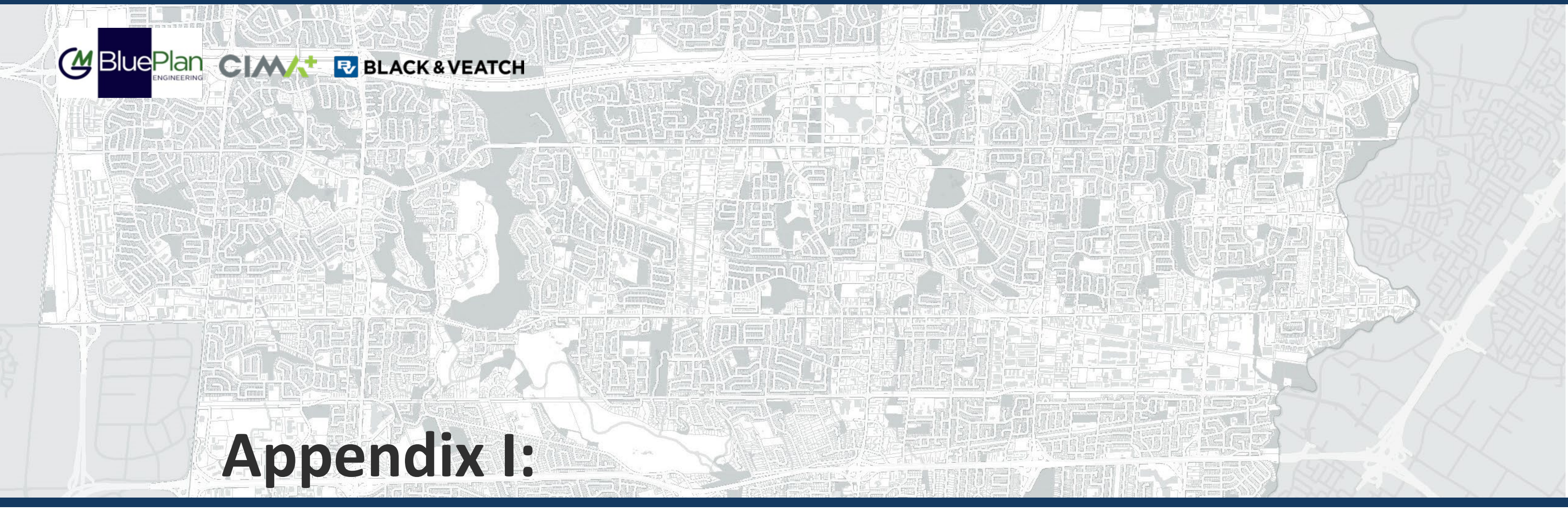
Volume 3:

Evaluation of Alternatives



Appendix I:

Alternative Solutions

I1: Phase 2 Evaluation Criteria

Criterion	Description
Natural Environment	
Terrestrial systems	Potential for alternative solutions to impact terrestrial habitats or systems, including terrestrial features / functions (ANSIs, ESAs), unique vegetation species, mature trees, existing park / open spaces linkages or wildlife
Aquatic systems	Potential of the solution to impact aquatic habitats or systems, including possible impacts on aquatic life and species at risk features / functions.
Surface (Lake) Water Quality	Potential of the solution to impact the quality of surface water (Lake Ontario).
Groundwater Water Quality and Quantity	Potential of the solution to impact the quality and quantity of groundwater.
Air Quality	The potential of the solution to minimize increases in air emissions.
Climate Change	The qualitative impacts of the solution on climate change in terms of Greenhouse Gas (GHG) Emissions
Social – Cultural	
Odour (post construction)	The potential of the solution to produce odour (post-construction).
Noise / Vibrations (post construction)	The potential of the solution to produce noise / vibration (post-construction).
Visual aesthetics (post construction)	The potential of the solution to impact the scenic attributes of the community and surrounding areas (post-construction).
Truck Traffic (post construction)	The potential of the solution to increase truck traffic (post-construction).
Disruption During Construction	The potential of the solution to impact surrounding landowners and users, including disruption to traffic and parking, noise and odour generation, parks, and greenspace impacts.
Property acquisition and easements	The extent to which property acquisition or easements are required to implement the solution.
Recreational Use and Users	The potential for the solution to impact surrounding recreational uses including both land and water uses.
Human Health and Safety	The potential of the solution to impact human health and safety; community and occupation.
Existing and Future Land Use Compatibility	The extent to which the solution fits in with the existing land and future planned land uses in the area.

Criterion	Description
Archaeology / Natural Heritage	The potential of solution to impact any archaeological sites and / or significant / natural heritage areas.
Technical	
Effectiveness	Effectiveness of the solution at meeting stated project objectives, including meeting wastewater, biosolids and wet weather management needs.
Long-term flexibility	The ability of the solution to meet to meet future demands beyond 2041, provide flexibility in biosolids treatment and product utilization, and flexibility in managing wet weather flows.
Ease of Operation	The solution's relative complexity as it relates to operation and maintenance of the Region's wastewater collection/treatment system.
Redundancy	Ability for the solution to provide treatment, biosolids, and/or wet weather flow redundancy for maintenance during regular and emergency situations.
Compatibility with existing infrastructure	The ability for the solution to be compatible and easily implemented within the existing plant site and its infrastructure.
Geotechnical and Hydrogeology	The extent of potential geotechnical challenges and impact to hydrogeology as related to the infrastructure during and post construction.
Contaminated Soils	The potential of the solution to encounter contaminated soils during construction and/or operation.
Energy use and recovery	The ability of the solution to include energy efficient technologies, reduce overall energy requirements and potentially result in energy recovery.
Climate Change Adaptability	The ability of the solution to adapt to climate change impacts (i.e., wet weather flow, severe events, higher Lake levels).
Permits and Approvals	Ease of receiving permits and approvals, including the agency approvals necessary.
Economic	
Capital costs	Capital costs estimates based on Phase 2 high level assumptions based on experience on other similar sized projects and assumptions with respect to the technologies to be implemented
Operating and Maintenance Costs	Operating and maintenance costs were not estimated in Phase 2; A qualitative approach was applied to compare alternatives based on operational experience on other similar sized projects and assumptions with respect to the technologies to be implemented.
Cash Flow	Expansion timing requirements were used to identify implications on Peel's cash flows.

Appendix I:

Alternative Solutions

I2: Evaluation of Alternative Solutions

Criteria	Evaluation of Alternative Solutions						
	Alt. 1 Expand Clarkson WRRF only (518 MLD / 500MLD); New PS at G.E. Booth WRRF	**Alt 2A Expand Both WRRFs (550MLD / 450MLD); New Outfall at G.E. Booth WRRF**	**Alt 2B Expand Both WRRFs (550MLD / 450MLD); New PS at G.E. Booth WRRF and divert 150 MLD peak flows**	**Alt 3 Expand Both WRRFs (550MLD / 500MLD); New Outfall at G.E. Booth WRRF**	**Alt 4A Expand Both WRRFs (600MLD / 400MLD); New Outfall at G.E. Booth WRRF**	**Alt 4B Expand Both WRRFs (600MLD / 400MLD); New PS at G.E. Booth WRRF and divert 300 MLD peak flows**	**Alt 5 Expand Both WRRFs (600MLD / 500MLD); New Outfall at G.E. Booth WRRF**
Natural Environment							
Terrestrial System	The G.E. Booth WRRF has significant woodlot habitats in the northwest and southwest portions of the site, as well as the storage lagoon ponds. Natural features adjacent to the G.E. Booth WRRF site include Applewood Creek, Serson Creek, the Significant Marie Curtis Park Woodlot Complex, and natural habitats being constructed as part of JTLCA. Consequently, alternatives with larger expansion of the G.E. Booth WRRF have more potential to impact terrestrial systems. The Clarkson WRRF has limited significant natural features on and surrounding the site; impacts on terrestrial systems will be minor.						
	7	5	5	5	3	3	3
Aquatic System	Alternatives with the largest capacity expansions at the G.E. Booth WRRF have greater potential to impact the aquatic habitats and species in Applewood Creek, the on-site stormwater wetland, and the wetlands in JTLCA. Alternatives with no new outfall at the G.E. Booth WRRF may have more potential to impact aquatic systems, because the existing outfall extends only about 1.4 km offshore, and as flows through the outfall increase, the size and area of the effluent plume will increase. The plume may impinge on the nearshore, impacting water quality and associated aquatic habitats. The Clarkson WRRF is outside the Lakeside Creek and Lake Ontario floodplain, and its outfall has sufficient capacity under all alternatives and extents over 2 kms into Lake Ontario. There is little risk to aquatic systems on site or in the nearshore of Lake Ontario.						
	3	8	3	8	6	3	6
Lake Ontario Water Quality	Alternatives with no new outfall at the G.E. Booth WRRF may have more potential to impact nearshore water quality, as the effuent plume may impinge on the nearshore as flows increase. The Clarkson WRRF outfall has capacity under all alternatives and extends over 2 km into Lake Ontario. There is little risk of nearshore water quality, water treatment plant intakes, Lakeside Creek, or Lake Ontario floodplains being impacted.						
	5	8	3	8	8	3	8
Groundwater Water Quality and Quantity	All alternatives are not expected to impact groundwater quality or quantity. Measures to mitigate impacts on groundwater quality and quantity during construction will be implemented.						
	7	7	7	7	7	7	7
Air Quality	Alternative solutions will be designed to include emission control and treatment such that emissions meet all air quality standards. However, with the mid-to-high rise residential buildings being planned as part of the Lakeview Development, there may be challenges meeting the incinerator point-of-impingement requirements for the alternatives with higher treatment capacities at the G.E. Booth WRRF.						
	7	6	6	6	4	4	4
Climate Change	All alternatives will include energy recovery and reuse technologies to help reduce greenhouse gas (GHG) emissions. Alternatives with the largest expansions will have less opportunities to reduce GHG emission from WRRF processes. In addition, alternatives that include an effluent pumping station will have less opportunities for energy recovery/reuse given their need for large standby power equipment.						
	6	8	6	8	7	4	5
Total Score (Out of 60)	**35**	**42**	**30**	**42**	**35**	**24**	**33**
Normalized Score (Total 25)	**14.6**	**17.5**	**12.5**	**17.5**	**14.6**	**10.0**	**13.8**
Natural Environmental Preference Rating	**2nd**	**1st**	**4th**	**1st**	**2nd**	**5th**	**3rd**

Criteria	Evaluation of Alternative Solutions						
	Alt. 1 **Expand Clarkson WRRF only (518 MLD / 500MLD); New PS at G.E. Booth WRRF**	**Alt 2A** **Expand Both WRRFs (550MLD / 450MLD); New Outfall at G.E. Booth WRRF**	**Alt 2B** **Expand Both WRRFs (550MLD / 450MLD); New PS at G.E. Booth WRRF and divert 150 MLD peak flows**	**Alt 3** **Expand Both WRRFs (550MLD / 500MLD); New Outfall at G.E. Booth WRRF**	**Alt 4A** **Expand Both WRRFs (600MLD / 400MLD); New Outfall at G.E. Booth WRRF**	**Alt 4B** **Expand Both WRRFs (600MLD / 400MLD); New PS at G.E. Booth WRRF and divert 300 MLD peak flows**	**Alt 5** **Expand Both WRRFs (600MLD / 500MLD); New Outfall at G.E. Booth WRRF**
Social - Cultural							
Odour	Odour control measures are in place at both WRRFs. Although there are no odour complaints associated with the Clarkson WRRF operations, there have been odour concerns with the operation of the G.E. Booth WRRF, due to its proximity to sensitive residential receptors. Odour control measures will continued to be implemented to manage odours from operations for all alternatives, with particular emphasis on controls at the G.E. Booth WRRF. It is expected that alternatives with the largest capacity expansions at G.E. Booth WRRF will required the most odour controls.						
	7	6	6	6	4	4	4
Noise/Vibrations	Noise attenuation measures will be implemented to manage noise from WRRF operation for all alternatives, resulting in a decrease in the risks of off-site noise. However, it is expected that alternatives with larger capacity expansions at G.E. Booth WRRF will have the greatest potential for noise concerns, and require more noise control measures. Vibrations are not expected to be a concern of the WRRF operations.						
	8	7	7	7	5	5	5
Visual Aesthetics	The visual aesthetics of the G.E. Booth WRRF will be a concern of the local community, including the new Lakeview Community development adjacent to the plant site. The larger the expansion of the G.E. Booth WRRF, the more visual aesthetics will be a concern. With the Clarkson WRRF located in an industrial area, visual aesthetics of the facility are not expected to be as much of a concern. Site landscaping and facility design will be part of all alternatives.						
	8	7	7	7	4	4	4
Truck Traffic	Truck traffic during operation will be required at each site to transport treated biosolids to off-site utilization areas, as well as for operational and maintenance purposes. Truck traffic in and out of Clarkson WRRF avoids residential areas; while truck traffic to and from the G.E. Booth WRRF has the potential to impact businesses on Lakeshore and the proposed Lakeview Community Development. The alternatives involve treatment and management of biosolids at each plant separately, therefore the larger the Clarkson WRRF expansion the more potential for truck traffic to utilize biosolids.						
	6	5	5	6	7	7	4
Disruption During Construction	All alternatives will have similar impacts during construction, which will be mitigated. The larger the expansion at G.E. Booth WRRF the more potential for short-term construction related impacts however, given the sensitivity of surrounding areas, landowners and users. The construction of a new outfall at the G.E. Booth WRRF will also have short-term impacts on the newly constructed JTLCA. Alternatives with the highest capacity expansion at G.E. Booth WRRF will have the most disruption during construction, although impacts will be mitigated.						
	6	5	5	5	3	3	3
Property Acquisition and Easement Requirements	There are no property acquisition requirements for any of the alternatives. All expansion can be accommodated on the existing sites. Easements will be required in Lake Ontario for alternatives that include a new outfall.						
	9	8	9	8	8	9	8
Recreational Use and Users	Alternatives with no new outfall at the G.E. Booth WRRF may have more potential to impact water quality, and associated shoreline and nearshore recreational activities, because the existing outfall at the G.E. Booth WRRF extends only about 1.4 km offshore, and as flows through the outfall increase, the size and area of the effluent plume will increase. The plume may impinge on the nearshore, thereby impacting shoreline and water users. The Clarkson WRRF outfall has capacity under all alternatives and extends over 2 km into Lake Ontario. There is little risk of nearshore water quality of water treatment plant intakes being impacted. There is also more residential land users in the vicinity of the G..E. Booth WRRF that may be impacted from odour during operations, with more potential for impacts the larger the expansion.						
	6	8	5	8	8	5	8
Human Health and Well Being	All alternatives will be designed to ensure air emission and effluent quality requirements are met to protect human health and the environment. Alternatives with no new outfall at the G.E. Booth WRRF may have some challenges meeting Lake Ontario Provincial Water Quality Objectives (PWQO) in the nearshore and not interfering with WTP intake protection zones (IPZs) as flows increase.						
	7	9	7	9	9	7	9
Existing and Future Adjacent Land Use Compatibility	The Clarkson WRRF is in an industrial area and is consistent with the existing and planned uses. The G.E. Booth WRRF is located within an urban community, with the new Lakeview Village Development planned adjacent to the WRRF, and is therefore currently not compatible with existing and future land uses. All alternatives allow Peel the opportunity to develop the G.E. Booth WRRF site so that it is more consistent with future land uses through implementation of enhanced odour and noise controls, and visual facility and site improvements. Alternatives with a new outfall also allow Peel to protect nearshore water quality to ensure compatibility with the JTLCA.						
	7	7	6	7	6	4	6

Archaeology & Natural Heritage	The Stage 1 and 2 Archaeological Assessments indicate that the potential for archaeological resources on site is low at both WRRFs. No cultural heritage features in the vicinity of the WRRFs are expected to be impacted.						
	9	9	9	9	9	9	9
Total Score (Out of 100)	**73**	**71**	**59**	**63**	**54**	**50**	**51**
Normalized Score (Total 25)	**18.3**	**17.8**	**14.8**	**15.8**	**13.5**	**12.5**	**12.8**
Social-Cultural Preference Rating	**1st**	**1st**	**3rd**	**2nd**	**4th**	**5th**	**5th**

