note that the 240 days storage requirements under O. Reg. 267/03 can be a combination of a "permanent biosolids nutrient storage facility, a temporary field nutrient storage site (dewatered municipal sewage biosolids only) or a combination of such facilities and sites that is capable of storing generated sewage biosolids during a period of at least 240 days."

2.1.2.2 Quality Standards and Guidelines to produce Compost (2012)

In 2012, Ontario updated its quality standards and guidelines to produce compost, to encourage the composting of more materials, while protecting the environment and human health (Ontario Ministry of the Environment, Waste Management Policy Branch, 2012). The new standards include three categories of compost (AA, A, and B), which provide additional options for the management of biosolids. Category AA is unrestricted use that allows compost to be given away and used by the public freely. Under the Ontario compost regulation, a compost that contains biosolids cannot be classified as AA Category. These standards set quality criteria for metals, pathogens, maturity and foreign matter for each category of finished compost.

The maximum metals concentration for compost categories A and B are detailed Table 7, as well as the maximum metals concentration in compost feedstock (biosolids in this case).

Table 7. Maximum Metals Concentration

METAL	CATEGORY A COMPOST (MG/KG DRY WEIGHT)	CATEGORY B COMPOST (MG/KG DRY WEIGHT)	FEEDSTOCK FOR CATEGORIES A & B COMPOST (MG/KG DRY WEIGHT)
Arsenic	13	75	170
Cadmium	3	20	34
Chromium	210	1060	2800
Cobalt	34	150	340
Copper	400	760	1700
Lead	150	500	1100
Mercury	0.8	5	11
Molybdenum	5	20	94
Nickel	62	180	420
Selenium	2	14	34
Zinc	700	1850	4200

Compost Category A and B must not exceed the following pathogen reduction requirements: 1,000 CFU or Most Probable Number (MPN) E. coli/gram total solids and 3 MPN Salmonella/4 grams total solids. Both categories must be cured for 21 days at a set respiration rate to achieve required standard maturity. Compost product must be maintained at a moisture concentration of no more than 40%.

For Category A foreign matter >3 mm cannot exceed 1%, calculated on a dry weight basis and will contain no sharp matter. For Category B foreign matter >3 mm cannot exceed 2%, dry weight, and must contain no more than 3 sharp pieces per 50 ml, no greater than 12.5 mm. For both categories, plastic cannot exceed 0.5%, dry weight, and foreign matter cannot exceed 25 mm.

Category A material must be labelled with:

- A statement that the product contains municipal sewage biosolids, if biosolids included in feedstock
- Recommended application rate
- A statement that failure to comply with recommended application rate could result in accumulation of metals in soil
- A statement that product should not be used on soils with elevated copper or zinc concentrations

Categories A and B allow municipal wastewater biosolids to be used as feedstocks up to 25%, allowing for the beneficial use of these resources. Category A compost is exempt from the need for approvals if it meets the new standards, including labelling, while Category B, falls under the same requirements as a NASM, will continue to require government approval for use and transportation, including an ECA or Environmental Activity and Sector Registry (EASR) registration for transport and ECA for use off-farm or approved NASM Plan for on-farm use. The new standards also align Ontario more closely with those set out in 2005 by the CCME.

2.2 Landfill Regulation

2.2.1 Federal

In Canada, federal, provincial, territorial, and municipal governments share the responsibility for managing wastes. Municipal governments manage the collection, recycling, composting and disposal of household wastes and provincial authorities approve and monitor waste management facilities and operations. The federal government complements the activities of municipal and provincial authorities by controlling international and interprovincial movements of hazardous waste and identifying best practices to reduce pollution from the management of this waste.

Hazardous wastes are managed under CEPA, by regulations such as the Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations and the Polychlorinated Biphenyl (PCB) Waste Export Regulations. Incinerator ash and digested dewatered cake do not qualify as hazardous wastes. Landfilling of these biosolids products is regulated under provincial regulations.

2.2.2 Provincial

In Ontario, landfilling sites and other waste management activities are regulated by the EPA and the regulations made under the Act. Regulatory requirements for the design and operation of waste disposal sites are included in O. Reg 347. For new or expanding landfilling sites, these regulatory requirements are superseded by O. Reg 232/98, under the EPA.

Under O. Reg 347 waste is considered non-hazardous if produced from the operation of a wastewater treatment plant which is subject to OWRA, where the works are owned by a municipality. Likewise, incinerator ash resulting from the incineration of waste that is not a hazardous waste is therefore considered non-hazardous. Non-hazardous waste is called “municipal” waste under O. Reg 347. Landfill standards in Regulation 232/98 only apply to sites accepting “municipal” waste.

An ECA must be obtained for the establishment, operation, alteration, or enlargement of a landfilling site. Prior to approval, a detailed assessment, per O. Reg 232/98, is required to identify any potential effects on the environment and how these effects will be addressed. Each site’s ECA defines the size of the landfill site, the types of waste to be accepted, and any necessary conditions for design and operation.

Dewatered wastewater solids cake can be disposed of in municipal sanitary landfills. The required solids concentration of dewatered cake to be landfilled are specified by the individual landfill authorities. Per the MECP’s Design Guidelines for Sewage Works, “with small quantities of sludge for co-disposal landfilling with municipal solid waste, liquid sludge at solids concentrations as low as 3 percent Total Solids (TS) may be acceptable.” For landfills that are sludge-only, a minimum 18 percent TS concentration is required, or a slump of 150 mm or less. O. Reg 347 includes the “Test Method for Determination of Liquid Waste (Slump Test)” (MECP, 2008). Although digested dewatered cake produced at Niagara Falls Wastewater Treatment Plant (WWTP) and Garner Road Biosolids Facility could be disposed of in approved municipal sanitary landfill sites, Niagara’s practice is to beneficially use their biosolids products and avoid disposal at landfill sites.

2.3 Potential Regulatory Trends and Changes

Regulations developed to protect human health and the environment are extremely important. The regulations are reviewed on a regular basis and are amended, when necessary, based on new findings within the scientific community. There are a few chemicals and materials being found in water and subsequently wastewater that may impact the future regulation of biosolids. These include:

- Per- and polyfluoroalkyl substances (PFAS), and

- Microplastics

This section provides an overview of these trends.

2.3.1 Per- and polyfluoroalkyl substances (PFAS)

PFAS are a group of chemicals that have been widely used for 50 years in consumer products, fire-fighting foams, and manufacturing. PFAS are characterized by a carbon molecule bonded to a fluoride molecule, one of the strongest chemical bonds in nature. Additionally, they are hydrophobic and repel fats in humans and animals, some of these compounds (especially the longer-chain versions) tend to bind to proteins and are found in blood serum and the liver. Some PFAS type compounds have half-lives of four or more years in humans.

The primary concern with PFAS in biosolids is related to its potential to leach to water supplies after being applied to soils, or runoff to the surface waters used for drinking water. There is less concern regarding inhalation, ingestion, dermal contact, or other possible organic residuals-related routes of exposure.

At the Federal level, perfluorooctanoic acid (PFOA), perfluorocarboxylic acid (PFCA) and perfluorooctane sulfonate (PFOS) are listed as substances subject to Prohibition of Certain Toxic Substances Regulations (2012), as regulated by Environment and Climate Change Canada (ECCC). The regulations prohibit the manufacture, use, sale, offer for sale or import of the toxic substances listed below, and products containing them, with a limited number of exemptions. In 2018 Health Canada introduced drinking water quality and screening values for PFOS, PFOA and other PFAS (see Table 8 and Table 9 below), followed by soil screening values in 2019 (see Table 10) (Government of Canada, 2019; Health Canada, 2019; Health Canada, 2016).

Table 8. Canadian drinking water quality - MACs for PFOS and PFOA

PFAS NAME	ACRONYM	MAXIMUM ACCEPTABLE CONCENTRATION (MAC) (MILLIGRAMS/LITER) (MG/L)	MAXIMUM ACCEPTABLE CONCENTRATION(MAC) (MICROGRAMS/LITER) (µG/L)
perfluorooctanoic acid	PFOA	0.0002	0.2
perfluorooctane sulfonate	PFOS	0.0006	0.6

Table 9. Health Canada drinking water screening values - other PFAS

PFAS NAME	ACRONYM	DRINKING WATER SCREENING VALUE (MILLIGRAMS/LITER) (MG/L)	DRINKING WATER SCREENING VALUE (MICROGRAMS/LITER) (µG/L)
perfluorobutanoate	PFBA	0.03	30
perfluorobutane sulfonate	PFBS	0.015	15
perfluorohexanesulfonate	PFHxS	0.0006	0.6
perfluoropentanoate	PFPeA	0.0002	0.2
perfluorohexanoate	PFHxA	0.0002	0.2
perfluoroheptanoate	PFHpA	0.0002	0.2
perfluorononanoate	PFNA	0.00002	0.02
6:2 fluorotelomer sulfonate	6:2 FTS	0.0002	0.2
8:2 fluorotelomer sulfonate	8:2 FTS	0.0002	0.2

Table 10. Health Canada Soil Screening Values

PFAS NAME	PFAS ACRONYM	SOIL SCREENING VALUES (SSVS) (MG/KG)		
		AGRICULTURAL/ RESIDENTIAL PARKLAND LAND USE	COMMERCIAL LAND USE	INDUSTRIAL LAND USE
Perfluorooctane sulfonate	PFOS	2.1	3.2	30.5
Perfluorooctanoic acid	PFOA	0.70	1.05	9.94
Perfluorooctane sulfonate + Perfluorooctanoic acid	PFOS + PFOA	$\frac{[PFOS]}{SSV_{PFOS}} + \frac{[PFOA]}{SSV_{PFOA}} \leq 1$		
Perfluorobutanoate	PFBA	114	173	1630
Perfluorobutane sulfonate	PFBS	61	92	872
Perfluoropentanoate[b]	PFPeA	0.80	1.21	11.41

