

Appendix H

TM7 - Identification and Screening of Alternative Solids Treatment Options



The Regional Municipality of Waterloo

Wastewater Treatment Master Plan Update

**Technical Memorandum No. 7:
Identification and Screening of Alternative
Solids Treatment Options**

Final



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1. Introduction

1.1 Background

The Regional Municipality of Waterloo (the Region) is an upper tier municipal government, providing municipal services to seven area municipalities with a total population of approximately 550,000 people. The Region owns thirteen (13) wastewater treatment plants (WWTPs), one (1) wastewater residuals processing facility, six (6) sewage pumping stations (SPSs) (with a seventh station planned for construction), and two wastewater collection systems (Ayr in the Township of North Dumfries and Wellesley in the Township of Wellesley), treating an approximate average of 66 million cubic meters annually. Wastewater facilities are operated and maintained by the Ontario Clean Water Agency (OCWA) under contract to the Region. Most of the collection systems and pumping station infrastructure that conveys wastewater to the Region's treatment facilities are owned, managed and operated by the area municipalities (City of Cambridge, City of Kitchener, City of Waterloo, Township of Wilmot, Township of North Dumfries and Township of Woolwich).

The Region has experienced steady residential and industrial/commercial/institutional (ICI) growth for many years and anticipates this will continue as a result of factors such as a strong local economy, the Province of Ontario's Places to Grow (P2G) Act, and major Regional and Provincial transportation initiatives that are underway. The Region completed a Wastewater Treatment Master Plan (WWTMP) in 2007 (Earth Tech, 2007) to plan for future growth and provision of treatment capacity throughout the Region. Due to changing population growth patterns, wastewater flows, and environmental regulations, the Region is now updating the WWTMP.

CIMA Canada Inc. (CIMA) has been retained by the Region to update the 2007 Master Plan to develop a current, comprehensive, cost-effective and feasible strategy to address the anticipated wastewater treatment and disposal needs of the Region over the next 35-year planning periods in a manner consistent with the Region's Strategic Plan.

This Technical Memorandum (TM-7) has been prepared to document alternative treatment options for solids treatment, consistent with the Region's wastewater

treatment objectives and existing facilities. Options to address process and capacity limitations, as well as for energy savings and greenhouse gas reductions through the solids treatment process are identified and screened on a Region-wide and plant specific basis.

The solids treatment train alternatives identified in this TM consider opportunities to reduce plant-wide energy demand and/or greenhouse gas footprint. This is consistent with the Region's goal of reducing energy consumption and working toward an Energy Net Neutral (ENN) operation. Important progress has been made at the Kitchener, Waterloo and Galt WWTPs with the on-going project to implement combined heat and power (CHP) systems that will enable on-site electricity production from digester gas (biogas).

1.2 Objectives

The objectives of this Technical Memorandum are to:

- + Develop and document alternative solids treatment options
- + Screen options based on overall Region-wide goals and specific service area needs for each wastewater treatment plant

Of note, the Region is conducting a separate, parallel Biosolids Master Plan that is reviewing the solids management process downstream of the digestion process. This study is proceeding in cooperation with the Region and coordination is being undertaken to ensure that the recommendations of both studies are compatible for a holistic overall approach to wastewater treatment and biosolids management within the Region.

2. Objectives of the WWTMP Update

The key objectives of the WWTMP Update include the following:

- + Provide capacity to service growth
- + Maximize and optimize the use of existing infrastructure
- + Reduce energy requirements and greenhouse gas emissions

Each of these objectives are discussed in more detail in the sections below.

2.1 Provide Capacity to Service Growth

Providing capacity to service growth as an integral objective to the development of any Master Plan. As presented in TM-1A: Wastewater Treatment Plant Population and Flow Projections and TM-1B: Sewage Pumping Station Population and Flow Projections, the 2007 WWTMP Update was based on the aggressive Places to Grow (P2G) population projections. Due to the more moderate growth observed in the Region (as compared to the P2G projections), the growth based capacity needs are not as great as previously expected.

2.2 Maximize and Optimize the Use of Existing Infrastructure

The Region has invested significant funds in wastewater infrastructure and any plan must ensure that this infrastructure is fully utilized and optimized to make good use of this investment. All options consider the infrastructure currently in place within a treatment plant and consider the compatibility of any new processes or technologies with this existing infrastructure.

Asset replacement items have also been documented with respect to each WWTP to identify opportunities to optimize current performance and operation. These items will be factored into each of the alternatives and related timing needs as the short-list of alternatives are further developed. In addition, a review of alternative technologies to reduce energy and operating costs is recommended as a component of any major asset replacement project.

2.3 Reduce Energy Requirements and Greenhouse Gas Emissions

As part of the Master Plan development, the Region is committed to investigating options for the reduction of energy and greenhouse gas (GHG) emissions through innovative processes and technologies. Additionally, as part of this objective, other

related initiatives are being considered, including recovery of energy and nutrients, minimizing waste, water reuse and any other processes to provide more environmentally sustainable and innovative wastewater treatment. These objectives will be discussed further in later sections as specific technologies are described. There are a number of solids processes with potential for energy and/or nutrient recovery and these will be described in later sections.

3. Growth Considerations for Wastewater Service Areas

Based on the moderate growth scenario (base case) developed as part of this WWTMP Update, flow forecasts have been developed for each treatment plant.

Figure 1 and Figure 2 provide the existing rated capacities, as well as the expected capacity needs in 2051 for each of the Region’s larger and smaller treatment plants, respectively.

Based on the population growth and flow forecasts, several plants will reach or exceed their rated capacity within the 2051 planning period. Table 1Table 1 shows which treatment plants are expected to require expansion within the short, medium and long term. Table 2 provides an overview of the capacity of each treatment plant, based on the information presented in TM-2: Status of Existing Treatment Facilities and Capacity Assessment.

In addition to the 10 treatment plants shown in Figure 1 and Figure 2, there are three (3) small development-based wastewater treatment plants within the Region (Heidelberg WWTP, Conestogo WWTP and Foxboro WWTP). These treatment plants have not been discussed with respect to options for solids treatment, as there are no plans to provide additional capacity at these facilities. There may be some opportunities for operational enhancement and reduced energy use, which could be considered on a business case basis when reviewing the results of pilots at larger plants or with asset renewal projects.