Evaluation of Alternative Solutions

Criteria	Description	Alt. 1 Expand Clarkson WRRF only (518 MLD / 500MLD); New PS at G.E. Booth WRRF	Alt 2A Expand Both WRRFs (550MLD / 450MLD); New Outfall at G.E. Booth WRRF	Alt 2B Expand Both WRRFs (550MLD / 450MLD); New PS at G.E. Booth WRRF and divert 150 MLD peak flows	Alt 3 Expand Both WRRFs (550MLD / 500MLD); New Outfall at G.E. Booth WRRF	Alt 4A Expand Both WRRFs (600MLD / 400MLD); New Outfall at G.E. Booth WRRF	Alt 4B Expand Both WRRFs (600MLD / 400MLD); New PS at G.E. Booth WRRF and divert 300 MLD peak flows	Alt 5 Expand Both WRRFs (600MLD / 500MLD); New Outfall at G.E. Booth WRRF
Technical								
Effectiveness	The alternatives with a new outfall are the most effective at meeting stated project objectives - wastewater, biosolids, and wet weather flow management (to 2041). There is a risk of the existing outfall not meeting nearshore water quality objectives as flows to the G.E. Booth WRRF increase. There is risk associated with relying on the East-to-West diversion to divert peak flows during wet weather events, given its location in the service area. Wet weather events occurring south of the diversion will not be able to be diverted and could be substantial.	6	9	4	9	9	4	9
Long-term Sustainability and Flexibility	Alternatives with the highest capacity expansions at the G.E. Booth WRRF may limit the ability to implement new technologies in the future, as an expansion of this size will extend into the lagoon area taking up much of the available site capacity. Maintaining the G.E. Booth WRRF at its rated capacity may limit treatment flexibility in the future as it limits flow diversion options. Alternatives with peak flow diversion limit treatment flexibility at the Clarkson WRRF by utilizing the additional excess capacity in the Clarkson WRRF outfall.	2	7	4	9	6	4	6
Ease of Operation	Alternatives with peak flow diversion may present challenges in operating the east-to-west flow diversion chambers intermittently during wet weather events. In addition, the alternatives with an effluent pumping station have more operational complexity than those with a new outfall.	4	8	3	8	8	3	8
Redundancy	All alternatives will be designed to provide treatment redundancy during emergency and maintenance conditions. However, there may be challenges to provide treatment redundancy during wet weather events at both the G.E. Booth WRRF and the Clarkson WRRF that rely on a diversion of peak flows during wet weather flow events.	4	8	4	9	8	4	8
Compatibility with Existing Infrastructure System	Alternatives with lower plant capacity expansions at the Clarkson WRRF do not take full advantage of the east-west flow diversion strategy. Likewise, maintaining the G.E. Booth WRRF at its current rated capacity does not take full advantage of the east-west flow diversion strategy.	3	8	8	9	3	3	8
Geotechnical and Hydrogeology	The on-site geotechnical and hydrogeological conditions at both the G.E. Booth WRRF and the Clarkson WRRF will not present significant challenges during construction, as site conditions and mitigation measures at both sites are well understood. Alternatives with a new outfall at the G.E. Booth WRRF will present more geotechnical challenges. Additional off-shore geotechnical investigations will be required to confirm construction techniques and mitigation measures before construction of a new outfall.	8	6	8	6	6	8	6
Contaminated Soils	All alternatives will have the potential to impact Areas of Potential Environment Concern (APECs) on both the G.E. Booth WRRF and Clarkson WRRF sites. Additional investigations and analysis may be required, and appropriate mitigation and remediation methods implemented. The larger the expansion, the more potential to impact on-site APECs at both WRRF sites.	8	7	7	7	5	5	4
Energy use and Recovery	Expansion of both WRRFs will allow for opportunities to further promote energy use and recovery. In particular, opportunities exist to increase energy recovery associated with biosolids generation and treatment at Clarkson WRRF. Alternatives with pumping will be somewhat less energy efficient.	6	7	6	8	**6**	**6**	8
Climate Change Adaptability	All alternatives will be designed to be adaptable to change climate change, by minimizing the risk of wet weather flows impacts on treatment processes. Alternatives without no new outfall at the G.E. Booth WRRF may not be as adaptable to raising lake levels as a consequence of climate change.	4	8	4	8	8	4	8
Permits and Approvals	Alternatives with peak flow diversion may take longer to approve, as there may be challenges in meeting MECP receiving water quality requirements using the existing outfall at the G.E. Booth WRRF. Alternatives with the greater capacity increases at G.E. Booth WRRF may also face approval challenges given the proximity of the new Lakeview Community development. Receiving approvals for expansion of the Clarkson WRRF are not expected to be as challenging as obtaining approvals for expansion of the G.E. Booth WRRF.	3	6	2	6	4	2	4
Total Score (Out of 100)		**48**	**74**	**50**	**79**	**63**	**43**	**69**

Normalized Score (Total 25)	12.0	18.5	12.5	19.8	15.8	10.8	17.3
Technical Preference Rating	6th	2nd	5th	1st	4th	7th	3rd

Criteria	Evaluation of Alternative Solutions						
	Alt. 1 Expand Clarkson WRRF only (518 MLD/500MLD); New PS at G.E. Booth WRRF	Alt 2A Expand Both WRRFs (550MLD/ 450MLD); New Outfall at G.E. Booth WRRF	Alt 2B Expand Both WRRFs (550MLD/ 450MLD); New PS at G.E. Booth WRRF and divert 150 MLD peak flows	Alt 3 Expand Both WRRFs (550MLD/ 500MLD); New Outfall at G.E. Booth WRRF	Alt 4A Expand Both WRRFs (600MLD/ 400MLD); New Outfall at G.E. Booth WRRF	Alt 4B Expand Both WRRFs (600MLD/ 400MLD); New PS at G.E. Booth WRRF and divert 300 MLD peak flows	Alt 5 Expand Both WRRFs (600MLD/ 500MLD); New Outfall at G.E. Booth WRRF
Economic							
Capital Cost	All alternatives involve a significant capital investment, ranging from $850 to $1200 M; Alternatives without the new outfall are at the lower end of the range; while those with the new outfall are at the higher end of the range. Alternative 5, which has an outfall and the largest WRRF expansion has the highest capital costs.						
	5	3	5	3	3	5	1
Operating and Maintenance (O&M) Costs	All alternatives will have comparable O&M costs, with the exception of alternatives with an effluent pumping station. Operating costs of a pumping station are higher than those alternatives that include a new outfall at the G.E. Booth WRRF.						
	4	6	4	6	6	4	6
Cash Flow	All Alternatives have similar construction scheduling periods, with the exception of Alternative 4, which has both plants being constructed during similar time periods. Peel would have large capital expenditures during a shorter time period. Alternatives which include an effluent pumping station at the G.E. Booth WRRF and diversion of peak flows help Peel reduce capital expenditures during the planning period for this study (to 2041). However, an outfall at the G.E. Booth WRRF will still eventually be required to meet future peak flow requirements.						
	4	6	4	6	2	2	6
Total Score (Out of 30)	**13**	**15**	**13**	**15**	**11**	**11**	**13**
Weighted	**25**	**25**	**25**	**25**	**25**	**25**	**25**
Normalized Score (Total 25)	**10.8**	**12.5**	**10.8**	**12.5**	**9.2**	**9.2**	**10.8**
Economic Preference Rating	**2nd**	**1st**	**2nd**	**1st**	**3rd**	**3rd**	**2nd**

Criteria	Evaluation of Alternative Solutions						
	Alt. 1 **Expand Clarkson WRRF only (518 MLD / 500MLD); New PS at G.E. Booth WRRF**	**Alt 2A** **Expand Both WRRFs (550MLD / 450MLD); New Outfall at G.E. Booth WRRF**	**Alt 2B** **Expand Both WRRFs (550MLD / 450MLD); New PS at G.E. Booth WRRF and divert 150 MLD peak flows**	**Alt 3** **Expand Both WRRFs (550MLD / 500MLD); New Outfall at G.E. Booth WRRF**	**Alt 4A** **Expand Both WRRFs (600MLD / 400MLD); New Outfall at G.E. Booth WRRF**	**Alt 4B** **Expand Both WRRFs (600MLD / 400MLD); New PS at G.E. Booth WRRF and divert 300 MLD peak flows**	**Alt 5** **Expand Both WRRFs (600MLD / 500MLD); New Outfall at G.E. Booth WRRF**
Total Scores							
Natural Environment	14.6	17.5	12.5	17.5	14.6	10.0	13.8
Social/Cultural	18.3	17.8	14.8	15.8	13.5	12.5	12.8
Technical	12.0	18.5	12.5	19.8	15.8	10.8	17.3
Economic	10.8	12.5	10.8	12.5	9.2	9.2	10.8
	56%	**66%**	**51%**	**66%**	**53%**	**42%**	**55%**
Alternative Ranking				**Preferred**			

Note: Alternative 3 was selected as the preferred over Alternative 2A as it provides Peel with better long-term sustainability and reliability in wastewater treatment, by providing more capacity at the Clarkson WRRF. Selecting solutions that are sustainable and reliable are key objectives of the Region of Peel.

Appendix J:

Biosolids Market Assessment

G.E. Booth Water Resource Recovery Facility Schedule C Class Environmental Assessment

Technical Memorandum:

Biosolids Product Market Assessment

10/3/2022

VERIFIED AND APPROVED					
Rev	**Prepared By**	**Date**	**Verified By**	**Date**	**Revision Description**
1	Mark Lang/ Emma Cabrera-Aragon	Dec 1, 2020	Zhifei Hu	Dec 2, 2020	Draft
2	Mark Lang	March 29, 2022	Zhifei Hu	March 29, 2022	Final Draft
3	Mark Lang	October 3, 2022	Zhifei Hu	October 3, 2022	Final

AUTHORIZED AND DISTRIBUTED					
Rev No	**Authorized By**	**Date**	**Issued To**	**Date**	**Copies**
1	Zhifei Hu	Dec 2, 2020	Laurie Boyce	Dec 2, 2020	1
2	Zhifei Hu	March 29, 2022	Laurie Boyce	March 29, 2022	1
3	Zhifei Hu	October 3, 2022	Laurie Boyce	October 3, 2022	1

QA/QC REVIEW – REV.1		
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QA/QC REVIEW - REV.2		
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QA/QC REVIEW – REV.3		
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APPENDICES

Term or Acronym	Definition
%	Percent
°C	Degrees Celsius
°F	Degrees Fahrenheit
µg	Microgram
µg/l	Microgram per Litre
6:2 FTS	6:2 fluorotelomer sulfonate
6:2 FTS	6:2 fluorotelomer sulfonate
8:2 FTS	8:2 fluorotelomer sulfonate
ABTP	Ashbridges Bay Treatment Plant
As	Arsenic
B&V	Black & Veatch
BMC	Biosolids Management Centre
BNQ	Bureau de normalization du Quebec
BTG	Biosolids Task Group
Ca(OH)2	Calcium Hydroxide
CaO	Calcium Oxide
CCME	Canadian Council of Ministers of the Environment
Cd	Cadmium
CEPA	Canadian Environmental Protection Act
CFIA	Canadian Food Inspection Agency
CFU	Colony Forming Units
CFU/g	Colony Forming Unit per Gram
CM1	NASM metal category 1 based on metal content
CM2	NASM metal category 2 based on metal content
Co	Cobalt
CP1	NASM pathogen category 1 based on pathogen level
CP2	NASM pathogen category 2 based on pathogen level
Cr	Chromium

Term or Acronym	Definition
Cu	Copper
DT	Dry Tonnes
DT/ha	Dry Tonnes per Hectare
DT/ha-yr	Dry Tonnes per Hectare per Year
DT/yr	Dry Tonnes per Year
EA	Environmental Assessment
EASR	Environmental Activity and Sector Registry
ECCC	Environment and Climate Change Canada
EPA	Environmental Protection Act
FzA	Fertilizers Act
FzR	Fertilizers Regulations
g	Gram
ha	Hectare
Hg	Mercury
kg	Kilogram
kg/ha	Kilogram per Hectare
KOH	Potassium Hydroxide
l	Litre
m3	Cubic Metre
MAC	Maximum Acceptable Concentration
MAD	Mesophilic Anaerobic Digester
MECP	Ministry of the Environment, Conservation and Parks
mg	Milligram
mg/kg	Milligram per Kilogram
mg/kg-day	Milligram per Kilogram per Day
mg/L	Milligram per Litre
mm	Millimetre
Mo	Molybdenum

Term or Acronym	Definition
MPN	Most Probably Number
MTO	Ministry of Transportation Ontario
N	Nitrogen
Na	Sodium
NaOH	Sodium Hydroxide
NASM	Non-Agricultural Source Material
ng	Nanograms
Ni	Nickel
NMA	Nutrient Management Act
NMP	Nutrient Management Plan
NPRI	National Pollutant Release Inventory
OC1	NASM odour category 1 based on odour detection threshold
OC2	NASM odour category 2 based on odour detection threshold
OC3	NASM odour category 3 based on odour detection threshold
OMAFRA	Ontario Ministry of Agriculture, Food and Rural Affairs
OPS	Ontario Provincial Standards for Roads and Public Works
ou	Odour Units
OWRA	Ontario Water Resources Act
Pb	Lead
PCB	Polychlorinated Biphenyl
PCDD	Polychlorinated Dibenzo-p-dioxins
PFAS	Per- and Polyfluoroalkyl Substances
PFBA	Perfluorobutanoate
PFBS	Perfluorobutane sulfonate
PFCA	Perfluorocarboxylic Acid
PFHpA	Perfluoroheptanoate
PFHxA	Perfluorohexanoate
PFHxS	Perfluorohexane sulfonate

Term or Acronym	Definition
PFNA	Perfluorononanoate
PFOA	Perfluorooctanoic acid
PFOS + PFOA	Perfluorooctane sulfonate + Perfluorooctanoic acid
PFOS	Perfluorooctane sulfonate
PFPeA	Perfluoropentanoate
PIWMF	Peel Integrated Waste Management Facility
Region	Region of Peel or Regional Municipality of Peel
Se	Selenium
SRM	Specified Risk Materials
SSO	Separated Source Organics
SSV	Soil Screening Values
TEQ	Toxic Equivalents
THP	Thermal Hydrolysis Process
TI	Thallium
TM	Technical Memorandum
ton	Imperial Ton
tonne	Metric Tonne
TPAD	Temperature Phased Anaerobic Digestion
TS	Total Solids
V	Vanadium
VSr	Volatile Solids Reduction
WPCP	Water Pollution Control Plant
WRRF	Water Resource Recovery Facility
WWTP	Wastewater Treatment Plant
yr	Year
Z	Zinc

1.0 Introduction

1.1 Background

The Region of Peel (Region) has retained the GM BluePlan, CIMA, and Black & Veatch (B&V) Team to complete two Schedule C Class Environmental Assessments (EAs); one each for the G.E. Booth and Clarkson Water Resource Recovery Facilities (WRRFs); formerly referred to as Wastewater Treatment Plants (WWTPs). The purpose of the Schedule C Class EAs is to identify a preferred solution for meeting future capacity requirements at both the G.E. Booth and Clarkson WRRFs. Enhanced conceptual designs for each facility will be developed that not only provide details on the expansion work required to meet 2041 demands, but a long-term comprehensive, sustainable vision for future plant designs beyond 2041.

Both WRRFs are conventional activated sludge facilities and biosolids generated at both facilities are incinerated at the G.E. Booth WRRF. The digested sludge generated at Clarkson WRRF is transferred to G.E. Booth for incineration. The residual ash slurry from the incineration process is transferred to two on-site settling lagoons which are dredged regularly and stored on-site in an ash pond.

Design Basis TMs established design basis wastewater flows, and loadings along with biosolids quantities and characteristics for each WRRF. The current and future biosolids production at the G.E. Booth and the Clarkson WRRFs were used to conduct the biosolids product market assessment.

1.2 Purpose of Biosolids Market Assessment Technical Memorandum

This technical memorandum (TM) documents the biosolids product market assessment conducted for G.E. Booth and Clarkson WRRFs. This TM summarizes the regulatory framework for the management of biosolids in Ontario, defines the different biosolids products and their characteristics, identifies target markets/outlets available and provides an overview of estimated demand and market potential. The TM provides recommendations and market considerations for the biosolids products and outlets with the most market potential. The information presented herein is being used to develop biosolids management alternatives for each WRRF.

2.0 Regulatory Framework

2.1 Biosolids Regulations

2.1.1 Federal

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

2.1.1.1 The Canadian Environmental Protection Act (CEPA)

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

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

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

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

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

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

The Fertilizer Trade Memoranda provides product specific information and requirements for fertilizers and supplements regulated under the *Fertilizers Act* Section T-4-93. The safety standards for fertilizers and supplements, provide a series of metals concentrations that are acceptable in a fertilizer product. As noted on **Table 2-1**, the maximum acceptable product metal concentration (in milligrams per kilogram (mg/kg)) on a dry weight basis) is calculated based on an anticipated 45-year cumulative loading (in kg per hectare (kg/ha)).

Table 2-1 CFIA Fertilizer and Supplements Metals Standards

METAL	MAXIMUM ACCEPTABLE CUMULATIVE METALS ADDITION TO SOIL OVER 45 YEARS (KG/HA)	EXAMPLES OF MAXIMUM ACCEPTABLE PRODUCT METAL CONCENTRATION BASED ON ANNUAL APPLICATION RATES (MG/KG) 4,400 KG/HA-YR	EXAMPLES OF MAXIMUM ACCEPTABLE PRODUCT METAL CCONCENTRATION BASED ON ANNUAL APPLICATION RATES (MG/KG) 2,000 KG/HA-YR	EXAMPLES OF MAXIMUM ACCEPTABLE PRODUCT METAL CONCENTRATION BASED ON ANNUAL APPLICATION RATES (MG/KG) 500 KG/HA-YR
Arsenic (As)	15	75	166	666
Cadmium (Cd)	4	20	44	177
Chromium (Cr)	210	1,060	2,333	9,333
Cobalt (Co)	30	151	333	1,333
Copper (Cu)	150	757	1,666	6,666
Mercury (Hg)	1	5	11	44
Molybdenum (MO)	4	20	44	177
Nickel (Ni)	36	181	400	1,600
Lead (Pb)	100	505	1,111	4,444
Selenium (SE)	2.8	14	31	124
Thallium (TI) (1)	1	5	11	44
Vanadium (V) (1)	130	656	1,444	5,777
Zinc (Z)	370	1,868	4,111	16,444

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

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

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

Table 2-2 CFIA Fertilizer and Supplements Dioxin and Furan Standards

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

Section T-4-93 of the *Fertilizers Act* also addresses pathogen reduction in biosolids using Salmonella and Faecal Coliforms as indicators. The section mentions that this approach is closely aligned with the US EPA's 40 Part 503 Regulations. The maximum level of these organisms in fertilizers and supplements is presented in **Table 2-3**. It further includes information regarding the acceptable tolerances for fertilizers that guarantee certain concentrations of micronutrients in their product.