PFAS NAME	PFAS ACRONYM	SOIL SCREENING VALUES (SSVS) (MG/KG)		
		AGRICULTURAL/ RESIDENTIAL PARKLAND LAND USE	COMMERCIAL LAND USE	INDUSTRIAL LAND USE
Perfluorohexane sulfonate[a]	PFHxS	2.3	3.5	33
Perfluorohexanoate[b]	PFHxA	0.80	1.21	11.41
Perfluoroheptanoate[b]	PFHpA	0.80	1.21	11.41
Perfluorononanoate	PFNA	0.08	0.13	1.2
6:2 fluorotelomer sulfonate[b]	6:2 FTS	0.80	1.21	11.41
8:2 fluorotelomer sulfonate[b]	8:2 FTS	0.80	1.21	11.41

a) SSV is based on PFOS toxicity and an estimated daily intake from other sources assumed to be 0 mg/kg-day
b) SSV is based on PFOA toxicity and an estimated daily intake from other sources assumed to be 0 mg/kg-day

To date, there have been no impacts to biosolids programs in Ontario resulting from the implemented limits at the Federal level. A 2018 paper titled *Land Application of Municipal Biosolids: Managing the Fate and Transport of Contaminants of Emerging Concern*, produced by Agriculture and Agri-Food Canada, summarized a suite of studies conducted in Ontario and found that “although a considerable PBDE and PFAA, Perfluoroalkyl Acids, load was applied at time of biosolids application … detection of PBDEs and PFAAs in subsurface drainage, groundwater, and soil indicated that atmospheric deposition was likely an important source of these compounds. In addition, post-application levels of PBDEs and PFAAs in the soil remained largely within background soil levels derived from the literature” (Agricultural and Agri-Food Canada, 2018).

The USEPA published “PFAS Strategic Roadmap: Commitments to Action 2021 – 2024”, in October 2021. The document outlines their proposed steps to “Research, Restrict and Remediate” PFAS compounds in the environment. One of the most significant activities outlined in the document is the completion of a risk assessment for PFOA and PFOS in Biosolids. The risk assessment, which will consider highly exposed individuals under a variety of exposure pathways, will result in actual concentrations and loading rates of PFAS compounds. A case study was performed in Arizona in response to the land application ban that was a result of public opposition. The case study lead by the University of Arizona on behalf of the Pima County Regional Wastewater Reclamation Department sampled and analyzed the land that has had biosolids irrigation used in their agricultural programs, as well as the land that did not have biosolids applied. The study demonstrated that the use of biosolids and irrigation had limited PFAS concentrations at various depths from one to nine feet below the ground surface. The study resulted in the County lifting the ban on land application. The University of Arizona is working with several Biosolids Associations to conduct similar case studies throughout North America.

Conventional wastewater treatment will not remove PFAS compounds. The compounds can be removed from the liquid stream using Granular Activated Carbon (GAC). The State of Michigan in the United States is monitoring the success of GAC pretreatment from industrial sources that use the compounds in production. That will reduce the concentration in the wastewater collection systems but not eliminate it, in States with limited industrial influence, such as Vermont, the highest concentrations of PFAS compounds in the collection systems were found in residential areas.

Some high temperature biosolids treatment processes, including gasification and pyrolysis, are being tested as various levels of pilot scales to reduce the PFAS concentrations in biosolids. These processes which begin with a dried biosolids product have not yet been operated consistently at full scale. To eliminate PFAS from our environment, including wastewater and biosolids we must end the use of the compounds in out daily lives. The concentration for two long chain PFAS compounds in human blood samples, PFOA and PFOS, have dropped substantially since they were banned in the United States in 2010.

2.3.2 Microplastics

Microplastics are defined as plastic material that are ≤ 5 mm in size. Microplastics are produced from the breakdown of plastic materials and can include fragments (from litter or plastic molding), line and fiber (from rope, netting or cigarette butts), foam (from food containers and packaging), film (from plastic bags and wrappers), microbeads (from toiletry products) as well as production pellets (from the manufacture of plastic products). Microplastics can enter domestic wastewater through sources such as household dust, water from washing machines and erosion of paints.

Researchers recently (Mahon, et al., 2017) investigated the fate of these particles through different biosolids stabilization processes at seven wastewater treatment facilities in Ireland. The researchers found that lime stabilization and thermal drying produce the most microplastics (up to 13,675 particles per kg of dry matter), whereas anaerobic digestion produced up to 4,000 particles per kg of dry matter. The researchers postulated that the higher content in lime stabilized biosolids was due to shredding and flaking, while melting and blistering were potential contributors in thermal drying.

At the Federal level, Canada enacted a ban prohibiting the manufacture, import and sale of toiletry products that contain microbeads in 2018, extending the ban to include microbeads in natural health products and non-prescription drugs in 2019. A 2020 paper analyzed biosolids from two suppliers and the soils of three agricultural fields to which they were applied in Ontario (Crossman, Hurley, Futter, & Nizzetto, 2020). The study found that all fields receiving biosolids had higher soil microplastics concentrations than the control. The study findings suggested that biosolids applications at all sites likely result in microplastics export to surrounding aquatic systems from the terrestrial environment where biosolids were applied. The study noted that the recent ban on microbeads in cosmetics and personal care products would likely lead to a reduced load of microplastics in biosolids.

While there is limited scientific research documenting the effects of microplastics on soil (Nizzetto, Futter, & Langaas, 2016; Abel de Souza Machado, et al., 2018; Crossman, Hurley, Futter, & Nizzetto, 2020), studies indicate that there are no adverse effects from the presence of microplastics in land applied biosolids. The benefits of organic matter and nutrients from biosolids improving the soil’s microbial health are believed to outweigh the possible concerns of effects from microplastics.

3.0 Niagara Region Biosolid Quantities and Characteristics

3.1 Existing Biosolids and Residuals Characteristics

The Garner Road Biosolids and Dewatering Facility (Garner Road Facility) receives liquid biosolids and residuals from the Region's wastewater and water treatment plants. The Garner Road Facility consists of ten (10) clay lined lagoons each with 6,830 m^3 of storage capacity and three (3) above ground glass fused to steel storage tanks each with 7,736 m^3 of storage capacity. The total storage volume available is approximately 92,000 m^3. The facility is permitted to receive a daily maximum of 3,000 m^3 hauled liquid biosolids or residuals six days per week. The facility does not accept material on Sundays. They also do not accept material on statutory holidays (ECA A120215, April 2018).

Currently, the Garner Road Facility receives biosolids from the following wastewater treatment plants:

- Anger Avenue WWTP
- Baker Road WWTP
- Crystal Beach WWTP
- Niagara on the Lake WWTP
- Port Dalhousie WWTP
- Port Weller WWTP
- Seaway WWTP
- Niagara Falls WWTP (occasionally, as needed)

The Garner Road Facility also receives residuals from the following water treatment plants:

- Welland WWTP
- Decew Falls WTP
- Grimsby WTP
- Niagara Falls WTP

The wastewater biosolids transported to the Garner Road Facility have an average total solids concentration between 2 and 3 percent. The residuals received from the water treatment plants have an average total solids concentration between 1 and 2 percent. The solids are deposited into the lagoons for storage prior to management.

The biosolids added to the lagoon cells settle and are concentrated. Supernatant generated on the lagoons' surfaces are decanted and treated. Following storage, the total solids of the biosolids increases to as high as 6 to 7 percent. Biosolids that are land applied typically have total solids concentration between 4 and 5 percent to facilitate pumping. The thickened solids are land applied between April 1st and November 30th (weather dependent), with the majority land applied between July and September due to field conditions, weather and crop schedules.

Thomas Nutrient Solutions is responsible for managing the Region of Niagara's land application program and identifying and partnering with farmers for biosolids application on agricultural land. They are also responsible for liquid biosolids transportation, and the operation and maintenance of the storage lagoons at the Garner Road facility. Thomas Nutrient Solutions maintains a NASM plan for each agricultural end user and is responsible for acting in accordance with the Nutrient Management Act.

The biosolids that are not land applied are dewatered at the Garner Road Facility using centrifuge technology. The Region has a contract with Walker Environmental (formerly N-Viro Systems Canada) to transport, process and manage the resulting advanced alkaline stabilized product. Walker Environmental uses the N-Viro advanced lime stabilization process at their privately-owned facility to further process the biosolids creating a fertilizer grade product for land application. In addition to the dewatered cake from Garner Road Facility, Walker Environmental transports dewatered cake from the Niagara Falls WWTP, which has an average rated flow capacity of 68 MLD. The Niagara Falls WWTP also uses centrifuge technology at their facility for dewatering their anaerobically digested biosolids.

As described in TM 1, Background and Existing Conditions, July 2022, Table 27, during the period of 2017 through 2019 approximately 11,990 dry tons (DT) (4,000 DT/yr) of biosolids were transported from the Garner Road Facility for land application on agricultural fields. This represents just over 50 percent of the solids received at the facility. The remaining solids approximately 10,800 DT, (3,600 DT/yr) were dewatered to an average of 32 percent total solids and a volume of approximately 921,900 m^3. These biosolids were managed under contract with Walker Environmental.

