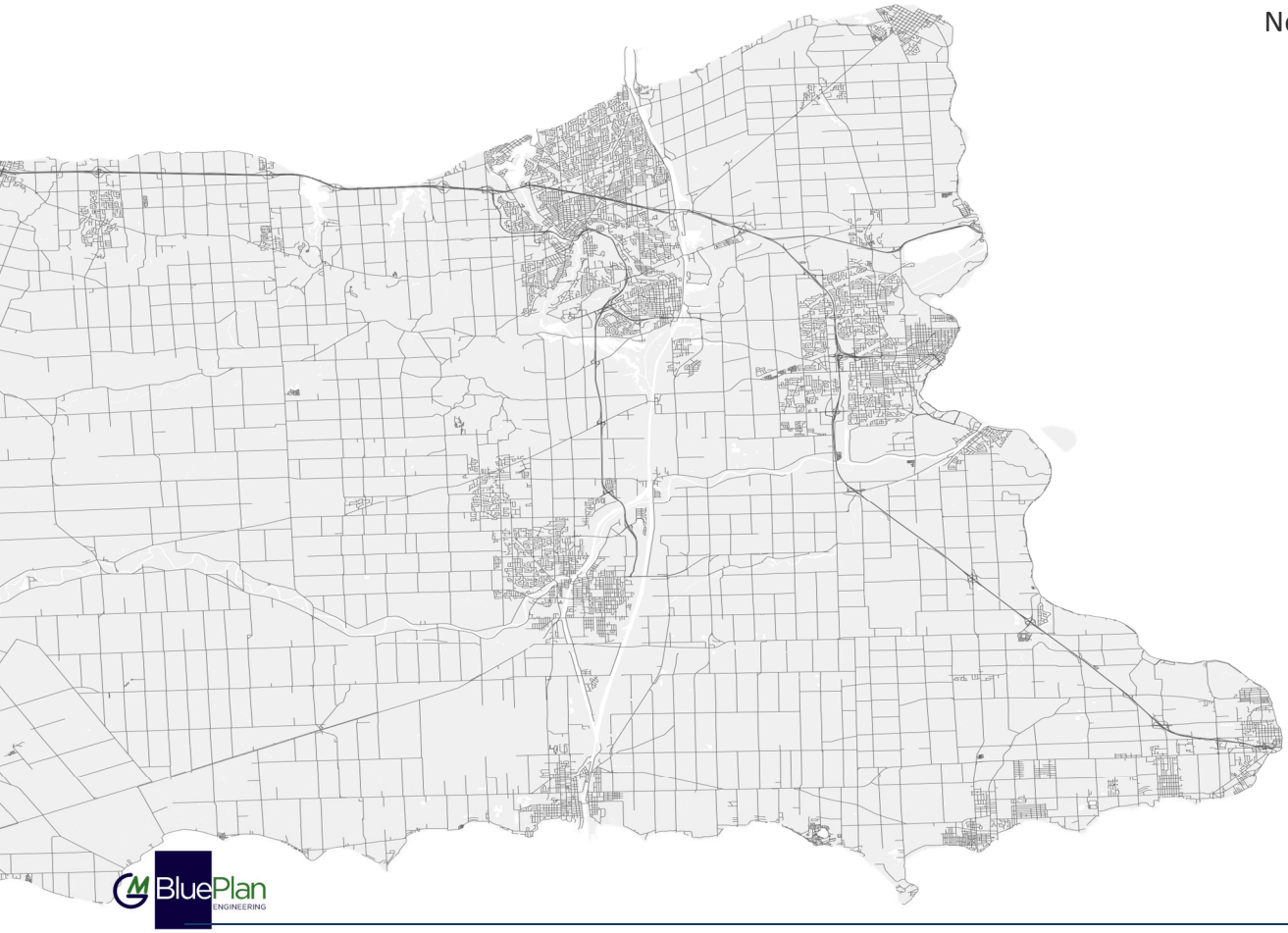
APPENDIX A5:
TM 5 – Dewatering Evaluation and Implementation

Technical Memorandum 5

Garner Road Biosolids Facility Review, Dewatering Evaluation and Implementation

2021 Biosolids Management Master Plan Update

November 2023



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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

The Niagara Region has an extensive water and wastewater treatment system, with ten (10) wastewater treatment plants (WWTP) and six (6) water treatment plants. The majority of liquid biosolids from the WWTPs are trucked to the centralized Garner Road Biosolids Facility. The residuals from the water treatment processes at the DeCew, Grimsby and Niagara Falls WTPs are also transported to the Garner Road Biosolids Facility to be mixed with Regional biosolids. The residuals from the remaining WTPs are conveyed to the WWTPs through the wastewater collection system.

The Region has two (2) third-party service providers to help manage their biosolids. Each provider manages approximately 50% of the Region's biosolids:

- Thomas Nutrient Solutions (TNS): TNS is responsible for haulage of liquid biosolids, and lagoon Operation and Maintenance at the Garner Road Biosolids Facility. TNS is also responsible for managing Niagara's land application program which includes partnering with farmers for biosolids application to their agricultural land.

- Walker Environmental: Walker Environmental is responsible for further treatment of biosolids through their alkaline stabilization N-Viro process, as well as marketing and selling the end-product ("N-Rich") through licensed distributors who sell the material as fertilizer and provide direct application services to farmers in Ontario. The Region must first dewater biosolids before they are transported and processed by Walker Environmental.

Between 2010 to 2011, the Region of Niagara completed a Biosolids Management Master Plan (BMMP) to review the Region's biosolids management practices, assess alternative management strategies, and develop a strategy for managing their biosolids (including residuals) to 2031 in a sustainable and diverse manner. Since completion of the 2010 BMMP, there have been regulatory and environmental changes, as well as updated population growth projections that have implications for biosolids management in Niagara.

This current BMMP Update will develop a strategy for continued management of biosolids from the wastewater treatment plants (WWTPs) and residuals from the water treatment plants (WTPs) in a transparent, sustainable, reliable, environmentally friendly, cost-efficient, and flexible manner. This BMMP will build upon the 2010 BMMP, while considering regulatory and environmental changes and infrastructure works implemented since its completion.

To date, several Technical Memoranda (TM) have been completed as part of this BMMP Update:

TM 1 – Background and Existing Conditions
TM 2 – Sewer Use By-Law Review
TM 4 – Treatment Facility Operations, Functions and Future Needs
TM 7 - Long List of Biosolids Treatment Alternatives and Detailed Evaluation of Strategies
TM 9 – Long Term Market Strategies

TM 5 builds upon the information presented in these previous TMs.

As summarized in TM 7, seven biosolids management strategies were developed and evaluated, and the top three strategies identified were:

- Strategy 4: Anaerobic Digestion + Dewatering + Advanced Alkaline Treatment to produce a fertilizer product for land application
- Strategy 2: Anaerobic digestion + Dewatering + Cake Land Application
- Strategy 1: Anaerobic Digestion + Liquid Biosolids Land Application

As identified in the Opportunity Statement, the biosolids management program should be reliable and resilient, which can be achieved through diversification and flexibility in biosolids management strategies. As such, a combination of the above strategies is considered in developing the preferred biosolids management program. The purpose of Technical Memorandum No. 5 (TM 5) is to further develop upgrade, expansion and optimization opportunities at the Garner Road Biosolid Facility, inline with these preferred biosolids management strategies.

TM 5 is organized into the following sections:

1. **Introduction:** This section describes the BMMP in general, the objectives of this TM, and the TM outline.
2. **Methodology:** This section provides an overview of the approach used to develop the proposed upgrade, expansion and optimization recommendations at the Garner Road Biosolids Facility.
3. **Existing Conditions, Constraints and Future Requirements:** This section reviews the existing Garner Road Biosolids Facility, identifies constraints to meeting existing requirements for storage and dewatering, and describes future needs. This section is a review of content presented in TM 1 and TM 4.
4. **Dewatering Evaluation:** This section describes and evaluates where in the Region to consider adding or maintaining dewatering to reduce storage requirements at Garner Road and hauling.
5. **Storage Types, Approaches and Optimization:** This section describes opportunities to reduce storage requirements at Garner Road through operational optimization or capital upgrades. It also describes specific types of storage and general approaches to storage.
6. **Garner Road Capital Upgrades Alternative Assessment:** This section develops expansion alternatives for Garner Road, considering implications for adding dewatering at select WWTPs.
7. **Further Opportunities for Optimization:** This section provides further opportunities for optimization that could occur at Garner Road and within the Region's biosolids management program.
8. **Recommendations, Implementation and Phasing:** This section reviews how recommended upgrades and changes to program should be implemented over time.
9. **Summary and Next Steps**

2.0 Methodology

To determine the optimized approach for implementing the preferred biosolids management strategies to address future needs to 2051, the steps below are undertaken:

Step 1: Identify existing conditions, future needs and constraints at water and wastewater treatment facilities and Garner Road Biosolids Facility. Existing conditions and future needs are described in detail in TMs 1 and 4, respectively. A review of the findings of these TMs is presented herein.

Step 2: Dewatering Evaluation:

a. Identify WWTPs that could feasibly incorporate dewatering through a screening level evaluation.
b. For each WWTP where dewatering is feasible, complete a cost-benefit analysis to assess impacts to capital, operating and life cycle costs, as well as impacts to truck traffic and staffing requirements. Determine which WWTPs should consider dewatering based on this analysis.

Step 3: Review Opportunities to Reduce Storage and Evaluate Storage Approaches:

a. Review opportunities to reduce required storage volume through operational optimization or capital upgrades and make recommendations.
b. Evaluate types of biosolids storage and make recommendations.

Step 4: Evaluate Garner Road Capital Upgrade Alternatives:

Based on the findings of Steps 2 and 3:

a. Review the upgrade and expansion needs at the Garner Road Facility's site with and without increased offsite dewatering.
b. Select the overall preferred strategy for dewatering at WWTPs and proposed capital upgrades at the Garner Road Facility.

Step 5: Identify Further Opportunities for Operational Optimization of Biosolids Management:

a. Centrate Management
b. WAS thickening
c. Haulage Routes
d. Biosolids Training Program
e. Material Quantity Measurement
f. Security Protocols
g. Land Application Program

Step 6: Summarize Overall Recommendations and Develop Phasing and Implementation Plan

Step 7: Identify and evaluate WTP residuals management alternatives:

a. Screening of high-level strategies
b. Establish and evaluate alternatives for each WTP
c. Incorporate into preferred build-out strategy for the Garner Road Biosolids Facility

Step 8: Establish the service delivery plan, including third-party involvement and contract considerations.

Step 9: Develop a Contingency Plan to mitigate risk and ensure reliable performance of the biosolids management program.

Step 1 is complete and is documented in TM 1 and TM 4. This TM summarizes key findings identified in Step 1 and will also document Steps 2 to 6 to obtain Region acceptance on the recommended dewatering approach for the Region, as well as recommended storage approach, built-out and operational optimization at the Garner Road Biosolids Facility. TM 8 evaluates Water Treatment Residual management (Step 7), TM 10 summarizes the service delivery plan (Step 8), and TM 11 provides the contingency plan (Step 9).

3.0 STEP 1: Existing Conditions, Constraints and Future Needs

3.1 Existing Conditions

As detailed in TM 1, the Niagara Region contains ten (10) WWTP, eight (8) of which send their biosolids to the Garner Road Biosolids facility; one (1) plant (Niagara Falls WWTP) has on-site dewatering and one (1) plant (Queenston WWTP) hauls their waste activated sludge (WAS) to the Port Weller WWTP for anaerobic digestion. The Garner Road Biosolids Facility receives the liquid biosolids from the other eight (8) WWTPs along with the residuals from three (3) surrounding WTPs. The biosolids and residuals received at the Garner Road Biosolids Facility are either stored and trucked to be utilized directly on agricultural lands or dewatered and transported to the N-Viro facility (owned by Walker Environmental), a biosolids processing facility located in Thorold. Liquid biosolids received at the Garner Road Biosolids Facility are unloaded from tanker trucks into lagoons where gravity settling occurs. A portion of the liquid biosolids from the lagoons is transferred to steel storage tanks prior to centrifuge-based dewatering, and the remaining settled biosolids are hauled away for direct land application. Supernatant from the lagoons and centrate from the centrifuge dewatering system are pumped to the sanitary sewer for treatment at the Niagara Falls WWTP.

Each of the lagoons at Garner Road have a storage capacity of 6,830 m^3, and the three glass-steel fused storage tanks each have capacity of 7,736 m^3. However, not all the lagoons are dedicated to biosolids storage, as one (1) of the lagoons is used for storage of centrate. In total, the facility has approximately 85,200 m^3 of liquid biosolids storage capacity.

Currently the facility is land applying approximately 50% of the biosolids that enter the facility as a liquid, while the remainder is stored at the facility or sent to the centrifuges for dewatering and further processing at the N-Viro facility. Over the past two (2) years, the facility has been exceeding capacity for storage at the lagoon due to pumping limitations.

The Garner Road facility has two (2) centrifuges for dewatering biosolids. A portion of the lagoon biosolids are sent to the centrifuges for dewatering. The centrifuges produce a cake that has historically been approximately 32.1% solids, along with centrate. The centrate is either stored on site at Garner Road, or sent to the sanitary sewer system, via forcemain, and then processed at the downstream Niagara Falls WWTP. The cake from the centrifuges is sent to Walker Environmental for further processing.

3.2 Future Needs

Table 3-1 provides both the current quantity of biosolids and residuals produced in the Region as well as future expected values within the 2051 planning horizon. From these values, the future storage requirements can then be determined, and the possible storage limitations at Garner Road can be assessed.

Table 3-1. Annual Solids to be Managed at Garner Road Facility Current and at 2051 Horizon

PARAMETER	VALUE
BIOSOLIDS	
Current Total Annual Biosolids [1]	334 ML / 7,601 DT (excluding biosolids from Niagara Falls WWTP)[2] 454 ML / 10,522 DT (including biosolids from Niagara Falls WWTP)[3]
2051 Total Annual Biosolids: Including biosolids from future South Niagara Falls WWTP and all WWTPs	586 ML / 14,041 DT (excluding biosolids from Niagara Falls WWTP)[4] 706 ML / 16,962 DT (including biosolids from Niagara Falls WWTP)
RESIDUALS	
Current Total Annual Residuals [5]	82.8 ML / 1,242 DT
2051 Total Annual Residuals [5]	116.8 ML / 1,752 DT

Notes:

1. Garner Road does not normally receive biosolids from Niagara Falls WWTP, except on occasions when dewatering equipment at Niagara Falls WWTP is unavailable.
2. Dry tonnes are calculated based on 2.28% total solids concentration (average for all WWTPs sending biosolids to Garner Road).
3. Digester failure occurred during the period of evaluation. Flows and loads are not expected to significantly increase with the New South Niagara Falls WWTP online, thus mass balances were used to estimate current production. The estimates are comparable with available data prior to digester failures.
4. Dry tonnes are calculated based on anticipated future 2.4% total solids concentration.
5. Considers residuals generated at Decew Falls, Grimsby and Niagara Falls WTPs. Calculated based on anticipated 1.5% total solids concentration.

A solids mass balance for flows into and out of the Garner Road Biosolids Facility under both current and future conditions was completed as part of TM 4 – Treatment Facility Operations, Functions and Future Needs.