Table 2-3 CFIA Indicator Organisms in Fertilizers and Supplements

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

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

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

Labelling requirements

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

Safety standards

- Physical contaminants
- Chemical contaminants which include most of the metals outlined in **Table 3-1**.
- Biological contaminants which include the indicator organism information outlined in **Table 3-3**.
- Maturity. The sale of compost is restricted to mature product. It is the producer's responsibility to demonstrate the maturity using scientifically valid methods.
- Prohibited materials including Specified Risk Materials (SRM)

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

Safety standards for fertilizers and supplements, provides a series of metals concentrations that can be contacted as a fertilizer product.

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

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

2.1.1.4 CCME Guidelines for Compost Quality

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

- Foreign matter
- Maturity
- Pathogens and
- Trace Elements

The Guidelines established two grades of material:

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

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

2.1.2 Provincial

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

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

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

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

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

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

- Pathogen Category: Biosolids that meet the CP1 standard must meet levels of E.coli ≤1,000 colony forming units (CFU)/g dry weight or 100ml, Salmonella < 3 CFU or Most Probable Number (MPN)/4g or 100 ml, and Viable Helminth Ova & total culturable Enteric Virus < 1 organism per 4g or 100 ml. Sewage biosolids categorized as CP2 must meet the E.coli < $2x10^6$ CFU/g of total solids dry weight standard.

- Odour Category: Biosolids must have an odour detection threshold of less than 500 odour units (ou) per cubic metre (m^3) to be categorized as OC1. OC2 biosolids are between 500-1,500 ou/m^3 and OC3 biosolids are between 1,500 and 4,500 ou/m^3. O.Reg 267/03 does not allow NASM materials to be applied to agricultural land if they exceed 4,500 ou/m^3.

- Metal Category: Biosolids are classified as CM1 if they do not exceed the metal concentrations laid out in the middle column of **Table 2-4** and CM2 if they fall between CM1 concentrations and the right-most column.

Table 2-4 Biosolids Categories CM1 and CM2 Metal Concentrations (O. Reg 267/03 (2002))

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

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

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

The maximum application rates of regulated metals are presented in **Table 2-5**. The application of regulated metals through biosolids application must be limited to the listed amounts per hectare (ha) over a five-year period. The MECP must be satisfied that the application of CM2 materials will not result in a measurable increase in soils whose concentrations exceed those listed in the third column of **Table 2-5**.

Table 2-5 Maximum Application Rates of Regulated Metals

O. Reg 267/03 (2002)

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

Category 3 NASM must also meet the application limits listed in **Table 2-6** for sodium and fats, oils, and greases for each soil hydrologic group. Soil hydrologic groups are defined and described in the Drainage Guide for Ontario, Publication 29, published by the OMAFRA (2007).

Table 2-6 Maximum Application Limits for Sodium, Fats, Oils and Greases

O.Reg 267/03 (2002)

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

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

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

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

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

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

2.1.2.2 Quality Standards and Guidelines for the Production of Compost (2012)

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

The maximum metals concentration for compost categories A and B are detailed in **Table 2-7**, as well as the maximum metals concentration in compost feedstock (biosolids in this case).

Table 2-7 Maximum Metals Concentration

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

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

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

Category A material must be labelled with:

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

Categories A and B allow municipal wastewater biosolids to be used as feedstocks up to 25%, allowing for the beneficial use of these resources. Category A compost is exempt from the need for approvals if it meets the new standards, including labelling, while Category B, falls under the same requirements as a

NASM, will continue to require government approval for use and transportation, including an ECA or Environmental Activity and Sector Registry (EASR) registration for transport and ECA for use off-farm or approved NASM Plan for on-farm use. The new standards also align Ontario more closely with those set out in 2005 by the CCME.

2.2 Landfill Regulation

2.2.1 Federal

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

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

2.2.2 Provincial

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

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

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

Wastewater solids, such as the undigested and digested dewatered cake produced at G.E. Booth and Clarkson WRRFs, respectively, can be disposed of in approved municipal sanitary landfills. The required solids concentration of sludges to be landfilled are specified by the individual landfill authorities. Per the MECP's Design Guidelines for Sewage Works, "with small quantities of sludge for co-disposal landfilling with municipal solid waste, liquid sludge at solids concentrations as low as 3 percent Total Solids (TS) may be acceptable." For landfills that are sludge-only a minimum 18 percent (TS) concentration is required, or a slump of 150 mm or less. O. Reg 347 includes the "Test Method for Determination of Liquid Waste (Slump Test)" (MECP, 2008).

2.3 Potential Regulatory Trends and Changes

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

- Per- and polyfluoroalkyl substances (PFAS), and
- Microplastics

This section provides an overview of these trends.

2.3.1 Per- and polyfluoroalkyl substances (PFAS)

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

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

A 2010 CCME report titled Emerging Substances of Concern in Biosolids: Concentrations and Effects of Treatment Processes looked at a select group of pharmaceuticals, fragrance and alkylphenolic compounds. Due to budgetary limitations, it did not look at other emerging substances of concern, such as other pharmaceutical compounds, natural and synthetic human hormones, industrial chemicals (e.g. phthalate esters, polybrominated diphenyl ethers and other flame retardants, perfluorinated organic substances, alkylphenol ethoxylates, quaternary ammonium compounds), and personal care products (insect repellents, sunscreens, parabens, organic siloxanes, fabric softeners, fluorescent whitening agents, etc.) (Canadian Council of Ministers of the Environment, 2010).

At the Federal level perfluorooctanoic acid (PFOA), perfluorocarboxylic acid (long-chain PFCAs) and perfluorooctane sulfonate (PFOS) are listed as substances subject to Prohibition of Certain Toxic

Substances Regulations (2012), as regulated by Environment and Climate Change Canada (ECCC). The regulations prohibit the manufacture, use, sale, offer for sale or import of the toxic substances listed below, and products containing them, with a limited number of exemptions. In 2018, Health Canada introduced drinking water quality and screening values for PFOS, PFOA and other PFAS (see **Table 2-8** and **Table 2-9** below), following by soil screening values in 2019 (see **Table 2-10**) (Government of Canada, 2019; Health Canada, 2019; Health Canada, 2016).

Table 2-8 Canadian drinking water quality - MACs for PFOS and PFOA

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

Table 2-9 Health Canada drinking water screening values - other PFAS

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

Table 2-10 Health Canada Soil Screening Values

PFAS NAME	PFAS ACRONYM	SOIL SCREENING VALUES (SSVS) (MG/KG)		
		AGRICULTURAL/ RESIDENTIAL PARKLAND LAND USE	COMMERCIAL LAND USE	INDUSTRIAL (COMMERCIAL WITHOUT TODDLER) LAND USE
Perfluorooctane sulfonate	PFOS	2.1	3.2	30.5
Perfluorooctanoic acid	PFOA	0.70	1.05	9.94
Perfluorooctane sulfonate + Perfluorooctanoic acid	PFOS + PFOA	$\frac{[PFOS]}{SSV_{PFOS}} + \frac{[PFOA]}{SSV_{PFOA}} \leq 1$		
Perfluorobutanoate	PFBA	114	173	1630
Perfluorobutane sulfonate	PFBS	61	92	872
Perfluoropentanoate[b]	PFPeA	0.80	1.21	11.41
Perfluorohexane sulfonate[a]	PFHxS	2.3	3.5	33
Perfluorohexanoate[b]	PFHxA	0.80	1.21	11.41
Perfluoroheptanoate[b]	PFHpA	0.80	1.21	11.41
Perfluorononanoate	PFNA	0.08	0.13	1.2
6:2 fluorotelomer sulfonate[b]	6:2 FTS	0.80	1.21	11.41
8:2 fluorotelomer sulfonate[b]	8:2 FTS	0.80	1.21	11.41

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

To date, there have been no impacts to biosolids programs in Ontario resulting from the implemented limits at the Federal level. A 2018 paper titled *Land Application of Municipal Biosolids: Managing the Fate and Transport of Contaminants of Emerging Concern*, produced by Agriculture and Agri-Food Canada, summarized a suite of studies conducted in Ontario and found that “although a considerable

PBDE and PFAA, Perfluoroalkyl Acids, load was applied at time of biosolids application … detection of PBDEs and PFAAs in subsurface drainage, groundwater, and soil indicated that atmospheric deposition was likely an important source of these compounds. In addition, post-application levels of PBDEs and PFAAs in the soil remained largely within background soil levels derived from the literature" (Agricultural and Agri-Food Canada, 2018).

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

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

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

2.3.2 Microplastics

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

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

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

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

3.0 Biosolid Products and Their Characteristics

3.1 Existing Sludge Characteristics

The Clarkson WRRF currently produces anaerobically digested and dewatered biosolids cake. The G.E. Booth WRRF produces dewatered cake that has not been stabilized. Design basis assessments of the G.E. Booth and Clarkson WRRFs were carried out to establish existing conditions. It is estimated that that the G.E. Booth WRRF currently produces approximately 40,000 dry tonnes (DT)/yr of dewatered cake and the Clarkson WRRF produces approximately 13,000 DT/yr of digested, dewatered cake.

Biosolids sampling data for Clarkson WRRF for 2020 to-date is presented and compared to regulatory values in Appendix A, **Table A-1**. The data indicates that biosolids meet CFIA maximum acceptable cumulative metals limits, Category 3 NASM CM2 metals concentration limits and metals limits for feedstock for categories A & B of Ontario compost quality standards.

Due to the level of stabilization performed, the biosolids generated at the Clarkson WRRF currently do not meet CFIA fecal coliform limit of <1000 MPN/g or Category 3 NASM's CP1 E.coli limit of <1000 MPN or CFU/g of dry weight, falling under CP2 E.coli limit of $<2x10^{6}$ CFU/g dry weight (average recorded value of 5,945 CFU/g).

Since the solids generated at the G.E. Booth WRRF are not stabilized, they also do not meet these pathogen reduction requirements. The biosolids generated at both facilities could meet the CFIA pathogen limits with further stabilization. Solids processing alternatives and the resulting biosolids products are discussed in the following sections.

3.2 Biosolid Products

To understand potential markets for various biosolids products, it is important to understand both how biosolids products differ and how those characteristics impact their use. This section addresses both needs and "sets the stage" both for the identification of target markets and potential market size evaluations.

Biosolids products can be placed into the following general categories:

- Anaerobically digested dewatered cake
- Advanced digested dewatered cake
- Incinerator ash
- Thermal-dried products
- Compost product
- Alkaline stabilized products
- Thermal-Alkaline hydrolyzed products
- Manufactured soils

Each of these products can be applied to land to add nutrients and organics to soil and are generally referred to as "soil amendments". While the products are markedly different, they share the benefits listed in **Table 3-1**.

Table 3-1 Biosolids Benefits

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

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

3.3 Anaerobically Digested and Dewatered Biosolids Cake

As mentioned, the Clarkson WRRF uses anaerobic digestion and centrifuges to stabilize and dewater biosolids prior to transport to the G.E. Booth WRRF for incineration and ash disposal. If the solids from both facilities were to be used in a land application program all of the solids would require stabilization. Anaerobic digestion is a popular process at the scale of these WRRFs to meet the CP2 limits class. If anaerobic digestion was also employed at the G.E. Booth WRRF the dewatered cake could be used as part of a land application program.

Anaerobically digested and dewatered biosolids cake typically have a TS concentration between 25 and 30 % and are clay-like in appearance and consistency. These can be land applied with certain management practice requirements to meet agricultural crop nutrient requirements.

The application of digested and dewatered cake to agricultural land is regulated under the NMA, as described in Section 2.1.2. Application of biosolids to non-agricultural land requires an ECA. Application rates vary based on crop needs, and are limited by the nitrogen, phosphate, metals, and sodium content of the biosolids products. Typical application rates range from 2 dry tonnes per hectare (DT/ha) to 4 DT/ha.

3.4 Advanced Digested Dewatered Biosolid Cake

Some agencies elect to employ an advanced digestion process which allows them to meet the CP1 criteria, Category A CCME Guidance, and with certain biosolids characteristics of the CFIA requirements. The following advanced digestion processes can be considered:

- **Thermal Hydrolysis**: The thermal hydrolysis process (THP) is a high-pressure, high temperature, pretreatment process used prior to anaerobic digestion. Dewatered solids entering the process are heated and pressurized. When the pressure is quickly released the cell walls of the microorganisms within the wastewater solids rupture increasing the bioavailability of the material entering the anaerobic digestion system. Because the THP process is performed on dewatered solids, the concentration in the downstream anaerobic digesters is much higher than in conventional mesophilic anaerobic digesters (MAD), 8 % TS or higher, which reduces the required digester volume. The THP process typically achieves a volatile solids reduction (VSr) of approximately 60 percent or more. This results in increased biogas production while reducing total solids production. As with any process that increases VSr, the nutrient loads in the dewatering sidestream will increase with THP. The process improves the dewaterability of the digested solids, resulting in dewatered cake solids concentrations of 28 percent or higher, regardless of dewatering technology. The heating step in the THP process can meet Class A Pathogen reduction requirements.

- **Thermophilic Anaerobic Digestion**: Thermophilic anaerobic digestion includes one or more stages that are operated at thermophilic temperatures, ranging from 50 to 60°C (122 to 140°F). Thermophilic digestion typically results in increased VSr and pathogen reduction. Depending on the configuration, thermophilic digestion can meet Class A criteria and most thermophilic digestion systems are designed to generate a Class A biosolids product. Existing mesophilic digestion can be converted to a thermophilic process. The conversion typically requires the addition of new heat exchangers along with system pumping and piping modifications, tank insulation, batch tanks, and modification to the existing biogas system. Thermophilic digestion processes have a higher odour potential and often reduced dewaterability when compared to mesophilic digestion.

- **Temperature Phased Anaerobic Digestion**: Temperature phased anaerobic digestion (TPAD) process uses a combination of thermophilic and mesophilic stages to optimize digester performance. Batch thermophilic tanks used in the systems allow the process to meet the Class A pathogen reduction criteria. The TPAD process requires similar modifications to as existing MAD system as outlined above with the Thermophilic anaerobic digestion process. The TPAD systems also face challenges with odour potential and reduce dewaterability.

While the biosolids that have undergone advanced digestion can meet the CP1 criteria, Category A CCME Guidance, and with certain biosolids characteristics of the CFIA requirements, their physical characteristics, totals solids concentration and clay like handling, primarily limit their use to bulk agriculture or silviculture applications.

3.5 Incinerator Ash

Incineration is a unit process which evaporates the water and burns the organic matter in dewatered cake using high temperature chemical oxidation reactions. The solids generated at both the G.E. Booth and the Clarkson WRRFs are currently incinerated at the Fluidized Bed Incinerator at the G.E. Booth facility.

The main advantages of incineration are the reduction in weight and volume of dewatered solids. Another advantage is the potential for energy recovery. The disadvantage is that emissions from the incinerator may impact surrounding air quality. These impacts are mitigated by using air pollution control systems including a quenching device, wet scrubber and mercury scrubber, like those operated at the G.E. Booth facility.

The ash generated during the incineration process can be disposed of at a landfill or beneficially used. The ash, which has a bulk density higher than fly ash but lower than Portland cement can be used in the production of concrete. The ash has also been used in the production of asphalt, bricks, light weight blocks and tile. The Region is currently conducting a separate study to investigate these and other potential beneficial uses for ash, which will be considered in the Class EAs.

3.6 Thermal Dried Products

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

During drying, biosolids undergo several structural changes as the moisture content decreases. The most critical stage is called the plastic stage when the moisture content is between 40 to 60% TS. In this stage, the dried product becomes sticky and difficult to manipulate. The power input required to move the product through this phase to higher concentrations is significant. It is essential to minimize dust production or accumulation during the drying process due to the increased probability of fire or explosions, which have occurred in this process. Dust collection systems are used in multiple locations throughout the process to reduce the potential of fire or explosion.

The benefits of thermal dried products include:

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

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

A summary of selected thermal drying facilities in Canada is presented in **Table 3-2**. All the facilities identified have used a direct drying technology.

Table 3-2 Selected Thermal Drying Facilities in Canada

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

As noted in **Table 3-2** Veolia operates the drying facility on behalf of the City of Toronto. They currently produce approximately 22,000 tonnes of thermally dried product at the Ashbridges Bay WRRF annually.

Veolia representatives explained to B&V that the product, Nutri-Pel, is certified as a CFIA fertilizer product and is successfully marketed to the agriculture market. The Veolia representatives explained that they manage the material through the entire drying and product sales market stages. In the Ontario market, Veolia works with approximately 250 farmers. They work with the farmers to determine their fertilizer needs, transport the material to the farms and apply the product on the farmers' behalf. The program that Veolia has developed allows them to successfully manage all of the dried product generated at the Ashbridges Bay WRRF. In addition to the agricultural market, the City of Toronto's thermally dried product is used in the City's parks in turf grass and horticultural applications.