Biosolids sampling data for the Garner Road Facility from 2017 to 2021 is presented and compared to regulatory values in Appendix A, Table A-1. The data indicates that biosolids meet CFIA maximum acceptable cumulative metals limits, Category 3 NASM CM2 metals concentration limits and metals limits for feedstock for categories A & B of Ontario compost quality standards.

Based on the test results, the biosolids generated at the Garner Road Facility currently do not meet CFIA faecal coliform limit of <1000 MPN/g or Category 3 NASM's CP1 E. coli limit of <1000 MPN or CFU/g of dry weight, and instead would fall under CP2 E. coli limit of < $2x10^6$ CFU/g dry weight (5-yr average recorded value of 13704.8 CFU/g). Meeting the more stringent faecal coliform of E Coli limits would allow the biosolids to be distributed to the public. Meeting the CP2 E. Coli limit allows the biosolids to be used in agricultural applications

3.2 Biosolid Products

To consider the potential markets for various biosolids products, it is important to understand how the biosolids products differ and how those product differences impact their use. This section addresses the differences in the products and "sets the stage" for the identification of target markets.

Biosolids products can be placed into the following general categories:

- Anaerobically digested biosolids; liquid or dewatered cake
- Advanced Anaerobically digested biosolids; liquid or dewatered cake.
- Incinerator ash
- Thermal dried products
- Compost products
- Alkaline stabilized products
- Advanced Alkaline stabilized products
- Manufactured soils

Each of these products can be applied to land to add nutrients and organics to soil. They are often referred to as "soil amendments". While the products are markedly different, they share the benefits listed in Table 11.

Table 11. Biosolids Benefits

BENEFIT	EXPLANATION
Improved soil structure	Biosolids can enhance the physical structure of soil, reducing its erosion potential
Improved drought resistance	Increased organic matter provided through biosolids can increase water retention, improving drought resistance and promoting more efficient water utilization

BENEFIT	EXPLANATION
Increased Cationic Exchange Capacity (CEC)	An increased CEC improves a plant's ability to utilize nutrients more effectively, reducing nutrient loss by leaching
Enhanced soil biota	The activity of soil organisms is essential in productive soils and for healthy plants. Their activity is largely based on the presence of organic matter, which can be provided through biosolids applications.
Slow-release nitrogen (N)	The N in biosolids is predominantly organic N and must be converted to inorganic N by soil microbes to become available to plants. This process is generally slow, and consequently the N in biosolids is referred to as "slow release." Slow-release N products can better match the N uptake of growing plants, minimizing the "burning" sometimes associated with inorganic N products and the potential for excess N leaching as well
Carbon sequestration	The organic matter in land applied biosolids sequesters carbon in the soil, reduces greenhouse gas emissions and energy consumption as compared to the production of fossil fuel based inorganic fertilizer
Fertilizer replacement	The nutrients in biosolids can reduce the greenhouse gas emissions from fossil-fuel based fertilizer production

Specific characteristics and uses for each product assessed are discussed in the sections below.

3.3 Anaerobically Digested Liquid and Dewatered Biosolids Cake

As mentioned, biosolids received from Region's WWTPs are anaerobically digested prior to transport to the Garner Road Facility. Anaerobic digestion is a popular process for wastewater treatment plants that include primary clarifiers. It is also popular for WWTPs similar in size to those that serve the communities in the Niagara Region. Facilities that have anaerobic digestion for their solids blend the primary and secondary solids prior to digestion. Anaerobic digestion allows the resulting biosolids to meet CP2 pathogen limits described in Section 2.

Anaerobically digested biosolids that are dewatered into a biosolids cake typically have a Total Solids (TS) concentration between 20 and 30 percent and are clay-like in appearance and consistency. These biosolids can be land applied with certain management practice requirements to meet agricultural crop nutrient requirements.

The application of digested biosolids to agricultural land is regulated under the NMA. Application of biosolids to non-agricultural land requires an ECA. Application rates vary based on crop needs and are limited by the nitrogen and phosphorus concentrations. The metals and sodium content of the biosolids also need to be considered. Typical application rates range from 2 dry tonnes per hectare (DT/ha) to 4 DT/ha.

3.4 Advanced Digested Liquid and Dewatered Biosolid Cake

Some agencies use advanced digestion to further reduce the concentration of pathogens in the stabilized material. Advanced digestion allows the biosolids to meet the CP1 criteria, Category A CCME Guidance, and with certain biosolids characteristics, the CFIA requirements. The following advanced digestion processes can be considered:

- **Thermal Hydrolysis**: The thermal hydrolysis process (THP) is a high-pressure, high temperature, pretreatment process used prior to anaerobic digestion. Dewatered solids entering the process are heated and pressurized. When the pressure is quickly released, the cell walls of the microorganisms within the wastewater solids rupture, increasing the bioavailability of the material entering the anaerobic digestion system. Because the THP process is performed on dewatered solids, the concentration in the downstream anaerobic digesters is much higher than in conventional mesophilic anaerobic digesters (MAD), 8 percent TS or higher, which reduces the required digester volume. The THP process typically achieves a volatile solids reduction (VSr) of approximately 60 percent or more. This results in increased biogas production while reducing total solids production. As with any process that increases VSr, the nutrient loads in the dewatering side-stream will increase with THP. The process improves the dewaterability of the digested solids, resulting in dewatered cake solids concentrations of 28 percent or higher, regardless of dewatering technology. The heating step in the THP process can meet CFIA requirements.
- **Thermophilic Anaerobic Digestion**: Thermophilic anaerobic digestion includes one or more stages that are operated at thermophilic temperatures, ranging from 50 to 60°C (122 to 140°F). Thermophilic digestion typically results in increased Volatile Solids and pathogen reduction. Depending on the configuration, thermophilic digestion can meet CFIA criteria and most thermophilic digestion systems are designed to generate a CFIA Fertilizer product. Existing mesophilic anaerobic digestion processes can often be converted to a thermophilic process. The conversion typically requires the addition of new heat exchangers along with system pumping and piping modifications, tank insulation, batch tanks, and modification to the existing biogas system. Thermophilic digestion processes have a higher odour potential and often reduced dewaterability when compared to mesophilic anaerobic digestion.
- **Temperature Phased Anaerobic Digestion**: Temperature phased anaerobic digestion (TPAD) process uses a combination of thermophilic and mesophilic stages to optimize

digester performance. Batch thermophilic tanks used in the systems allow the process to meet the CFIA Fertilizer criteria. The TPAD process requires similar modifications to existing Mesophilic Anaerobic Digestion systems as outlined above. The TPAD systems also face challenges with odour potential and reduced dewaterability.

While the biosolids that have undergone advanced digestion can meet the requirements of CP1 criteria, Category A CCME Guidelines, and with certain CFIA requirements, they have physical characteristics like conventional anaerobically digested dewatered cake (i.e., clay like consistency with a TS concentration in the 20 to 30 range). As a result, the use of the advanced digested biosolids are typically generally limited to agriculture and silviculture applications.

3.5 Incinerator Ash

While there are no incinerators in use with wastewater solids in the Region of Niagara, the potential for ash use has been included in the assessment. Incineration is a unit process which evaporates the water and burns the organic matter in dewatered cake using high temperature chemical oxidation reactions. The main advantages of incineration are the reduction in weight and volume of dewatered solids. Another advantage is the potential for energy recovery. The disadvantage is that emissions from the incinerator make implementation of an incineration facility a challenge. Concerns regarding air quality impacts from incineration can be mitigated by using air pollution control systems including a quenching device, wet scrubber and mercury scrubber.

The ash generated during the incineration process can be disposed of at a landfill or beneficially used. The ash, which has a bulk density higher than fly ash but lower than Portland cement can be used in the production of concrete. The ash has also been used in the production of asphalt, bricks, light weight blocks and tile.

3.6 Thermal Dried Products

Thermal drying is the process of evaporating the water in the dewatered cake by the addition of heat. Complete drying typically results in a product with 5 to 10 percent moisture content, and results in an approximate 30-fold volume reduction as compared with digested biosolids. Except for incineration, the moisture content of thermally dried biosolids is the lowest of the process alternatives considered. Heat is one of the most effective pathogen destructors. Thermal drying results in a product that meets the requirements of CFIA indicator organisms and the Category A CCME Guidance. The dried product can be used as a fertilizer or soil conditioner on acidic or alkaline soils. The dried biosolids, often referred to as pellets or granules, can also be used as a biofuel. The quality of the granules produced, drying system used, and local economic factors are likely to determine the end use of the dried biosolids.

During drying, biosolids undergo several structural changes as the moisture content decreases. The most critical stage is called the plastic stage when the moisture content is between 40 to 60% TS. In this stage, the dried product becomes sticky and difficult to manipulate. The power input required to move the product through this phase to higher concentrations is significant.

It is essential to minimize dust production or accumulation during the drying process due to the increased probability of fire or explosions, which have occurred in this process. Dust collection systems are used in multiple locations throughout the process to reduce the potential of fire or explosion.

The benefits of thermal dried products include:

- Storage of dried sludge requires less volume and is easier to handle.
- Transportation costs are reduced.
- Dried solids have a higher fuel value and can be used as a fuel source or incinerated.

The process is energy intensive. Safety is a key factor during design start up and operation. It is recommended that all biosolids that are thermally dried be anaerobically digested prior to dewatering to ensure product quality.

The thermal drying process is used in eastern Canada. A summary of direct drying facilities in Ontario and Quebec is presented in Table 12.