3.3 Constraints

3.3.1 Storage Capacity

With a population that is anticipated to increase by 40% from 2022 to 2051, the Garner Road facility will face a storage challenge in the coming years. There are development pressures in the surrounding area which are anticipated to increase due to the opening of the new South Niagara Hospital and other planned residential and commercial developments nearby. Storage at the facility is greatly affected by its current use of liquid land application as the solids must be stored and the outlet inherently carries seasonal risk due to environmental conditions.

Land application historically has taken place from May to November, with some variability of volume that can be land applied month to month. The volumes that can be land applied are affected by either dry or wet weather in the Region, effecting storage requirements. The Garner Road facility must have the capacity to store biosolids throughout the winter and must also have adequate capacity for wet weather years.

The ability to adequately dewater biosolids is a factor when calculating future storage requirements. Historically, the facility's centrifuges have been used to process approximately 50% of the biosolids entering Garner Road, despite one of the facility's centrifuges consistently being out of service. When calculating available storage, it is assumed that the solids content entering the centrifuges is 3.1% (2017-2022 average) during winter months, and 4% (adequate land applying solids content) during land application months. This assumption is based on historical solids concentrations; decanting has been historically increased during land application months.

The Garner Road facility utilizes predominantly lagoon storage for biosolids, and according to the Ontario Design Guidelines for lagoons, a lagoon cannot be pumped dry, and must maintain a minimum freeboard of 0.9 m above liquid level. The Operations and Management Plan for Garner Road states the minimum depth of each lagoon is 1.5 m, equating to approximately 60% of lagoon volume. The residual that must be kept in each lagoon, and the minimum required freeboard, limits storage availability for liquid storage at the facility. The Region is currently reviewing actual lagoon capacity, as they suspect there may be unaccounted volume available after lagoon upgrades completed in recent years. For the purposes of this Master Plan study, the lagoon volumes stated in the ECA are assumed to be correct, as this is a more conservative approach. Regardless, the available storage at Garner Road is insufficient for future needs to 2051. The storage tanks on-site do not have this requirement and can be pumped to a lower ratio.

3.3.2 Dewatering Capacity

Currently the biosolids flow into the centrifuges is approximately 550 m^3/d, which can fill approximately two (2) trucks per day. The centrifuges are capable of processing larger daily quantities if allowed to run longer hours but are restricted due to contractors' limitations on truck availability.

The centrifuges are currently producing a cake with a solids content of 32.1%, while typical solids content range for cake is 22 to 35%. The facility provides the centrifuges an above average amount of polymer about 25 kg/Dt (average is between 7.5 kg/Dt to 15 kg/Dt), which is likely contributing to the high solids content of the cake.

Two issues that have hindered the Garner Road facility are the reliability of the centrifuges and staffing limitations as the facility is only able to operate eight (8) hours per day. Garner Road has two (2) centrifuges and often one is shutdown for maintenance or repair. Furthermore, it is challenging to remove the centrifuges for maintenance based on the current building design, and requires a temporary platform be installed. This increases shut-down time if repairs are required on the centrifuges.

3.4 Planned Upgrades

Preliminary design is currently underway for construction of a new administration building at the Garner Road Biosolids Facility. The scope of this project had originally included upgrades to the existing dewatering building to allow for better accessibility for maintenance of centrifuges. However, due to limitations of the existing building, this has since been removed from the project scope. Further upgrades to the facility may be pursued based on the recommendations of the current Biosolids Management Master Plan and associated implementation plan.

4.0 STEP 2 – Dewatering Evaluation

TM 7 identified the following three preferred strategies as outline above:

- Strategy 4: Anaerobic Digestion + Dewatering + Advanced Alkaline Treatment to produce a fertilizer product for land application
- Strategy 2: Anaerobic digestion + Dewatering + Cake Land Application
- Strategy 1: Anaerobic Digestion + Liquid Biosolids Land Application

Strategy 1 involves continuing with the existing processes at the Garner Road facility. Strategies 2 and 4 involve dewatering to reduce hauling requirements and associated community impacts, Greenhouse Gas (GHG) emissions and transportation costs. Dewatering is currently in place at Niagara Falls WWTP and the Garner Road facility.

To identify future needs at the Garner Road facility, the potential to add dewatering at each of the WWTPs in the Region is reviewed in this section, and a preferred dewatering approach identified. Not only will this reduce hauling but could reduce biosolids storage requirements at the Garner Road facility.

4.1 Step 2a - Screening of WWTPs for Dewatering

Dewatering was only considered at WWTPs in the Region that have sufficient space; have a large enough rated capacity to justify the investment; and are far enough from the Garner Road facility to incur a notable decrease in truck traffic. The screening criteria used are defined in Table 4-1 below:

Table 4-1: Screening Criteria for Evaluation of Feasibility of Dewatering at WWTPs

SCREENING CRITERIA	DESCRIPTION
1. Available Space Onsite	Is there available space onsite for dewatering that has not be allocated for other planned upgrades?
2. WWTP Capacity	Is the WWTP capacity (rated or solids volume) such that it warrants consideration of additional solids treatment? Plant with capacity <20MLD will be screened out.
3. Distance from Garner Road	Is the WWTP far enough from Garner Road that haulage is a substantial contributor to GHG and cost? WWTPs within 20km of Garner Road will be screened out.

The results of the screening level evaluation are summarized in Table 4-2 below.

Table 4-2: Results of Screening Level Evaluation for Determining Feasibility of Dewatering at WWTPs

WWTP	Space on Site	Plant Rated Capacity (MLD)	Distance from Garner Road (km)	RESULT
Screening Threshold (required to pass)	--	>20 MLD	>20 km	
Baker Road WWTP	**Yes**	**31.3**	**47 km**	**Space, capacity to dewater, far from Garner - Carry Forward**
Port Dalhousie WWTP	**Yes**	**61.4**	**27 km**	**Space, capacity to dewater, far from Garner - Carry Forward**
Port Weller WWTP	**Yes**	**56.2**	**29 km**	**Space, capacity to dewater, far from Garner - Carry Forward**
Queenston WWTP	No	0.5	22 km	Space and capacity too small - Screen out
Niagara Falls WWTP	**n/a**	**68.3**	**14 km**	****Dewatering in place – Carry Forward to detailed evaluation, even though <20km from Garner Road**
South Niagara Falls WWTP (Future)	Yes	60	~7 km	Too close to Garner Road Facility – Screen out
Anger Ave WWTP	**Yes**	**24.5**	**25 km**	**Space and capacity to dewater - Carry Forward**
Crystal Beach WWTP	No	9.1	26 km	Space too small - Screen out
Stevensville-Douglastown Lagoons	Yes	2.7	16 km	Capacity too small, not a mechanical plant, close to Garner Road – Screen out
Welland WWTP	Yes	54.6	15 km	Too close to Garner Road Facility - Screen out
Seaway WWTP	Yes	19.6	24 km	Small capacity plant, 2051 flows much less than rated capacity – Screen out

Overall, Baker Road WWTP, Port Dalhousie WWTP, Port Weller WWTP, Niagara Falls WWTP and Anger Avenue WWTP pass the screening and are carried forward for completion of a cost-benefit analysis.

4.2 Step 2b – Cost-Benefit Analysis of WWTPs that Passed Screening

To determine if dewatering should be pursued at Baker Road, Port Dalhousie, Port Weller, and Anger Avenue WWTPs or continued at Niagara Falls WWTP, a cost analysis for dewatering is completed for the following four (4) areas as described in the following sections. The four (4) areas are shown in Figure 4-1 below.

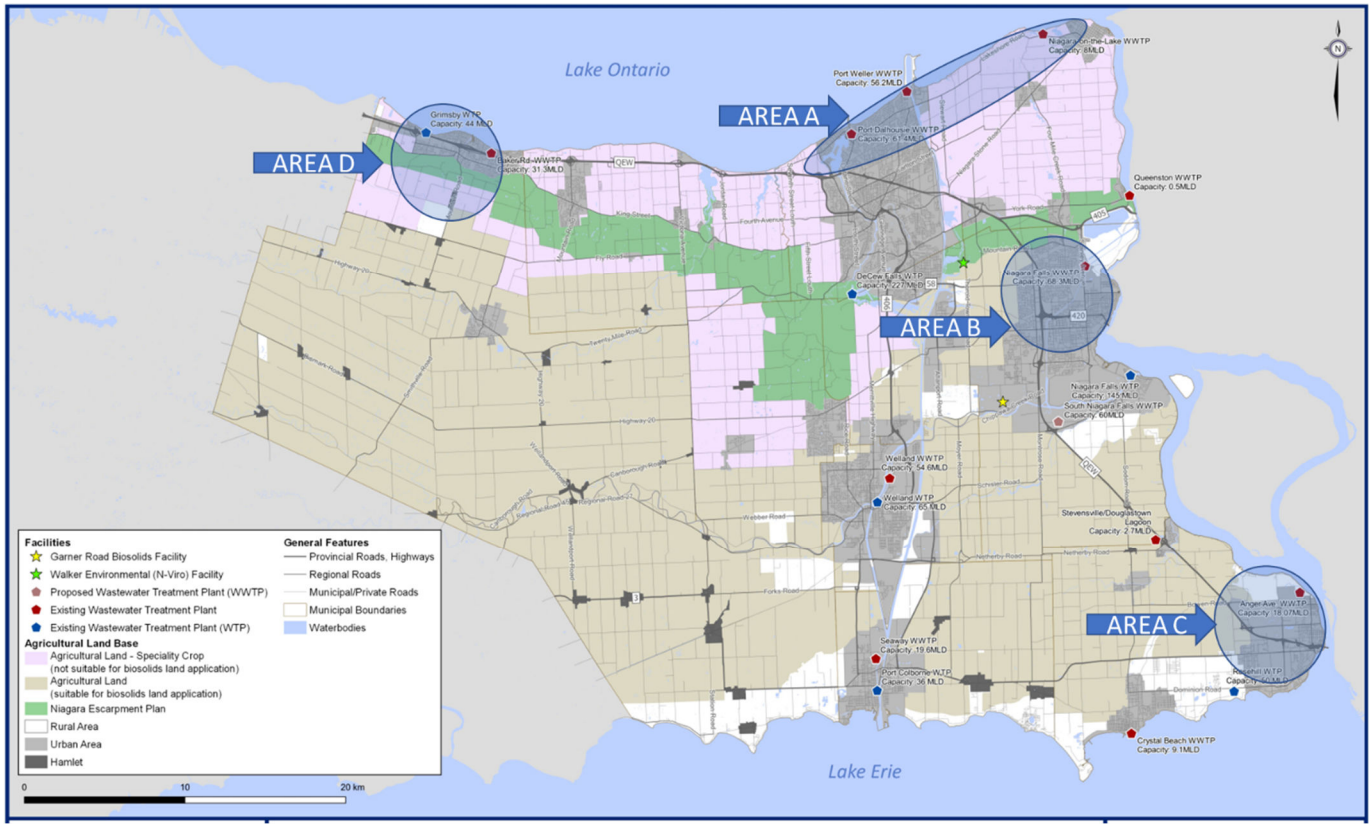

Figure 4-1: Areas Within Region with WWTPs Under Consideration for Dewatering

4.2.1 Dewatering Scenarios in Area A - Northeastern WWTPs

Area A consists of Port Dalhousie, Port Weller and Niagara-on-the-Lake WWTPs. Both Port Dalhousie and Port Weller WWTPs passed the screening level evaluation in Step 1, as they are larger capacity WWTPs and more than 20 km from Garner Road. Because Port Dalhousie and Port Weller are near each other (approximately 7km apart), a centralized facility at one (1) of these two (2) plants would be more cost effective than dewatering at each plant separately, due to the lower capital investment. Port Weller WWTP was selected as the location for the centralized facility as it is located between Port Dalhousie and Niagara-on-the-Lake WWTPs, although Port Dalhousie could also potentially be the centralized location.

Two (2) scenarios were developed to manage biosolids for the northeastern WWTPs, as shown below. Scenario 1 involves continuing with the existing management approach to year 2051, which is to continue transporting liquid biosolids from the WWTPs in Area A to Garner Road. Scenario 2 involves implementing dewatering at the Port Weller WWTP and transporting liquid biosolids from the Port Dalhousie and Niagara-on-the-Lake WWTPs to the Port Weller WWTP for dewatering. The cake would be transported to the Garner Road facility for storage and management. The Region could also consider having the dewatered cake transported by Walker Environmental to their alkaline stabilization facility for alkaline stabilization under their current agreement for additional stabilization and product marketing. The two scenarios developed are presented in shown in Figure 4-2.

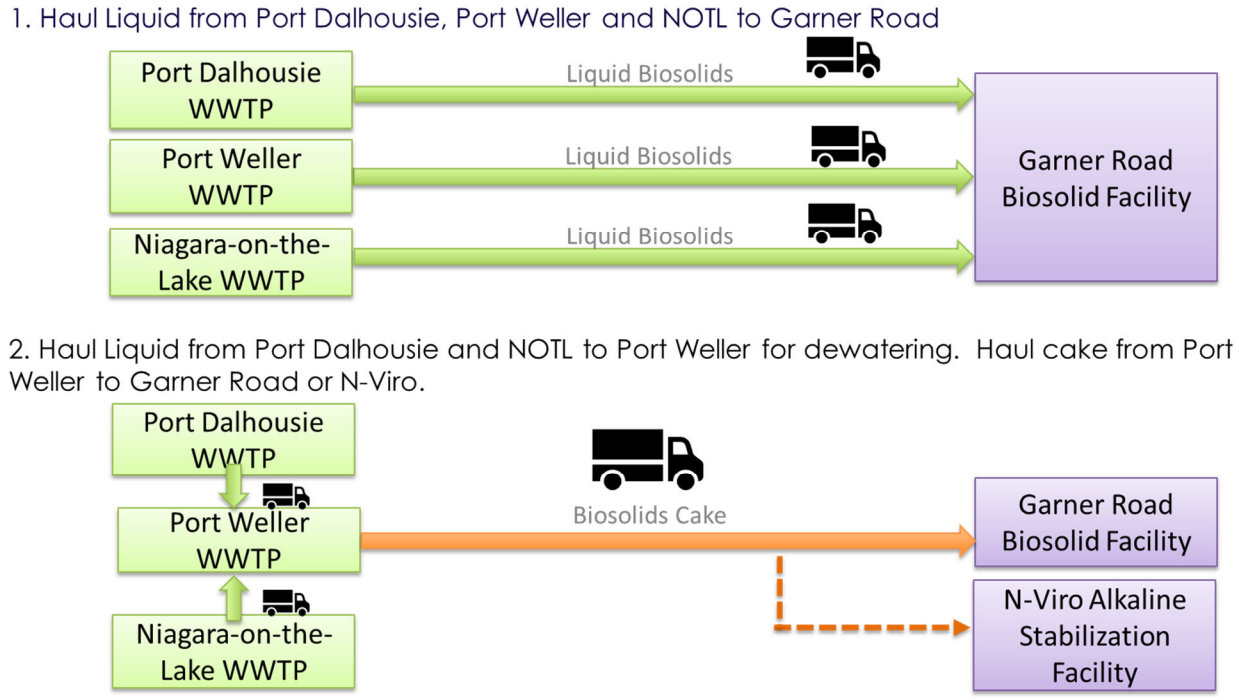

Figure 4-2: Area A Northeastern WWTPs Scenarios for Dewatering

Table 4-3 summarizes the results of the cost-benefit analysis for Area A scenarios, including a comparison of hauled volumes, number of truck trips and costing. Note that the cost or Scenario 2 is based on cost to haul cake to Garner Road, rather than hauling cake to the N-Viro facility to reduce the number of variables in the comparison.