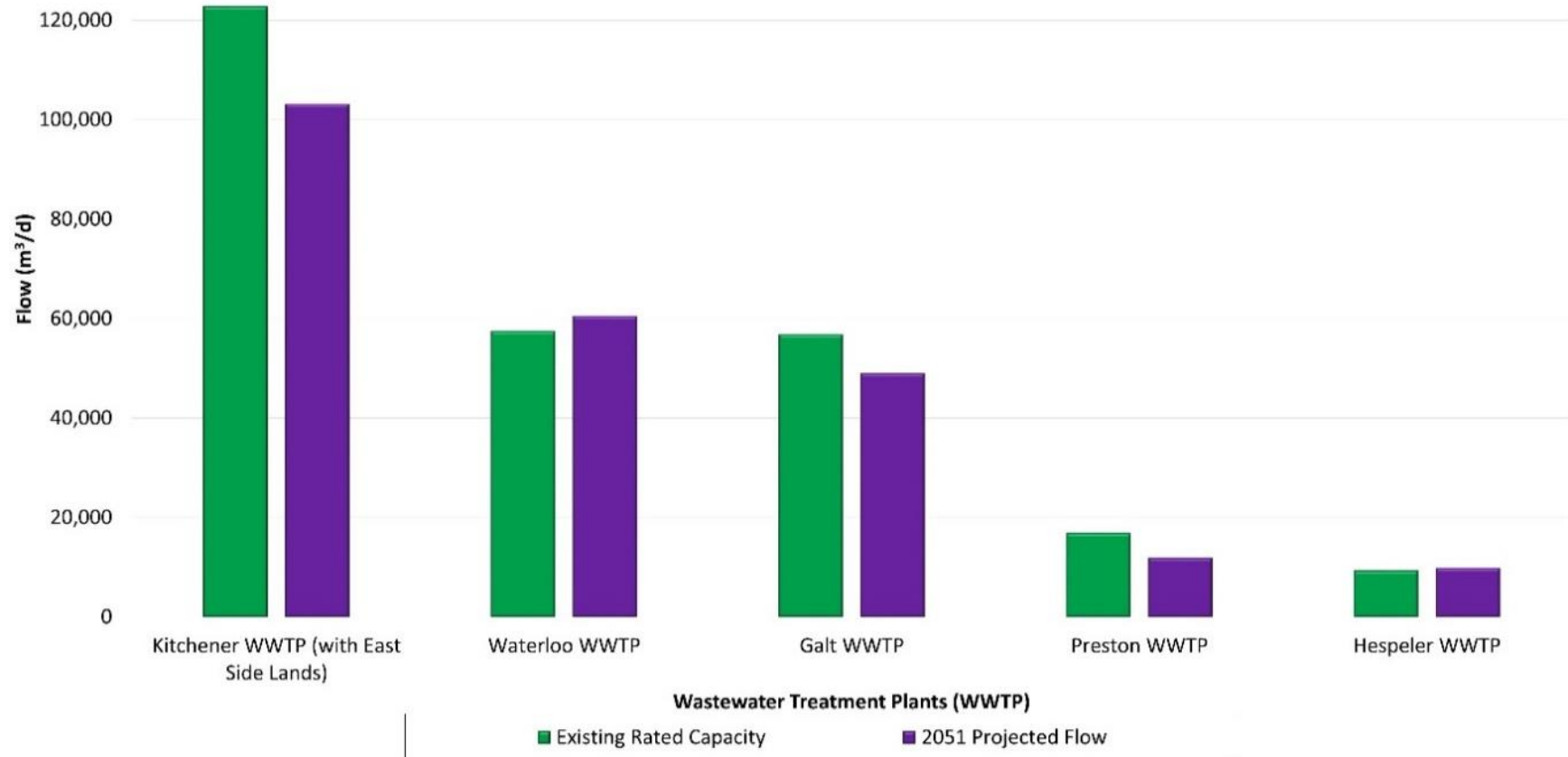


Figure 1 Future Wastewater Flow Capacities – Larger Plants

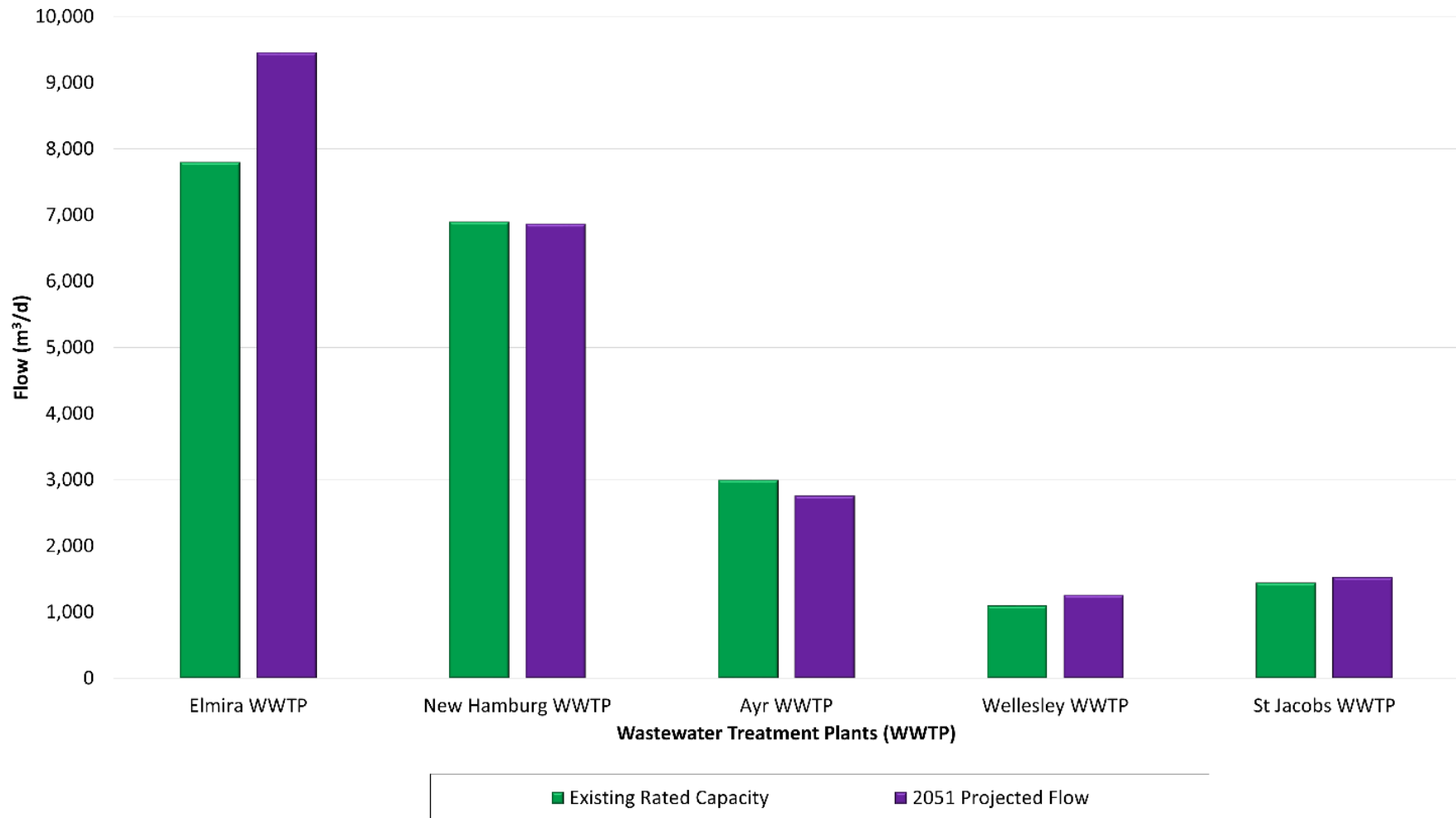


Figure 2 Future Wastewater Flow Capacities – Smaller Plants

Table 1 Timing for Expected Plant Capacity Increases

WWTP Service Area	Timing	Year Reaching 85% of Rated Capacity	Year Exceeding Rated Capacity
Waterloo	Short-term	2020	2041
St Jacobs	Short-term	2025	2042
Elmira	Medium-term	2030	2039
Wellesley	Medium-term	2032	2041
Hespeler	Long-term	2036	2047
Kitchener with East Side Lands	Long-term	2041	Beyond 2051
Galt	Long-term	2047	Beyond 2051
Ayr	Long-term	2043	Beyond 2051
New Hamburg	Long-term	2041	Beyond 2051
Preston without East Side Lands	Long-term	Beyond 2051	Beyond 2051

Table 2 Solids Handling Capacities at WWTPs ⁽¹⁾

WWTP	Rated Capacity (m ³ /d)	Digester Type	Digester Volume (m ³)	Basis	Equivalent Average Day Capacity (m ³ /d)
Kitchener	122,745	Anaerobic	16,490	15 day HRT	163,380 ⁽²⁾ 192,000 ⁽³⁾
Waterloo	57,500	Anaerobic	13,000	15 day HRT	110,770
Galt	56,800	Anaerobic	6,490	15 day HRT	52,190
Preston	16,860	Anaerobic	2,188 primary 2,188 secondary	15 day HRT	21,750

WWTP	Rated Capacity (m ³ /d)	Digester Type	Digester Volume (m ³)	Basis	Equivalent Average Day Capacity (m ³ /d)
Hespeler	9,320	Aerobic	1,920	45 day SRT ₍₄₎	23,810
New Hamburg	6,900	Aerobic	6,530	45 day SRT ₍₄₎	10,370
Ayr	3,000	Aerobic	1,400	45 day SRT ₍₄₎	3,360
St Jacobs	1,450	Aerated holding tank	195	5 day storage	3,900
Elmira	7,800	Fermenter, sludge blending tank	377 fermenter	8 day SRT fermenter	9,830
			377 blending tank	5 day SRT blending	5,600
Wellesley	1,100	Aerated holding tank	72	5 day storage	1,100

Notes:

1. Based on existing sludge transfers between facilities.
2. Based on existing practice, without implementation of separate WAS thickening.
3. Based on separate WAS thickening.
4. Based on MOECC Guidelines for 45 days in aeration tanks and aerobic digestion.

As is evident in Table 2, some WWTPs have excess solids handling capacity, while others have some limitations. It is important to note that while some facilities may require additional solids handling capacity, some capacity constraints may be addressed through operational enhancements.

4. Technology Considerations

The WWTMP Update is developed on the basis that any treatment plant upgrades or expansions undertaken will need to undergo further study and design, during which, technologies will be reviewed in more detail in view of local constraints and opportunities to best meet the objectives of the process upgrade, increased loadings, energy recovery and nutrient recovery.

Depending on the timing of the project from the completion of the WWTMP Update, any time an upgrade is being considered, the state of the industry should be reviewed to determine if a new or innovative technology would provide a benefit to the Region that may have been developed in the period between the assessment and the implementation of the upgrade.

A broad overview of solids treatment technologies including available and emerging technologies is provided in Table 3, as well as a preliminary review of the suitability and benefit of the technology for the Region. These technologies include sludge pre-treatment, and sludge stabilization technologies. Table 3 is adapted from the US EPA document “Emerging Technologies for Biosolids Management” (US EPA, 2006).