Table 12. Selected Thermal Drying Facilities in Canada

FACILITY LOCATION	COMMISSION DATE
City of Windsor (operated by Synagro Technologies Inc.)	1999
City of Toronto (operated by a Veolia)	2000
Smiths Falls (operated by Smiths Falls)	1992
Gatineau (operated by Synagro Technologies Inc.)	1992
Hamilton (operated by Synagro Technologies Inc.)	2020

As noted in Table 12, Veolia operates the drying facility on behalf of the City of Toronto. They currently produce approximately 22,000 tonnes of thermally dried product at the Ashbridges Bay WWTP annually. Veolia representatives explained to the Project Team that the product, Nutri-Pel, is certified as a CFIA fertilizer product and is successfully marketed to the agriculture market. The Veolia representatives explained that they manage the material through the entire drying and product sales market stages. In the Ontario market, Veolia works with approximately 250 farmers. They work with the farmers to determine their fertilizer needs, transport the material to the farms and apply the product on the farmers' behalf. The program that Veolia has developed allows them to successfully manage all the dried product generated at the Ashbridges Bay WWTP. In addition to the agricultural market, the City of Toronto's thermally dried product is used in the City's parks in turf grass and horticultural applications.

3.7 Compost Products

Composting is a biological process in which organic material undergoes biological degradation to a stable product. This technology can be applied for stabilization of dewatered wastewater solids (between 14 percent and 30 percent solids), supplied in undigested, digested or chemically stabilized forms. This self-heating aerobic process can attain temperatures in the pasteurization range of 50ºC to 70ºC. These temperatures destroy pathogens and can result in the production of a well-stabilized compost product that can be stored for extended periods with minimal odour. Drying during the composting process can result in a product with a total solids concentration of 55 percent to 65 percent.

The compost product can be used as a soil conditioner or organic fertilizer supplement for the horticultural and agricultural industry. Composting requires a relatively large footprint when compared to digestion, incineration or thermal drying. Composting, if not properly managed, can generate offsite odour. There is a benefit to digesting the biosolids prior to initiating the composting process. Digestion helps to provide a more stable product and reduces the potential for odor generation during the composting process. Even with digested biosolids entering the process and careful operation, there will be periods of odour. It is recommended that a composting facility be sited with sufficient buffer from homes and institutions.

Maintenance of a minimum temperature of 55°C for at least three days is required to inactivate the pathogens within an aerated static pile system. Some fungi however, including Aspergillus fumigatus, can survive the composting process because they are thermotolerant organisms. Compost product must meet the Ontario quality standards and restrictions on use outlined in Section 2.2.1. In addition, compost products sold in the Canadian marketplace must meet the safety, microbial quality, efficacy, and labelling requirements in the federal FzA and FzR administered by the CFIA.

As mentioned previously, compost product is easily handled and is often used for small- and large-scale landscaping, turf farming, soil blending, golf course construction, and nursery applications. The market for the composted biosolids includes home and garden use as well as commercial and institutional fertilizer uses.

Category B compost can also be used as daily and intermediate cover at a landfill that permits it's use. This, however, is not considered to be a significant market for compost products.

The Region currently contracts with Walker Environmental to compost source separated organics (SSO) and processed yard waste that is collected from residents. It may be possible to expand this operation to include a portion of the biosolids generated in the Region.

The primary markets for compost products include use in landscaping, nursery and garden centers, golf course and park maintenance. The material is often marketed in bulk to landscape firms, departments of Public Works and golf course operators, and to the public in smaller "retail" quantities.

The main disadvantage of composting is the large quantity of other organic material needed to produce Class A compost, the subsequent material handling requirements and the large footprint required. To be exempt from NMA and EPA regulations, biosolids can only be a maximum of 25% of feedstock. This results in a larger footprint for composting and product storage when compared to some other alternatives. While unlikely, if biosolids are composted and metal standards for Category A are not met, the compost can only be applied to land with NMA or EPA approval.

3.8 Alkaline Stabilized Product

Alkaline stabilization is a reliable physical chemical process used to stabilize wastewater solids. In the process, an alkaline material such as lime is mixed with biosolids to raise the pH to greater than 12.0 standard units. The elevated pH reduces pathogens. This process yields a product that can be land applied in support of agriculture. The most common alkaline compounds used to raise the pH are either hydrated lime ($Ca(OH)_2$), also known as calcium hydroxide or slaked lime, or quicklime (CaO).

To further stabilize the biosolids, additional materials such as sodium hydroxide ($NaOH$), potassium hydroxide (KOH), cement kiln or lime kiln dust, Portland cement or fly ash, can be added to the mixture to generate heat and/or ancillary heat can be applied. These additional materials or processes serve to further reduce the pathogens in the product.

Proprietary alkaline systems and processes are provided by suppliers such as Walker Environmental and RDP Technologies, Inc. Walker Environmental employs an advanced alkaline stabilization process with accelerated drying. RDP Technologies offers a lime stabilization system and a pasteurization system which incorporates ancillary heating to further reduce pathogens.

A list of alkaline stabilization facilities in Canada is presented Table 13.

Table 13. Alkaline Stabilization Facilities for Municipal Biosolids in Canada

FACILITY LOCATION	SUPPLIER	COMMISSIONING YEAR
Leamington, Ontario	Walker	1996
Sarnia, Ontario	Walker	2001
Stellarton, Nova Scotia	RDP Technologies	2005
Region of Niagara, Ontario	Walker	2005
Halifax Regional Municipality, Nova Scotia	Walker	2006
Summerside, Prince Edward Island	Walker	2008

Walker Environmental has registered their product as a fertilizer under the CFIA regulations. This allows them to distribute the product through agriculture marketing groups. Walker Environmental explained to the Project Team that in addition to organics and nutrients contained in their product, the elevated pH and liming characteristics of the material are a benefit to agricultural customers. Walker Environmental is currently working with enough agricultural property in southern Ontario to successfully market the over 60,000 tonnes they produce each year. They anticipate that they can market additional material once produced.

3.9 Thermal-Alkaline Hydrolysis

Lystek International has a proprietary technology that uses a low temperature, low pressure thermal-alkaline hydrolysis process to stabilize biosolids. The process mixes biosolids and alkaline material and operates at 70 degrees Celsius (°C), at atmospheric pressure and a pH of 9.5 to 10.0 to create a product with a TS concentration of approximately 15 percent. The product has been registered as fertilizer by the CFIA under the *FzR*. There are several Lystek International facilities operating in Ontario. One of these is the Southgate Organic Materials Recovery Centre, which can accept up to 150,000 DT/yr of wastewater solids.

The thermal-alkaline hydrolysis facilities located in Ontario are presented in Table 14.

Table 14. Thermal-Alkaline Hydrolysis Facilities in Ontario.

FACILITY LOCATION	SUPPLIER	COMMISSION DATE
Guelph, Ontario	Lystek International	2002
Southgate Organic Materials Recovery Centre, Dundalk, Ontario*	Lystek International	2013
City of Peterborough, Ontario	Lystek International	2010
Third High Farms, Iroquois, Ontario	Lystek International	2013
Township of Center Wellington, Ontario	Lystek International	2014

**Standalone facility owned and operated by Lystek*

Lystek representatives explained to the Project Team that in 2020 they processed approximately 130,000 tonnes of material at the Southgate facility, including approximately 20,000 tonnes that they receive from the City of Toronto.

Lystek supports the operation of eleven stabilization facilities in North America. They manage the product marketing and distribution for all but one of those facilities. The fertilizer produced at Southgate Facility is beneficially used within a 90-minute radius of the facility.

3.10 Manufactured Soils

There is no standard specification for “manufactured soils,” “soil blends,” “engineered soils,” or “imported soils”. These blended products vary depending on the materials available. When biosolids are used in manufactured soil, the biosolids are typically dewatered cake following an advanced digestion process. The process serves to further reduce pathogen content but often leaves the dewatered product “wet” 20% to 30% TS and clay like in consistency. Mixing this material with a dryer material such as sand, sandy loam soil or sawdust results in a product that in much more marketable. Some facilities have been able to establish a market for this product in bulk and in bags at retail facilities.

As noted in Section 2.1.2.1 there are no regulations on the inclusion of biosolids in topsoil and manufactured soil blends. If the blends are applied to agricultural land, a NASM plan under O.Reg. 267/03 would be required. If the blended products are applied on non-agricultural land, then an ECA under EPA would be required.

4.0 Target Markets & Market Availability Assessment

4.1 Biosolids Market End Users

The biosolids products described in Section 3 can be managed in several manners. These include a variety of beneficial use and disposal alternatives. This section reviews the potential markets for the beneficial use of stabilized biosolids products. The following markets in the Niagara Region and the Golden Horseshoe were considered.

- Agriculture Silviculture and Horticulture
- Parks and Recreation Departments
- Ontario Ministry of Transportation
- Landscape Contractors
- Golf Courses
- Land Rehabilitation
- Landfill Management
- Co-management with Source Separated Organics

Biosolids products could also be disposed of in a landfill if they have the acceptable characteristics, primarily solids content. Landfill disposal is not considered in this section since the Region's goal is beneficial use of the products of wastewater treatment.

A thermally dried biosolids product could be used as an alternative fuel source in power generation. If the Region elects to implement thermal drying, use as an alternative fuel source could be considered along with land application alternatives to provide additional redundancy in the biosolids management program.