3.7 Compost Products

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

The high-quality product can be used as a soil conditioner or organic fertilizer supplement for the horticultural and agricultural industry. Composting requires a relatively large footprint when compared to digestion, incineration or thermal drying. Based on the characteristics of the solids generated at the G.E. Booth and Clarkson WRRFs, it is anticipated that the Region could generate a Class A Compost product. Composting, if not properly managed, can be an odour intensive process. There is a benefit to digesting the biosolids prior to initiating the composting process. Even with digested biosolids entering the process and careful operation, there will be periods of odour. It is recommended that a composting facility be sited with sufficient buffer from homes and institutions. Maintenance of a minimum temperature of 55˚C for at least three days is required to inactivate the pathogens within an aerated static pile system. Some fungi however, including Aspergillus fumigatus, can survive the composting process because they are thermotolerant organisms. Compost product must meet the Ontario quality standards and restrictions on use outlined in Section 2.2.1. In addition, compost products sold in the Canadian marketplace must meet the safety, microbial quality, efficacy, and labelling requirements in the federal FzA and FzR administered by the CFIA. See Section 2.1.2.2 for additional information.

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

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

The primary markets for compost product include use in landscaping, nursery and garden centers, golf course and park maintenance. The Region currently operates a composting program, converting organics (food and yard waste) collected from residents. Regional compost sells for approximately 3.5¢ per kg or $35 per tonne.

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

3.8 Alkaline Stabilized Product

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

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

Proprietary alkaline systems and processes are provided by suppliers such as Walker Industries (formerly N-Viro Systems Canada) and RDP Technologies, Inc. Walker Industries employs an advanced alkaline stabilization with accelerated drying. RDP Technologies offers a lime stabilization system and a pasteurization system which incorporates lime stabilization and ancillary heating to further reduce pathogens. Walker industries currently processes approximately 60,000 DT/yr of biosolids in Southern Ontario.

A list of alkaline stabilization facilities in Canada is presented in **Table 3-3**.

Table 3-3 Alkaline Stabilization Facilities for Municipal Biosolids in Canada

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

Walker Industries has registered their product as a fertilizer under the CFIA regulations. This allows them to distribute the product through agriculture marketing groups. Walker Industries explained to B&V that in addition to organics and nutrients contained in their product, the elevated pH and liming characteristics of the material are a benefit to agricultural customers. Walker Industries is currently working with enough agricultural property in southern Ontario to manage over 60,000 tonnes per year. They have had demand for all the product that they can deliver.

3.9 Thermal-Alkaline Hydrolysis

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

The thermal-alkaline hydrolysis facilities located in Ontario are presented in **Table 3-4**.

Table 3-4 Thermal-Alkaline Hydrolysis Facilities in Ontario.

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

**Standalone facility owned and operated by Lystek*

Lystek representatives explained to B&V that in 2020 they anticipate processing 130,000 tonnes at the Southgate facility, including approximately 20,000 tons that they receive from the City of Toronto. Lystek supports the operation of eleven stabilization facilities in North America. They manage the product marketing and distribution for all but one of those facilities. All of the fertilizer produced at Southgate is used within a 90-minute radius of the facility.

3.10 Manufactured Soils

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

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

4.0 Target Markets & Market Availability Assessment

4.1 Biosolids Market End Users

The biosolids products described in Section 3 can be managed in a number of manners including beneficial use, thermal reduction, landfilling and co-management with municipal solid waste. Each management option yields different potential end users, as outlined in **Table 4-1**.

Certain products, such as dewatered biosolids cake or compost products can be managed in more than one way, depending on the intended end use. The availability of end users listed in **Table 4-1**, and the markets they represent, in and around the Region are described in the following sections.

Table 4-1 Management Options and End Users for Biosolids Products

MANAGEMENT OPTIONS	BIOSOLID PROCESS AND PRODUCTS	MARKET END USERS
Beneficial Use	▪ Digested biosolids (liquid) ▪ Digested biosolids (dewatered cake) ▪ Manufactured soil material ▪ Advanced digested biosolids; liquid or cake ▪ Thermal-dried biosolids ▪ Alkaline stabilized biosolids ▪ Thermal-alkaline hydrolysis biosolids ▪ Composted biosolids products	▪ Agricultural land application ▪ Silviculture (tree farming) ▪ Horticultural market ▪ Golf courses, parks and recreation ▪ Landscaping ▪ Land rehabilitation
Thermal Reduction	▪ Incinerator residual ash disposal ▪ Incinerator residual ash use	▪ Municipal waste landfill ▪ Incorporation into cement ▪ Other ash reuse options
Landfilling	▪ Unstabilized dewatered cake ▪ Stabilized dewatered cake ▪ Compost products ▪ Thermally dried product	▪ Municipal landfill and landfill cover ▪ Monofill (dedicated landfill)
Co-management with municipal solid waste	▪ Compost products ▪ Biosolids cake (dewatered)	▪ Management with source separated organics

4.2 Agriculture, Silviculture and Horticulture

4.2.1 Market Availability

As summarized in the Region's 2016 Census of Agriculture Farm and Food Operator Data, livestock is the Region's largest agricultural sector, accounting for 43% of Peel's farms (Region of Peel, 2017). Oilseed, grain, and hay farms represent 32% of the Region's farms. Farms, woodlots and greenhouses producing flowers, maple syrup, honey, fruits, and vegetables represent another 24% of the Region's farms. The amount of land in agriculture decreased by 7% between the 2011 and 2016 census, with a total of 34,265 hectares of agricultural land owned, rented, leased or crop-shared in the Region in 2016. Of that agricultural land 27,000 hectares is dedicated to cropland and 2,800 hectares to pasture.

Christmas trees, the principal product of silviculture in the Region, are grown on only 9 hectares of land in Peel Region. In the horticultural market, farms growing nursery products represented 90 hectares of land. Neither represents a significant market when compared to overall agricultural cropland in Peel Region (OMAFRA, 2017).

The Golden Horseshoe of Ontario, comprised of the Regions of Durham, Halton, Niagara, Peel, York and the Cities of Hamilton and Toronto, is a rich agricultural area and represents a significant end user market for biosolid products. The Region of Peel is located at the center of the Golden Horseshoe, allowing easy access to agricultural end users to the east and west in the Golden Horseshoe (Figure 4-1). Currently the Golden Horseshoe has 296,000 hectares dedicated to cropland and 29,000 hectares dedicated to pasture (OMAFRA, 2017).

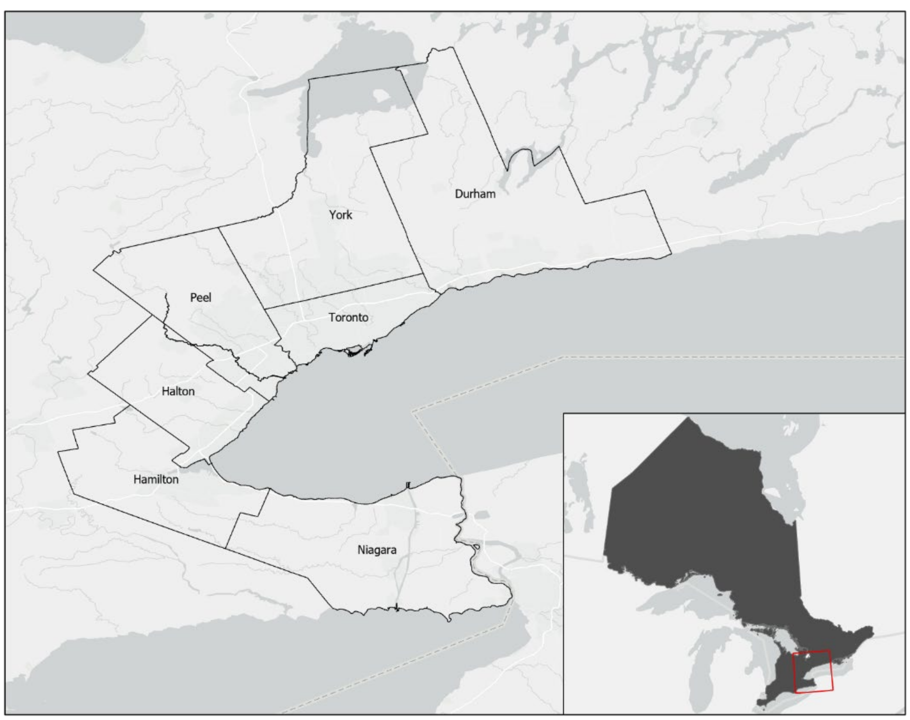

Figure 4-1 Peel Region and Surrounding Golden Horseshoe

4.2.2 Demand Assessment

Using the lower application rate of 2 DT/ha-yr, the 27,000 hectares of cropland in the Region could represent an annual demand of 54,000 DT of biosolids product. Cropland in the Golden Horseshoe, anticipating the same application rate, could represent an annual demand of 600,000 DT. Both numbers exceed the amount of biosolids produced at the Clarkson and G.E. Booth WRRFs combined, which is currently approximately 53,000 DT/yr (refer to Section 3.1). If the solids generated at the G.E. Booth WRRF were to be used in agriculture, they would need to first be stabilized, resulting in a reduction in the amount of solids to be applied.

As discussed, Veolia, Lystek and Walker Industries representatives, in conversation with B&V, all indicated that the agricultural market in southern Ontario would be able to absorb some or all biosolids produced at the two facilities. Veolia indicated that during the high season, from August to October, their agricultural market could absorb two to three times the amount of biosolids currently produced at their Toronto facility (22,000 DT/yr). Walker Industries indicated that a new facility could accommodate 10,000 - 15,000 DT/yr of solids generated at the Clarkson or G.E. Booth WRRFs. Lystek indicated that their standalone Southgate Organic Materials Recovery Centre could potentially accommodate up to an additional 80,000 DT/yr, more than are currently generated at the two WRRFs.

Although the actual demand is likely lower than the maximum demand, as a number of end users already land apply biosolids, the market should be able to accommodate some or all biosolids produced at the Clarkson and G.E. Booth WRRFs, given the volume of potential demand versus volume of biosolids produced.

4.3 Parks and Recreation Departments

4.3.1 Market Availability

In addition to agricultural use, as a result of the additional stabilization, advanced digested products, thermally dried products, and compost products could be used to supplement fertilization programs and as soil amendments to maintain outdoor recreational fields and parks in the Region. The application of any product other than Category A compost, however, would require an ECA. Parks maintained by lower-tier municipalities within the Region cover approximately 2,600 hectares of land (City of Mississauga, 2019; City of Brampton, 2017; Town of Caledon, 2010).

4.3.2 Demand Assessment

As mentioned above based on an application rate of 2 DT/ha-yr, the 2,600 hectares of parks and recreational fields in the Region could represent a maximum annual demand of 5,200 DT of product. This represents approximately 10 percent of the biosolids produced at Clarkson and G.E. Booth WRRFs combined (refer to Section 3.1), although stabilization of solids generated at the G.E. Booth WRRF would result in a reduction of solids to be applied. Exploration of parks and recreational fields as an outlet for the Region's biosolids would require further investigation and communication with the three lower-tier municipalities listed above.

4.4 Ministry of Transportation Ontario (MTO)

4.4.1 Market Availability

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

4.4.2 Demand Assessment

The Region owns and maintains 1,555 lane-kilometers (number of lanes, multiplied by their length) of road (The Region of Peel Public Works Department, Transportation Division). Over the 8-year period captured in the Region's Transportation Fact Sheet, the road network grew by only 100 lane-kilometers, with yearly growth varying from 0 to 31 lane-kilometers. Given the variability of network growth and maintenance and the relatively low demand of biosolids as feedstock for compost or blended soils, this is considered a limited market.

4.5 Landscape Contractors

4.5.1 Market Availability

Soil amendments and composts are often sold, used, or distributed by landscapers but the volumes handled vary considerably. As an ECA would be required for application of biosolids products not regulated as a fertilizer by the CFIA or classified as a Category A Compost, this is considered to be a limited market.

4.5.2 Demand Assessment

As stated above, this is considered a limited market. Veolia, Lystek and Walker Industries, who produce biosolids products meeting CFIA standards, indicated that the principal demand and market share for these products is in the agricultural market.

4.6 Golf Courses

4.6.1 Market Availability

Both thermally dried biosolids and compost are used at golf courses, with dried product used as an organic fertilizer and compost used as a top dressing that supplies nutrients to the turfgrass. Biosolids products, other than Category A compost, would require an ECA for the golf course operator to be able to apply solids to their land. Although this would add additional cost and effort to fertilization programs at Regional golf courses, it would need to be weighed against potential savings in commercial fertilizer costs. Some golf courses in neighbouring York Region use ECAs to allow beneficial reuse of reclaimed water, WRRF effluent, on golf courses.

An online search was used to identify golf courses in Peel Region, which are presented in **Table 4-2** below. Courses are both public or private and have 9 holes, 18 holes or 27 holes. On average, 27-hole courses have 135 acres of greenway, 18-hole courses have 90 acres of greenway and 9-hole courses typically have 45 acres of greenway. Altogether, 16 courses were identified within Peel Region, representing 1,400 acres or 570 hectares of greenway.

4.6.2 Demand Assessment

Using an application rate of 4 DT/ha-yr, the 570 hectares of golf courses in the Region could represent a maximum annual demand of 2,300 DT of biosolids product. This represents approximately 4 percent of the biosolids produced at Clarkson and G.E. Booth WRRFs combined (refer to Section 3.1), although stabilization of solids generated at the G.E. Booth WRRF would result in a reduction of solids to be applied. Exploration of parks and recreational fields as an outlet for the Region's biosolids would require further investigation and communication with private golf course owner or the lower tier municipalities (Mississauga and Brampton) which own and operate golf courses in the Region. Compared to the potential demand from the agricultural market, this is considered a limited market.

Table 4-2 Golf Courses in Peel Region

GOLF COURSE	SIZE	AREA (ACRES)
Glen Eagle Golf Club	27-Hole	135
Mayfield Golf Course/Club	18-Hole	90
Caledon Country Club	27-Hole	135
Turnberry Golf Club	18-Hole	90
Parkshore Golf Club	9-Hole	45
Peel Village Golf Couse (owned/operated by Brampton)	9-Hole	45
Brampton Golf Club	18-Hole	90
Lionhead Golf Club & Conference Centre	18-Hole	90
Streetsville Glen Golf Club	18-Hole	90
Derrydale Golf Course	12-Hole	68
BraeBen Golf Course (owned/operated by Mississauga)	18-Hole	90
Grand Highland Golf Club	9-Hole	45
Centennial Park Golf Centre	27-Hole	135
Markland Wood Golf Club	18-Hole	90
Lakeview Golf Course (owned/operated by Mississauga)	18-Hole	90
Credit Valley Golf and Country Club	18-Hole	90

4.7 Land Rehabilitation

4.7.1 Market Availability

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

4.7.2 Demand Assessment

Although there are a number of mines and contaminated sites in Ontario, their number within and adjacent to the Region indicate that this a limited market. The number of active federal contaminated sites in and around the Region can be seen in Figure 4-2, with fewer than 5 sites in the Region itself (Treasury Board of Canada Secretriat, 2020). There are 40 mines in Ontario, but they are all at a distance that would make hauling biosolids to tailings sites an impractical solution (refer to Figure 4-3).