Table 3 New/Innovative Technologies to Consider

Technology	High-Level Description	Benefit/Suitability to the Region
Sludge Pre-Treatment		
Chemical Cell Destruction (Microsludge™)	Waste activated sludge from the secondary clarifier enters a central unit where caustic chemicals (NaOH) are added. The mixture is held for one hour to weaken cell membranes and significantly lower viscosity. The technology employs an industrial-scale high-pressure homogenizer or “cell disrupter” to provide an enormous and sudden pressure drop to lyse the bacterial cells in the sludge. The processed sludge is liquefied, mixed with primary sludge, and anaerobically digested to produce stabilized biosolids and biogas.	Limited additional benefit over other pre-treatment technologies, with added chemical requirements and associated potential operational impacts.
Ultrasonic Cell Destruction	Acoustic waves are applied to solids prior to digestion to attain extremely high pressures and temperatures within the biosolids. This results in the implosion of gas bubbles, which produces shear stresses that break up surfaces of bacteria, fungi, and other cellular matter. Different disintegration objectives can be achieved using either high- or low-frequency waves. Process has been shown to increase cell disruption, reduce anaerobic digestion time, reduce sludge quantity and raise biogas production. Typically, this process is applied to waste activated solids, not primary solids.	Limited full-scale applications within North America and limited additional benefit over other sludge pre-treatment technologies.

Technology	High-Level Description	Benefit/Suitability to the Region
Enzyme Conditioning	Objective is to degrade organic material to increase the dewaterability of biosolids and, in some cases, to reduce odors and aid in digestion processes. Mixtures of enzymes, specialized nutrients (i.e. humic acids, amino acids) and often aerobic and anaerobic bacteria cultures are added to thickening and digestion systems that produce enzymes specially engineered to degrade organic materials converting them into carbon dioxide and water. Reported advantages include limited damage to biological treatment systems and cost savings as the enzymatic reaction will continue to occur over several days.	Limited full scale applications and relatively high capital and operating costs to incorporate the required enzyme solutions.
Thermal Hydrolysis	Prior to digestion, sludge is dewatered to 15%–20% solids and fed through a hydrolysis vessel. The process involves the oxidation of sludge under elevated temperature (approximately 160°C) and pressure (approximately 690 kPa). Under these conditions, pathogens are destroyed and cell structures in the sludge breakdown, releasing energy-rich compounds. Following hydrolysis, sludge is fed to an anaerobic digester where it readily breaks down, resulting in high volatile solids destruction (approximately 65%) and increased biogas production compared to conventional anaerobic digestion. Thermal hydrolysis can also be added after digestion to improve solids dewatering, however, this configuration would be reviewed as part of the Biosolids Master Plan.	Potential to provide energy efficiency benefits to the Region. Most well understood sludge pre-treatment technology with several full scale applications. Will be reviewed in further detail as part of this master plan. Continue to monitor other pre-treatment technologies for potential future implementation.

Technology	High-Level Description	Benefit/Suitability to the Region
Sludge Stabilization		
Autothermal Thermophilic Aerobic Digestion (ATAD)	A thermophilic process operating in a temperature range of 50-70°C without external heat input, which provides for pathogen inactivation and volatile solids reduction sufficient to meet guidelines for 'Class A' beneficial reuse. Advantages of the process include rapid treatment, stable process with minimal supervision, ability to accommodate widely varying loads, and a small land foot print. Disadvantages include high energy use, need for odour collection and treatment and a moderately difficult sludge to dewater.	Offers minimal benefit from a treatment perspective due to high energy use. May be a driver from a Biosolids Master Plan perspective if a 'Class A' biosolids product is required.
Temperature-Phased Anaerobic Digestion (TPAD)	Objective is to improve the quality of biosolids by combining thermophilic and mesophilic anaerobic digestion. Temperature-phased anaerobic digestion (TPAD), also referred to as thermophilic/ mesophilic digestion, is a promising process option for the wastewater treatment facilities due to its higher performance and ability to control product odor. The process employs thermophilic (>55°C) conditions in the first phase of digestion followed by mesophilic (35°C) conditions in the second phase of digestion.	Limited additional benefit to the Region over existing technologies and energy intensive process.
Nutrient Recovery		
Struvite Precipitation	Emerging technology being developed to extract phosphorus and nitrogen from the WWTP sidestreams in the form of a marketable fertilizer product using a chemical process called struvite crystallization. The nutrient recovery process helps save on chemical and energy costs, reduce sludge loads, minimize nuisance struvite formation, and create a new revenue stream.	Chemical phosphorus removal limits phosphorus loadings in the recycle streams and availability of struvite precipitation. Scale of the treatment process also limits applicability to Region's WWTPs.

This section presents a general Region-wide long-list of potential solids treatment enhancement technologies.

Enhancements in solids treatment can have impacts not only on downstream biosolids management, but also on the upstream liquids treatment process as well. There are a number of potential opportunities that have been considered for optimizing the solids digestion process to achieve the Region's goals of reduced operating costs and reduced energy consumption, including:

- + Fats, Oils and Greases (FOG) Import (Co-Digestion)
 - Benefit at facilities with excess digester capacity
- + Digester Enhancements
 - Sludge pre-treatment - thermal hydrolysis
 - Temperature Phased Anaerobic Digestion (TPAD)
 - Autothermal Aerobic Digestion (ATAD)
- + Gas can be considered for multiple uses
 - Combined Heat and Power (CHP)
 - Clean to natural gas quality & export to utility
 - Natural Gas Vehicles

These alternatives are discussed in greater detail in the following sections.

4.1 FOG Import (Co-Digestion)

Co-digestion is a process whereby additional substrates are imported into the digestion process to increase the biogas production. These substrates can typically include source separated organics (SSO), and energy-rich organic wastes (e.g. fats, oils and grease (FOG)). The Region conducted a study (CH2M Hill, 2014) reviewing the potential for co-digestion of the Region's SSO materials with wastewater sludge at the Region's existing wastewater treatment facilities. Due to the quantities of SSO collected and the scale of treatment facilities required, it was determined that utilizing existing wastewater infrastructure was not feasible for the co-digestion of SSO with wastewater sludge.

This option considers the potential to add energy-rich organic wastes (e.g. fats, oils, and grease (FOG), or food scraps) to anaerobic digesters.

A primary benefit of co-digestion is that it uses existing infrastructure to divert food waste and/or FOG for the purpose of biogas production. The high-energy organic wastes have at least three times the methane production potential (e.g. biogas) of biosolids and manure (US EPA, 2010). Other benefits include greenhouse gas emission reductions, economic benefits and landfill diversion opportunities.

The implementation of a co-digestion system at a WWTP would require the following works:

- ✦ A FOG receiving/processing system (including odour treatment)
- ✦ A beneficial gas utilization system (combined heat & power or processing to natural gas quality for injection to the grid or used to fuel Region vehicles).
- ✦ Potential modifications to the gas handling systems to handle the increase in methane output that is common with co-digestion.

Figure 3 shows the key components of a FOG receiving station. FOG is pre-treated through rock traps/grinders, stored in heated tanks and blended with primary and waste activated sludge (WAS) before being fed sequentially to the digesters. Typical co-substrate addition rates range between 5-20% by weight of sludge feed. Biogas yield could rise by 40-230% (Blischke, *et al.*, 2009). Table 4 provides a summary of the advantages and disadvantages of the co-digestion process.

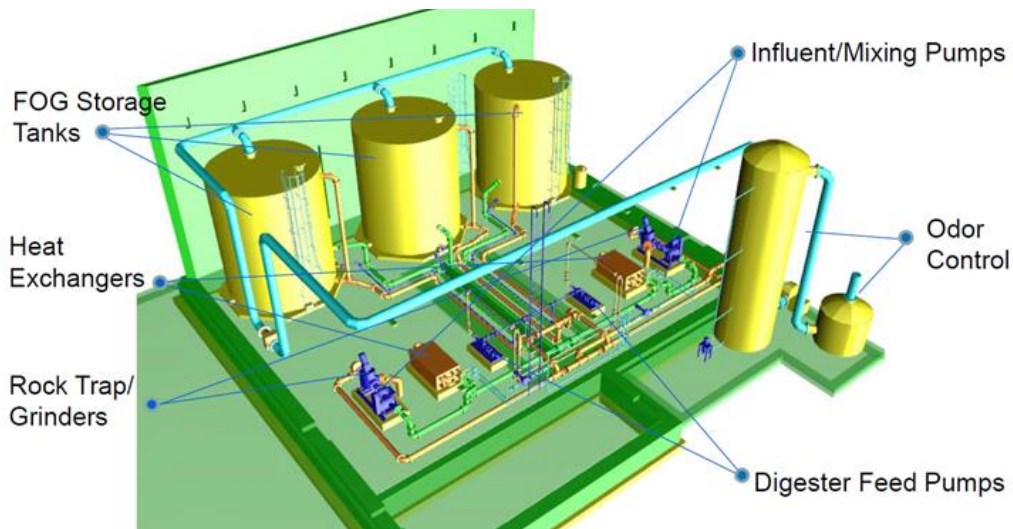


Figure 3 FOG Receiving Station Schematic

Table 4 Summary of Advantages and Disadvantages of FOG Import (Co-Digestion)

Advantages	Disadvantages
• Increased biogas production • Uses existing infrastructure to divert FOG for the purpose of biogas production • Greenhouse gas emission reductions • Diversion opportunities for other waste streams	• Potential need for digester upgrades and pre-processing facilities to support FOG receiving • Potential digester toxicity and nuisance foaming due to food waste addition • Care must be taken to avoid accepting materials that may inhibit biogas production • Odour emission from receiving facility • Increased truck traffic

There are many full scale applications in North America, including Annacis Island Wastewater Treatment Plant in Vancouver, BC and Lethbridge Wastewater Treatment Plant, Alberta, Canada.