4.2 Agriculture, Silviculture and Horticulture

4.2.1 Market Availability

As summarized in the Region's 2016 Census of Agriculture, fruit orchards are the Region's largest agricultural sector, accounting for two-thirds of Ontario's tender fruit orchards (Region of Niagara, 2017). Fruit and tree nut farms represent 30% of the Region's farms. Oilseed and grain farms represent 18% of the Region's farms. Greenhouse, nursery and floriculture producing flowers, maple syrup, honey and vegetables represent another 14% of the Region's farms. The amount of land in agriculture decreased by 9% between the 2011 and 2016 census. 39% of agricultural land was leased, rented or crop-shared in the Region in 2016. Of that agricultural land 152,564 acres (61,740 hectares) is dedicated to cropland and 6,245 acres (2,527 hectares) to pasture for both natural land and managed grassland.

The Golden Horseshoe of Ontario, comprised of the Regions of Durham, Halton, Niagara, Peel, York and the Cities of Hamilton and Toronto (Figure 1), is a rich agricultural area and represents a significant end user market for biosolid products. Niagara's agricultural sector represents 42.8% of the gross farm receipts, which is a major portion in the Golden Horseshoe region. Currently the Golden Horseshoe has 296,000 hectares dedicated to cropland and 29,000 hectares dedicated to pasture (OMAFRA, 2017).

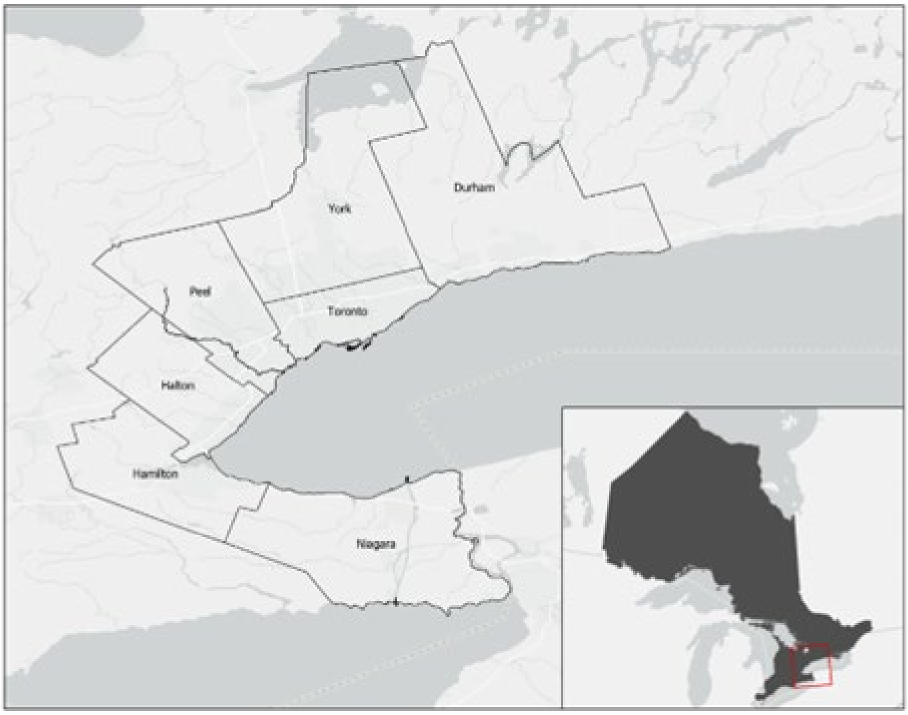

Figure 1: Niagara Region and Surrounding Golden Horseshoe

4.2.2 Demand Assessment

The demand for biosolids products will depend on the land use being supported and the biosolids product(s) being applied. In agriculture, application rate-based nutrient requirements typically could range between 2 and 4 DT/ha-yr. Anticipating an application rate of 2 DT/ha-yr, the 61,740 hectares of cropland in the Niagara Region could require over 120,000 DT of biosolids annually. Cropland in the Golden Horseshoe, 296,000 hectares, anticipating the same application rate, could require approximately 600,000 DT of biosolids to meet the nutrient demand. A summary of the 2019 Garner Road operating data indicates the Region land applies approximately 7,000 dt of biosolids, 3,800 DT of liquid biosolids and 3,200 DT of dewatered cake. It was noted that this represent 54 percent of the total biosolids generated, just under 13,000 DT/ year. This current generation rate, 13,000 DT/year represents 9 percent of the nutrients required in the Region of Niagara and 2 percent of the cropland nutrient requirements in the Golden Horseshoe.

Anaerobically digested biosolids, conventional or advanced, as a liquid, a cake or thermally dried, will provide the highest concentration of nitrogen per dry ton. Alkaline stabilized biosolids products will provide a lower concentration per dry ton of product due to the amount of alkaline material added to the biosolids in the process. This will result in a slightly higher required application rate. The alkaline material in the product will provide a lime substitute which is attractive in several agriculture practices. An alkaline stabilized product using the N-Viro process was one on of the highest sources of agricultural lime in Central New York State. The lime used in the process was an added benefit to farmers who wanted to raise the pH of their soil. It is difficult to estimate the lime demand in the Region, however there are several firms producing agricultural lime that is applied on agricultural lands in Niagara Region.

Compost product and thermally dried biosolids can be marketed as a CFIA fertilizer product. This broadens the available markets beyond the agricultural market. As mentioned above, thermally dried biosolids product can be used efficiently in agriculture applications. Compost products can also be used in agriculture, but the volume required is greater due the amendment used in the process, so it is not often used in the production of row crops. Thermally dried biosolids have a much higher total solids concentration, greater than 90 percent compared to 20 to 30 percent for a dewatered cake. As a result, less volume of dried product is required. This is a benefit to the agriculture community by reducing the truck traffic needed to transport biosolids to and onto the farm fields there by reducing impacts such as noise, air emission and soil compaction.

The City of Kelowna, British Columbia uses an Aerated Static Pile process (ASP) to create a compost product using dewatered biosolids from two WWTPs along with processed yard waste and ground waste dimensional lumber. They are a member of the Canadian Composting Council. The city mentioned that the process optimization recommendations provided by the Council has benefited their overall program

One of the outlets for their compost product are the vineyards in their area. They have seen competition in the vineyard market from other compost products that do not contain biosolids. Some vineyards have chosen to use other compost products that have been certified organic.

Estimates indicate that the potential agricultural demand for biosolid products in the Niagara Region is higher than the amount that could be produced in the 2051 plan year. To support this demand the Region will require proper stabilization, transportation, storage and marketing by the Region and any third-party firms that they may choose to work with.

4.3 Parks and Recreation Departments

4.3.1 Market Availability

In addition to agricultural use, there is a demand for biosolids products to provide fertilization and soil amendments to outdoor recreational fields and parks in the Region. Since these areas serve the public the biosolids products used will require additional stabilization to meet the fertilizer standards discussed previously.

Parks within the Region cover approximately 2,100 hectares of land (City of Niagara Falls, 2021; City of Port Colborne, 2019; City of St. Catharines, 2015; City of Thorold, 2020; City of Wellend, 2019; Town of Fort Erie, 2018; Town of Lincoln, 2019; Township of West Lincoln, 2010).

4.3.2 Demand Assessment

The 2,100 hectares of parks and recreational fields in the Region represent a significant demand. The grounds could be top dressed using compost product or thermally dried product.

The City of Kelowna, BC sells their compost product to soil blenders who could provide the product to these municipal Departments directly or to the landscaping firms who are contracted to maintain the grounds.

In 2022 The City of Kelowna is selling their compost product wholesale in a minimum volume of 3.8 m^3 (5 yd^3) for approximately \$25/ m^3 (\$33/ yd^3). They sell their compost in 20 Liter bags for \$4/bag.

4.4 Ministry of Transportation Ontario (MTO)

4.4.1 Market Availability

The Ontario Provincial Standards for Roads and Public Works (OPS) organization produces a comprehensive set of standards for use by road and public works departments, contractors, and consultants in Ontario. The Ministry of Transportation Ontario (MTO) manages the publishing and electronic distribution of the OPS standards. The use of OPS standards by MTO and other infrastructure owners is not mandatory, however they do serve as a guideline and are often considered by municipalities when developing their design standards and specifications. The use of compost or biosolids in blended soils is not restricted by these standards. OPS construction specification for topsoil (OPSS.MUNI 802) requires only that topsoil shall not contain material greater than 25 mm in size, such as stones and clods, shall not have contaminants that adversely affect plant growth and will have organic content between 7-11% by weight and a pH between 6 to 8 (Ministry of Transportation Ontario, 2019).

4.4.2 Demand Assessment

The Region had 6.9 million vehicle-km daily in 2011. Over the 30-year period captured in the Region’s population and employment growth, travel by motorized vehicles is expected to grow by 55%, reaching 10.7 million vehicles-km daily in 2041 (Region of Niagara, 2017). Manufactured topsoil products using compost product or thermally dried biosolids product could be used in the revegetation of right of way areas following road construction or maintenance projects. Given the variability of network growth and maintenance and the currently relatively low demand of biosolids as feedstock for compost or blended soils, this is considered a limited market.

4.5 Landscape Contractors

4.5.1 Market Availability

Soil amendments and composts are often sold, used, or distributed by landscapers. As mentioned previously, Class A or AA compost and thermally dried biosolids product that meet fertilizer requirements of the CFIA can be used in the production of a manufactured topsoil. This topsoil product can be used in a variety of landscaping projects including new construction, landscape maintenance and sod production.