Figure 4-2 Federal Contaminated Sites in and Around the Region of Peel

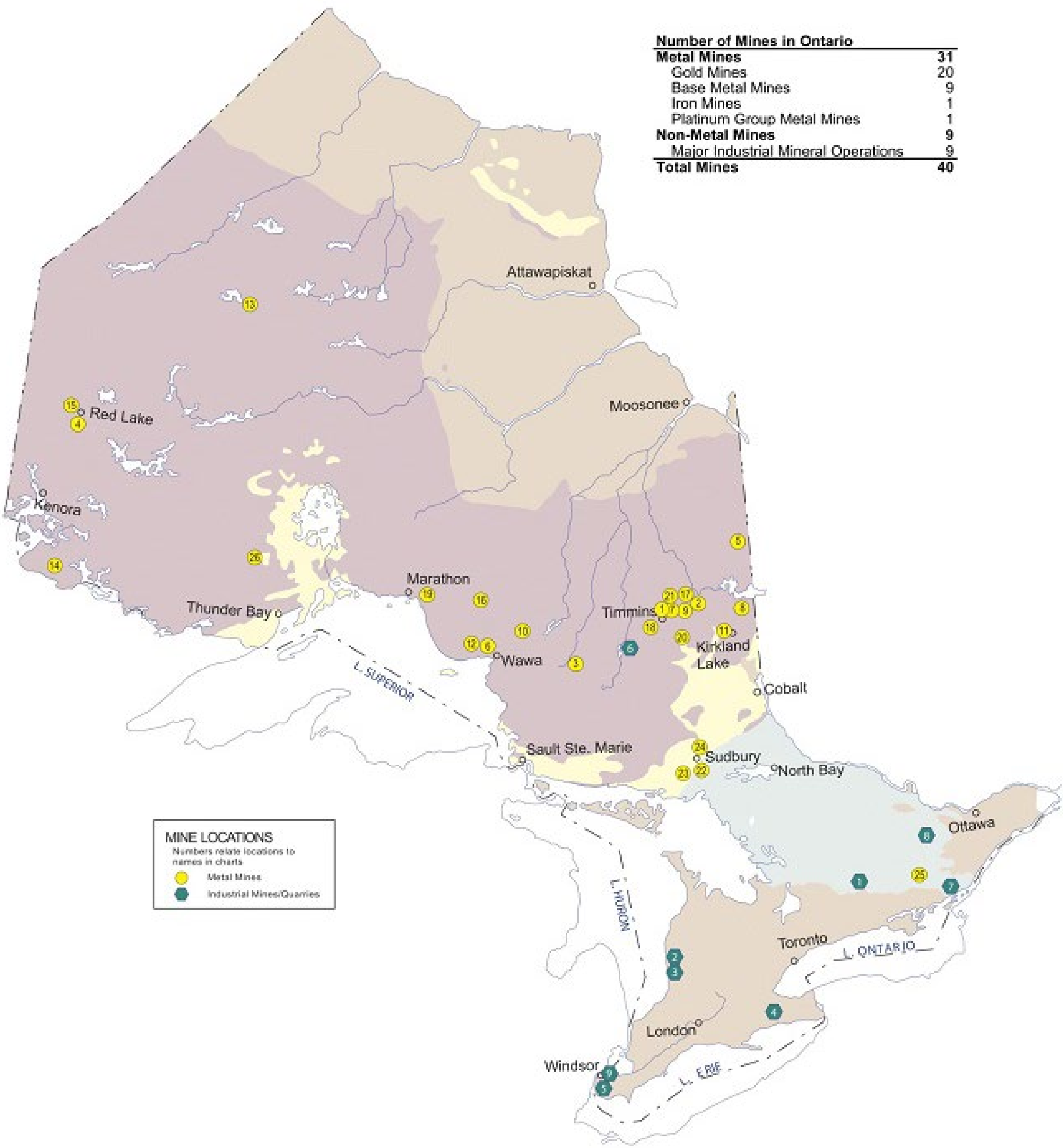

Figure 4-3 Ontario Mining Operations 2020

4.8 Landfill Sites

4.8.1 Market Availability

Currently ash produced at G.E. Booth WRRF, and dewatered biosolids cake produced at Clarkson WRRF not hauled to G.E. Booth for incineration, is transferred to landfill for disposal. Clarkson WRRF biosolids hauled to landfill from 2017-2019 totaled approximately 5,800 tonnes. Ash produced by the incinerators could be diverted for beneficial use (as discussed in Section 3.5, this is the subject of a separate, ongoing study) or continue to be landfilled. Landfills can be monofil (dedicated to only biosolids products), or co-disposal (accepting both biosolids products and municipal solid waste). Biosolids products such as compost products and their feedstock biosolids could be beneficially reused for landfill cover. As discussed in Section 3.7, Category B compost can be used as daily, intermediate cover at a landfill, as permitted by an ECA.

4.8.2 Demand Assessment

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

Based on reporting from 2012, Peel contracts with Waste Management Corporation to haul municipal waste to a landfill site in Warwick, Ontario (Brampton Guardian, 2012). The Twin Creeks Landfill underwent an Environmental Screening Process in order to amend to the ECA for the landfill in 2017. The project proposed by Waste Management Corporation increases the maximum annual fill rate to 1,400,000 tonnes, from 750,000 tonnes. The increase was proposed to allow the Twin Creeks Landfill to receive wastes historically directed to the Petrolia Landfill, scheduled to close in 2017, in addition to retaining and servicing a growing customer base (Waste Management of Canada Corporation, 2020).

The Roadmap to a Circular Economy in the Region of Peel aims to divert 75% of waste generated in the Region from landfill (Region of Peel, n.d.). This aligns with the provincial framework for waste management as set out in the Waste-Free Ontario Act, 2016 and the Strategy for a Waste-Free Ontario, 2017. Although there is capacity for landfilling of biosolids, decreasing capacity and the Region's goal to move away from landfilling as a solution, make this a less favourable outlet than the beneficial uses outlined in the above sections.

4.9 Co-Management with Source Separated Organics (SSO)

4.9.1 Market Availability

As discussed in Section 3.7, the Region currently operates a composting program, converting organics (food and yard waste) collected from residents. Peel Region has two existing composting facilities, the Peel Integrated Waste Management Facility (PIWMF) in Brampton and a smaller facility in Caledon. Both have been used to treat Source Separated Organics (SSO) - PIWMF since 2007, and Caledon since 1995. Together the facilities process approximately 80,000 tonnes of SSO annually, roughly half food and half yard waste (Canadian Biogas Association). Regional compost is sold for 3.5¢ per kg or $35 per tonne and has been successfully marketed to residents, farmers, soil blenders, Filtrex applications, and nurseries.

As part of the Region's Roadmap to a Circular Economy in the Region of Peel an Anaerobic Digestion Facility is planned, with the ability to process 120,000 tonnes of organic material per year, with the possibility for expansion. The facility will allow the Region to add disposal of diapers and pet waste to its green bin (SSO) program and increase diversion by 5% (The Regional Municipality of Peel, 2019).

4.9.2 Demand Assessment

As detailed in Section 3.7, compost Categories A and B allow municipal wastewater biosolids to be used as feedstocks up to 25%. Category A compost is exempt from the need for approvals, provided that it meets quality standards, while Category B compost can be land applied as a NASM (agricultural land) or through an ECA (non-agricultural land). In the case of the planned Anaerobic Digestion Facility, products would not be covered under Ontario's compost quality standards and guidelines, as they only apply to compost produced by aerobic composting of organic materials. Products of the facility could meet CFIA requirement to be sold as fertilizer.

Neither the existing composting facilities, nor the planned Anaerobic Digestion Facility, were, or are, being designed to accommodate biosolids from G.E. Booth and Clarkson WRRFs. Although it is technically feasible to co-manage biosolids with SSO through composting and/or anaerobic digestion, these facilities would not have the capacity to absorb biosolids from the two WRRFs.

4.10 Summary and Recommendation

Of the target markets discussed in the sections above, application of biosolids products to agricultural land represents the greatest potential market. Within the Region, agricultural land accounts for over ten times the area associated with parks and recreational facilities, and almost fifty times the area available on golf courses (see **Table 4-3**). Given that other target markets discussed in the sections above offer a limited market, impractical solutions, or insufficient ability to meet demand, the recommended market to explore, going forward, is the agricultural market for biosolids products in and around the Region.

Table 4-3 Biosolid Products Target Markets in Peel and Golden Horseshoe

OUTLET	PEEL REGION		GOLDEN HORSESHOE	
	LAND AREA (HECTARES)	ANNUAL MAXIMUM POTENTIAL DEMAND (DT/YR)	LAND AREA (HECTARES)	ANNUAL MAXIMUM POTENTIAL DEMAND (DT/YR)
Agriculture	27,000	54,000	296,000	600,000
Parks & Rec. Dept.	2,600	5,200		
Golf Courses	570	1,100		
TOTAL	**30,170**	**60,300**	**296,000**	**600,000**

5.0 Market Considerations for Peel

5.1 Recommended Target Markets/Outlets

As summarized in Section 4.10, the greatest potential market for biosolids products in and around the Region is the agricultural market. Biosolids products can serve to fertilize soils, increase soil organic matter, and amend soil pH, in the case of biosolids products such as alkaline stabilized and thermal-alkaline hydrolyzed products. Outlets for biosolids products in the agricultural market include land application of biosolids as a Category 3 NASM or as a biosolids product meeting CFIA fertilizer requirements (refer to Sections 2.1.2.1 and 2.1.1.2, respectively). Beneficial use options for incinerator ash are also being explored, with landfill being considered only if beneficial use options are not available.

In summary, the three potential target markets/outlets for biosolids products recommended for consideration under the Schedule 'C' Class EAs of the South Peel WRRFs are:

- Land application of dewatered, anaerobically digested biosolids.
- Soil amendment with fertilizers (biosolids products) meeting CFIA requirements.
- Beneficial use of ash and, or landfilling, based on the results of the study being conducted concurrently with this TM (see Section 3.5).

Further considerations for each market/outlet are outlined in Sections 5.2 to 5.5 below.

5.2 Product Distribution

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

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

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

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

A third-party could operate a biosolids processing facility off-site, or on-site at a Regional WRRF. An example of an off-site facility is the Lystek Southgate Organic Materials Recovery Centre, which processes biosolids from neighbouring municipalities. Lystek explained during a conversation with B&V, that they have the ability to accommodate a portion of the biosolids generated by the Region. An example of an on-site facility would be Veolia's operation of the thermal drying facility at the Ashbridges Bay Treatment Plant (ABTP) for the City of Toronto. In both cases the third-party operates the biosolids process facility under contract with the municipality producing the biosolids, and is responsible for marketing, sales, transport, and storage of biosolids products as well as management of the customer base.

5.3 Market Competition

A biosolids product that is produced at Clarkson and/or G.E. Booth WRRF would need to compete with other fertilizing and liming products in the marketplace, including other biosolids products and commercial fertilizers used in and around the Region.

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

- In **York and Durham Regions,** the majority of biosolids produced by the wastewater treatment facilities are transferred to Duffin Creek Water Pollution Control Plant (WPCP) for incineration (Durham Region, 2018; Durham Region, 2019; York Region, 2014). The ash from the incineration process is beneficially used to create cement products (Durham Region, 2019). In 2019 only two WPCPs in the Regions produced biosolids for land application to agricultural fields. Corbett Creek WPCP produced 37,514 m^3 of anaerobically digested sludge which was transferred to a holding facility for storage, before being land applied to agricultural fields (Durham Region, 2019). The Courtice WPCP produced 33,342 m^3 of anaerobically digested sludge which was also transferred to a holding facility for storage before being land applied to agricultural fields (Durham Region, 2019).
- **Halton Region's** seven wastewater treatment facilities (WWTF) produce over 35,000 wet tonnes of biosolids per year. Solids are anaerobically digested and dewatered. A Biosolids Management Centre (BMC) provides storage for liquid biosolids prior to land application (Halton Region, 2020). The Halton Region's Biosolids Master Plan indicated that Halton's biosolids are increasingly being land applied outside of the Region as the land available to receive biosolids within Halton Region declines. It estimated that by 2021 Halton's WWTFs will produce 278,546 m^3 of anaerobically digested liquid biosolids and 32,937 wet tonnes of anaerobically digested, dewatered biosolids per year. The Master Plan recommended investigation of other outlets including composting to enhance Halton's land application program and incineration (XCG Consultants Ltd, 2012; Halton Region, 2016).The Region of Halton is currently investigating potential sites for a composting facility.

- Approximately half of **Niagara Region's** biosolids are land applied to local agricultural fields as a liquid (Niagara Region, n.d.). The remaining biosolids are dewatered and transported to Walker Industries' N-Viro Biosolids Facility, in Thorold, Niagara Region, for processing (Niagara Region, n.d.; Gun, 2015). In 2015 the facility was producing approximately 33,000 wet tons (30,000 wet tonnes) of alkaline stabilized biosolids product per day. They were able to market the material for $10/ton. The facility was receiving between 100 and 165 tons every weekday of which approximately 85 percent was from Niagara Region and the balance from the City of Toronto (Gun, 2015; Houle, 2015).
- The **City of Hamilton's** new Biosolids Management Process began operations in May 2020. It can process up to 60,000 wet tonnes of wastewater biosolids annually and produces a thermal-dried biosolids product meeting the requirements of the CFIA (City of Hamilton, 2020). Currently Hamilton's wastewater treatment produces approximately 43,000 wet tonnes of anaerobically digested and dewatered biosolids per year. It is estimated that thermal drying will reduce the volume of the biosolids product by approximately 75 percent (Moro, 2020).
- The **City of Toronto** thermal dries about half of all biosolids produced, land applies about a quarter of biosolids produced and alkaline stabilizes or thermal-alkaline stabilizes the remaining quarter (City of Toronto, n.d.). In 2019 28,641 wet tonnes of the biosolids produced at the ABTP were land-applied and 7,731 wet tonnes were used at mine reclamation sites. A total of 34,494 wet tonnes were transported off-site, for alkaline stabilization and thermal-alkaline stabilization. (Toronto Water, 2020). As discussed in Section 3.6, Veolia operates a thermal drying facility at ABTP, producing approximately 22,000 DT/yr of thermal dried product; in 2019 83,970 wet tonnes of biosolids were processed by the thermal drying facility (Toronto Water, 2020). All the wastewater solids generated at Humber WRRF and North Toronto WRRF are transferred to ABTP for processing, making up part of the biosolids produced (Toronto Water, 2020; Toronto Water). Dewatered biosolids produced at Highland Creek WRRF are incinerated at the plant, producing an ash that is stored in two ash lagoons. When a lagoon is full, ash is removed and hauled to landfill for final disposal (Toronto Water, 2020).

The different units (m^3, DT, wet tonnes, tonnes) used to report generated biosolids products across different municipalities make it difficult to calculate the exact number of biosolid products being land-applied or used to amend agricultural land in the Golden Horseshoe. To produce a high-level estimate of biosolids produced and applied to agricultural land in the Golden Horseshoe, the following assumptions were made:

Anaerobically digested biosolids produced at Corbett, Courtice Creek WPCPs and Halton's wastewater treatment facilities are assumed to have a density of approximately 1000 kg/m^3 and 3% TS concentration.

Anaerobically digested and dewatered biosolids produced at Halton Region, Niagara Region, Hamilton and Toronto's wastewater treatment facilities were assumed to have a 20-25 % TS concentration. TS concentration of 25 %was used to produce a high-level estimate. The biosolids processed at Walker Industries' Niagara facility, reported as tons or tonnes, were anticipated to be wet tonnes, confirmed during a conversation with Walker Industries'. Walker Industries' processes approximately 30,000 wet tonnes per year at its facility, of which 85%, or 25,500 wet tonnes, are sourced from Niagara Region and 15%, or 4,500 wet tonnes, are sourced from Toronto. By this estimate, an additional 25,500 wet tonnes of Niagara Region biosolids are liquid land applied, as the biosolids processed at Walker's facility represent half of Niagara Region's biosolids.

The resulting biosolids quantities and outlets to which they are directed are summarized in **Table 5-1**.

Table 5-1 Biosolids Products and Outlets in the Golden Horseshoe

MUNICIPALITIES IN GOLDEN HORSESHOE	BIOSOLIDS PRODUCTS GENERATED APPROXIMATE (DT/YR)	BIOSOLIDS PRODUCT	OUTLET
Durham Region	2,126	Anaerobically Digested	Land applied (liquid)
Halton Region	8,356	Anaerobically Digested	Land applied (liquid)
	8,234	Anaerobically Digested and Dewatered	Land applied (cake)
Niagara Region	6,375	Anaerobically Digested	Land applied (liquid)
	6,375	Alkaline Stabilized	Soil amendment (fertilizer)
City of Hamilton	10,750	Thermal Dried	Soil amendment (fertilizer)
City of Toronto	7,160	Anaerobically Digested and Dewatered	Land applied (cake)
	1,933	Anaerobically Digested and Dewatered	Land rehabilitation (mine site)
	8,624	Alkaline Stabilized or Thermal-Alkaline Stabilized	Soil amendment (fertilizer)
	20,993	Thermal Dried	Soil amendment (fertilizer)
Total	**80,925**		

The high-level estimate in **Table 5-1** indicates that approximately 81,000 DT/yr of biosolids products with potential for land application or use as soil amendment are currently produced in the Golden Horseshoe. This figure is significantly less than the estimated 600,000 DT/yr potential demand for biosolids products from the agriculture community within the Golden Horseshoe as described in Section 4.2.2. The fertilizer demand that is not met with biosolids is met using commercial fertilizers and application of other NASM, such as manure. According to the 2016 Census figures, commercial fertilizer was used on 56 percent of all agricultural land (total agricultural land was 380,000 ha, including 296,000 ha of cropland), lime was used on 3.5% of all agricultural land and solid or composted manure was used on 2.4% of all agricultural land in the Golden Horseshoe (OMAFRA, 2017). Anticipating that these products reduce the potential demand by approximately 50 percent, the remaining demand (592,000 DT/yr) still exceeds biosolids production in the Golden Horseshoe. This aligns with Veolia, Lystek and Walker Industries' indication in Section 4.2.2, that the agricultural market in southern Ontario would be able to use all biosolids produced at the G.E. Booth and Clarkson WRRFs, even with existing market competition taken into account.

5.4 Seasonality and Storage

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

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

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

Given the space constraints at G.E. Booth WRRF there would exist limited opportunities for storage of biosolids products on site, apart from the existing storage for incinerator ash. There may be some opportunity to store biosolids at the less space constrained Clarkson WRRF.

5.5 Transportation

The cost of transporting biosolids products varies and is dependent on solids concentration of the product being transported, the transportation mode and hauling distance. Fuel, labour and permitting costs would be the direct responsibility of either the Region or the third-party vendor depending on the product distribution model adapted. Per Section 2.1.2.1 hauling biosolids products may require an ECA or EASR registration. Third-party biosolids processors and vendors indicated that in Ontario, due to market demand, biosolids products are typically not transported more than two to three hours from their point of origin. To maintain cost effectiveness, it is assumed biosolids products generated in the Region would likely adhere to the same constraints.

6.0 Summary

The biosolids currently produced at the Clarkson WRRF meet CFIA, NASM Category 3 CM1 and Category A & B feedstock metals limits. With anaerobic digestion, the Clarkson WRRF biosolids meet CP2 limits for faecal coliform and could meet the CP1 and CFIA limits with further processing. It is anticipated that the biosolids characteristics are similar at G.E. Booth WRRF. There appears to be no regulatory issues that would prevent biosolids products from either WRRF entering the target markets discussed in this TM.