Table 4-3: Cost Benefit Analysis of Area A Scenarios

	1. HAUL LIQUID FROM PORT DALHOUSIE, PORT WELLER AND NOTL TO GARNER ROAD	2. HAUL LIQUID FROM PORT DALHOUSIE AND NOTL TO PORT WELLER FOR DEWATERING. HAUL CAKE FROM PORT WELLER TO GARNER ROAD
Annual Volume Hauled	217,854 m^3 (liquid)	140,900 (liquid) 24,200 m^3 (cake)
Annual Haul Distance[1]	281,700 km	182,322 km
Annual # of Trucks Trips (1 way)	5,066	3,968
O&M Cost	$1.24 Million / year	$1.17 Million / year
Capital Cost	Nil – continue current operations	$13.5 Million
30 Year Life Cycle Cost	**$24.2 Million**	**$36.3 Million**

Notes:

1. Includes distance from WWTP to Garner Road, not to final land application or N-Viro facility
2. Unit liquid haul cost based on Thomas NS contract.
3. Number of trucks based on 43m^3 tanker truck for liquid hauling and 35m^3 dump trailer for cake hauling

Scenario 2, which incorporates dewatering at Port Weller WWTP, has a 30-year life cycle cost approximately 150% that of continuing with liquid hauling from northeastern WWTPs to Garner Road. This is partially due to the additional capital investment to construct dewatering at Port Weller. Although Scenario 2 has approximately 35% reduction in distance hauled per year, the operational cost savings are partially offset by the increase in O&M for dewatering operation. Based on the large cost differential between the two (2) scenarios, it is recommended to continue hauling liquid biosolids from the northeastern WWTPs to Garner Road.

4.2.2 Dewatering Scenarios in Area B – Niagara Falls WWTP

Niagara Falls WWTP currently dewaters the biosolids generated at their WWTP onsite. Walker Environmental transports the dewatered cake directly from the Niagara Falls WWTP to their N-Viro facility for advanced stabilization and product sale and marketing. The Region requested that the evaluation consider the option to remove dewatering from Niagara Falls WWTP and instead haul liquid to the Garner Road facility for storage and liquid land application or storage and dewatering at Garner Road before transportation by Walker Environmental for further stabilization. These two scenarios are presented in Figure 4-3 below. Although the dewatering equipment at Niagara Falls WWTP can achieve greater than 30% total solids (TS), to be conservative in the analysis, it was assumed that dewatering at Niagara Falls WWTP achieves 22% TS, which is the minimum required solids concentration to allow the biosolids cake to be accepted by Walker Environmental. If a higher TS percentage can be achieved, the amount of hauling for Scenario 2 below will be reduced further.

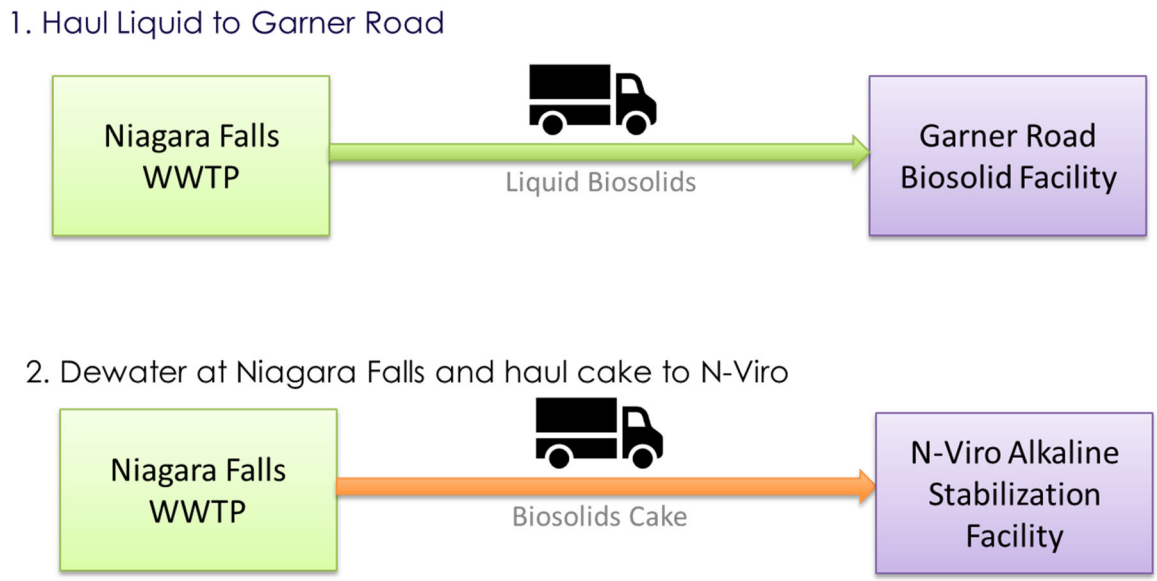

Figure 4-3: Area B Scenarios for Dewatering

Table 4-4 summarizes the results of the cost-benefit analysis at Niagara Falls WWTP, including a comparison of hauled volumes, number of truck trips and costing. A detailed cost breakdown is provided in Appendix B.

Table 4-4: Cost Benefit Analysis of Area B Scenarios

	1. HAUL LIQUID TO GARNER ROAD	2. DEWATER AT NIAGARA FALLS AND HAUL CAKE TO N-VIRO
Annual Volume Hauled	118,600 m^3 (liquid, 2.2% TS)	11,800 m^3 (cake, 22% TS)
Annual Haul Distance[1]	82,760 km	10,100 km
Annual # of Trucks Trips (1 way)	2,760	340
O&M Cost	$0.62 Million / yr	$0.50 Million / yr
Capital Cost	Nil – assume existing equipment repurposed	Nil – continue current operations
30 Year Life Cycle Cost	**$12.2 Million**	**$9.8 Million**

Notes:

1. Includes distance from WWTP to Garner Road or N-Viro, not to final land application
2. Unit liquid haul cost based on Thomas NS contract.
3. Number of trucks based on 43m^3 tanker truck for liquid hauling and 35m^3 dump trailer for cake hauling

Based on the cost analysis, it is more economical to continue transporting dewatered cake from Niagara Falls WWTP to N-Viro compared to hauling liquid biosolids to Garner Road. This is the case even when the cost to decommission the existing centrifuge at Niagara Falls is excluded from the capital cost. Furthermore, there is a more significant reduction in hauled volume by dewatering at Niagara Falls (approximately 90% reduction). Based on discussions with the Region, the centrifuge at Niagara Falls is performing well and resulting in a cake that is dryer than 22% (assumed TS % in life cycle cost analysis) which could further reduce transportation costs should the Region choose to land apply the material directly from the WWTP.

However, Region staff have also indicated that the centrifuge at Niagara Falls WWTP is nearing the end of its useful life. There are advantages to discontinuing dewatering at Niagara Falls once the existing equipment reaches the end of its useful life, and centralizing dewatering at the Garner Road facility. This approach would simplify operations, and potentially reduce labour costs.

4.2.3 Dewatering Scenarios in Area C – Anger Avenue WWTP

Anger Avenue WWTP is located in Fort Erie in the southeastern corner of the Region. Overall, dewatering is not economical at this plant due to the high solids concentration that is achieved with the use of their gravity belt thickener upstream of the digester. The transportation savings projected by transporting dewatered cake do not justify the capital and operating cost projected for dewatering. Another method considered to reduce the cost of liquid transport from Anger Ave to Garner Road is the direct land application of the liquid biosolids from Anger Avenue. Anger Avenue has liquid storage capacity that could support this approach. The scenarios for Area C, Anger Avenue WWTP, are shown in Figure 4-4 below.

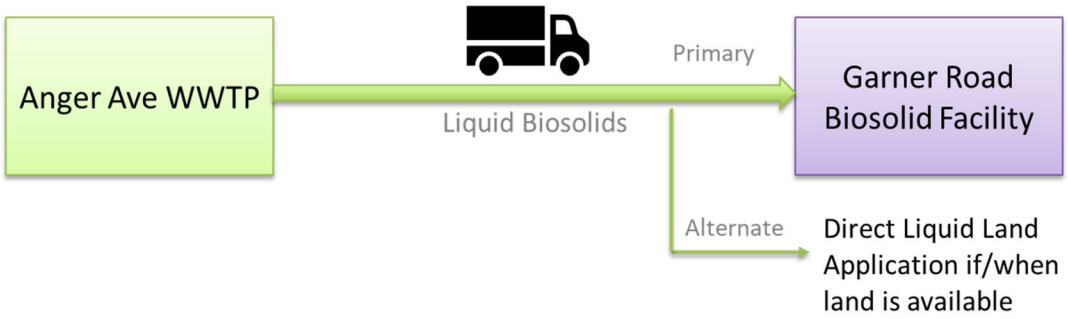

Figure 4-4: Area C Scenarios for Dewatering

Based on discussions with the Region, it is understood that, while there is considerable agricultural land in the vicinity of the Anger Avenue WWTP, currently there is limited use of biosolids to provide nutrients and organics to the soil on this land. It is recommended that the Region reach out the biosolids management firms and the agricultural community to determine if there is a market for this product. Once a market is developed, the direct land application of the biosolids generated at the Anger Avenue WWTP in the southern portion of the Region would save transportation costs and reduce truck traffic. It is recommended to continue transporting liquid biosolids from Anger Avenue WWTP to the Garner Road Facility, while exploring opportunities to land apply biosolids in the area.

4.2.4 Dewatering Scenarios in Area D – Baker Road WWTP

Baker Road WWTP is the plant located the furthest from the Garner Road Facility, and also has available space for dewatering. Furthermore, this plant has significant population growth forecast within the 2051 time horizon with rated capacity to increase from its current level of 31.3 MLD to 48 MLD by 2051. The biosolids quantities are anticipated to increase accordingly. Scenarios considered for Area D, Baker Road WWTP, are summarized in Figure 4-5.

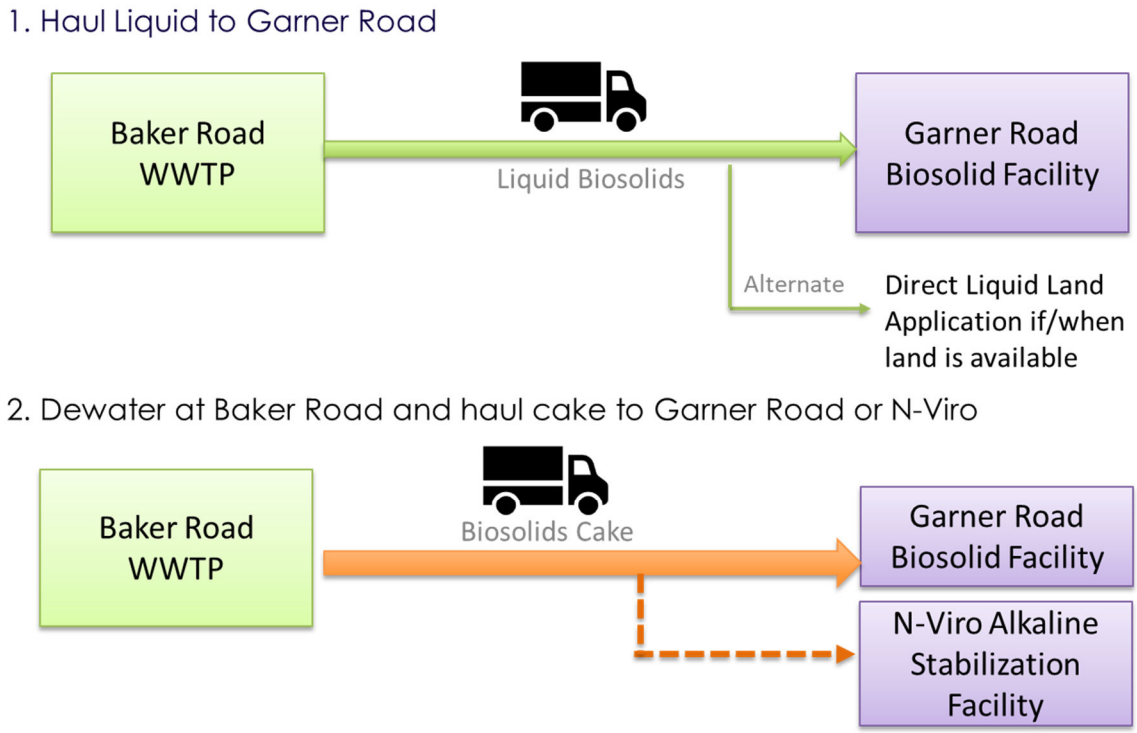

Figure 4-5: Area D Scenarios for Dewatering

Table 4-5 summarizes the results of the cost-benefit analysis at Baker Road WWTP, including a comparison of hauled volumes, number of truck trips and costing. A detailed cost breakdown is provided in Appendix B.

Table 4-5: Cost Benefit Analysis of Area D Scenarios

	1. HAUL LIQUID TO GARNER ROAD	2. DEWATER AT BAKER ROAD AND HAUL CAKE TO GARNER ROAD
Annual Volume Hauled	109,600 m^3 (liquid)	11,300 m^3 (cake)
Annual Haul Distance[1]	239,600 km	30,340 km
Annual # of Truck Trips (1 way)	2,550	320
O&M Cost	$1.07 Million / yr	$0.80 Million / yr
Capital Cost	Nil – continue current operations	$13.0 Million
30 Year Life Cycle Cost	**$21.0 Million**	**$28.7 Million**

Notes:

1. Includes distance from WWTP to Garner Road, not to final land application or N-Viro
2. Unit liquid haul cost based on Thomas NS contract.
3. Number of trucks based on 43m^3 tanker truck for liquid hauling and 35m^3 dump trailer for cake hauling

Scenario 1 (continuing to haul liquid to Garner Road) has a lower 30-year life cycle cost than Scenario 2 (providing dewatering at Baker Road). However, Scenario 2 has the additional benefit of significantly reducing the annual number of truck traffic, thereby reducing truck traffic in a growing community, as well as reducing GHG emissions. There is approximately a 90% reduction in the total distance travelled by trucks carrying biosolids from Baker Road WWTP if dewatering is added at Baker Road WWTP. However, decentralizing dewatering would add complexity to operations. Furthermore, Baker Road WWTP is located closer to residential developments than Garner Road Biosolids facility and odour control requirements would likely be higher. Note that costing shown in Table 4-5 does not include the cost of odour control, so the total lifecycle cost for Scenario 2 would likely be higher than stated. Overall, dewatering at Baker Road WWTP should be considered due to the potential savings in transportation costs and associated greenhouse gas emissions.

4.3 Dewatering Recommendations

Based on the assessment above, our recommendations for dewatering are as follows:

1. Continue hauling liquid biosolids from northeastern WWTPs (Port Weller, Port Dalhousie, Niagara-on-the-Lake) to Garner Road Biosolids facility

2. Maintain dewatering at Niagara Falls WWTP. When dewatering equipment at Niagara Falls WWTP reaches the end of its useful life, consider liquid hauling from Niagara Falls WWTP to Garner Road for dewatering or liquid land application.

3. Continue hauling liquid biosolids from Anger Avenue, and consider direct liquid land application from the WWTP is land becomes available.

4. Consider adding dewatering at Baker Road WWTP due to higher potential for reduction in cost and hauling.

Adding dewatering at Baker Road WWTP will impact the storage and long-term dewatering requirements at the Garner Road facility. Therefore, before confirming whether dewatering should be implemented at the Baker Road WWTP, a more detailed evaluation of the impacts on future upgrade and expansion needs at Garner Road was undertaken and is presented in Section 6 of this TM.