A case study was completed for the Middle Basin WWTP in Johnson County, Kansas, with a rated capacity of 55,000 m³/d (14.5 MGD) and a current flow of 47,300 m³/d (12.5 MGD). The estimated capital cost of co-digestion and cogeneration improvements was \$10.0 million, and the estimated annual energy recovery revenue from biogas and FOG tipping fee was \$0.7 million, providing net annual revenue of \$0.6 million when adjusted for O&M costs. Not accounting for any potential incentives to the County, this represents a simple payback of approximately 16 years. The biogas production doubled (increased from 3,500 m³/d to 7,000 m³/d) with co-digestion. For the Region's facilities where CHP is currently being constructed, additional biogas would be utilized to maximize the operation of the CHP systems. Any excess biogas above the capacities of the CHP systems could be utilized for a CHP expansion or conversion to bio-methane for vehicle fuel or injection to the natural gas grid.

4.2 Digester Enhancements

4.2.1 Sludge Pre-Treatment – Thermal Hydrolysis

Where digesters are part of the biosolids process train, pre-treatment of sludge prior to digestion offers opportunity to enhance the digestion and downstream processes, through:

- ✦ Increased digestion efficiency, resulting in improved volatile solids reduction leading to an increase in biogas production and overall reduction in biosolids mass.
- ✦ Improved dewaterability. This coupled with higher volatile solids destruction reduces biosolids for end disposal.
- ✦ Reduction in pathogens such that the digested, dewatered biosolids could be potentially registered as a fertilizer product.

There are a number of commercially available wastewater sludge pre-treatment processes, with the most common being the thermal hydrolysis process. For the purposes of the WWTMP, thermal hydrolysis was investigated as it is the most commercially advanced and viable process at this time and offers the most benefit to the Region. Prior to implementation, additional study should be undertaken to review sludge pre-treatment technologies available at that time and determine the preferred technology for implementation.

Thermal hydrolysis is a high-pressure, steam treatment process, as shown in Figure 4.

Prior to digestion, WAS and/or primary sludge is dewatered up to 15%–20% solids and fed through a hydrolysis vessel. The process involves the oxidation of sludge under elevated temperature (approximately 160°C) and pressure (approximately 689 kPa). Under these conditions, pathogens are destroyed and cell structures in the sludge break down, releasing energy-rich compounds.

Following hydrolysis, sludge is fed to the anaerobic digester where it readily digests, resulting in high volatile solids destruction (approximately 65%) and approximately 20-30% more biogas production compared to conventional anaerobic digestion. Thermal hydrolysis can also enable the treatment of sludge in reduced digester volume, allowing for increased capacity to treat more sludge and/or external wastes.

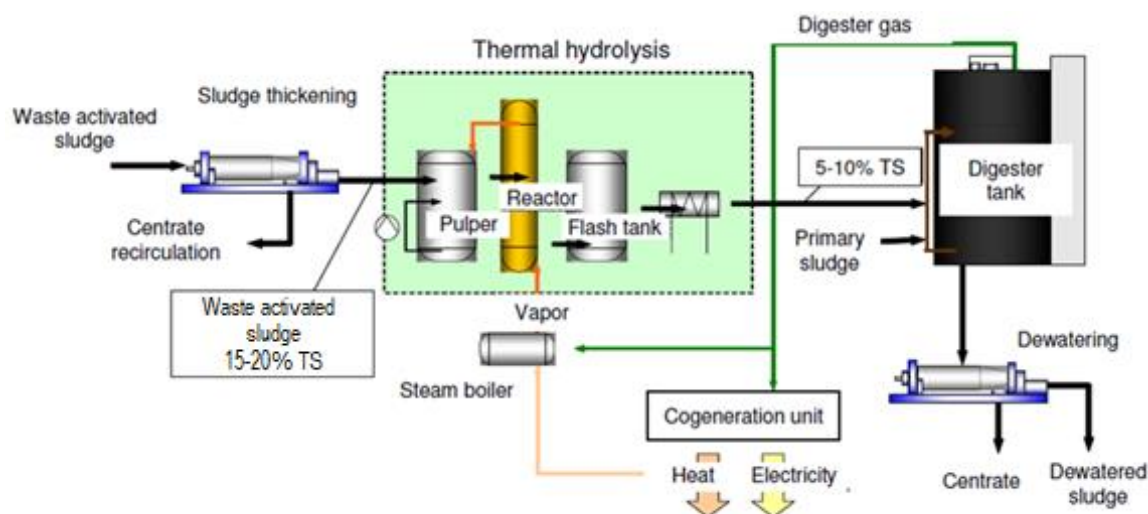


Figure 4 Thermal Hydrolysis Sludge Pre-Treatment Process Schematic

There are a number of commercially available wastewater thermal hydrolysis sludge pre-treatment processes, with package systems available for medium to large hydrolysis plants. Reactor size ranges from 5 – 500 tons dry solids (DS)/day.

Table 5 provides a summary of the advantages and disadvantages of the thermal hydrolysis process.

Table 5 Summary of Advantages and Disadvantages of Thermal Hydrolysis

Advantages	Disadvantages
- Higher gas production - Increased dewaterability - Increased capacity in digesters - Reduced biosolids production	- High recycle ammonia and volatile fatty acid loads must be factored into liquid processing as they may have a significant impact and must be managed if sidestream processes are considered - Continuous staffing for 24/7 operation - Specialized staffing may be required for steam systems (i.e., stationary engineers) - External energy source required for steam generation.

It is noted that thermal hydrolysis can also be added after digestion to improve dewatering (up to 35% solids with no polymer); however, this would be considered as part of the parallel Biosolids Master Plan.

4.2.2 Temperature-Phased Anaerobic Digestion (TPAD)

Temperature-Phased Anaerobic Digestion (TPAD) is a two-phase, series operation anaerobic digestion process. The first stage digesters are operated in the thermophilic range (50–60°C) to promote pathogen destruction with the intent of producing Class A biosolids, while subsequent digesters are operated in the mesophilic range (30–38°C) to reduce volatile solids.

Following thermophilic digestion with mesophilic digestion allows for this process to take advantage of the thermophilic digestion rate, which is estimated to be four times faster than mesophilic digestion. A schematic of the TPAD process is shown in Figure 5. Table 6 provides a summary of the advantages and disadvantages of the TPAD process.

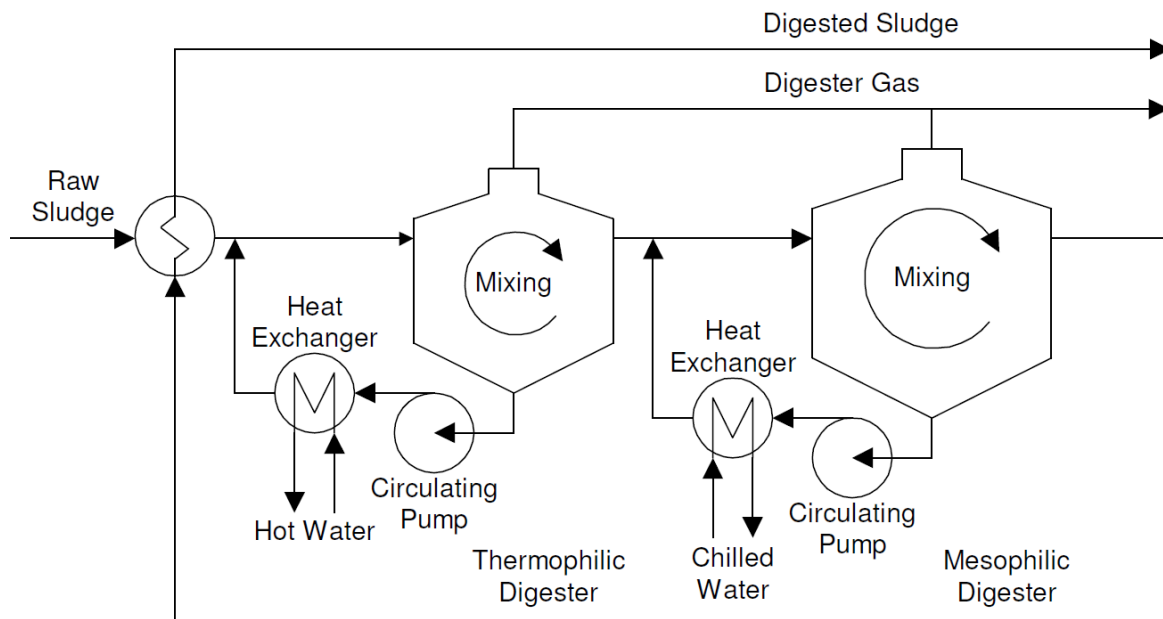


Figure 5 Temperature-Phased Anaerobic Digestion (TPAD) Schematic

Table 6 Summary of Advantages and Disadvantages of TPAD

Advantages	Disadvantages
• Increased volatile solids reduction for greater bioenergy conversion • Faster reaction rates for shorter retention times and greater capacity for a given volume • Increased pathogen destruction for improved biosolids quality (Generation of a US EPA Class “A” biosolids product) • Improved dewaterability of the digested biosolids • Increased gas production, approximately 10-15%	• Higher operation and maintenance (O&M) requirements than single-stage systems. • More expensive than single-stage systems, although this is more of a factor when retrofitting into TPAD systems. • Mechanical thickening would be required to thicken the sludge to 5% prior to entering the thermophilic digester.