The greatest target market availability is found in agricultural cropland. It is anticipated that this market represents a biosolid demand much higher than the biosolids quantity currently produced at Clarkson and G.E. Booth WRRFs combined. Conversations with third-party operators and vendors indicate that the biosolids market in Southern Ontario would be able to absorb some, if not all, biosolids produced at the two WRRFs.

The information presented in this TM will be used to establish biosolids management alternatives at each of the WRRFs. As a next step, alternatives for processing and utilizing biosolids will be further assessed, taking into considered product markets, distribution, storage, and transportation.

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Region of Peel

Appendix A

Biosolids Characteristics

Table A-1 Biosolids and Sludge Analysis Values

			CFIA				NASM			Ontario Compost				Sludge Analysis Values 2020						
Parameter	Maximum acceptable cumulative metals addition to soil over 45 years (kg/ha)	Examples of maximum acceptable product metal concentration based on annual application rates (mg/kg) 4,400 kg/ha-yr	Examples of maximum acceptable product metal concentration based on annual application rates (mg/kg) 2.000 kg/ha-yr	Examples of maximum acceptable product metal concentration based on annual application rates (mg/kg) 500 kg/ha-yr	Pathogen Level	Pathogen Minimum detection limit	CM1 Concentration in non-aqueous material (containing 1% or more total solids, wet weight), expressed as mg per kg of total solids, dry weight / CP1 Standards	CM2 Concentration in non-aqueous material (containing 1% or more total solids, wet weight), expressed as mg per kg of total solids, dry weight / CP2 Standards	Maximum addition to soil (in kilograms of regulated metal per hectare/per five years)	Maximum concentration in soil (in milligrams per kilogram of soil, dry weight)	Plant Available Nitrogen (12 Month Period) KG/HA	Plant Available Phosphate (5 Year Period + Phosphorus Removed by Crop Harvesting) KG/HA	Category A Compost (mg/kg dry weight)	Category B Compost (mg/kg dry weight)	Feed for Categories A & B Compost (mg/kg dry weight)	Clarkson Average 2020 Sludge Cake NASM Analysis Values (mg/kg)	GE Booth Average 2020 Sludge Cake Analysis Values (mg/kg)	Clarkson assuming an application rate of 4 DT/ha/yr Over 12 Months (kg/ha)	Clarkson assuming an application rate of 4 DT/ha/yr Over 5 Years (kg/ha)	Clarkson assuming an application rate of 4 DT/ha/yr Over 45 Years (kg/ha)
Arsenic (As)	15	75	166	666			13	170	1.4	14			13	75	170	0.30		0.0012	0.006	0.05
Cadmium (Cd)	4	20	44	177			3	34	0.27	1.6			3	20	34	0.04		0.0002	0.0009	0.008
Chromium (Cr)	210	1,060	2,333	9,333			210	2,800	23.3	120			210	1060	2800	3.4		0.014	0.069	0.62
Cobalt (Co)	30	151	333	1,333			34	340	2.7	20			34	150	340	0.2		0.0006	0.0032	0.03
Copper (Cu)	150	757	1,666	6,666			100	1,700	13.6	100			400	760	1700	31		0.12	0.62	5.5
Mercury (Hg)	1	5	11	44			0.8	11	0.09	0.5			0.8	5	11	0.1	0.1	0.00022	0.0011	0.01
Molybdenum (Mo)	4	20	44	177			5	94	0.8	4			5	20	94	0.4		0.0017	0.0087	0.08
Nickel (Ni)	36	181	400	1,600			62	420	3.56	32			62	180	420	1.1		0.0042	0.021	0.19
Lead (Pb)	100	505	1,111	4,444			150	1,100	9	60			150	500	1100	0.8		0.0031	0.0154	0.14
Selenium (Se)	2.8	14	31	124			2	34	0.27	1.6			2	14	34	0.1		0.0006	0.0028	0.03
Thallium (Tl)	1	5	11	44														-	-	-
Vanadium (V)	130	656	1,444	5,777														-	-	-
Zinc (Z)	370	1,868	4,111	16,444			500	4,200	33	220			700	1850	38	25		0.10	0.50	4.52
Salmonella					Not Detectable	< 1 CFU / 25 grams	< 3 CFU or MPN/4g						3 MPN /4 g total solids	3 MPN /4 g total solids						
Faecal Coliforms					<1000 MPN / gram	< 2 CFU / gram	E. coli ≤1,000 CFU/g dry weight	E.coli < 2x10^{6} CFU/g dry weight					1,000 CFU or MPN E.coli/g total solids	1,000 CFU or MPN E.coli/g total solids		5945 CFU/g				
Nitrogen											200					3308	(Total Kjeldahl Nitrogen)	13	66	595
Phosphorus												390				1527	(Total Phosphorus)	6.1	31	275

Appendix K:

Phase 3 Detailed Evaluation Criteria

K1: Evaluation Criteria for Wastewater and Sludge/Biosolids Design Concepts

Table K1-1. Detailed Evaluation for Assessing Alternative Wastewater and Sludge/Biosolids Design Concepts (Natural Environment)

Comparative Criteria	Criteria Description	Source of Information for Assessing Alternative Design Concepts
Terrestrial System	Potential for alternative to impact terrestrial habitats or systems, including terrestrial features/functions (ANSIs, ESAs), unique vegetation species, mature trees, existing park/open spaces, linkages, or wildlife.	Sensitive terrestrial area impacted by alternative design concept as identified in the **Section 6.1** and **Volume 2 Appendix A1** (Natural Heritage Characterization Report).
Aquatic System	Potential of the alternative to impact aquatic habitats or systems, including possible impacts on aquatic life and species at risk features / functions.	Sensitive Aquatic Habitat area impacted by alternative design concept as identified in the **Section 6.1** and **Volume 2 Appendix A1** (Natural Heritage Characterization Report).
Surface Water Quality and Source Water Protection	Potential of the alternative to impact surface water quality and support the Region's Source Water Protection Program.	Impact of the alternative design concept to Lake Ontario Water Quality, including the potential from stormwater runoff from the site, as well as the ability to meet Provincial Water Quality Objectives (PWQOs). Information sources for identifying potential impacts are included in **Section 6.1** and **Volume 2 Appendix B** (Receiving Water Impact Assessment).
Groundwater Water Quality and Quantity	Potential of the alternative to impact the quality and quantity of groundwater.	Potential impacts of alternative design concept on existing groundwater quality and quantity as identified in the **Section 6.1** and **Section 6.3** and in **Volume 2 Appendix F** (Hydrogeological and Geotechnical Background Information).
Air Quality	Potential of the alternative to minimize increases in air emissions.	Potential impacts of alternative design concept on air quality based on information in **Section 6.2**, engineering expertise on air emission controls that will be implemented as part of all design concept alternatives, further information provided in **Volume 2 Appendix C** (Air Quality Impact Assessment).
Greenhouse Gas (GHG) Emissions	The ability of the alternative to support Peel's Climate Change Master Plan's goals with respect to energy efficiency and GHG emission reductions.	A detailed evaluation of GHG emissions was completed considering the following GHG Emission Scopes: • Scope 1 corresponds to direct emissions from owned or controlled sources at the WRRF. • Scope 2 represents indirect emissions resulting from purchased electricity, heating and cooling used at the plant. • Scope 3 corresponds to all other indirect emissions related to materials and goods required at the facility (e.g., chemicals, equipment, etc.) across their supply chain. While Scope 1 and 2 emissions can be readily quantified, Scope 3 emissions are difficult to quantify and there is limited consensus on the standard approach to assessing them. For the purposes of this evaluation, the evaluation of overall GHG emissions is based on quantitative estimates of Scope 1 and 2 emissions in terms of tonnes CO_2 equivalent/year (eq/yr) and a qualitative/relative assessment of Scope 3 emissions. An alternative's impact in terms of Scope 1 and 2 emissions is assigned 75% of the overall score for GHG emissions, while Scope 3 emissions are assigned 25% of the score. Information on climate change impacts provided in **Section 6.4** was used to support the evaluation.

Table K1-2. Detailed Evaluation for Assessing Alternative Wastewater and Sludge/Biosolids Design Concepts (Social/Cultural Environment)

Comparative Criteria	Criteria Description	Source of Information for Assessing Alternative Design Concepts
Odour	The potential of the alternative to produce odour (post-construction).	Potential impacts of alternative design concept on air quality based on information in Section 6.2, engineering expertise on air emission controls that will be implemented as part of all design concept alternatives, and Volume 2 Appendix C (Air Quality Impact Assessment).
Noise / Vibrations	The potential of the alternative to produce noise/vibrations (post-construction).	Potential impacts of alternative design concept on noise/vibration levels based on information in Section 6.2, engineering expertise on noise/vibration controls that will be implemented as part of all design concept alternatives, and Volume 2 Appendix D (Acoustic Assessment Report).
Visual / Aesthetics	The potential of the alternative to impact the scenic attributes of the community and surrounding areas.	Potential to impact scenic attributes is based on inventory of surrounding land uses presented in Section 6.2, and planning/engineering expertise on landscape/design measures to be implemented as part of all design concept alternatives.
Truck Traffic / Transportation System	The potential of the alternative to increase truck traffic and demands on the transportation system.	Impacts identified based on changes to existing number of trucks coming to and from the G.E. Booth WRRF on a daily basis, and surrounding transportation network. Information sources include Section 6.2, future biosolids quantities, and engineering expertise on number of trucks required under each alternative design concept.
Disruption During Construction	The potential of the alternative to impact surrounding landowners and users, including disruption to traffic and parking, noise, and odour generation, parks, and greenspace impacts.	Potential disruptions during construction are based on the inventory of surrounding land uses as identified in Section 6.2, and engineering expertise on construction methods needed to implement the alternative design concepts, and the associated schedule for construction.
Property Acquisition and Easement	The potential of the alternative to require additional property acquisition and/or an easement.	Potential impacts of alternative design concepts on the requirements for additional property and/or easement acquisition based on information in Section 6.2.
Recreational Use and Users	The potential for the alternative to impact surrounding recreational uses including both land and water uses.	Potential impacts to recreational users based on an inventory of recreational uses and users identified in Section 6.1 and Section 6.2, and Volume 2 Appendix B (Receiving Water Impact Assessment).
Residential Land Uses and Users	The potential for the outfall alternative to impact surrounding residential uses including both land and water uses.	Potential impacts to residential users based on an inventory of existing and potential future (i.e., Lakeview development) residential uses and users identified in Section 6.1 and Section 6.2, and Volume 2 Appendix B (Receiving Water Impact Assessment).
Agricultural Use and Users	The potential of the alternative to impact the agricultural productivity (i.e., ability to improve quality of soil and yields).	There are no agricultural land uses in the vicinity of either the G.E. Booth WRRF or the Clarkson WRRF, so there will be no impacts to agricultural lands as a result of the expansions of the facilities themselves. However, a major end use for biosolids has been identified as agricultural lands. The impacts on agricultural lands consider the implications of biosolids use on agricultural productivity and is based on the quality of the biosolids product.
Human Health and Well Being	The potential for the alternative to impact human health and well-being.	Potential impacts to human health and safety based on an inventory of recreational uses and users identified in Section 6.2, and engineering expertise on operations.
Existing and Future Adjacent Land Use Compatibility	The extent to which the alternative fits in with the existing land and future planned land uses in the area.	Impacts on existing and future land use compatibility based on information presented in Section 6.2.
Archaeology / Cultural Heritage	The potential of alternative to impact any archaeological sites and/or significant cultural heritage sites or buildings.	Potential impacts of alternative design concept on archaeological potential and/or known cultural heritage sites or buildings as identified in the Section 6.2 and in Volume 2 Appendix E (Stage 1 and 2 Archaeological Assessment Reports).
Source Water Protection (IPZs)	The potential for the outfall alternative to impact IPZs.	Potential impacts on the IPZs of the A.P. Kennedy and R.L. Clark WTPs in terms of impacting the current direction will be considered as the predominant current direction relative to the diffuser pipe alignment will affect effective mixing as identified in Volume 2 Appendix B (Receiving Water Impact Assessment).
Shoreline and Water Uses and Users	The potential for the outfall alternative to impact shoreline users and water uses.	The potential for the alternative location of the outfall to impact shoreline and lake recreational users as identified in Volume 2 Appendix B (Receiving Water Impact Assessment).
Marine Archeological Resources	The potential for the alternative location to impact marine archaeological resources.	The potential for the alternative location to impact marine archaeological resources as identified in Volume 2 Appendix E3 (Marine Archaeological Assessment)

Table K1-3. Detailed Evaluation for Assessing Alternative Wastewater and Sludge/Biosolids Design Concepts (Technical Considerations)

Comparative Criteria	Criteria Description	Source of Information for Assessing Alternative Design Concepts
Effectiveness	The effectiveness of the alternative to meet performance and product quality criteria within the planning period.	Measured based on existing system and future needs as identified in Section 4.0 and Section 5.0, and information presented in Volume 2 Appendix B (Receiving Water Impact Assessment), and engineering expertise on wastewater treatment and biosolids management.
Long-term Sustainability	The ability of the alternative to meet current needs, while not compromising the ability to meet future needs and market demands (i.e., the ability of the alternative to provide sustainable treatment and end use markets through the planning period and reduce risks to the Region.)	Measured based on existing system and future needs as identified in Section 4.0 and Section 5.0, the environmental inventories (Section 6.0), information presented in Volume 2 Appendix B (Receiving Water Impact Assessment) and Volume 3 Appendix K (Biosolids Product Market Assessment), and engineering expertise on wastewater treatment and biosolids management.
Ease of Operation	The alternative's relative complexity as it relates to operation and maintenance of the Region's wastewater treatment system.	Measured based on information in Section 4.0 and Section 5.0 on the treatment needs and processes, and engineering expertise on operations.
Ease of Implementation	The alternative's relative ease at which it can be implemented considering constructability, regulatory, and public acceptability factors.	Measured based on information in Section 4.0 and Section 5.0 on the treatment needs and processes, environmental inventory information (Section 6.0) and engineering expertise on operations.
Constructability	The potential for the alternative to involve constructability challenges given its configuration, location, and size.	Measured based on information in Section 5.0 on the existing wastewater treatment and biosolids management systems at the G.E. Booth WRRF.
Ability to Connect to Existing Infrastructure	The relative ease through which each outfall alternative can be connected to existing infrastructure.	Measured based on information in Section 5.0 on the existing wastewater treatment system at the G.E. Booth WRRF.
Resiliency	The ability to adapt to abrupt changes in the environment and emergency situations (i.e., the alternative has system redundancy during regular and emergency situations).	Measured based on information in Section 4.0 and Section 5.0 on the treatment needs and processes, environmental inventory information (Section 6.0) and engineering expertise on operations.
Compatibility with Existing Infrastructure System	The ability for the alternative to be compatible and easily implemented within the existing plant site and its infrastructure.	Measured based on information in Section 4.0 and Section 5.0 on the treatment needs and processes, environmental inventory information (Section 6.0), and engineering expertise on operations and the potential impacts of the alternative design concepts.
Geotechnical and Hydrogeology	The extent of potential geotechnical challenges and impact to hydrogeology as related to the infrastructure during and post construction.	Potential impacts of alternative design concept on geotechnical and hydrogeology as identified in Section 6.3 and in Volume 2 Appendix F (Hydrogeological and Geotechnical Background Information).
Contaminated Soils	The potential of the alternative to encounter contaminated soils during construction and/or operation.	Potential impacts of alternative design concept on contaminated soils as identified in Section 6.3 and in Volume 2 Appendix G (Phase 1 Environmental Site Assessment).
Energy Use and Recovery	The ability of the alternative to include energy efficient technologies, reduce overall energy requirements, and potentially result in energy recovery.	Energy use estimates (kWh) and energy production potential (kW3) of each alternative is estimated for comparison purposes.
Climate Change Adaptability	The ability of the alternative to adapt to climate change impacts (i.e., wet weather flow, severe events, higher lake levels).	Potential for alternative design concept to adapt to the climate change impacts as identified in Section 6.4, and engineering expertise on potential impacts of the alternative design concepts.
Permits and Approvals	Ease of receiving permits and approvals, including the required agency approvals.	Based on the permits and approvals required as identified in Section 3.0, information presented in and planning expertise on the ease and schedule of receiving the approvals and permits.
Water depths (Bathymetry)	The potential for the alignment of the outfall to reach deeper waters more efficiently to reduce outfall pipe length.	Based on the bathymetry of the lakebed as identified in Volume 2 Appendix B (Receiving Water Impact Assessment).
Diffuser Effectiveness	The relative effectiveness of the diffuser based on the alternative outfall alignment.	Effectiveness of the diffuser is based on the direction and velocity of predominant currents which influences effluent plume movement and dilution. Preference is for higher current velocity and directions that are perpendicular to the diffuser pipe as identified in Volume 2 Appendix B (Receiving Water Impact Assessment).

Table K1-4. Detailed Evaluation for Assessing Alternative Wastewater and Sludge/Biosolids Design Concepts (Economic Considerations)

Comparative Criteria	Criteria Description	Source of Information for Assessing Alternative Design Concepts
Capital Cost	Capital costs estimates to provide a relative comparison of alternatives.	Capital costs are derived using benchmark costing from other large facility expansion projects. They represent the capital costs required to increase design flows capacity from 518 MLD to 550 MLD for the G.E. Booth WRRF (planning level estimates for comparison purposes).
Operating and Maintenance (O&M) Costs	Operating Costs	O&M costs are derived from existing O&M costs and benchmark costing from other large facilities using similar processes. Operating costs are based on the projected future average day design flows over the 30-year planning horizon (planning level estimates for comparison purposes).
Life-Cycle Costs	Life-cycle costs (30-year) to provide a relative comparison of alternatives.	Life cycle costs are calculated based on a 30-year life expectancy, with a 3% inflation rate and 3% discount rate (planning level estimates for comparison purposes).