5.0 STEP 3 – Storage Reduction Opportunities and Storage Approaches at Garner Road Biosolids Facility

Storage at Garner Road has been historically adequate; however, with the population expected to increase 40% by 2051, the facility will face a storage constraint. Furthermore, in recent years, the Region has needed to truck excess water offsite on multiple occasions during wet weather conditions due to limited liquid storage and the inability to land apply during wet weather. Although there is a centrate pumping system that will discharge excess water to a forcemain that discharges into the Niagara Fall WWTP catchment, this system has limited capacity to meet pumping needs during wet weather events. Step 3 first examines methods to reduce the total volume of biosolids requiring storage at Garner Road. Potential types of biosolids storage will then be reviewed.

5.1 Step 3a – Identifying Methods to Reduce Storage Requirements

Reducing storage requirements at Garner Road will help reduce upgrade and expansion needs at the facility. This section describes methods to reduce storage requirements at Garner Road and recommends approaches for reducing storage.

5.1.1 Methods to Reduce Storage Requirements

5.1.1.1 Increase Dewatering at WWTPs

The preferred dewatering strategy outlined in Section 4 is to continue dewatering at the Niagara Falls WWTP and add dewatering capacity at Baker Road WWTP. Adding a capacity at Baker Road will reduce the liquid biosolids sent to Garner Road for storage and reduce storage requirements at Garner Road.

5.1.1.2 Modify Supernatant Management at Garner Road Facility

Currently a third-party contractor is responsible for the supernating of the lagoons. Supernatant is then pumped from Garner Road lagoons through a forcemain to the Niagara Falls WWTP sanitary catchment. In practice, the solids content of the land applied biosolids has been decreasing over a three-year period (4.48% to 3.59%). Optimal solids content for land application is between 4% to 6%; the five-year average of the solids content is 4.2%. Increasing supernating at Garner Road would decrease the volume that must be stored at the facility. This technique would also ensure that the solids content of the biosolids that are land applied are within the desired solids content range.

This optimization would put more strain on the WWTPs that receive the supernatant from Garner Road. Under normal conditions, supernatant is discharged to the Niagara Falls WWTP sanitary system via forcemain. When this forcemain is not available, supernatant is hauled to a maintenance hole (MH) within the Port Weller WWTP catchment. Receiving WWTPs will have to receive more supernatant, even if Garner Road maintains current solids content output, due to the anticipated increased flows. Further analysis, beyond the scope of this Master Plan, would be required to ensure the WWTPs have the ability to receive Garner Road supernatant, and that the forcemain from Garner Road has the capacity to receive increasing supernatant pumping.

5.1.1.3 Mechanical Thickening at Garner Road Facility and Wastewater Treatment Plants

Mechanical thickening prior to the biosolids entering storage at Garner Road could help decrease the storage requirements at the facility. This process reduces the water content of the biosolids, allowing a lower volume to be stored, and subsequently increasing the solids content, achieving a higher quality land application product. With this solution, there could be a rotary drum thickener or other mechanical thickening equipment implemented at Garner Road that would thicken the biosolids prior to storage. Furthermore, it would be possible to reduce the total volume of liquid biosolids entering the Garner Road facility by thickening WAS at the WWTPs prior to digestion. This has the added benefit of potentially increasing digester performance. Currently, only Anger Avenue and Niagara-on-the-Lake using thickening upstream of their digesters. Based on space currently available at the remaining WWTPs, there is an opportunity to add mechanical thickening at Port Dalhousie, Port Weller and Welland WWTPs.

Mechanical thickening, such as rotary drum thickening, is preferred over gravity thickening as higher solids content can be reliably achieved. Mechanical thickening can reliably achieve greater than 4% solids content. In addition to mechanical thickening, there is also an opportunity to increase supernating of the digesters at the WWTPs to increase the solids concentration in the final liquid biosolids product that will need to be hauled to Garner Road.

It is likely that storage of the biosolids, prior to mechanical thickening, would be required, as thickening may not be operated every hour of each day.

5.1.1.4 Dewatering at the Garner Road Facility

Dewatering at the Garner Road facility is likely to increase as the flows to the facility increase. To account for the increase in flow entering the facility, the centrifuges will likely have to be run longer to accept at minimum 780 m^3/d, if not more

The centrifuges are producing quality cake that is sent to Walker Environmental for N-Viro processing. The current contract between the Region and Walker Environmental provides incentive to Garner Road to send higher solids content cake as the Region is charged less for this material, versus cake with a low solids content. Therefore, with the expected increased flows to Garner Road, it would be beneficial to the Region to keep the quality of cake high as this could result in significant savings over time.

As previously noted, an issue that has hindered the Garner Road facility is the reliability of the centrifuges. Garner Road has two centrifuges and often one is shutdown for maintenance or repair. To improve the efficiency of the dewatering practices at Garner Road, implementation of a back-up third centrifuge (mobile), or a new dewatering centrifuge facility with additional redundancy will help improve the reliability of the dewatering process as sludge flow increases.

To increase capacity of the existing centrifuges without capital upgrades, increasing the daily run-time could be considered, which would require additional hours for operations staff.

5.1.2 Recommendations to Reduce Storage Requirements

To reduce required storage volume, it is proposed that increased supernating (decanting) of the lagoons be taken as a first step. This can be done in a gradual manner to assess impacts on the downstream WWTPs. Capacity of the forcemain from Garner Road may require upgrades to accommodate expected decanting flows for current and future conditions depending on the increased level of decanting implemented. Mechanical thickening may also be considered in future if the limits of decanting are reached, in order to hold-off investment in additional storage capacity.

The impacts of increased decanting as well as implementing dewatering at the Baker Road WWTP are discussed further in Section 6.

5.2 Step 3b – Identify Storage Approach

Even if upgrades or operational optimization are undertaken to reduce the total volume required to be stored at Garner Road, additional storage capacity will be required to meet 2051 biosolids quantities. This section provides a review of types of storage and recommends the preferred storage approach.

5.2.1 Storage Types

Three (3) main storage types are available for the facility: tank storage, lagoon storage, and cake storage.

5.2.1.1 Lagoon Storage

Lagoon storage is the prevalent technology used at the Garner Road Biosolids and Dewatering Facility. Lagoons are a simple technology that require little work to construct and operate; however, they take up large plots of land.

Table 5-1 highlights the advantages and disadvantages of the lagoon technology.

Table 5-1: Lagoon Storage Advantages and Disadvantages

ADVANTAGES	DISADVANTAGES
• Simple installation • Effective at removing BOD, TSS, pathogens, fecal coliform, and ammonia • Low capital and O&M costs	• Periodic dredging of lagoon bottom required • Large footprint • Strong odour during spring & fall turnovers • Colder climates limit lagoon effectiveness due to freezing • Breeding ground for mosquitos and other insects • Difficult to ensure mixing • Must monitor for leakage

Increasing the number of lagoons at the facility is an option to increase the storage capacity at the facility. This option is largely dependent on the amount of available land around the facility as lagoons tend to require large plots of land. Lagoons typically have a depth that does not exceed 2.5 m to 3 m, thus the footprint must be large to account for the lack of depth that they can utilize.

This storage option is practical, as lagoons are cheap to construct and are low maintenance once built. Lagoons do not hold as much volume as storage tanks when considering equal footprints, thus this is likely not a viable alternative option to help with the future storage constraint that the Garner Road facility will face by 2051.

5.2.1.2 Tank Storage

Garner Road currently has three (3) storage tanks (glass fused to steel tanks) with a volume of 7736 m^3 each. These tanks offer more storage than the lagoons (each lagoon can store 6830 m^3), while also having a smaller footprint. If the facility has limited access to additional land, storage tanks could be a viable option as they have a smaller footprint than the lagoon alternative.

This storage option also provides more flexibility to Garner Road. These tanks can be increased in height, instead of footprint, to add storage, making them an efficient option. Several tanks could be placed on the same sized area as a lagoon while adding two (2) to three (3) times more storage than a lagoon of the same footprint.

This leads to the option of adding additional tank storage near the existing tanks. This would allow for increased storage at the facility, while minimizing footprint.

Table 5-2 below highlights the advantages and disadvantages of tank storage.

Table 5-2: Tank Storage Advantages and Disadvantages

ADVANTAGES	DISADVANTAGES
• Low O&M costs • Weather has negligible effects on the contents of the container • Tanks provide odour reduction • Smaller footprint • Construction is quick and reliable • Expansion and relocation are simple • Anti-corrosive properties	• High capital cost • Insulation may be preferable to prevent freezing, adding cost • Tanks can chip & crack • Leaks may develop without proper design & installation • Tanks will require inspection every few years

5.2.1.3 Cake Storage (Stockpiled)

Cake storage could be implemented at Garner Road to allow for cake land application. Ontario Design Guidelines for Sewage Works (2008) provides guidelines on cake storage at a WWTP; although the Garner Road Biosolids Facility is not a WWTP, this guideline is used as reference. The guideline suggests that cake storage on a concrete slab should only be considered for cake with a solids concentration greater than or equal to 35%. For dewatered biosolids that are below a solids content of 35%, it should be stored in a steel or concrete container.

The length of storage time recommended in the Design Guideline also varies depending on the solids content of the biosolids. If the solids content is greater than or equal to 35%, the biosolids can be stored for up to 90 days onsite, while the storage time is decreased to 7 days if the solids content is below 35%.

To conform to the Design Guideline recommendations, cake storage at Garner Road would need to be limited to 90 days for solids concentrations 35% or greater or limited to 7 days for solids content below 35%. This could be achieved by storing the biosolids in liquid form until approximately February or 90 days before land application can begin in spring. An SOP could be devised for the start of dewatering to stockpile cake and prepare for the beginning of land application season. Cake production and storage would then be on demand after this reserve is depleted until the end of the land application season, when this process must be repeated.

However, the current solids content of the dewatered biosolids produced at Garner Road is 32.1%; it is not practical to consistently achieve greater than 35% TS, considering the large quantities of polymer required. The Environmental Protection Agency (EPA) Guide to Field Storage of Biosolids (2000) also provides recommendations for storage of biosolids as both liquid and cake. For dewatered biosolids, defined as 12 – 30% solids in the guide, either storage on a concrete pad or within an enclosed building are suggested.

Table 5-3 illustrates the advantages and disadvantages, assuming the stockpile storage technique can be implemented.

Table 5-3: Cake Storage Advantages and Disadvantages

ADVANTAGES	DISADVANTAGES
• Cake storage for up to 90 days • Stockpile storage technique, easy to implement • Allows for direct cake land application	• Precipitation must be diverted from pile • Odour potential • Requires discussions with MECP to determine feasibility of storage cake <35% onsite longer than 7 days.

If cake storage is implemented at the Garner Road facility, the preferred storage type would be a covered concrete slab with containment curb or low side walls, allowing the cake to be stockpiled while remaining protected from precipitation. Keeping the pile open to the air reduces anaerobic conditions to help control odour and removes the need for active ventilation. To maintain handleability of the biosolids, it is proposed that biosolids be dewatered to at least 22% TS and preferably >30% before storing. This will also meet the minimum solids concentration required by Walker Environmental, so the cake could potentially be hauled to the N-Viro facility if direct cake land application is not readily available, adding flexibility to the program.

There are also several examples of cake storage facilities in Ontario that store cake for longer than 7 days (i.e., through the winter) using fully enclosed, or simply covered facilities. This practice is used at the Oxford County Biosolids Storage Facility in Salford, ON, and the Mississippi Mills WWTP in Lanark County.

Regardless, additional consultation with the MECP will be required to confirm acceptability of this approach, and the opportunity to store cake with a solids content <35% for longer than 7 days onsite.

5.2.2 Recommended Storage Approach

For liquid storage, it is recommended that the existing lagoons and tanks be maintained and continue to be utilized at the Garner Road Facility to maintain existing liquid storage capacity. Additional liquid storage is required at the Garner Road Facility within the 2051 time horizon; installation of tank storage for liquid biosolids is recommended due to the smaller footprint, containment of odour, and resilience to wet weather events when compared to lagoon storage.

Cake storage on a covered concrete pad is also recommended if direct cake land application is pursued, pending results of a planned pilot project to determine acceptability of cake product to local famers.

The combination of both liquid and cake storage will provide increased operational flexibility at the Garner Road Facility.

6.0 STEP 4 - Capital Upgrade Alternatives for the Garner Road Facility

6.1 Development of Upgrade Alternatives for Garner Road Facility

As recommended in Step 3, the biosolids within the lagoons at the Garner Road Facility can be thickened by decanting to consistently achieve a TS concentration between 3.5% and 4.0%. This thickening through decanting will reduce the cost to transport solids for land application and increase the amount of solids that can be stored in the existing lagoons and storage tanks.

Implementing dewatering at Baker Road WWTP and managing the resulting cake either through the Region's existing contract with Walker Environmental for additional processing and marketing or through a land application program operated by a third-party contractor, would also reduce total liquid storage required at Garner Road. As there is a capital investment to install dewatering at Baker Road, consideration should also be given to increasing dewatering capacity at Garner Road only and maintaining this as a centralized facility for dewatering.

Two alternatives were developed and evaluated for Garner Road:

Alternative 1: Continue transporting liquid biosolids from all WWTPs to Garner Road excluding the Niagara Falls WWTP and decant the Garner Road lagoons and storage tanks to achieve biosolids TS concentration of 3.5%. A TS of 3.5% was selected as it is at the lower end of the expected TS range of 3.5% to 4% and provides a more conservative estimate of future liquid storage requirements. This alternative anticipates that no dewatering is added at any the Region's WWTPs, including Baker Road WWTP. The dewatering capacity at Garner Road will increase under this alternative to accommodate increased biosolids production over time while continuing to meet Walker Environmental contractual obligations.

Alternative 2: Haul liquid biosolids from all WWTPs to Garner Road, excluding the Niagara Falls and Baker Road WWTPs. The biosolids generated at the Niagara Falls and Baker Road WWTPs will be dewatered at those two WWTPs. The resulting dewatered cake from both WWTPs will be transported by Walker Environmental to their N-Viro processing facility. The lagoons and storage tanks at the Garner Road Facility will be decanted to achieve 3.5% biosolids TS. An increase in dewatering capacity will still be required at Garner Road under this alternative, but this can be done at a later time compared to Alternative 1.

We acknowledge that Niagara Falls WWTP has been excluded from the above Garner Road Upgrade alternatives to simply the scenarios for comparison purposes only. There are benefits to receiving liquid biosolids from Niagara Falls at Garner Road, and dewatering all biosolids at a centralized facility, which will be discussed further in Section 8.

6.2 Review of Impacts of Alternatives

Figure 6-1 illustrates the impacts of increased lagoon decanting on liquid storage requirements at Garner Road under the two alternatives described above.