4.5.2 Demand Assessment

Landscape contractors represent a good market to showcase the benefits of Class A and AA compost and thermally dried biosolids. While the volume of material they will consume may be less than other markets, they can help to educate the public on the benefits of biosolids use, which will benefit all markets.

4.6 Golf Courses

4.6.1 Market Availability

Both thermally dried biosolids and compost are used at golf courses, with dried product used as an organic fertilizer and class AA and A compost is used as a top dressing that supplies nutrients to the turfgrass.

The 37 golf courses in Niagara Region, are presented in Table 15**Error! Reference source not found.** below. The courses are public, semi-private or private. They are comprised of 9 holes, 11 holes, 18 holes, 27 holes or 45 holes. On average, 27-hole courses have 135 acres of greenway, 18-hole courses have 90 acres of greenway and 9-hole courses typically have 45 acres of greenway. Altogether, the courses identified within Niagara Region, representing 1,400 hectares of greenway (3,430 acres).

4.6.2 Demand Assessment

Using an application rate of 2 DT/ha-yr, the 1,400 hectares of golf courses in the Region could represent a maximum annual demand of 2,800 DT of biosolids product. This represents almost all the biosolids produced at Garner Road Facility. Thermally dried biosolids products are very popular at golf courses. Golf courses in the Niagara Region have not been contacted at this time to discuss the potential use of dried biosolids. There are courses in Western New York State that use a thermally dried biosolid products. They use the material on their greens and tees. The product is produced in Wisconsin and available only in bags in New York. The manager of one course's grounds explained, that due to the organic material in the product and the slow nitrogen release they would use the product for the entire course if it were cost competitive.

Table 15. Golf Courses in Niagara Region

GOLF COURSE	SIZE	AREA (ACRES)
Beechwood Golf & Social House	18-Hole	90
Bridgewater Country Club	18-Hole	90
Brock Gold Course	18-Hole	90
Cardinal Lakes Golf Club	36-Hole	180
Caistorville Gold Club	18-Hole	90
Cherry Hill Club	18-Hole	90
Eagle Valley GC & Golf Academy	18-Hole	90
Fort Erie Golf Club	18-Hole	90
Fox Run Golf Course	9-Hole	45
Freedom Oaks Golf Club	18-Hole	90

GOLF COURSE	SIZE	AREA (ACRES)
Garden City Golf Course	18-Hole	90
Grand Niagara Golf Club	18-Hole	90
Grassy Brook Golf Course	9-Hole	45
Heritage Woods Golf Course	11-Hole	55
Legends on the Niagara	45-Hole	225
Long Beach Country Club	9-Hole	45
Lookout Point Country Club	18-Hole	90
Niagara Falls Golf Club	18-Hole	90
Niagara National Golf Club	27-Hole	135
Niagara-on-the-Lake Golf Club	9-Hole	45
Oak Hall Par 3 Golf Course	9-Hole	45
Pelham Hills Golf Club	18-Hole	90
Peninsula Lakes Golf Club	27-Hole	135
Port Colborne Country Club	18-Hole	90
Queenston GC / St. Davids GC	9-Hole	45
Riverview Golf and Country Club	18-Hole	90
Rockway Vineyards Golf Course	18-Hole	90
Rolling Meadows G&CC	18-Hole	90
Royal Niagara Golf Club	27-Hole	135
Sawmill Golf Course	18-Hole	90
St. Catharines Golf & Country Club	18-Hole	90
Thundering Waters Golf Club	18-Hole	90
Twenty Valley Golf & Country Club	18-Hole	90
Water Park Golf & Country Club	18-Hole	90
Whirlpool Golf Course	18-Hole	90
Whiskey Run Golf Club	27-Hole	135
Willodell Golf Club of Niagara	18-Hole	90

4.7 Land Rehabilitation

4.7.1 Market Availability

Biosolids products can be applied to rehabilitate or reclaim land. Biosolids products have been used in the reclamation of mine tailing sites, re-vegetation of remediated environmentally contaminated sites, and in the establishment of vegetation around construction sites. From 2014 to 2018, a project at Vale Canada's Copper Cliff operation in Sudbury, Ontario, reclaimed approximately 150 hectares of Vale's tailings with 25,000 DT of biosolids (Terrapure). Under an ECA permit, biosolids were used to provide organic matter and nutrients to vegetation and to stabilize the pH of the tailings.

4.7.2 Demand Assessment

Although there are several mines and contaminated sites in Ontario, their number within and adjacent to the Region indicate that this a limited market. The number of active federal contaminated sites in and around the Region can be seen in Figure 2: Federal Contaminated Sites in and around the Niagara Region, with 7 active sites in the Region itself (Treasury Board of Canada Secretriat, 2020).

Figure 2: Federal Contaminated Sites in and around the Niagara Region

4.8 Landfill Sites

4.8.1 Market Availability

Biosolids products such as compost and their feedstock biosolids could be beneficially used at landfills for routine maintenance and for establishing vegetation on the final landfill cover. As discussed previously Category B compost can be used as daily, intermediate cover at a landfill, as permitted by an ECA.

4.8.2 Demand Assessment

The Ontario Waste Management Association's 2018 Landfill Report estimated that Ontario's 805 most active public and private sector landfill sites had a remaining capacity of 122 million tonnes, which could be depleted by 2032 (Ontario Waste Management Association, 2018). Landfills received 8.1 million tonnes of waste in 2017, an increase of 5% over 2016. Based on the current landfill capacity depletion rate, Ontario's available landfill capacity is expected to be exhausted in 12 years, by the year 2032. If the United States were to prohibit Ontario's waste from crossing the border, Ontario's landfill capacity could be exhausted by 2028.

Biosolids products could be used in the operation and cell closures of the following landfills located in the Niagara Region:

- Humberstone Landfill
- Niagara Road 12 Landfill
- Modern Landfill Inc. of Canada.

These facilities could be good markets for compost products and manufactured soil products Landfill sites can also be opportunities for longer term product storage, such as over winter months and as potential processing sites. There are several composting facilities constructed in open areas of active landfills.

4.9 Co-Management with Source Separated Organics (SSO)

4.9.1 Market Availability

The co-management of biosolids and Source Separated Organics (SSO) is a process option more than a market. Biosolids are used with other organics and amendment types to create compost products. Biosolids and processed SSO are also co-digested to generate biogas created by volatile solids reduction in the digestion process.

As mentioned previously biosolids can be one of the feed stocks in a composting process. The carbonaceous amendment required in the process can be provided by processed yard waste or other clean wood wastes. Other compostable organic material such as food waste can also be used as a feedstock.

The various components of a compost mixture will be dependant on the material available and the desired final compost product characteristics. When biosolids are used in the mixture the resulting product is considered a biosolid product. As discussed in Section 3.7, the Region currently contracts with Walker Enterprise to compost source separated organics (SSO) and processed yard waste that is collected from residents. It may be possible to expand this operation to include a portion of the biosolids generated in the Region. The compost product that incudes biosolids will be required to meet more stringent quality requirements. The product containing biosolids will have additional organics and may be more desirable to some users. The fact that biosolids are in the compost product may result the product being less desirable to others. This is a challenge faced by many facilities that requires continuous education and product demonstration to the public and the users

4.9.2 Demand Assessment

The potential markets for compost products have been discussed in previous sections. The potential demand for co-management of biosolids and SSO material including food waste and yard waste will be dependant on the quantities available and the potential benefits realized by bringing the material together in a single operation. A single operation could generate a range of products based on the how the feedstocks where blended.

4.10 Summary and Recommendations

Of the target markets discussed in the sections above, application of biosolids products to agricultural land represents the greatest potential market. Within the Region, agricultural land accounts for more land area than that associated with parks and recreational facilities, and golf courses. The land area associated with each, and the potential demand are summarized in Table 16.

Table 16. Biosolid Markets in the Niagara Region and Golden Horseshoe

OUTLET	NIAGARA REGION		GOLDEN HORSESHOE	
	LAND AREA (HECTARES)	ANNUAL MAXIMUM POTENTIAL DEMAND (DT/YR)	LAND AREA (HECTARES)	ANNUAL MAXIMUM POTENTIAL DEMAND (DT/YR)
Agriculture	61,740	120,000	296,000	600,000
Parks & Rec. Dept.	2,100	3,200		
Golf Courses	1,400	2,800		
TOTAL	**65,240**	**126,000**	**296,000**	**600,000**

While agricultural practices have the greatest demand for biosolids, the Region will benefit from a diverse market that includes parkland, golf courses, landscape contractors and the public.

This will allow the region to benefit from there current agricultural program and advanced stabilization processes. It will also provide markets for other processes such as expanded composting and thermal drying.

5.0 Recommended Target Markets/Outlets

As summarized in Section 4.10, the greatest potential market for biosolids products in and around the Region is the agricultural market. Biosolids products can serve to fertilize soils, increase soil organic matter, and amend soil pH, in the case of biosolids products such as alkaline stabilized and thermal-alkaline hydrolyzed products. Outlets for biosolids products in the agricultural market include land application of biosolids as a Category 3 NASM or as a biosolids product meeting CFIA fertilizer requirements.

In summary, the three potential target markets/outlets for biosolids products recommended for consideration under the 2021 Niagara Biosolids Management Master Plan Update are:

- Land application of anaerobically digested biosolids.
- Soil amendment with fertilizers (biosolids products) meeting CFIA requirements.
- Composted products to be used by landscape contractors

5.1 Product Distribution

Biosolids producers can access available target markets in three different ways: direct distribution, third-party distribution, and third-party processing and distribution.