Numerous facilities use some form of TPAD. For example, in 2002 the wastewater treatment facility in Waterloo, Iowa, rehabilitated its existing anaerobic digestion system to operate as a TPAD system by converting two of its six digesters into thermophilic digesters, with a goal to increase its biosolids treatment capacity and improve its volatile solids (VS) destruction and gas production. The City achieved its goals with VS reduction increasing from 47 percent in the old system to approximately 60–64 percent in the new system. (Wilson *et al.* undated).

4.2.3 Sludge Sidestream Treatment – Post-Aerobic Digestion

Post-aerobic digestion (PAD) is a recently developed process, where anaerobically digested sludge is further stabilized aerobically with an aerobic digestion step prior to dewatering. A significant benefit of PAD is the nitrogen removal without the need for supplemental carbon and alkalinity (Johnson *et al.*, 2013). Other benefits include reduced ammonia loading to secondary treatment, improved VS destruction and reduced biosolids mass for dewatering and disposal. Table 7 provides a summary of the advantages and disadvantages of the PAD process.

Table 7 Summary of Advantages and Disadvantages of PAD

Advantages	Disadvantages
• Good volatile solids destruction • Nitrogen removal without the need for supplemental carbon and alkalinity • Reduced ammonia loading to secondary treatment • Reduced biosolids for end disposal	• High construction and present worth costs • Higher energy consumption due to additional aeration requirements • Can generate nuisance odors

4.2.4 Autothermal Thermophilic Aerobic Digestion (ATAD)

The ATAD process is a refinement of the conventional aerobic digestion process that operates at thermophilic temperatures by utilizing the heat produced by aerobic digestion of the biosolids. In an ATAD process, thickened sludge (4-6% solids) is fed to an insulated reactor. High levels of oxygen or air are added to accelerate the aerobic decomposition of organic matter, an exothermic reaction which releases heat, thereby increasing the temperature. The operating temperature in the reactor is about 50 – 70 °C.

Table 8 provides a summary of the advantages and disadvantages of the ATAD process.

Table 8 Summary of Advantages and Disadvantages of ATAD

Advantages	Disadvantages
• Good volatile solids destruction • Generation of a US EPA Class “A” biosolids product • Relatively small footprint • Reduced biosolids for end disposal	• High construction and present worth costs • Higher energy consumption • Mechanical thickening of feedstock to 5% solids is required • May experience foaming • Thermophillically treated biosolids are more difficult to dewater • Can generate nuisance odors

Due to the severe odor problems associated with the off-gases expelled from the first generation ATAD systems, a second generation ATAD process was developed. The second generation ATAD process typically destroys 50 to 70% of the volatile solids in the biosolids with less odor. This reduces downstream solids support capacity requirements, such as dewatering facilities. Figure 6 shows a typical second generation ATAD schematic.

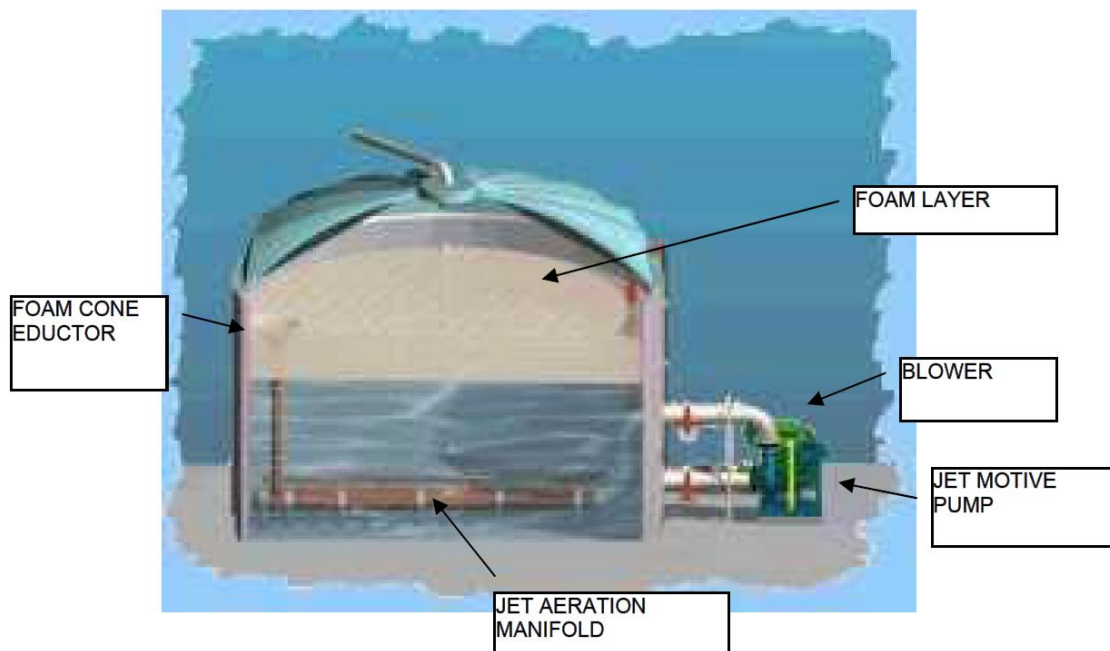


Figure 6 Second Generation ATAD Schematic

The second generation ATAD process is used at the Amherstview, Ontario and Morrisburg, Ontario WWTPs.

ATAD would only be considered for the Region's smaller facilities that do not already have anaerobic digestion. In consideration of the need for mechanical thickening and the high energy costs of ATAD systems, there would be no energy savings or energy recovery opportunities compared to the existing systems. As a result, ATAD is not recommended for consideration under the Wastewater Treatment Master Plan. However, the system may be considered as part of the parallel Biosolids Master Plan, due to the benefits of producing a Class A biosolids.

4.2.5 Aerobic Digestion Upgrades

Additional upgrades to existing aerobic digestion processes, including potential for improved pH and dissolved oxygen (DO) control, or digester covers could be considered as part of asset management and renewal of existing processes.

4.3 Nutrient Recovery through Struvite Precipitation

Nutrient recovery technology is an emerging technology being developed to extract phosphorus and nitrogen from the WWTP sidestreams in the form of a marketable fertilizer product using a chemical process called struvite crystallization. The nutrient recovery process helps save on chemical and energy costs, reduce sludge loads, minimize nuisance struvite formation, and create a new revenue stream.

The struvite recovery process consists of:

- + Fluidized bed crystallizer struvite recovery reactor
- + Product drying and handling system
- + Sodium hydroxide and magnesium chloride storage and dosing system

A schematic of the struvite recovery process is shown in Figure 7.

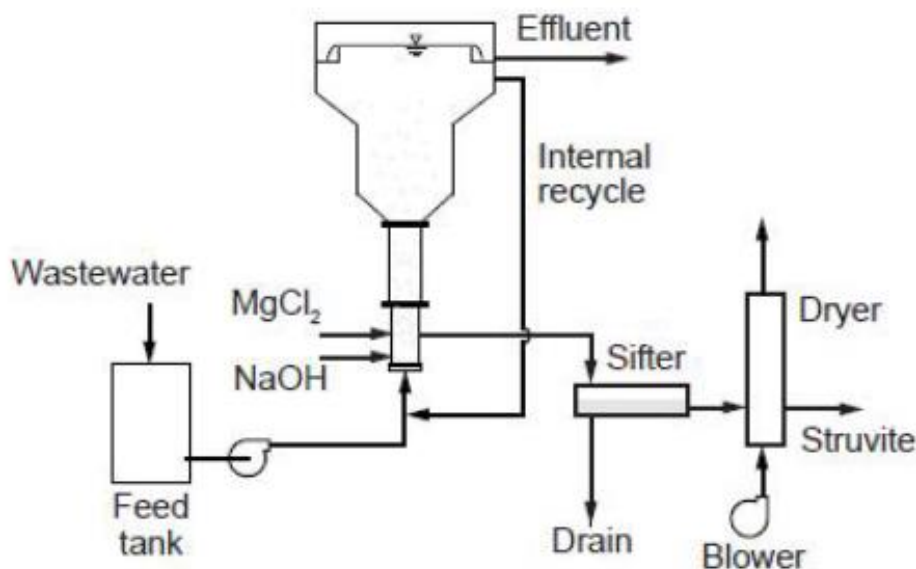


Figure 7 Struvite Recovery Process Schematic

The struvite recovery process requires sodium hydroxide (NaOH) and magnesium chloride (MgCl₂) dosing to generate the ideal struvite crystallization conditions. These

conditions and required chemical doses are strongly impacted by the incoming wastewater pH with a higher temperature being preferred.