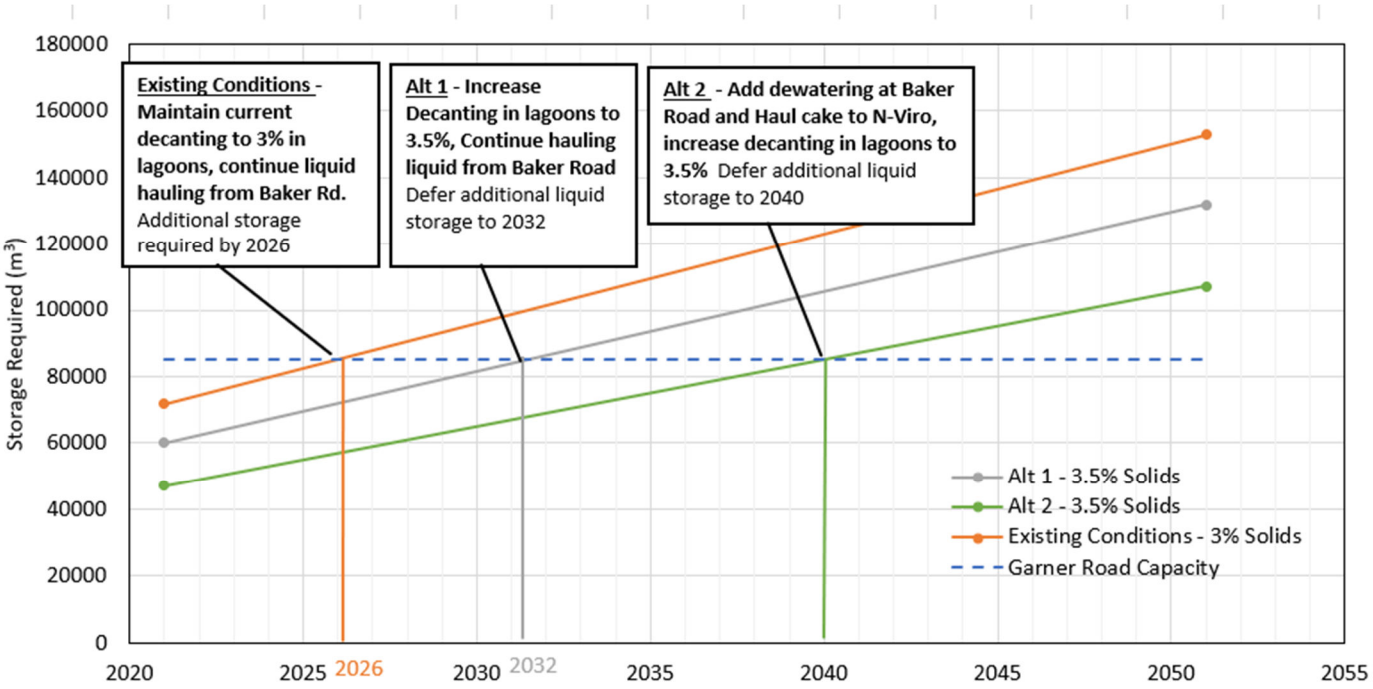

Figure 6-1: Impacts of Dewatering at Baker Road WWTP and Increasing Lagoon Decanting at Garner Road on Liquid Storage Requirements at Garner Road

As shown in Figure 6-1, if the current strategy is continued without increasing decanting, liquid storage at Garner Road will be insufficient by 2026. If decanting is increased to achieve 3.5% total solids in the lagoons, and liquid biosolids from Baker Road continue to be hauled to Garner Road (alternative 1), liquid storage at Garner Road will be insufficient by 2032. By implementing dewatering at Baker Road WWTP and diverting this volume of biosolids from Garner Road WWTP to N-Viro, in combination with increased decanting (alternative 2), the existing liquid storage capacity at Garner Road will be sufficient until approximately 2040. Overall, increasing decanting at Garner Road and dewatering at Baker Road WWTP would both contribute to delaying the need for increased storage and dewatering at the Garner Road facility.

A comparison of scope, community impacts, haulage, staffing requirements and costing of the two alternatives is shown in Table 6-1. For comparison purposes, continuing with the existing biosolids strategy is included in Table 6-1. This includes dewatering up to 6000 dt/year of biosolids and hauling to the N-Viro Alkaline stabilization facility to meet requirements of the Region's current contract with Walker Environmental. The remaining biosolids would continue to be hauled to Garner Road and then land applied as a liquid product. Under the existing strategy, capital upgrades would still be required at Garner Road to meet capacity requirements for liquid storage to 2051.

Table 6-1: Scope and Costing of Dewatering Alternatives

6	Continue Existing Strategy; Dewater between 4700 and 6000 dt/year of Biosolids to meet Current Contract Obligations to Walker Environmental, with remaining biosolids land applied as liquid; Increase Decanting in Lagoons to 3.5% TS	ALT 1 Dewater ALL Biosolids in Region for Direct Cake Land Application OR Alkaline Stabilization; Increase Decanting in Lagoons to 3.5% TS, Continue dewatering at Niagara Falls WWTP and Garner Road Facility Only	ALT 2 Dewater ALL Biosolids in Region for Direct Cake Land Application OR Alkaline Stabilization; Increase Decanting in Lagoons to 3.5% TS, Add dewatering at Baker Road WWTP and Continue dewatering at Niagara Falls WWTP and Garner Road Facility	
Scope of Upgrades	<u>Garner Road Upgrades:</u> 3 Centrifuges, 2 duty Rated for 11.2 dt/d 8 additional liquid storage tanks (14,000 m^3 each) Cake from Niagara Falls and additional biosolids from Garner Road required to provide 4700 to 6000 dt /yr to be transported and processed by Walker at $584/dt	<u>Garner Road Upgrades:</u> 6 Centrifuges, 5 duty Rated for 39.3 dt/d 25,000 m^3 cake storage All cake land applied by 3rd party at $85/$m^3$, except for cake from Niagara Falls which is transported and processed by Walker and the remaining solids required to meet the 6,000 dt /yr maximum contract requirements at $584/dt	<u>Garner Road Upgrades:</u> 5 Centrifuges, 4 duty Rated for 32.5 dt/d 23,000 m^3 cake storage 926 dt/yr of cake processed by Walker at $128.5/$m^3$ ($584.10/dt). Remaining cake land applied by 3rd party at $85/$m^3$.	<u>Baker Road Upgrades:</u> 2 Centrifuges, 1 duty Rated for 6.8 dt/d No storage at Baker Rd WWTP All cake from Baker Rd hauled/processed by Walker at $128.50/$m^3$ ($584.10/dt).
Community Impacts / Haulage	Existing haulage routes avoid sensitive communities to the greatest extent possible. Haulage through existing routes will continue. Highest truck traffic due to higher volumes associated with liquid biosolids hauled to land application compared to cake.	Existing haulage routes avoid sensitive communities to the greatest extent possible. Haulage through existing routes will continue. Reduced hauling from Garner Road to land application compared to ALT 0 due to increased volumes of cake compared to liquid biosolids.	Reduce # of trucks by trucks per day compared to Alt 1; no different haulage routes expected	
Additional Regional Staffing Requirements	2 additional staff expected	2 additional staff expected	3.5 additional staff expected	
Capital Cost	$ 91.2 M	$ 41.6 M	$ 51.1 M	
Annual Operation, Maintenance and Hauling Cost	$ 0.65 M (dewatering O&M, labour) + $ 3.8 M (liquid to Garner) + $ 2.4 M (liquid to land app) + $ 3.5 M (Walker Hauling/processing) = $ 10.4 M / year	$ 1.4 M (dewatering O&M, labour) + $ 3.8 M (liquid to Garner) + $ 0.4 M (cake to land app) + $ 3.5 M (Walker Hauling/processing) = $ 9.1 M / year	$ 1.5 M (dewatering O&M, labour) + $ 2.8 M (liquid to Garner) + $ 0.4 M (cake to land app) + $ 3.9 M (Walker Hauling/processing) = $ 8.2 M / year	
Life Cycle Cost (3%, 30 year)	$ 290.2 M^2	$220.1 M	$211.7 M	

Notes:

1. Centrifuge capacities listed are based on operating 5 days per week, one 8hr shift/day.
2. Life cycle cost is based on sending 6000 DT/year to Walker Environmental. If only 4700 dt/year is sent, the annual O&M for liquid to land application will increase and the annual O&M for dewatering and Walker Hauling/processing will decrease

Overall, adding dewatering at Baker Road WWTP will save approximately 8 million dollars over a 30- year life cycle period when compared to liquid transport and dewatering all the solids at Garner Road. This is approximately a 4% savings, which is within the margin of error of this estimate. Dewatering at both facilities would require an additional centrifuge but saves over $900,000 per year due to reduced transportation cost between the Baker Road WWTP and the Garner Road Facility. More additional staff will be required to operate dewatering at both Garner Road and Baker Road WWTP, compared to operating dewatering at only Garner Road.

Continuing with the Region's current approach of liquid land application and dewatering and sending to Walker Environmental has the highest life cycle cost. This is due to both a higher capital cost to install additional liquid storage at Garner Road, as well as additional dewatering capacity to produce up to 6000 dt/year of cake for Walker Environmental. Annual costs to continue the existing strategy are also highest due to hauling cost of large volumes of liquid biosolids.

If dewatering is implemented at Baker Road WWTP, this will delay the need for liquid storage upgrades at Garner Road. Nevertheless, Garner Road upgrades would be required prior to 2051, regardless of whether dewatering is added at Baker Road in order to address increasing biosolids volumes over time associated with population growth. The scope of upgrades required at Garner Road will depend on whether the Region implements a program to directly land apply cake in collaboration with third-party contractors or maintain their current liquid land application program. The Region is planning a pilot program within the next year to determine the level of acceptance from agricultural end-users on receiving cake and determine other operational requirements to implement such a program.

Additional liquid storage would not be required at Garner Road if dewatering capacity is increased to allow all liquid biosolids sent to Garner Road to be dewatered and land applied as cake. If land application of cake is pursued, cake storage would be required at Garner Road between February and April, when land application is not possible. This storage would allow for a stockpile of cake to form, ensuring adequate quantities for spring land application, while not exceeding a storage time of 90 days.

If the proposed pilot project for land application of cake is successful, additional dewatering at Garner Road with cake storage should be considered to further reduce hauling and associated operating costs. There are some advantages to adding dewatering at Baker Road WWTP due to reduced community impacts through reduced truck traffic, reduced greenhouse gas emissions, and a lower operating cost. To minimize potential odour impacts on surrounding residences, the dewatering processes would be designed to include odour control measures as well.

Although the life cycle costs for Alternative 1 and 2 are not significantly different, Alternative 2 will delay the need for major capital upgrades at Garner Road and will reduce overall truck traffic in the Region. However, because of current operational issues with the centrifuges at the Garner Road facility, short-term upgrades are required to allow accessibility for maintenance. As such, it is preferable to add more dewatering capacity at the Garner Road facility in the short-term and delay the potential addition of dewatering at Baker Road WWTP. This will avoid the need for two large scale capital dewatering upgrades in the short-term.

7.0 STEP 5: Further Opportunities for Optimization of the Region's Biosolids Management Program

Along with the recommendations presented above, there are additional operational considerations that can help Niagara optimize their biosolids management program. These are reviewed in this section.

7.1 Centrate Management

There are two avenues for centrate management at Garner Road, either the centrate is pumped to the sewer system via a forcemain for treatment at the receiving Niagara Falls WWTP, or it is stored on-site in a lagoon designated for centrate storage. As the facility expands and the centrifuges are run more often, larger pumps may need to be installed to pump the centrate to the sewer system or the lagoon to account for the increased flow that will be experienced. An upgrade of the forcemain may also be required to ensure adequate capacity to accept larger future centrate flows. The Region is currently planning an upgrade to this forcemain where the detailed design can account for potential additional flows.

7.2 Waste Activated Sludge (WAS) Thickening

WAS thickening can be considered at Port Dalhousie, Port Weller and Welland WWTPs to provide additional digester capacity and reduce hauled liquid volume to Garner Road. These plants are candidates for WAS thickening due to their larger capacities and requirement for digester expansion. Currently the plants use co-thickening for the PS and WAS. This process generates a biosolids with approximately 2% total solids, while if the sludges were separated 3-3.5% total solids could be expected.

The available footprint available at these sites allow for construction of WAS thickening or additional tank volumes to be implemented. From a biosolids management perspective, dedicated WAS thickening will reduce the number of trucks and hauling from the facilities. The implementation can be confirmed at the time of digester expansion to best suite each individual site.

7.2.1 Upgraded Forcemain at Garner Road

An option to reduce hauling and optimize the Region's overall biosolids management strategy is to consider increasing the capacity of the forcemain at Garner Road so that supernatant does not have to be hauled to WWTPs for treatment, which is currently done on an intermittent basis as required. Currently, if the forcemain is unavailable, the supernatant from Garner Road must be hauled to a MH in the Port Weller WWTP catchment, creating truck traffic. If the forcemain were to be upgraded, such that it can handle more flow, this would limit the number of trucks that must be used to transport supernatant from Garner Road. Upgrades are planned in the short-term to bring the forcemain back to its rated capacity, which will allow higher flows of decanted liquid from the lagoons to be discharged. As part of the Region's longer term plan strategy, the feasibility of expanding the existing forcemain should be considered.

7.3 Biosolids Training Program

Training programs are important for any facility as these programs ensure that competent people are working on site, such that minimal mistakes are made, and the facility can run efficiently. The Garner Road facility echoes this view and requires training for all staff that work on-site. The following sections describe the training practices for staff, comparing these to industry best practices, along with identifying opportunities for the optimization of the Region's training program.

7.3.1 Staff Training Practices

The municipality requires that all persons who work at the Garner Road facility are trained and receive refresher training according to Condition 17.3 of the training manual. Condition 17.3 states:

- The Municipality shall maintain a training manual covering at a minimum a list of employee functions and the type of training required to fulfil that job function with respect to the operation, management, inspection, record keeping requirements, contingency plan, monitoring, and maintenance of this Site.
- The training plan shall be reviewed on an annual basis, at a minimum, and updated as required to reflect any changes in equipment, operational procedures, or Site conditions.
- A copy of the training manual shall be available at the Site for review by a Provincial Officer upon request.

Other municipalities of comparable size, with similar operations, share similar training regiments for their employees. Various training programs are offered and subsequently required by the employee's depending on the scope of their responsibilities at the facility.

These training requirements have led Garner Road to follow the best practices of the industry, ensuring that all staff on-site are competent workers, who could respond accurately and timely to an adverse situation.

7.3.2 Opportunities for Training Optimization

Throughout the lifetime of Garner Road, and other similar facilities, different situations will arise that have not been covered in training, thus making the staff react and respond in the best possible manner they can in that moment. Only after the situation has been rectified, can it be reviewed and discussed to determine how the response could have been improved and more streamlined. Therefore, an annual review, at a minimum, of the facilities training programs is important. To optimize the training received by staff, a bi-annual revision of the training programs at the facility could be done, or mandatory training to all on-site personnel once an adverse situation has occurred and an appropriate response to the situation has been determined.

The facility has in place refresher training for training courses that are given to employees. To optimize the efficiency of these refresher courses, occurrence every year would ensure that the staff retains the training knowledge and is always up to date with the current industry best practices.

7.4 Material Quantity Measurement

It has been assumed that each truck either bringing biosolids into Garner Road, or hauling biosolids from Garner Road, are filled to their capacity. This cannot be verified as there are no material quantity measurement practices in place at the Region. Having a system in place to correctly measure the quantities of biosolids that are being hauled around the Region would improve the granular data that is provided to the Region, allowing them to make more accurate predictions of storage requirements at Garner Road.

The material quantity measurement could take place as a weigh scale that trucks must pass through when they are entering or leaving Garner Road. This would allow the Region to accurately calculate the volume of biosolids that each truck contains, improving the reliability of the haulage volumes and data. Additionally, material quantity measurements could also take place to track the biosolids leaving the site that are being used for land application as well.