Direct distribution of biosolids products to end users would require the greatest level of time and effort on the Region's part. Regional staff would be responsible for biosolids processing, permitting and approvals, building a customer base, branding and marketing of biosolids products, delivery and transport of biosolids, communications and outreach to end users and the public, financial management of biosolids program and management of ongoing relationships with end users.

Third-party distribution, whereby the Region would be responsible for processing biosolids to be marketed and distributed by a third-party, would reduce some of the burden on the Region. The third-party would be responsible for branding and marketing of biosolids products, managing the customer base, distribution program and delivery and transport of biosolids products. Product storage under the third-party distribution option could be the Region's responsibility, the third-party's responsibility or some combination of the two. A concern of third-party distribution is the quality of the biosolids product. The agreement would likely include required characterization of the product. If those quality criteria are not complied with, the third-party may have difficulty marketing the product and the Region may have some risk.

Under a third-party processing and distribution scenario, a third-party would accept responsibility for creating the biosolids product and be responsible for branding and marketing of the product, managing the customer base, sales program and delivery of the product. Under this scenario, the entity managing the biosolids is also responsible for its marketing and distribution. This greatly reduces the risk to be managed by the Region. Companies such as Veolia, Walker and Lystek, can operate as either a third-party distribution or third-party processing and distribution partner to the Region.

A third-party could operate a biosolids processing facility off-site, or on-site at a regional facility. An example of an off-site facility is the Walker Environmental facility, which currently processes approximately 50% of the biosolids from the Region. Another example is the Lystek process facility at Southgate. An example of an on-site facility would be Veolia's operation of the thermal drying facility at the Ashbridges Bay Treatment Plant (ABTP) for the City of Toronto. In both cases the third-party operates the biosolids process facility under contract with the municipality producing the biosolids, and is responsible for marketing, sales, transport and storage of biosolids products as well as management of the customer base.

5.2 Market Competition

5.2.1 Municipalities in Southern Ontario

A biosolids product that is produced at the Region's WWTPs would need to compete with other products in the marketplace, including other biosolids products and commercial fertilizers used in and around the Region.

A survey of the other municipalities in the Golden Horseshoe indicated that biosolids products generated, including those generated by the Niagara Region, will likely not exceed the current agricultural demand in the area. Biosolids products generated in the Golden Horseshoe and their associated outlets are summarized below.

5.2.1.1 York and Durham Regions

In York and Durham Regions the majority of biosolids produced by the wastewater treatment facilities are transferred to Duffin Creek Water Pollution Control Plant (WPCP) for incineration (Durham Region, 2018; Durham Region, 2019; York Region, 2014). The ash from the incineration process is beneficially used to create cement products (Durham Region, 2019). The Duffin Creek WPCP is sized to meet future demands in the York and Durham Regions to the year 2041.

In 2019, only two WPCPs in the Regions produced biosolids for land application to agricultural fields. Corbett Creek WPCP produced 37,514 m3 of anaerobically digested sludge which was transferred to a holding facility for storage, before being land applied to agricultural fields (Durham Region, 2019). The Courtice WPCP produced 33,342 m3 of anaerobically digested biosolids which were also transferred to a holding facility for storage before being land applied to agricultural fields (Durham Region, 2019).

5.2.1.2 Halton Region

Halton Region's six wastewater treatment facilities (WWTF) produce over 35,000 wet tonnes of biosolids per year. Solids are anaerobically digested and dewatered. A Biosolids Management Centre (BMC) provides storage for liquid biosolids prior to land application (Halton Region, 2020). The Halton Region's Biosolids Master Plan indicated that Halton's biosolids are increasingly being land applied outside of the Region as the land available to receive biosolids within Halton Region declines. It estimated that by 2021 Halton's WWTFs will produce 278,546 m3 of anaerobically digested liquid biosolids and 32,937 wet tonnes of anaerobically digested, dewatered biosolids per year. The Master Plan recommended investigation of other outlets including composting to enhance Halton's land application program and incineration (XCG Consultants Ltd, 2012; Halton Region, 2016).The Region is currently investigating potential sites for a composting facility.

5.2.1.3 Niagara Region

As reported by the Region of Niagara representatives, approximately half of Niagara Region's biosolids are land applied on local agricultural fields as a liquid. The remaining biosolids are dewatered and transported to Walker Industries' N-Viro Biosolids Facility, in Thorold, Niagara Region, for processing (Region of Niagara, n.d.; Gun, 2015). In 2015 the facility was producing approximately 33,000 wet tons (30,000 wet tonnes) of alkaline stabilized biosolids product per day. They were able to market the material for $10/ton. The facility was receiving between 100 and 165 tons every weekday of which approximately 85 percent was from Niagara Region and the balance from the City of Toronto (Gun, 2015; Houle, 2015).

5.2.1.4 City of Hamilton

The City of Hamilton's new Biosolids Management process began operations in May 2020. It can process up to 60,000 wet tonnes of wastewater biosolids annually and produces a thermal-dried biosolids product meeting the requirements of the CFIA (City of Hamilton, 2020). Currently Hamilton's wastewater treatment produces approximately 43,000 wet tonnes of anaerobically digested and dewatered biosolids per year. Anticipating a 24 percent total solids cake entering the drier and 92 percent total solids in the dried product, the 43,000 wet tons per year of biosolids will result in 11,220 wet tons of dried product.

5.2.1.5 City of Toronto

The City of Toronto thermal dries about half of all biosolids produced, land applies about a quarter of biosolids produced and alkaline stabilizes or thermal-alkaline stabilizes the remaining quarter (City of Toronto, n.d.). In 2019, 28,641 wet tonnes of the biosolids produced at the Ashbridges Bay WWTP were land-applied and 7,731 wet tonnes were used at mine reclamation sites. A total of 34,494 wet tonnes were transported off-site, for alkaline stabilization and thermal-alkaline stabilization. (Toronto Water, 2020). As discussed in Section 3.6, Veolia operates a thermal drying facility at ABTP, producing approximately 22,000 DT/yr of thermal dried product; in 2019, 83,970 wet tonnes of biosolids were processed by the thermal drying facility (Toronto Water, 2020). All the wastewater solids generated at Humber WWTP and North Toronto WWTP are transferred to ABTP for processing, making up part of the biosolids produced (Toronto Water, 2020; Toronto Water). Dewatered biosolids produced at Highland Creek WWTP are incinerated at the plant, producing an ash that is stored in two ash lagoons. When a lagoon is full, ash is removed and hauled to landfill for final disposal (Toronto Water, 2020).

The different units (m3, DT, wet tonnes, tonnes) used to report generated biosolids products across different municipalities make it difficult to calculate the exact number of biosolid products being land-applied or used to amend agricultural land in the Golden Horseshoe. To produce a high-level estimate of biosolids produced and applied to agricultural land in the Golden Horseshoe, the following was anticipated:

- Anaerobically digested biosolids produced at Corbett, Courtice Creek WPCPs and Halton's wastewater treatment facilities are anticipated to have a density of approximately 1000 kg/m3 and 3% TS concentration.
- Anaerobically digested and dewatered biosolids produced at Niagara Region, Halton Region, Hamilton and Toronto's wastewater treatment facilities were anticipated to have a 25% TS concentration.
- The biosolids processed at Walker Industries' Niagara facility, reported as tons or tonnes, were anticipated to be wet tonnes, confirmed during a conversation with Walker Environmental. Walker Environmental processes approximately 30,000 wet tonnes per

year at its facility, of which 85%, or 25,500 wet tonnes, are sourced from Niagara Region and 15%, or 4,500 wet tonnes, are sourced from Toronto. By this estimate, an additional 25,500 wet tonnes of Niagara Region biosolids are liquid land applied, as the biosolids processed at Walker's facility represent half of Niagara Region's biosolids.

The resulting biosolids quantities and outlets to which they are directed are summarized in Table 17.

Table 17. Biosolids Products and Outlets in the Golden Horseshoe

MUNICIPALITIES IN GOLDEN HORSESHOE	BIOSOLIDS PRODUCTS GENERATED APPROXIMATE (DT/YR)	BIOSOLIDS PRODUCT	OUTLET
York & Durham Regions	2,100	Anaerobically Digested	Land applied (liquid)
Halton Region	8,400	Anaerobically Digested	Land applied (liquid)
	8,200	Anaerobically Digested and Dewatered	Land applied (cake)
Niagara Region	6,400	Anaerobically Digested	Land applied (liquid)
	6,400	Alkaline Stabilized	Soil amendment (fertilizer)
City of Hamilton	10,800	Thermal Dried	Soil amendment (fertilizer)
City of Toronto	7,200	Anaerobically Digested and Dewatered	Land applied (cake)
	2,000	Anaerobically Digested and Dewatered	Land rehabilitation (mine site)
	8,600	Alkaline Stabilized or Thermal-Alkaline Stabilized	Soil amendment (fertilizer)
	21,0003	Thermal Dried	Soil amendment (fertilizer)
Total	**81,100**		

The high-level estimate in Table indicates that approximately 81,000 DT/yr of biosolids products with potential for land application or use as soil amendment are currently produced in the Golden Horseshoe. As previously summarized, the current potential agricultural demand for these products in the Niagara Region alone is 126,000 DT/yr. Considering the entire Golden Horseshoe Area, the demand increases to 600,000 DT/yr.

The biosolids production in the Golden Horseshoe Area could increase by 50 percent and the biosolids production would meet the demand in the Niagara Region. Considering the entire Golden Horseshoe area, the 50 percent increase doubling the biosolids product would meet approximately 20 percent of the current agricultural fertilizer demand.