Most commonly, struvite ($\text{NH}_4\text{MgPO}_4 \cdot 6\text{H}_2\text{O}$) can be recovered by one of two ways: in the first method, the pH is raised by adding alkaline compounds like NaOH or MgCl_2 , or by aeration of the stream to de-gas the solution and release carbon dioxide (CO_2). The second method is to increase the concentration of one of the constituent ions, usually magnesium (Mg^{2+}), so that the driving force for precipitation is promoted. Struvite precipitation processes typically use fluidized bed reactors or pellet reactors, where struvite is collected as small pellets.

Generally, the reactor can extract approximately 80-90% of the phosphorus and 10-50% of the ammonia from centrate, resulting in significantly reduced nutrient loadings to secondary treatment process. This would potentially mitigate any secondary treatment expansion needs.

It is reported that there are currently approximately thirty full-scale nutrient recovery facilities in North America, including Gold Bar and HM Weir WWTPs in Canada. Some challenges preventing the adoption of nutrient recovery may include lack of regulatory driver and relatively long payback period.

To be economically feasible, struvite recovery process requires that sidestreams contribute (Ostara, 2016):

- + $\geq 20\%$ of influent total phosphorus load (or orthophosphate concentration $> 60 \text{ mg PO}_4\text{-P/L}$)
- + $\geq 15\%$ of the influent total ammonia nitrogen (TAN) load

Other than the Elmira WWTP, the Region plants utilize chemical phosphorus removal which limits phosphorus loadings in the recycle streams to very low levels on the order of approximately 5% and would not meet the above criteria. As a result, this process is not considered economically viable for Region facilities with the exception of potentially the Elmira WWTP, which utilizes a biological nutrient removal process. There are, however, potential limitations to implementation of the process at the Elmira WWTP, including the lack of anaerobic digestion process required to solubilize the phosphorus, as well as the scale of the treatment process. Ostara reports that the smallest treatment reactor available has a capacity of 65 kg TP/d, corresponding to an approximate plant rated capacity of 30,000 m^3/d .

Table 9 provides a summary of the advantages and disadvantages of the struvite nutrient recovery process. Other opportunities for nutrient removal may be available, however, are not as well developed or cost effective as the struvite recovery process described. It is recommended to review nutrient recovery as part of future WWTMP updates to determine feasibility of newer technologies.

Table 9 Summary of Advantages and Disadvantages of Struvite Recovery

Advantages	Disadvantages
• Extracts nutrients for a marketable fertilizer product • Removes 80-90% of phosphorus and 10-50% of ammonia from centrate stream - Significantly reduces nutrient loadings to secondary treatment	• Favorable conditions strongly impacted by incoming wastewater pH and temperature • Chemical phosphorus removal facilities do not meet economic criteria for struvite recovery - Most phosphorus remains tied up in chemical sludge in digester • Elmira WWTP BNR facility is well below smallest commercially available capacity (30 MLD)

5. Plant-Specific Solids Treatment Options

Several key areas of consideration are discussed in the sections below for each treatment plant, as well as the options that are feasible for that treatment plant based on the constraints and considerations identified.

5.1 Kitchener WWTP

The Kitchener WWTP is a conventional activated sludge plant with a rated average day flow capacity of 122,745 m³/d. Sludge management is provided by anaerobic digestion of the co-thickened sludge and off-site biosolids dewatering at the Manitou Drive Biosolids Dewatering facility, with centrate being returned to Plant 2 for treatment.

Anaerobic digestion is provided in two primary anaerobic digesters, with a total capacity of 16,500 m³. One secondary digester is available for increased capacity and to provide redundancy. Biogas produced is currently used in the plant boilers for digester process and building heating, with excess gas flared in a waste gas burner.

Currently as part of the plant Phase 3 upgrades, the existing primary digesters have been upgraded for enhanced performance. The existing secondary digester was upgraded to allow for both sludge and digester gas storage. Included in the Phase 3 upgrades, the Region is installing a biogas combined heat and power (CHP) unit for energy recovery and greenhouse gas emission reduction.

5.1.1 Capacity Considerations

At future predicted 2051 flows, the existing anaerobic digestion facility at the Kitchener WWTP has sufficient capacity to treat future solids production, assuming separate waste activated sludge thickening. As presented in Table 2, the digesters have an equivalent average day capacity of 192,000 m³/d, compared to the rated capacity of 122,745 m³/d. Therefore, no digester expansion would be required within the planning period. As previously noted, the Region is currently installing an 800 kW combined heat and power (CHP) facility to utilize digester gas at the facility for energy recovery and process heating.

Currently the sludge generated at the plant is treated in single-stage mesophilic anaerobic digesters. There are opportunities to improve volatile solids reduction and increase biogas production through digester optimization and incorporation of

alternative innovative technologies (e.g. Thermal Hydrolysis, TPAD, and post-aerobic digestion).

The digestion process at Kitchener WWTP was recently upgraded to provide a minimum capacity of 122,745 m³/d and the plant is currently only operating at approximately 60% of the rated capacity. As a result, there is significant excess digester capacity that could be used to treat FOG or other external wastes in the interim. Additional study is required to fully understand the potential benefits and impacts associated with availability of imported wastes and the potential gas generation. With the on-going installation of the CHP system, CHP capacity would be first maximized with the additional inputs. Additional gas beyond CHP capacity could be utilized through a CHP expansion or alternatively purified for natural gas vehicles or injection to the natural gas grid.

5.1.2 Plant Specific Opportunities

Table 10 provides a summary of the solids treatment opportunities relevant to the Kitchener WWTP related to optimization and energy efficiency and identifies those that are considered feasible for further development and evaluation.

Table 10 Summary of Options for Kitchener WWTP

Potential Option	Feasibility for Kitchener WWTP	Rationale
FOG Import (Co-Digestion)	✓	Significant excess digester capacity that could be used to treat FOG or other external wastes
Sludge Pre-Treatment – Thermal Hydrolysis	✓	Potential benefits including increased gas production compatible with CHP currently being installed
TPAD	✓	Increased gas production compatible with CHP currently being installed
ATAD	X	No aerobic digestion

Potential Option	Feasibility for Kitchener WWTP	Rationale
Sidestream Sludge Treatment – Post Aerobic Digestion	✓	Potential benefits including increased volatile solids destruction and reduction of ammonia loads
Nutrient Recovery through Struvite Precipitation	X	Not economically feasible for chemical phosphorus removal facilities

5.2 Waterloo WWTP

The Waterloo WWTP is a conventional activated sludge plant. The plant has an existing MOECC Environmental Compliance Approval (ECA) approved hydraulic capacity of 72,730 m³/d and a rated average day flow capacity of 57,500 m³/d. Sludge management is provided by anaerobic digestion of the raw sludge and mechanically thickened WAS and on-site biosolids dewatering, with centrate being returned to the plant headworks. The Region is currently installing a 600 kW combined heat and power (CHP) facility to utilize digester gas at the facility for energy recovery and process heating.

Anaerobic digestion is provided in one primary anaerobic digester, with a total capacity of 6,500 m³. A second digester equally sized digester is available for increased capacity and to provide redundancy.

5.2.1 Capacity Considerations

At future projected 2051 flows, the existing anaerobic digestion facility at the Waterloo WWTP has sufficient capacity to treat projected future solids production. As presented in Table 2, the digesters have an equivalent average day capacity of 110,770 m³/d, compared to the rated capacity of 57,500 m³/d. Therefore, no anaerobic digester expansion would be required within the 35-year planning period.

Currently, the sludge generated at the plant is treated in two mesophilic anaerobic digesters normally operated in series. There are opportunities to improve volatile solids reduction and increase biogas production through digester optimization and incorporation of alternative innovative technologies (e.g. TPAD).

The digestion process at the Waterloo WWTP was recently upgraded and the plant is currently operating at approximately 80% of the rated capacity. There is significant excess digester capacity that could be used to treat external wastes (e.g. FOG) in the interim.

Additional study is required to fully understand the potential benefits and impacts associated with the addition of FOG on digester capacity and gas generation. With the on-going installation of the CHP system, CHP capacity will be maximized and additional outlets for excess biogas could be investigated, such as purification for natural gas vehicles or injection to the natural gas grid.

5.2.2 Plant Specific Opportunities

Table 11 provides a summary of the solids treatment opportunities relevant to the Waterloo WWTP related to optimization and energy efficiency, and identifies those that are considered feasible for further development and evaluation.

Table 11 Summary of Options for Waterloo WWTP

Potential Option	Feasibility for Waterloo WWTP	Rationale
FOG Import (Co-Digestion)	✓	Significant excess digester capacity that could be used to treat FOG or other external wastes
Sludge Pre-Treatment – Thermal Hydrolysis	✓	Potential benefits including increased gas production compatible with CHP currently being installed
TPAD	✓	Increased gas production compatible with CHP currently being installed
ATAD	X	No aerobic digestion
Sidestream Sludge Treatment – Post Aerobic Digestion	✓	Potential benefits including increased volatile solids destruction and reduction of ammonia loads
Nutrient Recovery through Struvite Precipitation	X	Not economically feasible for chemical phosphorus removal facilities

5.3 Galt WWTP

The Galt WWTP is a conventional activated sludge plant with an existing Stage 1 rated average day flow capacity of 56,800 m³/d and a future Stage 2 rated capacity of 76,000 m³/d. Sludge management is provided by anaerobic digestion of the raw sludge and mechanically thickened WAS and on-site biosolids dewatering, with centrate being returned to the plant headworks.