7.5 Security Protocols

Security at Garner Road is of top priority such that anyone on site remains safe, to ensure that people outside of the facility can not enter without proper access, and to ensure no un-authorized disposals are occurring. By keeping everyone informed with signage and proper operating procedures, the security protocols are in place only to promote proper operation of the facility. The existing security protocols along with recommendations for future improvements to the security protocols are discussed in the following sections.

7.5.1 Existing Protocols

The existing security protocols of the Garner Road Biosolids and Dewatering Facility are as follows:

- The Municipality shall ensure that a competent person is on site at all times during loading and unloading at this Site. No loading, unloading or transfer shall occur unless a competent person supervises the loading or unloading.
- The Municipality shall ensure the area of the Site bounded by the fence is locked and secured by a minimum 1.8-metre-high lockable security fence at all times when a competent person is not present.
- The Municipality shall ensure the Site is adequately lit at all times during loading and unloading
- The Municipality shall post a sign at the site, readable at a distance of 25 metres from the public roadway bordering the site, identify the name of the Site, the Municipality's name and emergency telephone number.

In 2021 to 2022, the facility added the following new upgrades to their security system:

- Addition of 2 new automated security gates
- Addition of security card swipes for entry at the new security entry gates
- Addition of security cameras at each of the new security gates

With the future upgrades to the security system, and the existing protocols already in place, Garner Road facility meets industry best practices and will continue to have adequate security protocols in place when the upgrades are complete.

7.5.2 Recommendations for Improvement of Security Protocols

Further improvement to the facility may include the addition of cameras throughout the grounds of the facility, to ensure that all equipment and storage are constantly monitored. These cameras would ensure that any unwanted visitors that access the facility away from the main gate are captured on tape, and the necessary steps could be taken. However, the current and future security protocols that are, and will be, in place at Garner Road are adequate and little improvement to the protocols is likely required for the facility.

7.6 Diversify and Optimize Biosolids Disposal

Two (2) main biosolids disposal options are currently employed at Garner Road; liquid land application and sending dewatered biosolids to Walker Environmental for alkaline stabilization. A third alternative disposal method is also recommended, direct land application of dewatered biosolids cake, as discussed in TM 7 under biosolids management Strategy 2. Overall, it is recommended that multiple disposal methods be implemented to maintain a diverse program, including liquid land application, cake land application and alkaline stabilization to create a fertilizer product for beneficial use on land.

The Region should continue to work with their third-party contractors to optimize their disposal land application program. Haulage routes should be continually reviewed so that the most efficient routes are select to minimize distance and impacts to communities.

The feasibility of direct land application from WWTP with storage capacity and that are furthest from Garner Road may help the Region reduce storage requirements at the Garner Road facility, as well as decrease haulage requirements. The Region's current contract with Thomas Nutrient Solutions has provisions for hauling liquid biosolids from WWTPs that have storage tanks directly to land application rather than first hauling to Garner Road. The intention is to reduce the total distance liquid biosolids need to be hauled in the Region. At this time, only Anger Avenue WWTP in Fort Erie and Baker Road WWTP in Grimsby have liquid storage tanks for biosolids. However, there is not the demand for liquid products in the vicinity of the Anger Rd. WWTP, so all liquid biosolids from this plant are currently hauled to Garner Road Biosolid Facility. As part of their overall Biosolids Management Strategy, the Region should review the market potential for liquid land application at different areas within the Region and adjust their program accordingly. Increased decanting from the existing storage tanks could be considered to increase gravity thickening of digested biosolids before hauling to land.

TM 10 will present a review of existing third party biosolids management contracts and will discuss potential opportunities for land application in more detail.

7.6.1 Liquid Land Application

Disposing of the biosolids through liquid land application has been the Region's preferred historic disposal option. This is a practical disposal method as the lagoons and storage tanks at Garner Road can be easily supernated to achieve the correct solids content for land application.

To continue with this disposal option, the storage at Garner Road must be increased to cope with the anticipated increase in flows that are expected as the Region's population increases, unless cake storage and direct cake land application is implemented. Furthermore, the volume increase required at Garner Road will be dependent upon the implementation of increased decanting or pre-thickening at the facility as discussed in Section 5.1.

7.6.2 Hauling to Walker Environmental

Another disposal option currently used for the facility is to haul the dewatered biosolids produced from the centrifuges to Walker Environmental's N-Viro Facility for Alkaline Stabilization. The Region's contract with Walker Environmental states that the Region is to provide a minimum of 4700 DT/year to Walker Environmental up to a maximum of 6000 DT/year. If the current approach of sending 50% of biosolids to Walker Environmental is maintained, this limit must be increased as the flow to Garner Road increases. Opportunities for existing third-party contracts are discussed further in TM 10.

7.6.3 Cake Land Application

To reduce the volume of biosolids hauled to land application, the biosolids could be land applied as a dewatered cake, rather than a liquid product. Similar to land application of liquid biosolids, biosolids cake is regulated as a Non-Agricultural Source Material (NASM) through the Nutrient Management Act and O.Reg.267/03. Different types of vehicles are required for hauling cake and land applying it, so moving to cake land application will require discussions with the third-party haulers and agriculture end users. A pilot program for cake land application is planned for the summer of 2024, as previously described in Section 6.

8.0 Recommendations, Implementation and Phasing

Overall, it is recommended that dewatering upgrades be implemented at the Garner Road Biosolids Facility in the short-term to provide a centralized dewatering centre for all the Region's biosolids. Upgrades should include a new building and centrifuges with capacity to manage all the Region's biosolids expected to 2041. The facility upgrades are also dependent on the success of the cake land application pilot, currently underway. If the pilot is successful, a cake storage area should be constructed at the Garner Road facility. If it is not successful, additional liquid storage will be required at Garner Road. Facility upgrades should also consider addition of security cameras and a weigh scale at Garner Road to improve security and accuracy of measurements.

It is recommended that dewatering at Niagara Falls WWTP continue in the interim, with cake hauled to N-Viro, until the dewatering equipment at Niagara Falls WWTP reaches the end of its useful life or additional dewatering capacity is available at the Garner Road facility, whichever comes first. The Region may also choose to send liquid biosolids from Niagara Falls WWTP to Garner Road for dewatering immediately if liquid storage capacity is available.

To reduce hauling in the Region, WAS thickening should be considered at Port Dalhousie, Port Weller and Welland WWTPs to reduce hauled liquid volume to Garner Road. Timing of WAS thickening upgrades could be matched with other required upgrades at these WWTPs. The potential to land-apply stabilized biosolids directly from the Anger Ave WWTP should be investigated further.

The recommended upgrades be phased over time based on increasing volumes of biosolids to be processed, as detailed below.

Very Short-term (1-3 years):

- Extend operating hours per day for centrifuges at Garner Road to increase output;
- Complete cake land application pilot to inform future upgrades;
- Work with Thomas Nutrient Solutions to reduce liquid storage and transportation requirements, by optimizing decanting of lagoons to increase total solids concentrations of liquid biosolids.

Short-Term (3 – 5 years):

Scenario 1 – Cake Land Application Pilot is successful

- Construct a new dewatering facility at Garner Road that can serve as centralized dewatering facility for the entire Region; size the dewatering facility structure to house the centrifuges needed to dewater all biosolids produced in Region to 2041. Prior to the centrifuge at the Niagara Falls WWTP reaching the end of its useful life, identify whether it is more cost-efficient to replace the centrifuge at the WWTP or to decommission the centrifuge and truck liquid sludge to Garner Road.
- Construct new cake storage at Garner Road
- Maintain existing liquid storage facilities (lagoons and tanks)

Scenario 2 - Cake Pilot is NOT successful

- Construct a new dewatering facility at Garner Road that can serve as centralized dewatering facility for the entire Region; Size the dewatering facility structure to house the centrifuges needed to dewater of all of Region's biosolids. Install the centrifuges necessary to dewater the maximum amount of biosolids that can be conveyed to Walker Environmental based on the current agreement along with an additional 20 percent, anticipating 40 hour per week operation under average annual operating conditions.
- Maintain existing liquid storage volume at Garner Road (lagoons and tanks).

Long Term (before 2051):

Scenario 1 – Cake Land Application Program is in place (along with liquid land application and N-Viro):

Option 1 - Install additional centrifuges at Garner Road to manage increased biosolids volumes due to population growth

Option 2 – Consider adding dewatering at Baker Road WWTP and reduce the size of the expansion at the Garner Road facility. This may be preferable based on reduced transportation costs, reduced GHG emissions and available land bank near Grimsby. Timing will depend on rate of population growth in Grimsby and available budget.

Scenario 2 – No Cake Land Application Program (only liquid land app and N-Viro)

Review the capacity of the liquid biosolids storage facilities at Garner Road by 2035 to determine if additional storage will be required to expand the liquid land application program in alignment with population growth. This potential expansion of liquid biosolids storage will be impacted by the amount of biosolids that are and will be managed by Walker Environment and other potential third party biosolids management firms. If required, additional tank storage is preferred. The tanks can be located either within an existing lagoon or available space adjacent pending constructability constraints with the lagoons and available location following dewatering facility upgrade.

Long Term (after 2051):

Consider moving to thermal drying to create a higher value end-product with a lower volume to further reduce truck traffic and reliance on third party contractors. The feasibility of thermal drying will depend on end-use market demand and compatibility with any future changes to regulations. By increasing dewatering capacity in the Region, which is a required pre-treatment for several other biosolids processing technologies (i.e., composting, drying, incineration), the Region will be in a better position to implement further biosolids stabilization processes in the future.

Table 8-1 below summarizes the recommendations and proposed timeline.

Table 8-1 – Summary of Recommendations

RECOMMENDATION	TIMELINE
Capital Projects	
1. New Dewatering Facility at Garner Road, cake storage at Garner Road, new admin building, weigh scale and increased security	Complete by 2028 (cake storage is recommended only if cake pilot is successful)
2. Sludge Thickening at Port Dalhousie WWTP	TBD (combine with other WWTP upgrades)
3. Sludge Thickening at Port Weller WWTP	TBD (combine with other WWTP upgrades)
4. Sludge Thickening at Welland WWTP	TBD (combine with other WWTP upgrades)
5. Additional Liquid Storage at Garner Road (if cake land application pilot is NOT successful)	Review the requirement for additional liquid storage at the Garner Road facility in 2035
6. Increase dewatering capacity to accommodate population growth by adding centrifuges at the Garner Road Biosolids Facility or Baker Road WWTP	Install additional centrifuges by 2041, as required
Operational	
1. Increase decanting of Garner Road lagoons	Once forcemain work is complete
2. Increase operating time for Garner Rd centrifuges to increase output in short-term	Immediately

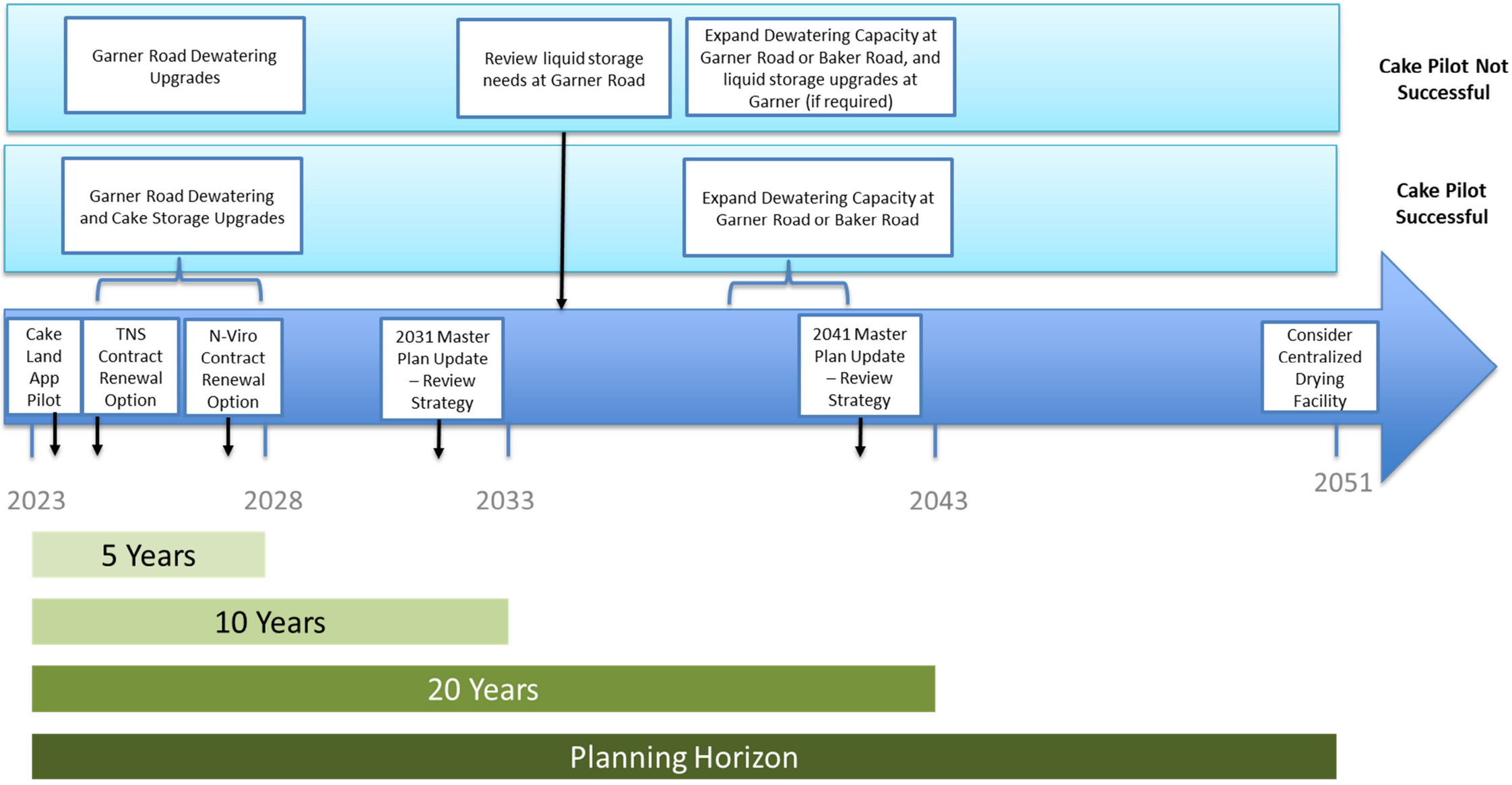

Figure 8-1: Potential Phasing of Biosolids Management Upgrades

9.0 Summary and Next Steps

Overall, solids management upgrades are required in the Niagara Region to meet current and future needs. This will include increased dewatering capacity to reduce storage and hauling requirements.

Next steps include review of potential improvements to third-party contracts (TM 10), and contingency measures (TM 11).

APPENDIX A

Dewatering Alternatives Costing and Transportation Calculations

Region of Niagara

Alternative 0
Dewatering at Niagara Falls and Garner Road to meet Walker Environmental 4,700 dt/yr minimum
Remaining solids in the Region to be stored and land applied as a liquid at 3.5% TS

This preliminary opinion of cost, capital along with operation and maintenance, anticipates that all of the liquid biosolids generated in the Region with the exception of those generated at the Niagara Fall WWTP will be transported to the Garner Road Facility for storage, and liquid land application or dewatering and transport to Walker Environmental Facility for N-Viro treatment and distribution. The biosolids generated at City of Niagara Falls WWTP will continue to be dewatered at that WWTP and transported to Walker Environmental for processing and distribution. The Region's agreement with Walker Environmental requires the delivery of a minimum of 4,700 dry tons annually with up to 6000 dry tons allocated exclusively to Niagara Region. Approximately 2,590 dt/yr of solids from the Niagara Falls WWTP will be dewatered and transported to Walker Environmental. New dewatering improvements will be installed at the Garner Road Facility to dewater the remaining solids, approximately 3,410 dt/yr required to be transported to Walker Environmental for processing. The Garner Road Facility will decant the biosolids storage lagoons and tanks to maintain a total solids concentration of 3.5 percent total solids. The costs of 128.5/m3 for cake at 25% TS ($584/dt) transported to Walker Environmental and $8.29/m3 for biosolids liquid land application at 3.5 percent TS are anticipated.