Appendix K:

Phase 3 Detailed Evaluation Criteria

K2: Evaluation Criteria for Outfall Shaft Location and Alignment

Table K2-1. Phase 3 Detailed Evaluation Criteria for Assessing Alternative Shaft Locations

Criteria Category	Criteria	Description
Natural Environment	Terrestrial habitats and species	The potential for the alternative location to impact surrounding natural terrestrial habitats and species.
	Aquatic habitats and species	The potential for the alternative location to impact aquatic habitats and species.
Social and Cultural Environment	Recreational Uses and Users	The potential for the alternative location to disrupt recreational users and uses of JTLCA, trails, lakeshore during and post construction.
	Residential Land Uses and Users	The potential for the alternative location to impact the planned Lakeview Development and other surrounding landowners during and post construction.
	Archaeological and Cultural Heritage Resources	The potential for the alternative location to impact the archaeological or cultural heritage resources.
Technical	Ease of Implementation	The ability to coordinate construction with other infrastructure works, including removal of the ash lagoons, construction of JTLCA, construction of other works (i.e., conduits, facilities) on the plant site, and the District Energy Centre.
	Constructability	Constructability refers to the complexity of the construction process itself. In this case, for shaft and tunnel launch, constructability is heavily governed by existing geotechnical conditions, but is also affected by water table depth and distance to Lake Ontario.
	Ability to connect to existing Infrastructure	This criterion considers ability of an alternative location to connect to existing Plants 1, 2, and 3 as well as potential for future expansions and connections to the future District Energy Centre. (Shorter overall distances and central location would be preferable.
Economic	Cost and Schedule	This criterion takes into consideration the different requirements to develop the site and to construct the shaft, the shaft connections, and the new outfall tunnel, and includes cost and schedule requirements associated with more onerous site staging needs, site reclamation, and other factors.

Table K2-2. Phase 3 Detailed Evaluation Criteria for Assessing Alternative Outfall Alignments

Criteria Category	Criteria	Description
Natural Environment	Aquatic habitats and species	Potential impacts of constructing the outfall on water aquatic habitats and species.
	Water quality	Potential impacts of constructing the outfall on water quality.
Social and Cultural Environment	Source Water Protection (IPZs)	The potential impacts on A.P. Kennedy and R.L. Clark WTPs IPZs (Intake Protection Zones) in terms of impacting the current direction will be considered as the predominant current direction relative to the diffuser pipe alignment will affect effective mixing, with preference for the diffuser pipe to be perpendicular to predominant currents.
	Shoreline and Water Uses and Users	The potential for the alternative location to impact shoreline and lake recreational uses. As noted above, current direction will be considered.
	Marine Archaeological Resources	The potential for the alternative location to impact marine archaeological resources.
Technical	Geotechnical Conditions	Potential impacts of the alternative on geotechnical conditions; ease of which the alternative can be constructed in the bedrock using tunneling techniques. Preference will be given towards known geotechnical conditions that have little weathered bedrock and shallower sound bedrock.
	Water depths (Bathymetry)	The ability to reach deeper waters more efficiently to reduce outfall pipe length. Measured based on the bathymetry of the lake bottom.
	Diffuser Effectiveness	Effectiveness of the diffuser based on the direction and velocity of predominant currents influence effluent plume movement and dilution. Preference is for higher current velocity and directions that are perpendicular to the diffuser pipe.
Economic	Costs and Schedule	The potential capital costs of the alternative relative to other alternatives, based on outfall/diffuser length.

Appendix L:

Disinfection Alternatives

L1: Screening of Disinfection Technologies

L1. Screening of Disinfection Technologies

No	Technology Alternative	Maturity of Technology	Proven Application at Large WRRFs	Compatibility with Existing and Future Processes	Compatibility with Regional Energy Management and GHG Reduction Goals	Consider for Evaluation
1	**Chlorination / dechlorination**	Yes, mature technology. Widely used in North America and internationally.	Yes, many large installations internationally.	Yes, currently used at the G.E. Booth WRRF. Might require a new contact tank or be integrated into proposed outfall.	Yes, but requires handling and storage of two separate chemicals. Low energy consumption.	**Carried Forward**
2	**UV Disinfection**	Yes, mature technology. Widely used in wastewater and water treatment.	Yes, several large installations in Canada.	Yes, but greater headloss due to flow control structures.	Yes, but requires high power requirements from UV lamps. However, chemical usage for disinfection would be eliminated.	**Carried Forward**
3	**Ozonation**	Yes, maturing technology for wastewater treatment.	No, limited operating large installations. Several had been previously discontinued.	Yes, but requires many new facilities to house liquid oxygen, ozone generation/off gas destruction equipment, and contact tanks.	No. High energy requirements from ozone generation, off gas destruction, and diffusion of gas into secondary effluent.	**Screened out**
4	**Peracetic Acid**	No. Newer technology not yet widely used at wastewater facilities.	No, applications at large facilities are limited.	No, limited bulk chemical availability.	Yes, but requires purchase and storage of one chemical.	**Screened Out**

Appendix L:

Disinfection Alternatives

L2: Evaluation of Short-List of Disinfection Technologies

L2. Evaluation of Disinfection Technology Alternatives

Sub-Criteria	Expansion Using Chlorination/Dechlorination	Expansion Using UV Disinfection
Natural Environment		
Terrestrial System	The footprint of the disinfection facility is to be constructed within the site boundary in the ash pond area. There is potential to impact natural areas associated with the neighbouring JTLCA and on-site wetland. However, the ash pond area has been previously disturbed.	
	6	6
Aquatic System	Both alternatives have a potential to impact aquatic systems due to construction into the on-site wetland. Chlorination/ dechlorination releases some chemicals into Lake Ontario.	
	5	6
Surface Water Quality and Source Water Protection	With chlorination/dechlorination there is a risk of disinfection by-product formation and release into Lake Ontario. As a result, chlorination/dechlorination has slightly more potential to impact surface water quality than UV disinfection.	
	7	9
Groundwater Water Quality and Quantity	Neither alternative is expected to impact groundwater quality and quantity. Mitigation measures would be implemented during construction.	
	8	8
Air Quality	UV disinfection will require increased standby power requirements, but air emissions from the generators will be controlled to meet air quality standards. The use of the generators would only be during emergency events.	
	9	8
Greenhouse Gas Emissions (GHG)	UV disinfection has high Scope 2 emissions from the power draw of the lamps. Chlorination/dechlorination has high Scope 3 emissions due to chemical use.	
	8	7
Total Score (Out of 60)	43	44
Normalized Score (Total 25)	**17.9**	**18.3**
Social-Cultural Environment		
Odour	Neither alternative would have odour impacts.	
	9	9
Noise/Vibrations	New Lakeview Development may be impacted from noise during construction. Impacts during construction would be short-term and mitigated.	
	9	9
Visual Aesthetics	The new facility would be designed to be aesthetically pleasing to neighbouring residential areas.	
	9	9
Truck Traffic	Truck traffic would be greater for chlorination/dechlorination due to regular chemical deliveries	
	6	9
Disruption During Construction	Both alternatives are expected to produce some disruption during construction, but mitigation measures would be implemented.	
	7	7

Sub-Criteria	Expansion Using Chlorination/Dechlorination	Expansion Using UV Disinfection
Property Acquisition and Easement	No property acquisition and easements would be required for either alternative.	
	9	9
Recreational Use and Users	Both alternatives have potential to impact recreational users at the neighbouring JTLCA. These are short-term impacts, and they can be mitigated.	
	7	7
Agricultural Use and Users	Agricultural use and users will not be impacted.	
	9	9
Human Health and Well-Being	Both alternatives would be designed to meet air emission and effluent quality requirements to protect human health.	
	9	9
Existing and Future Adjacent Land Use Compatibility	Neither alternative is compatible with adjacent existing and future planned land uses. However, visual site improvements increase compatibility to neighbouring areas.	
	8	8
Archaeology/Cultural Heritage	A small portion in the northwest area of the site has been identified as having archaeological potential. However, this area will not be impacted by construction of the disinfection facilities.	
	9	9
Total Score (Out of 110)	91	94
Normalized Score (Total 25)	**20.7**	**21.4**
Technical Considerations		
Effectiveness	Both alternatives would be designed to effectively treat wastewater to meet effluent objectives and wet weather management needs.	
	9	9
Long term Sustainability	Both alternatives would be designed to meet current needs, while not compromising the ability to meet future needs.	
	9	9
Ease of Operation	Both alternatives are easy to operate.	
	9	9
Ease of Implementation	Modifications would be required to direct secondary effluent to new disinfection facility. UV disinfection may require increased standby power capacity.	
	8	8
Resiliency	Both alternatives would be designed to have adequate levels of redundancy.	
	8	8
Compatibility with Existing Infrastructure System	Both alternatives would be compatible with existing infrastructure.	
	8	8
Geotechnical and Hydrogeology	Both alternatives would be designed according to on-site geotechnical and hydrogeological conditions.	
	8	8

Sub-Criteria	Expansion Using Chlorination/Dechlorination	Expansion Using UV Disinfection
Contaminated Soils	Both alternatives would be designed according to the on-site environmental/contamination conditions that may be present within the existing site boundary.	
	8	8
Energy Use and Recovery h	UV disinfection has high energy requirements due to the power draw from the lamps. Energy use for chlorination/dechlorination is negligible.	
	8	6
Climate Change Adaptability	UV has greater headloss. UV disinfection would, however, make the facility less reliant on external chemical deliveries which might make it less vulnerable to supply chain disruptions due to climate change.	
	8	8
Permits and Approvals	Both alternatives would be readily-approved by the MECP.	
	9	9
Total Score (Out of 110)	92	90
Normalized Score (Total 25)	**20.9**	**20.5**
Economic Considerations		
Capital Cost	UV has much higher initial capital cost expenditures	
	$29,438,000	$52,869,000
	8	6
Operating and Maintenance (O&M) Costs	UV disinfection has much lower annual O&M cost estimate.	
	$1,035,100	$357,733
	5	8
Life Cycle Costs	Chlorination/dechlorination and UV have similar 30-year life cycle costs.	
	$60,491,000	$63,601,000
	6	6
Total Score (Out of 30)	19	20
Normalized Score (Total 25)	**15.8**	**16.7**
Total Score	**75.3%**	**76.9%**

Appendix M:

Wastewater Treatment Alternatives and Design Concepts

M1: Screening of Wastewater Treatment Technologies

Table M1-1. G.E. Booth WRRF Secondary Treatment Technology Screening

No.	Technology Alternative	Maturity of Technology	Proven Application at Large WRRFs	Compatibility with Existing and Future Processes	Compatibility with Regional Energy Management and GHG Reduction Goals	Consider for Evaluation
1	Conventional Activated Sludge	Mature technology, the most common wastewater treatment process.	Yes, many large installations internationally.	Yes, current process utilized at G.E. Booth WRRF.	Higher energy requirements with opportunity for energy enhancement.	**Carried Forward**
2	Conventional Activated Sludge with CEPT	Mature technology, coagulation and flocculation in CEPT is a common wastewater treatment process.	Yes, several large installations internationally. Currently used for wet weather flow management at G.E. Booth WRRF.	Yes, variation of CAS process which is currently utilized at G.E. Booth WRRF.	Yes. Reduces loading to secondary treatment and aeration energy consumption.	**Carried Forward**
3	Conventional Activated Sludge with WWF Treatment	High-rate treatment technologies and RTC are mature technologies with proven installations.	No permanent installations of cloth media filters for parallel WWF in Ontario. Application of parallel high-rate clarification in large facilities is demonstrated. RTC in collection systems used in jurisdictions in the United States and Europe.	Yes. High-rate treatment technologies and RTC are beneficial for WWF attenuation due to space concerns at the site.	High-rate treatment technologies and RTC would be similar to CAS.	**Carried Forward**
4	Ballasted Activated Sludge	Limited number of installations.	No applications at large facilities.	Yes, variation of CAS process which is currently utilized at G.E. Booth WRRF.	Similar to CAS.	**Screened out**
5	Biological Nutrient Removal	Mature technology. However, S2EBPR process variation is relatively new.	Although BNR processes in general have successfully been implemented at large plants, experience with the S2EBPR process is limited.	No, since it requires larger tankage, it is not compatible with the New Plant 1 configuration and limited space at G.E. Booth WRRF.	Yes. Reduces chemical usage.	**Screened out**
6	Membrane Bioreactor	Mature technology, has become more widely used across North America.	Application at large facilities is limited.	Yes, existing facilities could be retrofitted to implement MBR in lieu of secondary treatment.	High energy requirements due to higher oxygen demand associated with higher MLSS operating concentrations, air scouring, recycle streams, and permeate pumps.	**Screened out**
7	Membrane Aerated Biofilm Reactor	Maturing Technology. Several pilot studies completed in Ontario.	No. However, the MECP is actively testing this technology with several pilot studies having been completed in Ontario.	Yes, variation of CAS process currently utilized at G.E. Booth WRRF. MABR could be installed within the anoxic zone of existing aeration tanks.	Significantly reduces energy consumption for aeration.	**Screened out**
8	Integrated Fixed-Film Activated Sludge / Moving Bed Bioreactor	Maturing technology. Limited number of installations in North America.	No. However, full-scale pilot testing has been previously completed at G.E. Booth WRRF.	No. High flows would lead to high headloss and hydraulic constraints from media bunching.	High energy requirements from increased oxygen demand.	**Screened out**
9	Sequencing Batch Reactor	Mature and well-developed technology. Many installations at small facilities.	Application at large facilities is limited.	No. Operation is complex at high, continuous flows. High headloss would require intermediate pumping.	High energy requirements from intermediate pumping.	**Screened out**
10	Aerobic Granular Sludge	Limited number of full-scale municipal wastewater installations.	Application at large facilities is limited.	No. High headloss would require intermediate pumping.	Limited information on energy requirements.	**Screened out**
11	Biological Aerated Filter	Mature technology, many installations internationally. Newer in North America.	Yes, several large installations internationally.	No. BAF requires fine screening and high headloss would require intermediate pumping.	High energy requirements from intermediate pumping.	**Screened out**

Appendix M:

Wastewater Treatment Alternatives and Design Concepts

M2: Evaluation of Wastewater Design Concepts

Table M2-1. Evaluation of Alternative Wastewater Treatment Design Concepts

Sub-Criteria	Expansion using CAS	Expansion using CAS with CEPT	Expansion using CAS optimized with High-Rate Clarification	Expansion using CAS optimized using RTC
Natural Environment				
Terrestrial System	The footprint for all alternatives will be located within the existing site boundary, primarily south of the existing New Plant 1 trains. The CAS and CEPT option involve expanding into the ash lagoon area. These concepts have greater potential to impact the natural areas of the adjacent Serson Creek, the JTLCA, and the wetland. The northeast and northwest corners of the property have been identified as candidate significant wildlife habitats (SWHs). Eleven Species at Risk (SAR) species were identified including five threatened bird species and three endangered bat species as well as one species each of endangered tree, butterfly, and fish. Construction will avoid these areas, so impacts are rated as minor.			
	6	6	7	7
Aquatic System	CAS and CEPT have a greater potential to impact any aquatic systems within Serson Creek and the on-site wetland due to construction in the ash lagoons and pond.			
	6	6	7	7
Surface Water Quality and Source Water Protection	CORMIX modelling indicates that the proposed new outfall will meet target dilutions within 200 m of the diffusers meaning there is low potential to impact the IPZs of Arthur P. Kennedy and R.L. Clark WTPs.			
	8	8	8	8
Groundwater Water Quality and Quantity	None of the alternatives are expected to significantly impact groundwater quality and quantity, given the soil and hydrogeological conditions on site. The site conditions are well known. Shoring and dewatering plans will be developed during design to protect groundwater resources. Impacts on groundwater quantity and quality are therefore rated as low.			
	8	8	8	8
Air Quality	Air emissions at the G.E. Booth WWTP meet MECP requirements, and any expansion of the WWTP will include controls to limit air emissions such that the WWTP continues to meet MECP requirements. All alternatives would be designed to include emission control and treatment to ensure air quality standards are met and impacts are mitigated. CAS and CEPT have a greater potential to impact nearby receptors due to proximity of the new tankage to the Lakeview Village Development.			
	6	6	7	7
Greenhouse Gas Emissions (GHG)	CEPT would have higher Scope 1 and 3 emissions from increased sludge to incinerate and chemical use. However, CEPT has lower Scope 2 emissions corresponding to lower aeration requirements.			
	7	6	7	7
Total Score (Out of 60)	41	40	44	44
Normalized Score (Total 25)	**17.1**	**16.7**	**18.3**	**18.3**
Social - Cultural Environment				
Odour	All alternatives would be designed to include odour control and treatment such that all air quality standards are met, and impacts mitigated. CAS and CEPT, given the new process train in the ash lagoon area, have a greater potential to impact the Lakeview Village Development.			
	6	6	7	7
Noise/Vibrations	All alternatives would be designed to mitigate noise/vibrations to meet requirements at the nearest receptors. The new Lakeview Village Development may be impacted from noise during construction due to new train in lagoon area in CAS and CEPT options.			
	6	6	6	6