According to the 2016 Census figures, commercial fertilizer was used on 56 percent of all agricultural land (total agricultural land was 380,000 ha, including 296,000 ha of cropland), lime was used on 3.5% of all agricultural land and solid or composted manure was used on 2.4% of all agricultural land in the Golden Horseshoe (OMAFRA, 2017). Anticipating that these products reduce the potential demand by approximately 50 percent, the remaining demand, 592,000 DT/yr, is still significantly more than the current biosolids production in the Golden Horseshoe.

5.2.2 Key Municipalities in Western Canada

Interviews with key municipalities in Western Canada indicated that, like in the Niagara Region, it appears that the biosolids products generated in their area will likely not exceed the current agricultural demand in the area. Biosolids products generated in key municipalities in Western Canada and their associated outlets are summarized below.

5.2.2.1 City of Kelowna

In City of Kelowna the majority of biosolids produced by Kelowna WWTP are transferred to a Regional Composing Facility for composting. The composting facility is located in Vernon and also receives biosolids produced by the Vernon Water Reclamation Centre (VWRC). Total of 36,400 wet tonnes of dewatered biosolids per year delivered to the composting facility. Composted biosolids produced in the composting facility are Class A product. Composted biosolids are shipped to a landfill site for both storage purpose and retail sale. However, majority of composted biosolids is distributed through wholesale. The major of end user for the composted biosolids are landscape contractors.

5.2.2.2 Metro Vancouver

Five (5) WWTPs and all biosolids in member municipalities including City of Vancouver are managed by Metro Vancouver, a regional government. Approximately 60,000 wet tonnes of anaerobically digested and dewatered biosolids are produced every year; and this value is expected to be approximately 90,000 wet tonnes in 2022. Approximately 98% of biosolids are beneficially used and all treated solids are trucked to Alberta for beneficial use. A third-party company is hired to manage local market. Metro Vancouver only pays for hauling fees to transport soils. A biosolids masterplan recommended a drying facility to diversify their biosolids end products and users. The drying facility is expected to be in service in 2026.

5.2.2.3 EPCOR Utilities Inc.

EPCOR Utilities Inc. operates the Goldbar WWTP in the City of Edmonton. Gold Bar WWTP produces 19,000 – 22,000 dry tonnes /year with additional 6,000 – 7,000 dry tonnes /year contributed by the capital region. The sludge is anaerobically digested at the WWTP. Approximately 20% of all biosolids products are beneficially used in non-agricultural sectors, such as land reclamation; the remaining 80% are beneficially used on agricultural lands, including approximately 65% of the biosolids used in a liquid program and 15% of the biosolids is further dewatered cake prior to beneficial use on land. In Winter, dewatered cakes are stored on farmlands.

5.2.2.4 City of Calgary

The City of Calgary has three (3) WWTPs. All sludge is anaerobically digested. The biosolids are divided into three (3) streams for beneficial use. Approximately 10,000 – 12,000 dry tonnes per year are land applied; 5,000 – 8,000 dry tonnes per year are composted and the remaining 2,500 - 7,500 dry tonnes per year are sent to the Willow Demonstration Program. In the winter season, anaerobically digested dewatered biosolids are sent to composting; in shoulder seasons, spring and fall, they are sent to land reclamation. The main end-users for composted products are landscaping companies; however, interests of using the composted products from agricultural communities are increasing.

5.3 Seasonality and Storage

Per Section 2.1.2.1, NASM, including biosolids, cannot be land applied from December 1st to March 31st and require a minimum of 240 days of available storage. Although biosolids products that meet the requirements for CFIA regulated fertilizers, such as those produced by Veolia, Lystek and Walker, do not need to meet the same requirements, they are also affected by Southern Ontario's limited growing season. A typical growing season for farmers in Niagara Region lasts from about May to November, with the greatest demand for biosolids between July and October. This means that biosolids products can be applied to agricultural land, at best, for four to five months of the year.

On-site and off-site storage can help to mitigate the impacts of the limited growing season. Certain third-party vendors such as Veolia partner with the end user, to provide bagged storage at the end user location. Veolia produces a product by thermal drying, which can be stored in bags for an extended time. The bags should be plastic, preferably wrapped on pallets, and stored in a covered or enclosed building.

To encourage sales outside of the growing season, another strategy is to reduce the price of biosolids products when not in high demand. Veolia has employed this strategy to increase sales, and to free up storage, when the sold biosolids can be stored at end user's site rather than at their facility.

5.4 Transportation

The cost of transporting biosolids products varies and is dependent on solids concentration, the amount of water in the product being transported, the transportation mode and hauling distance. The drier the product the less water must transported per dry tonne of product. The cost of transportation including fuel, labour and permitting costs would be the direct responsibility of either the Region or the third-party vendor depending on the product distribution model adapted. Hauling biosolids products may require an ECA or EASR registration. Third-party biosolids processors and vendors indicated that in Ontario, due to market demand, biosolids products are typically not transported more than two to three hours from their point of origin. To maintain cost effectiveness, it is anticipated biosolids products generated in the Region would likely adhere to the same constraints.

6.0 Summary and Next Steps

Overall, this TM summarizes the existing biosolids and residuals management plan in Niagara Region, and current treatment and disposal capacity. It provides historical context and a baseline for development of alternative strategies for biosolids and residuals management moving forward. The recommendations of this TM will be used to develop biosolids management strategies for the Region to be described in TM 7a.

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Region of Niagara

Appendix A

Biosolids Characteristics

Table A - 1 Biosolids and Sludge Analysis Values

	CFIA						NASM						Ontario Compost			Sludge Analysis Value			
Parameter	Maximum acceptable cumulative metals addition to soil over 45 years (kg/ha)	Examples of maximum acceptable product metal concentration based on annual application rates (mg/kg) 4,400 kg/ha-yr	Examples of maximum acceptable product metal concentration based on annual application rates (mg/kg) 2.000 kg/ha-yr	Examples of maximum acceptable product metal concentration based on annual application rates (mg/kg) 500 kg/ha-yr	Pathogen Level	Pathogen Minimum detection limit	CM1 Concentration in non-aqueous material (containing 1% or more total solids, wet weight), expressed as mg per kg of total solids, dry weight / CP1 Standards	CM2 Concentration in non-aqueous material (containing 1% or more total solids, wet weight), expressed as mg per kg of total solids, dry weight / CP2 Standards	Maximum addition to soil (in kilograms of regulated metal per hectare/per five years)	Maximum concentration in soil (in milligrams per kilogram of soil, dry weight)	Plant Available Nitrogen (12 Month Period) KG/HA	Plant Available Phosphate (5 Year Period + Phosphorus Removed by Crop Harvesting) (kg/ha)	Category A Compost (mg/kg dry weight)	Category B Compost (mg/kg dry weight)	Feed for Categories A & B Compost (mg/kg dry weight)	Garner Rd Average 2020 Sludge Cake NASM Analysis Values (mg/kg)	Garner Rd assuming an application rate of 4 DT/ha/yr Over 12 Months (kg/ha)	Garner Rd assuming an application rate of 4 DT/ha/yr Over 5 Years (kg/ha)	Garner Rd assuming an application rate of 4 DT/ha/yr Over 45 Years (kg/ha)
Arsenic (As)	15	75	166	666			13	170	1.4	14			13	75	170	8.5	0.034	0.17	1.53
Cadmium (Cd)	4	20	44	177			3	34	0.27	1.6			3	20	34	1	0.004	0.02	0.18
Chromium (Cr)	210	1,060	2,333	9,333			210	2,800	23.3	120			210	1060	2800	60.8	0.243	1.216	10.944
Cobalt (Co)	30	151	333	1,333			34	340	2.7	20			34	150	340	5.7	0.023	0.114	1.026
Copper (Cu)	150	757	1,666	6,666			100	1,700	13.6	100			400	760	1700	460.5	1.842	9.21	82.89
Mercury (Hg)	1	5	11	44			0.8	11	0.09	0.5			0.8	5	11	0.3	0.001	0.006	0.054
Molybdenum (Mo)	4	20	44	177			5	94	0.8	4			5	20	94	8.9	0.036	0.178	1.602
Nickel (Ni)	36	181	400	1,600			62	420	3.56	32			62	180	420	27.7	0.111	0.554	4.986
Lead (Pb)	100	505	1,111	4,444			150	1,100	9	60			150	500	1100	25.9	0.104	0.518	4.662
Selenium (Se)	2.8	14	31	124			2	34	0.27	1.6			2	14	34	4	0.016	0.08	0.72
Thallium (TI)	1	5	11	44													-	-	-
Vanadium (V)	130	656	1,444	5,777													-	-	-
Zinc (Z)	370	1,868	4,111	16,444			500	4,200	33	220			700	1850	38	635.8	2.543	12.716	114.444
Salmonella					Not Detectable	< 1 CFU / 25 grams	< 3 CFU or MPN/4g						3 MPN /4 g total solids	3 MPN /4 g total solids					
Faecal Coliforms					<1000 MPN / gram	< 2 CFU / gram	E. coli ≤1,000 CFU/g dry weight	E.coli < 2x10^6 CFU/g dry weight					1,000 CFU or MPN E.coli/g total solids	1,000 CFU or MPN E.coli/g total solids		E. Coli 4248.1 CFU/g			
Nitrogen											200				(Total Kjeldahl Nitrogen)	1779.5	7.118	35.59	320.31
Phosphorus												390			(Total Phosphorus)	24822.3	99.289	496.446	4468.014