Anaerobic digestion is provided in two primary anaerobic digesters, with a total capacity of 6,500 m³. A digested sludge holding tank is available for digested sludge storage. The Region is currently installing a 600 kW combined heat and power (CHP) facility to utilize digester gas at the facility for energy recovery and process heating.

With the on-going installation of the CHP system, CHP capacity would be maximized and additional outlets for excess biogas could be investigated, such as purification for natural gas vehicles or injection to the natural gas grid (“Renewable Natural Gas”).

5.3.1 Capacity Considerations

Additional treatment capacity beyond the Stage 1 rated capacity will not be required in the planning period to 2051. As presented in Table 2, the digesters have an equivalent average day capacity of 52,190 m³/d, compared to the rated capacity of 56,800 m³/d. Due to the digestion capacity limitations, there are limited opportunities for co-digestion at Galt WWTP in the planning period.

5.3.2 Plant Specific Opportunities

Table 12 provides a summary of the solids treatment opportunities relevant to the Galt WWTP related to optimization and energy efficiency, and identifies those that are considered feasible for further development and evaluation.

Table 12 Summary of Options for Galt WWTP

Potential Option	Feasibility for Galt WWTP	Rationale
FOG Import (Co-Digestion)	X	Limited digester capacity
Sludge Pre-Treatment – Thermal Hydrolysis	✓	Potential benefits including increased gas production compatible with CHP currently being installed
TPAD	✓	Increased gas production compatible with CHP currently being installed
ATAD	X	No aerobic digestion
Sidestream Sludge Treatment – Post Aerobic Digestion	✓	Potential benefits including increased volatile solids destruction and reduction of ammonia loads
Nutrient Recovery through Struvite Precipitation	X	Not economically feasible for chemical phosphorus removal facilities

In order to address the digestion capacity constraint, operational changes (i.e. HRT of approximately 14 days, optimize transfers of sludge from other WWTPs to free up capacity at Galt) may be sufficient to provide the small digestion capacity increase required to 2051. This can be achieved through recommendations of the Region's on-going Biosolids Master Plan and works at other facilities to optimize the loadings to the Galt WWTP. If operational changes aren't able to achieve the needed capacity, options such as thermal hydrolysis or TPAD could be considered as part of future capital projects.

5.4 Preston WWTP

The Preston WWTP is a conventional activated sludge plant with a rated average day flow capacity of 16,860 m³/d. Sludge management is provided by anaerobic digestion of the co-thickened sludge, with biosolids hauled to the Galt WWTP for dewatering.

Anaerobic digestion is provided in one primary anaerobic digester, with a total capacity of 2,200 m³. A second digester is available for increased capacity and to

provide redundancy. Biogas produced is currently used in the plant boilers for digester process and building heating, with excess gas flared in a waste gas burner.

5.4.1 Capacity Considerations

At future predicted 2051 flows, the existing anaerobic digestion facility has sufficient capacity to treat future solids production. As presented in Table 2, the digesters have an equivalent average day capacity of 21,750 m³/d, compared to the rated capacity of 16,860 m³/d. Therefore, no anaerobic digester upgrades would be required within the planning period.

5.4.2 Plant Specific Opportunities

Table 13 provides a summary of the solids treatment opportunities relevant to the Preston WWTP related to optimization and energy efficiency, and identifies those that are considered feasible for further development and evaluation.

Table 13 Summary of Options for Preston WWTP

Potential Option	Feasibility for Preston WWTP	Rationale
FOG Import (Co-Digestion)	X	- Limited digester capacity beyond rated capacity - Limited benefit compared to larger facilities
Sludge Pre-Treatment – Thermal Hydrolysis	X	Consideration for the largest treatment facility only (due to operational complexity)
TPAD	X	No net benefit in energy relative to heating to higher temperatures and need for capital investment in CHP.
ATAD	X	No aerobic digestion
Sidestream Sludge Treatment – Post Aerobic Digestion	X	No energy benefits
Nutrient Recovery through Struvite Precipitation	X	Not economically feasible for chemical phosphorus removal facilities

5.5 Hespeler WWTP

The Hespeler WWTP is an extended aeration plant with a rated average day flow capacity of 9,320 m³/d. Waste activated sludge is sent to the aerated sludge holding tanks where it is gravity thickened and hauled to the Kitchener or Galt WWTP for further treatment.

A Facility Assessment has recently been completed for the plant to identify processes and facilities that require improvements before the next planned expansion. The recommended upgrades include the construction of a new fine screening and grit removal facility, new air blowers, addition of a third secondary clarifier, and a new WAS thickening facility. With the implementation of WAS thickening in the near future, it is expected that the existing aerated sludge holding tanks will be operated as aerobic digesters. In this case, thickened digested sludge could be hauled to land application sites and/or storage at existing facilities in New Hamburg and Ayr.

With plant growth, there is a future opportunity to convert the Hespeler WWTP to an anaerobic digestion facility. In general, plants with capacities greater than 10,000 m³/d have a greater payback for anaerobic digestion in terms of capital versus operational costs. The Hespeler WWTP is approaching this threshold and therefore, as part of future expansions, a conversion to anaerobic digestion may be considered.

5.5.1 Capacity Considerations

At future predicted 2051 flow, the aerobic digestion facility at the Hespeler WWTP has sufficient capacity to treat future solids production. As presented in Table 2, the digesters have an equivalent average day capacity of 23,810 m³/d, compared to the rated capacity of 9,320 m³/d. Therefore, no aerobic digester expansion would be required within the 35-year planning period.

5.5.2 Plant Specific Opportunities

Table 14 provides a summary of the solids treatment opportunities relevant to the Hespeler WWTP related to optimization and energy efficiency, and identifies those that are considered feasible for further development and evaluation.

Table 14 Summary of Options for Hespeler WWTP

Potential Option	Feasibility for Hespeler WWTP	Rationale
FOG Import (Co-Digestion)	X	No anaerobic digestion
Sludge Pre-Treatment – Thermal Hydrolysis	X	Consideration for the largest treatment facility only (due to operational complexity)
TPAD	X	No anaerobic digestion
ATAD	X	No energy benefits
Sidestream Sludge Treatment – Post Aerobic Digestion	X	No energy benefits
Nutrient Recovery through Struvite Precipitation	X	Not economically feasible for chemical phosphorus removal facilities

5.6 Ayr WWTP

The Ayr WWTP is an extended aeration package plant with a rated average day flow capacity of 3,000 m³/d. Waste activated sludge is aerobically digested in two aerobic digesters, with a total capacity of 1,400 m³. Liquid digested sludge is stored in the on-site biosolids storage lagoons (4,200 m³) prior to land application.

5.6.1 Capacity Considerations

At future predicted 2051 flows, the existing aerobic digestion facility at the Ayr WWTP has sufficient capacity to treat future solids production. As presented in Table 2, the digesters have an equivalent average day capacity of 3,360 m³/d, compared to the rated capacity of 3,000 m³/d. Therefore, no digester expansion would be required within the 35-year planning period.

5.6.2 Plant Specific Opportunities

Table 15 provides a summary of the solids treatment opportunities relevant to the Ayr WWTP related to optimization and energy efficiency, and identifies those that are considered feasible for further development and evaluation.

Table 15 Summary of Options for Ayr WWTP

Potential Option	Feasibility for Ayr WWTP	Rationale
FOG Import (Co-Digestion)	X	No anaerobic digestion
Sludge Pre-Treatment – Thermal Hydrolysis	X	Consideration for the largest treatment facility only (due to operational complexity)
TPAD	X	No anaerobic digestion
ATAD	X	No energy benefits
Sidestream Sludge Treatment – Post Aerobic Digestion	X	No energy benefits
Nutrient Recovery through Struvite Precipitation	X	Not economically feasible for chemical phosphorus removal facilities

5.7 New Hamburg WWTP

The New Hamburg WWTP is a sequencing batch reactor (SBR) plant with an existing ECA rated capacity of 5,200 m³/d. The plant currently is in the process of detailed design for the Phase 2 expansion to increase the rated capacity to 6,900 m³/d to accommodate future community growth. Waste activated sludge generated at the plant is aerobically digested in two aerobic digesters, with a total capacity of 6,530 m³. In the original design, biosolids were transferred to a stabilized biosolids storage lagoon (6,000 m³) for long term storage and subsequently land applied. The stabilized biosolids storage lagoon has since been converted to a hauled waste receiving station. As a result, the aerobic digesters are now used for both digestion and biosolids storage.