			Notes
Sizing Criteria, Equipment and Operating Parameters			
Average Annual anaerobically digested biosolids	46.4	dry metric ton / day (dt/d)	
Maximum Month anaerobically digested biosolids	55.5	dt/d	
Average Annual anaerobically digested biosolids from the Niagara Falls WWTP	7.1	dt/d	
Average annual remaining solids	39.3		
Solids being transported by Walker Environmental	6,000.0	dt/yr minimum "put or pay"	
Annual biosolids from Niagara Falls	2,591.5	dt/yr	
Amount to from Garner road to meet the minimum	3,408.5	dt/yr	
Anticipated dewatering solids capture	90.0	%	
Additional solids based on Niagara Falls	287.9	dt/yr	Increase the Garner road solids to account for the solids capture
Additional solids based on Garner Road	378.7	dt/yr	loss from dewatering at Niagara Fallls WWTP and Garner Road
Solids to be dewatered at Garner Road	4,075.2	dt/yr	Anticpated to be 10.0 percent
	11.2	dt/d	
Dewatering at the Garner Road Facility			
Digested Biosolids to Dewatering (dtpd)			
Average Annual	11.2	dt/d	
Total Volume of Digested Biosolids Loading to Dewatering			
Number of days for dewatering	260		
Average Annual	15.7	dt/dewatering day	
	15,674	dkg/dewatering day	
Total Digested Biosolids Flow to Dewatering			
Total solids concentration	3.5	%	
Average Annual	3,134,744	l/wk.	
Number of centrifuges	3		
Number of duty centrifuges	2		
Number of standby centrifuges	1		
Anticipated days of centrifuge operation during max month (days/week)	5	days / week	
Operating shifts per day	1		
Anticipated shift hours of operation, allowing time for start up and shut down	7	hr/day	
Required throughput Average Annual	746	l/m	950 l/m to 1,100 l/m target feed
Anticipated dewatered biosolids total solids concentration	25	%TS	
Anticipated thickener solids capture	90	%	
Anticipated Polymer Consumption	11	kg/dt	
Anticipated digested biosolids cake production Average Annual	10.0	dt/d	
Check solids to Walker Environmental	6,000		Should equal 6,000.0 dt/yr to Walker
Anticipated dewatered biosolids Average Annual	40	wt/d	
Anticipated dewatered solids bulk density	1003	wet kg / m3 (wkg/m3)	
Anticipated dewatered biosolids volume Average Annual	40	m3/d	
Anticipated days of cake storage	20	days	75 days of storage of the required 240 days total could be provided in the existing lagoons and storage tanks at the Garner Road Facility. Cake storage of 240 days provides additional felxibilty
Required cake storage at Garner Road			
Cake storage required	801	m3	
Anticipated pile height	3	m	
Approximate cake storage area required	267	m2	
Liquid Biosolids for land application			
Average annual	28.1	dt/d	
	10,269	dt/yr	
	293,410	wt/yr	
	292,532	m3/yr	
Required additional storage at Garner Road			
Volume in existing lagoons	61,200	m3	
Volume in existing three storage tanks	24,000	m3	
Total storage volume available	85,200	m3	
Total Volume required			
Days Storage Required	240	days	
Anticipated Biosolids Volume (Based on Average Annual Generation Rate)	801	m3/d	
Total required volume	192,350	m3	
Additional volume required			
Total Volume required	192,350		
less volume available	85,200		
Additional storage volume required.	107,150		
Additional storage tanks required.			
Additional storage volume required.	107,150	m3	
Volume of each additional storage tanks	14,000	m3	
	7.7	additional storage tanks	
Total number of tanks	8		
Financial Information			
Interest Rate	3.00%		
Study Period	30	years	
Power Cost	$0.15	$/kw	
Natural gas cost	$10.00	MMBTU	
Fuel Cost	$4.00	$/liter	
Cost of transport and management of a cake land application program	$85.00	$/m3	
Cost of polymer	$5.00	$/kg	
Operation Labor Cost	$60.00	$/hr	
Maintenance Labor Cost	$60.00	$/hr	

Preliminary Opinion of Capital Cost

Item Description	Qty	Unit	Unit cost	Cost (1)	Remaining Value of Buildings and Equipment Projected Life (yrs.)	% Remaining	($)

Biosolids Dewatering

Dewatering Facility Site Work

Site grading	5,500	m3	9.00	50,000			
Paved Area	3,500	m2	11.00	39,000			
Stormwater collection and retention							
Grading	1,000	m3	8.00	8,000			
Catch basins and collection	1	ls	12,500.00	13,000			
Liner and outfall	1	ls	15,000.00	15,000			
Subtotal Dewatering Site				**125,000**			
Dewatering Facility							
Decommission existing dewatering facility	1	LS	750,000.00	750,000			
Pre-engineered structure							
Dewatering Structure	1,500	m2	2,500	3,750,000	30	10	375,000
Office Area	400	m2	1,000	400,000			
Centrifuge dewatering system	3	ea.	1,200,000	3,600,000			
Centrifuge system installation (%) of equipment	40	%		1,440,000			
Allowance water system, compressed air system, drains and piping	1	ls	500,000	500,000			
Electrical and instrumentation (%) of structures & equipment	10	%		775,000			
Subtotal Dewatering Facility				**11,215,000**			

Biosolids Storage

Dewatered Biosolids Storage

Site grading	1,000	m3	9.00	9,000			
Paved Area	500	m2	11.00	6,000			
Pre-engineered cake storage structure	300	m2	500	150,000	30	10	15,000
Stormwater collection and retention							
Grading	100	m3	8.00	1,000			
Catch basins and collection	1	ls	8,000.00	8,000			
Liner and outfall	1	ls	3,000.00	3,000			
Subtotal Dewatered Biosolids Storage				**177,000**			

Liquid Biosolids Storage

Site grading	8,800	m3	9.00	79,000			
Paved Area	8,000	m2	11.00	88,000			
Stormwater collection and retention							
Grading	400	m3	8.00	3,000			
Catch basins and collection	1	ls	20,000.00	20,000			
Liner and outfall	17,500	m2	5.00	88,000			
New 14,000m3 Glass Lined Bolted Steel Storage Tanks	112,000	m3	400	44,800,000	30	10	4,480,000
Allowance for mixing systems and piping	1	ls	200,000	200,000			
Allowance water system, drains and piping	1	ls	100,000	100,000			
Electrical and instrumentation (%) of structures & equipment	0.25	%		112,000			
Subtotal Thickened Biosolids Storage Tanks				**45,490,000**			4,480,000
Indirect Costs							
Contingency and estimating allowance % of improvements & equipment	30	%		17,100,000			
Contractor overhead, profit, mobilization and bonds (%) of improvements	15	%		8,550,000			
Engineering, (%) of improvements	15	%		8,550,000			
Subtotal indirect costs				**34,200,000**			
TOTAL				**91,207,000**			9,350,000

INITIAL OPERATION & MAINTENANCE COSTS

Item Description	Staff/shift	Shifts/Op day	Annual Qty	Unit	Unit Cost	Cost (1)
Labor					($/unit)	($/yr)
Operation Labor Dewatering	1.5	1	3,120	hr	60.00	187,000
Maintenance Labor Dewatering and Storage	0.5	1.0	1,040	hr	60.00	62,000
Dewatering Operation						
Power			900,000	$/KWh	0.15	135,000
Polymer			44,827	kg	5.00	224,000
Dewatering equipment maintenance (%) of process equipment			1	%	3,750,000	38,000
Storage Facility Maintenance (%) of storage volume			2	%	150,000	3,000
Transportation Walker Environmental and land application of dewatered cake .						
Solids to Walker Environmental			6,000	dt/yr	584.00	3,504,000
Land application of liquid solids			292,532	m3/yr	8.29	2,425,000
Subtotal for O&M						**6,578,000**

Transportation of liquid biosolids to Garner Road Facility

Wastewater Treatment Plant	Average Annual Biosolids Flow (m3/d)	Toatl Solids (%)	(dt/d)	Distance to Garner Road (km)	Unit Cost ($)	**Cost to Garner Road ($/yr)**
Anger Ave	58.13	3.36	1.95	25.00	6.72	$ 142,581
Baker Road	300.23	2.27	6.81	47.00	8.49	$ 930,378
Crystal Beach	21.75	3.36	0.73	26.00	9.09	$ 72,157
NOTL	55.84	3.59	2.00	28.00	6.54	$ 133,300
Port Dalhousie	330.10	2.25	7.43	27.00	5.59	$ 673,523
Port Weller	210.92	2.44	5.15	29.00	5.59	$ 430,357
Queenston	5.18	0.80	0.04			$ -
Seaway	62.23	2.26	1.41	24.00	8.36	$ 189,885
Welland	251.22	2.77	6.96	15.00	5.59	$ 512,583
SNF	355.60	2.50	8.89		5.27	$ 684,013
Subtotal for transportation to Garner Road Facility						**3,768,778**
Total O&M and Transportation to Garner Road Cost						**10,346,778**

LIFE CYCLE COSTS

Unit Cost, $/dt
$ 856.62

	P/F Factor	P/A Factor	Total Present Worth ($)
Initial Capital			$91,207,000
Present Value of Remaining Value	0.4120		($3,852,000)
Present Value of Annual O&M		19.6004	$202,801,000
TOTAL			**$290,156,000**

(1) Rounded to nearest $10,000
(2) Based on average annual solids generation

Region of Niagara

Alternative 1

Dewater all of the Region's biosolids at Niagara Fall and Garner Road. Transport 6,000 dt/yr of biosolids to Walker Environmental and Land Apply the remaining biosolids cake

11/27/2023

This preliminary opinion of cost, capital along with operation and maintenance, anticipates that all of the liquid biosolids generated in the Region with the exception of those generated at the Niagara Fall WWTP will be transported to the Garner Road Facility for storage, dewatering and land applied. The biosolids generated at City of Niagara Falls WWTP will continue to be dewatered at that WWTP. Liquid biosolids storage facilities at the Garner Road Facility will be decanted to maintain a total solids concentration of 3.5 percent total solids. The alternative anticipates new dewatering facilities for all of the biosolids transported to the Garner Road Facility and the addition of 240 days of storage for the biosolids that will be land applied. A land application cost of $85/m3 for dewatered biosolids at 25% TS is anticipated. The cost to have biosolids processed at Walker Environmental is $128.5/m3 at 25% TS. ($584/dt.)

			Notes
Sizing Criteria, Equipment and Operating Parameters			
Average Annual anaerobically digested biosolids	39.3	dry metric ton / day (dt/d)	
Maximum Month anaerobically digested biosolids	55.5	dt/d	
Dewatering at the Garner Road Facility			
Digested Biosolids to Dewatering (dtpd)			
Max Month	55.5	dt/d	
Average Annual	39.3	dt/d	
Total Volume of Digested Biosolids Loading to Dewatering			
Number of days for dewatering	260		
Average Annual	55.2	dt/dewatering day	
	55,171	dkg/dewatering day	
Total Digested Biosolids Flow to Dewatering			
Total solids concentration	3.5	%	
Average Annual	11,034,231	l/wk.	
Number of centrifuges	6		
Number of duty centrifuges	5		
Number of standby centrifuges	1		
Anticipated days of centrifuge operation during max month (days/week)	5	days / week	
Operating shifts per day	1		
Anticipated shift hours of operation, allowing time for start up and shut down	7	hr/day	
Required throughput Average Annual	1,051	l/m	950 l/m to 1,100 l/m target feed
Anticipated dewatered biosolids total solids concentration	25	%TS	
Anticipated thickener solids capture	90	%	
Anticipated Polymer Consumption	11	kg/dt	
Anticipated digested biosolids cake production Average Annual	35.4	dt/d	
Anticipated dewatered biosolids Average Annual	141	wt/d	
Anticipated dewatered solids bulk density	1003	wet kg / m3 (wkg/m3)	
Anticipated dewatered biosolids volume Average Annual	141	m3/d	
Anticipated dewatered biosolids volume to be land applied	104	m3/d	Anticipates 6,000 dt/yr to Walker Environmental. 2,592 from NF and 3,408 (9.3dt/d) (37.4 wt/d @25% TS) from Garner Road
Anticipated days of cake storage	240	days	75 days of storage of the required 240 days total could be provided in the existing lagoons and storage tanks at the Garner Road Facility. Cake storage of 240 days provides additional felxibilty
Required cake storage at Garner Road			
Cake storage required	24,904	m3	
Anticipated pile height	3	m	
Approximate cake storage area required	8,301	m2	
Financial Information			
Interest Rate	3.00%		
Study Period	30	years	
Power Cost	$0.15	$/kw	
Natural gas cost	$10.00	MMBTU	
Fuel Cost	$4.00	$/liter	
Cost of transport and management of a cake land application program	$8.29	$/m3	
Cost of polymer	$5.00	$/kg	
Operation Labor Cost	$60.00	$/hr	
Maintenance Labor Cost	$60.00	$/hr	

Preliminary Opinion of Capital Cost

Item Description	Qty	Unit	Unit cost	Cost (1)	Remaining Value of Buildings and Equipment: Projected Life (yrs.)	% Remaining	($)
Biosolids Dewatering							
Dewatering Facility Site Work							
Site grading	11,000	m3	9.00	99,000			
Paved Area	7,000	m2	11.00	77,000			
Stormwater collection and retention							
Grading	1,000	m3	8.00	8,000			
Catch basins and collection	1	ls	25,000.00	25,000			
Liner and outfall	1	ls	15,000.00	15,000			
Subtotal Dewatering Site				**224,000**			
Dewatering Facility							
Decommission existing dewatering facility	1	LS	750,000.00	750,000			
Pre-engineered structure							
Dewatering Structure	3,000	m2	2,500	7,500,000	30	10	750,000
Office Area	400	m2	1,000	400,000			
Centrifuge dewatering system	6	ea.	1,200,000	7,200,000			
Centrifuge system installation (%) of equipment	40	%		2,880,000			
Allowance water system, compressed air system, drains and piping	1	ls	1,000,000	1,000,000			
Electrical and instrumentation (%) of structures & equipment	10	%		1,510,000			
Subtotal Dewatering Facility				**21,240,000**			
Dewatered Biosolids Storage							
Storage Site							
Site grading	22,000	m3	9.00	198,000			
Paved Area	12,000	m2	11.00	132,000			
Pre-engineered cake storage structure	8,301	m2	500	4,151,000	30	10	415,100
Stormwater collection and retention							
Grading	600	m3	8.00	5,000			
Catch basins and collection	1	ls	20,000.00	20,000			
Liner and outfall	1	ls	7,000.00	7,000			
Subtotal Dewatering Site				**4,513,000**			
Indirect Costs							
Contingency and estimating allowance % of improvements & equipment	30	%		7,790,000			
Contractor overhead, profit, mobilization and bonds (%) of improvements	15	%		3,900,000			
Engineering, (%) of improvements	15	%		3,900,000			
Subtotal indirect costs				**15,590,000**			
TOTAL				**41,567,000**			1,165,100