The aerobic digesters are sufficient for the design capacity of the plant. However, it should be noted that under the current strategy of the dual use of the existing digesters for both digestion and storage, the capacity of the digester is insufficient for future load, even with no outside biosolids (AECOM, June 2011). Sludge management following digestion at the New Hamburg WWTP is currently being reviewed as part of the Region's parallel Biosolids Master Plan.

It is important to note that a new septage receiving station is currently being built at the Manitou Drive Biosolids Dewatering facility. Once the new septage receiving station at Manitou is constructed and septage is diverted from the New Hamburg WWTP to Manitou, the stabilized biosolids storage lagoon is to be used for biosolids storage and the aerobic digesters are to be used for digestion only. As a result, both the existing aerobic digesters and biosolids storage lagoon capacities will be restored for the original intent.

5.7.1 Capacity Considerations

At future predicted 2051 flows, the existing aerobic digestion facility has sufficient capacity to treat future solids production. As presented in Table 2, the digesters have an equivalent average day capacity of 10,370 m³/d, compared to the rated capacity of 6,900 m³/d. Therefore, no upgrades to the New Hamburg WWTP are required to accommodate the future biosolids generation rates.

5.7.2 Plant Specific Opportunities

Table 16 provides a summary of the solids treatment opportunities relevant to the New Hamburg WWTP related to optimization and energy efficiency, and identifies those that are considered feasible for further development and evaluation.

Table 16 Summary of Options for New Hamburg WWTP

Potential Option	Feasibility for New Hamburg WWTP	Rationale
FOG Import (Co-Digestion)	X	No anaerobic digestion
Sludge Pre-Treatment – Thermal Hydrolysis	X	Consideration for the largest treatment facility only (due to operational complexity)
TPAD	X	No anaerobic digestion
ATAD	X	No energy benefits
Sidestream Sludge Treatment – Post Aerobic Digestion	X	No energy benefits
Nutrient Recovery through Struvite Precipitation	X	Not economically feasible for chemical phosphorus removal facilities

5.8 Wellesley WWTP

The Wellesley WWTP is an extended aeration package plant with a rated capacity of 1,100 m³/d. Waste activated sludge generated at the plant is stored in a 72 m³ aerated sludge holding tank and then hauled to the Waterloo WWTP for further processing.

5.8.1 Capacity Considerations

At future predicted 2051 flows, the existing aerated sludge holding tank capacity is insufficient to store future average and maximum month solids production. As presented in Table 2, the aerated storage tank has an equivalent average day capacity of 1,100 m³/d that is equal to the rated capacity of 1,100 m³/d. Therefore, additional aerated sludge holding tank capacity would be required for future 2051 predicted flows of 1,260 m³/d.

5.8.2 Plant Specific Opportunities

Table 17 provides a summary of the solids treatment opportunities relevant to the Wellesley WWTP related to optimization and energy efficiency, and identifies those that are considered feasible for further development and evaluation.

Table 17 Summary of Options for Wellesley WWTP

Potential Option	Feasibility for Wellesley WWTP	Rationale
FOG Import (Co-Digestion)	X	No anaerobic digestion
Sludge Pre-Treatment – Thermal Hydrolysis	X	Consideration for the largest treatment facility only (due to operational complexity)
TPAD	X	No anaerobic digestion
ATAD	X	No energy benefits
Sidestream Sludge Treatment – Post Aerobic Digestion	X	No digestion
Nutrient Recovery through Struvite Precipitation	X	Not economically feasible for chemical phosphorus removal facilities

5.9 St Jacobs WWTP

The St Jacobs WWTP is an oxidation ditch extended aeration plant, with a rated capacity of 1,450 m³/d. Waste activated sludge generated at the plant is stored in a 195 m³ aerated sludge holding tank and then hauled to the Waterloo WWTP for digestion and further processing (discharged at the plant headworks).

5.9.1 Capacity Considerations

At future predicted 2051 flows, the existing aerated sludge holding tank at the St Jacobs WWTP has sufficient capacity to store future solids production. As presented in Table 2, the aerated storage tank has an equivalent average day capacity of 3,900 m³/d (based on a 5 day storage time), compared to the rated capacity of 1,450 m³/d. Therefore, no additional aerated sludge holding tank would be required within the 35-year planning period.

5.9.2 Plant Specific Opportunities

Table 18 provides a summary of the solids treatment opportunities relevant to the St Jacobs WWTP related to optimization and energy efficiency, and identifies those that are considered feasible for further development and evaluation.

Table 18 Summary of Options for St Jacobs WWTP

Potential Option	Feasibility for St Jacobs WWTP	Rationale
FOG Import (Co-Digestion)	X	No anaerobic digestion
Sludge Pre-Treatment – Thermal Hydrolysis	X	Consideration for the largest treatment facility only (due to operational complexity)
TPAD	X	No anaerobic digestion
ATAD	X	No aerobic digestion
Sidestream Sludge Treatment – Post Aerobic Digestion	X	No digestion
Nutrient Recovery through Struvite Precipitation	X	Not economically feasible for chemical phosphorus removal facilities

5.10 Elmira WWTP

The Elmira WWTP is a biological nutrient removal (BNR) plant with a rated average day flow capacity of 7,800 m³/d. Sludge management is provided by fermentation of primary sludge and on-site dewatering of the fermented sludge and WAS, with biosolids being currently landfilled. Prior to dewatering, WAS is sent to a 377 m³ sludge blending tank for blending and storage.

5.10.1 Capacity Considerations

At future predicted 2051 flows, the existing fermenter at the Elmira WWTP has sufficient capacity to treat future estimated raw sludge production. As presented in Table 2, the fermenter has an equivalent average day capacity of 9,830 m³/d, compared to the rated capacity of 7,800 m³/d. Therefore, no additional fermenter tank would be required within the 35-year planning period.

The existing sludge blending tank at the Elmira WWTP does not have sufficient capacity to treat projected sludge production in 2051. As presented in Table 2, the sludge blending tank has an equivalent average day capacity of 5,600 m³/d, compared to the rated capacity of 7,800 m³/d. The blending tank is too small for the current operation and operation staff cannot get enough solids out. Therefore, additional sludge blending tanks would be required. The expanded sludge blending tanks should have sufficient capacity to allow blending of fermented primary sludge and WAS prior to dewatering. Consideration may be required for chemical addition to manage soluble phosphorus release in the return streams.

5.10.2 Plant Specific Opportunities

Table 19 provides a summary of the solids treatment opportunities relevant to the Elmira WWTP related to optimization and energy efficiency, and identifies those that are considered feasible for further development and evaluation.

Table 19 Summary of Options for Elmira WWTP

Potential Option	Feasibility for Elmira WWTP	Rationale
FOG Import (Co-Digestion)	X	No anaerobic digestion
Sludge Pre-Treatment – Thermal Hydrolysis	X	Consideration for the largest treatment facility only (due to operational complexity)
TPAD	X	No anaerobic digestion
ATAD	X	No aerobic digestion
Sidestream Sludge Treatment – Post Aerobic Digestion	X	No digestion
Nutrient Recovery through Struvite Precipitation	X	Insufficient capacity - smallest available struvite recovery treatment reactor is 30 MLD

6. Short-List of Options

6.1 Plant Specific Options for Further Development

Plant specific options are listed in the following sections that are being short-listed for further development relative to the evaluation criteria. Options for solids treatment to provide energy and greenhouse gas reduction will be further developed for evaluation using a business case

Kitchener WWTP

1. Co-digestion
2. Thermal hydrolysis pre-treatment
3. Upgrades to TPAD
4. Post aerobic digestion

Waterloo WWTP

1. Co-digestion
2. Thermal hydrolysis pre-treatment
3. Upgrades to TPAD
4. Post aerobic digestion

Galt WWTP

1. Thermal hydrolysis pre-treatment
2. Upgrades to TPAD
3. Post aerobic digestion

The Galt, Wellesley, and Elmira WWTPs will require additional solids handling capacity within the planning period. Options for operational enhancements should be reviewed through further study at the time of upgrades or asset management and renewal to provide the additional capacity prior to constructing additional tankage.

All other treatment plants have limited opportunities for energy reduction through solids treatment. Table 20 summarizes the plant specific options for operational enhancement and energy reduction.

Table 20 Plant Specific Options for Solids Treatment

Plant	Co-Digestion (FOG Import)	Thermal Hydrolysis	TPAD	Post Aerobic Digestion	Struvite Recovery	Additional Capacity
Kitchener WWTP	✓	✓	✓	✓		
Waterloo WWTP	✓	✓	✓	✓		
Galt WWTP		✓	✓	✓		✓
Preston WWTP						
Hespeler WWTP						
Wellesley WWTP						✓
Ayr WWTP						
New Hamburg WWTP						
St Jacobs WWTP						
Elmira WWTP						✓

It should be noted that the above short-list of solids treatment options has been developed based the potential to improve energy efficiency and/or recovery. The ATAD process was not considered beneficial from an energy efficiency or recovery perspective and therefore was not considered as part of the WWTMP Update project. However, this technology does offer benefits in terms of improved volatile solids destruction and Class A biosolids and may be considered as part of the Region's on-going Biosolids Master Plan.

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