INITIAL OPERATION & MAINTENANCE COSTS

Item Description	Staff/shift	Shifts/Op day	Annual Qty	Unit	Unit Cost	Cost (1)
Labor					($/unit)	($/yr)
Operation Labor Dewatering	2.0	1	4,160	hr	60.00	250,000
Maintenance Labor Dewatering and Storage	1.0	0.5	1,040	hr	60.00	62,000
Dewatering Operation						
Power			900,000	$/KWh	0.15	135,000
Polymer			157,790	kg	5.00	789,000
Dewatering equipment maintenance (%) of process equipment			1	%	11,351,000	114,000
Storage Facility Maintenance (%) of storage volume			2	%	4,151,000	83,000
Transportation and land application of dewatered cake .						
Solids to Walker Environmental			6,000	dt/yr	584.00	3,504,000
3rd Party transportation and application of dewatered cake			51,486	m3/yr	8.29	427,000
Subtotal for O&M						**5,364,000**

Transportation of liquid biosolids to Garner Road Facility

Wastewater Treatment Plant	Average Annual Biosolids Flow (m3/d)	Total Solids (%)	(dt/d)	Distance to Garner Road (km)	Unit Cost ($)		**Cost to Garner Road ($/yr)**
Anger Ave	58.13	3.36	1.95	25.00	6.72	$	142,581
Baker Road	300.23	2.27	6.81	47.00	8.49	$	930,378
Crystal Beach	21.75	3.36	0.73	26.00	9.09	$	72,157
NOTL	55.84	3.59	2.00	28.00	6.54	$	133,300
Port Dalhousie	330.10	2.25	7.43	27.00	5.59	$	673,523
Port Weller	210.92	2.44	5.15	29.00	5.59	$	430,357
Queenston	5.18	0.80	0.04			$	-
Seaway	62.23	2.26	1.41	24.00	8.36	$	189,885
Welland	251.22	2.77	6.96	15.00	5.59	$	512,583
SNF	355.60	2.50	8.89		5.27	$	684,013
Subtotal for transportation to Garner Road Facility							**3,768,778**
Total O&M and Transportation to Garner Road Cost							**9,132,778**

LIFE CYCLE COSTS

Unit Cost, $/dt	
$	767.17

	P/F Factor	P/A Factor	Total Present Worth ($)
Initial Capital			$41,567,000
Present Value of Remaining Value	0.4120		($480,000)
Present Value of Annual O&M		19.6004	$179,006,000
TOTAL			**$220,093,000**

(1) Rounded to nearest $10,000
(2) Based on average annual solids generation

Region of Niagara

Alternative 2

Dewater the biosolids generated at the Baker Road and Niagara Fall WWTPs and transport the cake to Walker Environmental for addtional stabilization and distribution . The remaining solids in the region will be dewatered at Garner road and either transported to Walker Environmental to meet the 6,000 dt/yr requirement or land applied.

11/27/2023

This preliminary opinion of cost, capital along with operation and maintenance, anticipates that all of the liquid biosolids generated in the Region with the exception of those generated at the Niagara Fall WWTP and the Baker Road WWTP will be transported to the Garner Road Facility for storage, dewatering, land application or processing at the Walker Environmental Facility. The biosolids generated at City of Niagara Falls WWTP will continue to be dewatered at that WWTP. A new Dewatering Facility will be constructed at the Baker Road WWTP. Liquid biosolids storage facilities at the Garner Road Facility will be decanted to maintain a total solids concentration of 3.5 percent total solids. The Region's agreement with Walker Environmental requires the delivery of a minimum of 6,000 dry tons annually. The biosolids generated at the Niagara Falls and Baker Road WWTPs combined do not meet that requirement. The alternative anticipates that a portion of the dewatered biosolds from the Garner Road Facility, 926 dt/yr, for this alternative,will be transported to the Walker Environmental Facility to meet the 6,000 dt/yr requirement. Dewatered cake storage will be provided at the Garner Road Facility to allow 240 days of storage for the biosolids that will be land applied. A land application cost of $85/m3 of biosolids cake at 25% TS, along with a processing fee at the Wlaker Brothers facility of $128.5/m3 at 25% TS, ($528/dt) are anticipated.

Sizing Criteria, Equipment and Operating Parameters

			Notes
Average Annual anaerobically digested biosolids	39.3	dry metric ton / day (dt/d)	
Maximum Month anaerobically digested biosolids	55.5	dt/d	
Dewatering at the Baker Road Facility			
Digested Biosolids to Dewatering (dtpd)			Baker Road 6.8 dt/d (2,482 dt/yr transport to Walker Environmental)
Max Month	9.9	dt/d	Niagara Falls 7.1 dt/d (2,592 dt/yr transport to Walker Environmental)
Average Annual	6.8	dt/d	An additional 926 dt/yr (2.5 dt/d will be transported from Garner road to Walker Environmental to reach the 6,000 dt/yr minimum.
Total Volume of Digested Biosolids Loading to Dewatering			Total to Walker Brother 6,000 dt/d, 16.44 dt/d.
Number of days for dewatering	260		
Average Annual	13.8	dt/dewatering day	Centrifuge sized at Maximum Month due to reduced liquid biosolids storage at Baker Road
	13,842	dkg/dewatering day	May require extended operating schedule durig the maximum month
Total Digested Biosolids Flow to Dewatering			
Total solids concentration	3.5	%	
Average Annual	2,768,385	l/wk.	
Number of centrifuges	2		
Number of duty centrifuges	1		
Number of standby centrifuges	1		
Anticipated days of centrifuge operation during max month (days/week)	5	days / week	
Operating shifts per day	1		
Anticipated shift hours of operation, allowing time for start up and shut down	7	hr/day	
Required throughput Average Annual	1,318	l/m	950 l/m to 1,100 l/m target feed
Anticipated dewatered biosolids total solids concentration	25	%TS	
Anticipated thickener solids capture	90	%	
Anticipated Polymer Consumption	11	kg/dt	
Anticipated digested biosolids cake production Average Annual	6.1	dt/d	
Anticipated dewatered biosolids Average Annual	25	wt/d	
Anticipated dewatered solids bulk density	1003	wet kg / m3 (wkg/m3)	
Anticipated dewatered biosolids volume Average Annual	24	m3/d	
Anticipated days of cake storage	4	days	
Required cake storage at Baker Road			
Cake storage required	-	m3	Additional run time on the dewatering equipment would allow Baker Road to "catch up"
Anticipated pile height	3	m	Consider two trailers to transport to Garner Road Facility if required in winter months.
Approximate cake storage area required	-	m2	
Dewatering at the Garner Road Facility			
Digested Biosolids to Dewatering (dtpd)			
Max Month	45.7	dt/d	
Average Annual	32.5	dt/d	
Total Volume of Digested Biosolids Loading to Dewatering			
Number of days for dewatering	260		
Average Annual	45.6	dt/dewatering day	
	45,611	dkg/dewatering day	
Total Digested Biosolids Flow to Dewatering			
Total solids concentration	3.5	%	
Average Annual	9,122,192	l/wk.	
Number of centrifuges	5		
Number of duty centrifuges	4		
Number of standby centrifuges	1		
Anticipated days of centrifuge operation during max month (days/week)	5	days / week	
Operating shifts per day	1		
Anticipated shift hours of operation, allowing time for start up and shut down	7	hr/day	
Required throughput Average Annual	1,086	l/m	950 l/m to 1,100 l/m target feed
Anticipated dewatered biosolids total solids concentration	25	%TS	
Anticipated thickener solids capture	90	%	
Anticipated Polymer Consumption	11	kg/dt	
Anticipated digested biosolids cake production Average Annual	29.2	dt/d	
Anticipated dewatered biosolids Average Annual	117	wt/d	
Anticipated dewatered solids bulk density	1003	wet kg / m3 (wkg/m3)	
Anticipated dewatered biosolids volume Average Annual	117	m3/d	
Anticipated dewatered biosolids volume to be land applied	106	m3/d	Anticipates 6,000 dt/yr to Walker Environmental. 2,592 dt/yr from NF, 2,482 dt/yr from Baker Road and
Anticipated days of cake storage	240	days	926 dt/yr (2.5 dt/d) (10.1 wt/d @25% TS) from Garner Road
			75 days of storage of the required 240 days total could be provided in the existing lagoons and
Required cake storage at Garner Road			storage tanks at the Garner Road Facility. Cake storage of 240 days provides additional felxibilty
Cake storage required	25,487	m3	
Anticipated pile height	3	m	
Approximate cake storage area required	8,496	m2	

Financial Information		
Interest Rate	3.00%	
Study Period	30	years
Power Cost	$0.15	$/kw
Natural gas cost	$10.00	MMBTU
Fuel Cost	$4.00	$/liter
Cost of transport and management of a cake land application program	$8.29	$/m3
Cost of polymer	$5.00	$/kg
Operation Labor Cost	$60.00	$/hr
Maintenance Labor Cost	$60.00	$/hr

Preliminary Opinion of Capital Cost

Item Description	Qty	Unit	Unit cost	Cost (1)	Remaining Value of Buildings and Equipment Projected Life (yrs.)	% Remaining	($)
Biosolids Dewatering at Baker Road							

Dewatering Facility Site Work							
Site grading	4,000	m3	9.00	36,000			
Paved Area	2,500	m2	11.00	28,000			
Stormwater collection and retention							
Grading	300	m3	8.00	2,000			
Catch basins and collection	1	ls	25,000.00	25,000			
Liner and outfall	1	ls	15,000.00	15,000			
Subtotal Dewatering Site				**106,000**			
Dewatering Facility							
Pre-engineered structure							
Dewatering Structure	1,000	m2	2,500	2,500,000	30	10	250,000
Office Area	200	m2	1,000	200,000			
Centrifuge dewatering system	2	ea.	1,200,000	2,400,000			
Centrifuge system installation (%) of equipment	40	%		960,000			
Allowance water system, compressed air system, drains and piping	1	ls	1,000,000	1,000,000			
Electrical and instrumentation (%) of structures & equipment	10	%		510,000			
Subtotal Dewatering Facility at Baker Road				**7,570,000**			
Subtotal Dewatering at Baker Road WWTP				**7,676,000**			
Biosolids Dewatering at Garner Road							
Dewatering Facility Site Work							
Site grading	11,000	m3	9.00	99,000			
Paved Area	7,000	m2	11.00	77,000			
Stormwater collection and retention							
Grading	1,000	m3	8.00	8,000			
Catch basins and collection	1	ls	25,000.00	25,000			
Liner and outfall	1	ls	15,000.00	15,000			
Subtotal Dewatering Site				**224,000**			
Dewatering Facility							
Decommission existing dewatering facility	1	LS	750,000.00	750,000			
Pre-engineered structure							
Dewatering Structure	3,000	m2	2,500	7,500,000	30	10	750,000
Office Area	400	m2	1,000	400,000			
Centrifuge dewatering system	5	ea.	1,200,000	6,000,000			
Centrifuge system installation (%) of equipment	40	%		2,400,000			
Allowance water system, compressed air system, drains and piping	1	ls	1,000,000	1,000,000			
Electrical and instrumentation (%) of structures & equipment	10	%		1,390,000			
Subtotal Dewatering Facility				**19,440,000**			
Subtotal Dewatering at Garner Road Facility				**19,664,000**			
Dewatered Biosolids Storage							
Storage Site							
Site grading	19,000	m3	9.00	171,000			
Paved Area	10,000	m2	11.00	110,000			
Pre-engineered cake storage structure	8,496	m2	500	4,248,000	30	10	424,800
Stormwater collection and retention							
Grading	600	m3	8.00	5,000			
Catch basins and collection	1	ls	20,000.00	20,000			
Liner and outfall	1	ls	7,000.00	7,000			
Subtotal Storage Site				**4,561,000**			
Indirect Costs							
Contingency and estimating allowance % of improvements & equipment	30	%		9,570,000			
Contractor overhead, profit, mobilization and bonds (%) of improvements	15	%		4,790,000			
Engineering, (%) of improvements	15	%		4,790,000			
Subtotal indirect costs				**19,150,000**			
TOTAL				**51,051,000**			1,424,800

INITIAL OPERATION & MAINTENANCE COSTS

Item Description	Staff/shift	Shifts/Op day	Annual Qty	Unit	Unit Cost	Cost (1)
Labor at Baker Road					($/unit)	($/yr)
Operation Labor Dewatering	1.0	1	2,080	hr	60.00	125,000
Maintenance Labor Dewatering and Storage	1.0	0.25	520	hr	60.00	31,000
Dewatering Operation at Baker Road						
Power			155,000	$/KWh	0.15	23,000
Polymer			27,342	kg	5.00	137,000
Dewatering equipment maintenance (%) of process equipment			1	%	2,400,000	24,000
Labor at Garner road					($/unit)	($/yr)
Operation Labor Dewatering	2.0	1	4,160	hr	60.00	250,000
Maintenance Labor Dewatering and Storage	1.0	0.25	520	hr	60.00	31,000
Dewatering Operation at Garner Road						
Power			745,000	$/KWh	0.15	112,000
Polymer			130,447	kg	5.00	652,000
Dewatering equipment maintenance (%) of process equipment			1	%	6,000,000	60,000
Storage Facility Maintenance (%) of storage volume			2	%	4,248,000	85,000
Transportation and land application of dewatered cake .						
Solids to Walker Environmental			6,000	dt/yr	584.00	3,504,000
3rd Party transportation and application of dewatered cake			42,564	m3/yr	8.29	353,000
Subtotal for O&M						**5,387,000**

Transportation of liquid biosolids to Garner Road Facility

Wastewater Treatment Plant	Average Annual Biosolids Flow (m3/d)	Total Solids (%)	(dt/d)	Distance to Garner Road (km)	Unit Cost ($)		**Cost to Garner Road ($/yr)**
Anger Ave	58.13	3.36	1.95	25.00	6.72	$	142,581
Baker Road	300.23	2.27	6.81	47.00	0.00	$	-
Crystal Beach	21.75	3.36	0.73	26.00	9.09	$	72,157
NOTL	55.84	3.59	2.00	28.00	6.54	$	133,300
Port Dalhousie	330.10	2.25	7.43	27.00	5.59	$	673,523
Port Weller	210.92	2.44	5.15	29.00	5.59	$	430,357
Queenston	5.18	0.80	0.04			$	-
Seaway	62.23	2.26	1.41	24.00	8.36	$	189,885
Welland	251.22	2.77	6.96	15.00	5.59	$	512,583
SNF	355.60	2.50	8.89		5.27	$	684,013
Subtotal for transportation to Garner Road Facility							**2,838,400**
Total O&M and Transportation to Garner Road Cost							**8,225,400**

LIFE CYCLE COSTS

Unit Cost, $/dt	
$	737.86

	P/F Factor	P/A Factor	Total Present Worth ($)
Initial Capital			$51,051,000
Present Value of Remaining Value	0.4120		($587,000)
Present Value of Annual O&M		19.6004	$161,221,000
TOTAL			**$211,685,000**

(1) Rounded to nearest $10,000
(2) Based on average annual solids generation

Alternative	Total Capital Cost	Total Annual O&M	30 Yr. Life Cycle Cost	Estimated Unit Cost ($/dt)
ALT 0	$91,207,000	$10,346,778	$290,156,000	$ 856.62
ALT 1	$41,567,000	$9,132,778	$220,093,000	$ 767.17
ALT 2	$51,051,000	$8,225,400	$211,685,000	$ 737.86