Sub-Criteria	Expansion using CAS	Expansion using CAS with CEPT	Expansion using CAS optimized with High-Rate Clarification	Expansion using CAS optimized using RTC
Visual Aesthetics	There are concerns related to visual aesthetics due to the future neighbouring Lakeview Development and JTLCA. However, buffers can be used between the site and adjacent properties and visual aesthetics of new buildings can be designed appropriately.			
	6	6	7	7
Truck Traffic	Truck traffic would be greatest for CEPT over its life cycle due to additional chemical deliveries (two types of iron and polymer).			
	7	6	7	7
Disruption During Construction	All alternatives would produce some disruption during construction. The duration and magnitude would be greater for the CAS and CEPT options and would have potential to impact the neighbouring Lakeview Development and the JTLCA. However, these are short-term impacts, and they can be mitigated.			
	5	5	6	6
Property Acquisition and Easement	Property acquisition and easements would not be required.			
	9	9	9	9
Recreational Use and Users	The CAS and CEPT options have a greater potential to impact the recreational users of the neighbouring JTLCA during construction. As these are short-term impacts and they can be mitigated, the impacts are relatively low for all alternatives.			
	7	7	8	8
Agricultural Use and Users	The alternatives will have no impact on agricultural use and users.			
	9	9	9	9
Human Health and Well-Being	All alternatives would be designed to meet air emission and effluent quality requirements to protect human health.			
	8	8	8	8
Existing and Future Adjacent Land Use Compatibility	The new Lakeview development is being planned directly adjacent to the G.E. Booth WWTP site to the west and can be considered as incompatible with the G.E. Booth WWTP. However, the expansion provides the opportunity to enhance noise and odour controls at the G.E. Booth WWTP, as well as implement visual site improvements. The current upgrades and planned expansions are being designed to mitigate impacts to neighbouring areas.			
	7	7	7	7
Archaeology/Cultural Heritage	At this stage it is unknown if the preferred conceptual site plan will encroach upon areas identified as having archaeological and cultural heritage potential. A Stage 2 AA and Cultural Heritage review will be completed if required.			
	5	5	5	5
Total Score (Out of 110)	75	74	79	79
Normalized Score (Total 25)	**17.0**	**16.8**	**18.0**	**18.0**

Sub-Criteria	Expansion using CAS	Expansion using CAS with CEPT	Expansion using CAS optimized with High-Rate Clarification	Expansion using CAS optimized using RTC
Technical Considerations				
Effectiveness	All alternatives would be designed to effectively treat wastewater to meet effluent objectives and wet weather management requirements.			
	9	9	9	9
Long term Sustainability	All alternatives would be designed to meet current needs, while not compromising the ability to meet future needs.			
	9	9	9	9
Ease of Operation	All alternatives are relatively easy to operate and are variations of the existing CAS process. The CAS and CEPT would have increased operational requirements associated with Plant 4. The high-rate clarification facility may require slightly more operational intervention. However, operation requirements would be limited to periods of severe wet weather flow.			
	8	8	9	9
Ease of Implementation	There would be greater implementation complexity with the construction and tie-in of the train in the ash lagoon (Plant 4) for the CAS and CEPT options. The flow diversion structure to direct flows to the high-rate treatment facility and the tie-in to the secondary effluent would present constructability challenges.			
	5	5	6	7
Resiliency	All alternatives would be designed to have adequate levels of redundancy, providing one spare train. The high-rate treatment option (Concept 3A) would improve the resiliency of the facility to wet weather flows. The RTC option (Concept 3B) would be more robust as it would reduce the overall peak flows for the facility leveraging storage in the collection system.			
	8	8	9	9
Compatibility with Existing Infrastructure System	All alternatives are compatible with the existing CAS process on site.			
	7	7	7	7
Geotechnical and Hydrogeology	All alternatives would be designed according to on-site geotechnical and hydrogeological conditions.			
	8	8	8	8
Contaminated Soils	All alternatives would be designed according to on-site environmental/contamination conditions that may be present within the existing site boundary. CAS and CEPT would result in increased excess soil management requirements due to the larger footprint and requirement for a new train in the ash lagoon area.			
	6	6	7	7
Energy Use and Recovery	The CEPT option has the lowest energy use due to reduced aeration requirements.			
	7	8	7	7

Sub-Criteria	Expansion using CAS	Expansion using CAS with CEPT	Expansion using CAS optimized with High-Rate Clarification	Expansion using CAS optimized using RTC
Climate Change Adaptability	The high-rate clarification system and RTC are designed for wet weather flow management and would have reduced potential for bypassing at the WWTP.			
	7	7	8	8
Permits and Approvals	No significant challenges are expected in receiving permits and approvals with any of the alternatives. Implementation of RTC in the system may take longer to plan, design and construct. However, given that expansion of the G.E. Booth WWTP is not required until later in the planning period this is not expected to be an issue.			
	8	8	8	7
Total Score (Out of 110)	81	82	87	87
Normalized Score (Total 25)	**18.4**	**18.6**	**19.8**	**19.8**
Economic Considerations				
Capital Cost	The RTC option has the lowest capital cost since it does not require expansion of headworks or an extra train in the lagoon area. It also reduces the capacity requirements for the disinfection facility.			
	$363,569,000	$356,608,000	$377,275,000	$333,310,000
	6	6	5	7
Operating and Maintenance Cost	RTC has the lowest O&M costs. Operating costs for the other options are within 5% of each other.			
	$13,229,100	$15,110,900	$13,197,467	$13,165,833
	7	6	7	7
Life Cycle Costs	RTC has the lowest 30-year life cycle costs.			
	$760,442,000	$809,935,000	$773,199,000	$728,285,000
	6	5	6	7
Total Score (Out of 30)	19	17	18	21
Normalized Score (Total 25)	15.8	14.2	15.0	17.5
Total Score	**68.4%**	**66.3%**	**71.1%**	**73.6%**

Appendix N:

Sludge Treatment/Biosolids Management

N1: Screening of Sludge Treatment Technologies

Table N1-1. Screening of Long List of Solids Treatment Technologies (1. Anaerobic Digestion)

No.	Technology	Maturity of Technology	Compatibility with Existing and Future Processes and Biosolids End Use Markets	Proven Application at Large WRRFs	Compatibility with Regional Energy Management and GHG Reduction Goals	Consider for Further Evaluation
1a	**Conventional Mesophilic Anaerobic Digestion**	Mature Technology	Yes - would result in less mass requiring incineration and the lower volatile solids content would increase the incinerator's capacity.	Yes	Yes - Would reduce reliance on incineration and allow beneficial use on land. Additional biogas generated could reduce the need for purchased electrical energy and natural gas.	**Carried Forward**
1b	**Temperature-Phased Anaerobic Digestion (TPAD)**	Uncommon when compared to mesophilic anaerobic digestion.	More complex operation than conventional anaerobic digestion. THP has more large-scale experience to achieve the same outcome.	Yes	Yes - Would reduce reliance on incineration and allow beneficial use on land. Additional biogas generated could reduce the need for purchased electrical energy and natural gas.	**Screened out**
1c	**Acid/Gas Phased Anaerobic Digestion**	Limited number of installations.	More complex operation than conventional anaerobic digestion. THP has more large-scale experience to achieve the same outcome.	Yes	Yes - Would reduce reliance on incineration and allow beneficial use on land. Additional biogas generated could reduce the need for purchased electrical energy and natural gas.	**Screened out**

Table N1-2.Screening of Long List of Solids Treatment Technologies (2. Anaerobic Digestion with Hydrolysis Pre-treatment)

No.	Technology	Maturity of Technology	Compatibility with Existing and Future Processes and Biosolids End Use Markets	Proven Application at Large WRRFs	Compatibility with Regional Energy Management and GHG Reduction Goals	Consider for Further Evaluation
2a	**Thermal Hydrolysis Pre -treatment (THP)**	Maturing technology becoming popular	Yes	Yes	ɛs - Would reduce reliance on incineration and allow beneficial use on land. Additional biogas generated could reduce the need for purchased electrical energy and natural gas.	**Carried Forward**
2b	**Thermo / Alkaline Hydrolysis Pre-treatment**	Limited number of installations.	Yes	Limited	Yes - Would reduce reliance on incineration and allow beneficial use on land. Additional biogas generated could reduce the need for purchased electrical energy and natural gas.	**Screened out**

Table N1-3. Screening of Long List of Solids Treatment Technologies (3. Aerobic Digestion)

No.	Technology	Maturity of Technology	Compatibility with Existing and Future Processes and Biosolids End Use Markets	Proven Application at Large WRRFs	Compatibility with Regional Energy Management and GHG Reduction Goals	Consider for Further Evaluation
3a	**Conventional Aerobic Digestion**	Mature Technology	Not compatible with primary solids. Would require a separate stabilization process for primary solids.	No	High energy requirement for secondary solids stabilization and not compatible with primary solids.	**Screened out**
3b	**Autothermal Thermophilic Aerobic Digestion (ATAD)**	Maturing Technology (Second Generation)	Not compatible with primary solids. Would require a separate stabilization process for primary solids.	No	High energy requirement for secondary solids stabilization and not compatible with primary solids.	**Screened out**

Table N1-4. Screening of Long List of Solids Treatment Technologies (4. Thermal Drying)

No.	Technology	Maturity of Technology	Compatibility with Existing and Future Processes and Biosolids End Use Markets	Proven Application at Large WRRFs	Compatibility with Regional Energy Management and GHG Reduction Goals	Consider for Further Evaluation
4a	**Direct Thermal Dryer (Drum Dryer, Belt Dryer, Fluidized Bed Dryer)**	Mature Technology	Yes	Yes	Yes - Would reduce reliance on incineration and allow beneficial use on land.	**Carried Forward**
4b	**Indirect Thermal Dryer (Paddle Dryer, Disc Dryer)**	Mature Technology	Yes	Limited	No - while an indirect dryer could be used to support incineration, multiple units would be required to create a beneficial use product which would be very energy intensive.	**Screened Out**
4c	**Solar Dryer**	Newer, successful technology becoming popular but still not a mature technology for large WRRFs.	Yes	Limited	No – would require the transport of dewatered material off-site which is not compatible with the Region's energy management goals.	**Screened Out**

Table N1-5. Screening of Long List of Solids Treatment Technologies (5. Chemical Stabilization)

No.	Technology	Maturity of Technology	Compatibility with Existing and Future Processes and Biosolids End Use Markets	Proven Application at Large WRRFs	Compatibility with Regional Energy Management and GHG Reduction Goals	Consider for Further Evaluation
5a	**Alkaline Stabilization**	Mature Technology	hout additions presented in 5b and 5c, 5a results in large volume of product and does not compliment end-use alternatives identified. Insufficient space on-site and significant odour potential.	Large systems in operation	A large volume of alkaline material would be required, resulting in a large volume of product to transport.	**Screened Out**
5b	**Alkaline Stabilization with Supplemental Heat or Acid**	Mature Technology	Potential for an agreement with an advanced alkaline stabilization processing firm to transport, manage, and market the biosolids.	Large systems in operation	s - diversification would reduce reliance on incineration and allow beneficial use on land.	**Carried Forward**
5c	**Alkaline Stabilization with Supplemental Heat and High-Speed Mixing**	Maturing technology	Potential for an agreement with an advanced alkaline stabilization processing firm to transport, manage, and market the biosolids.	Large systems in operation	Yes - diversification would reduce reliance on incineration and allow beneficial use on land.	**Carried Forward**

Table N1-6. Screening of Long List of Solids Treatment Technologies (6. Composting)

No.	Technology	Maturity of Technology	Compatibility with Existing and Future Processes and Biosolids End Use Markets	Proven Application at Large WRRFs	Compatibility with Regional Energy Management and GHG Reduction Goals	Consider for Further Evaluation
6a	**Composting (Open Technologies; Aerated Static Pile and Windrow Composting) or co-composting with Region of Halton**	Mature Technology	No - Large volume of amendment material would be required, resulting in large volume of product. Does not compliment the end use alternatives and markets that have been identified for the Region of Peel.	Yes	Large volume of amendment material would be required, resulting in a large volume of product to transport.	**Screened out**

Table N1-7. Screening of Long List of Solids Treatment Technologies (7. Thermal Conversion)

No.	Technology	Maturity of Technology	Compatibility with Existing and Future Processes and Biosolids End Use Markets	Proven Application at Large WRRFs	Compatibility with Regional Energy Management and GHG Reduction Goals	Consider for Further Evaluation
7a	**Incineration**	Mature Technology	Yes	Yes	Yes – the existing incinerators are in use at the G.E. Booth WRRF and replacing incineration completely with another treatment method before the end of their useful life is inconsistent with the management of Peel's current infrastructure investments.	**Carried Forward**
7b	**Gasification**	Developing technology for use with biosolids	Yes	Currently not operating at a commercial scale	Thermal conversion of biosolids at both the G.E Booth and Clarkson WRRFs is not compatible with Region Energy Management and GHG Reduction Goals.	**Screened out**
7c	**Pyrolysis**	Developing technology for use with biosolids	Yes	Currently not operating at a commercial scale	Thermal conversion of biosolids at both the G.E Booth and Clarkson WRRFs is not compatible with Region Energy Management and GHG Reduction Goals.	**Screened out**
7d	**Wet Oxidation**	Process has been used for years. New technologies are being developing for use with biosolids.	Yes	Currently not operating at a commercial scale	Thermal conversion of biosolids at both the G.E Booth and Clarkson WRRFs is not compatible with Region Energy Management and GHG Reduction Goals.	**Screened out**
7e	**Hydrothermal Liquification**	Developing technology for use with biosolids	Yes	Currently not operating at a commercial scale	Thermal conversion of biosolids at both the G.E Booth and Clarkson WRRFs is not compatible with Region Energy Management and GHG Reduction Goals.	**Screened out**

Appendix N:

Sludge Treatment/Biosolids Management

N2: Evaluation of Sludge/Biosolids Design Concepts

Table N2-1. Evaluation of Alternative Sludge Treatment/Biosolids Management Design Concepts

Criteria	Concept 1: Optimize and Expand Incineration	Concept 2: Optimize Incineration and Transport Additional Solids off-site for Management at Clarkson WWTP	Concept 3: Thermal Hydrolysis followed by Anaerobic Digestion Prior to Incineration	Concept 4: Optimize Incineration and Third-Party Management of Additional Solids	Concept 5: Anaerobic Digestion, Dewatering and Direct Thermal Drying	Concept 6: Anaerobic Digestion Prior to Incineration
Natural Environment						
Terrestrial System	Improvements for all design concepts would be located within the site boundary and in areas that are activity used at this time for solids handling and ash storage.					
	8	8	8	8	8	8
Aquatic System	Improvements for all design concepts would be located within the site boundary and there are limited aquatic systems on the existing property.					
	8	8	8	8	8	8
Groundwater Water Quality and Quantity	None of the design concepts are anticipated to impact groundwater quality or quantity. Measures to mitigate impacts on groundwater quality and quantity during construction will be implemented.					
	8	8	8	8	8	8
Air Quality	The design concept with the highest volume of solids incinerated ranked the lowest. followed by the design concepts with the greatest volume of solids transported off site. Capital improvements would be designed to include emission control and treatment such that all air quality standards are met, and impacts mitigated. Design Concept 5, with direct thermal drying would require more stringent emission controls. This requirement would be offset by eliminating incineration.					
	6	5	7	5	8	7
Greenhouse Gas Emissions (GHG)	The design concept with the highest volume of solids incinerated ranked the lowest. The Design concept with highest volume of solids that could be used in agriculture and horticulture ranked the highest. Alternatives 3 and 6 are ranked in the middle because these two alternatives could allow a portion of the biosolids to be beneficially used on land.					
Region's GHG Reporting Emission Sources	4	4	5	4	8	6
Total Scope 1, 2 &3 Emissions	4	4	5	4	8	6
GHG Average Score	4	4	5	4	8	6
Total Score (Out of 50)	34.0	33	36	33	40	37
Weight	25	25	25	25	25	25
Normalized Score (Total 25)	**17.0**	**16.5**	**18.0**	**16.5**	**20.0**	**18.5**

Criteria	Concept 1: Optimize and Expand Incineration	Concept 2: Optimize Incineration and Transport Additional Solids off-site for Management at Clarkson WWTP	Concept 3: Thermal Hydrolysis followed by Anaerobic Digestion Prior to Incineration	Concept 4: Optimize Incineration and Third-Party Management of Additional Solids	Concept 5: Anaerobic Digestion, Dewatering and Direct Thermal Drying	Concept 6: Anaerobic Digestion Prior to Incineration
Social - Cultural						
Odour	All design concepts would include odour control and treatment such that all air quality standards are met, and impacts mitigated. Design Concepts 2 and 4 would transport unstabilized dewatered cake and would have the highest odour potential.					
	8	4	8	4	7	8
Noise/Vibrations	All concepts would be designed to mitigate noise / vibration to meet requirements at nearest receptors.					
	7	7	7	7	7	7
Visual Aesthetics	All options will eliminate the ash lagoons. The design concept that phased out incineration in the long term are ranked highest.					
	7	7	7	7	8	8
Truck Traffic	All design concepts would require some level of truck traffic to transport incinerator ash, solids between WWTPs or biosolids product; Design Concept were ranked based on anticipated vehicle trips.					
	8	4	8	4	7	9
Disruption During Construction	All design concepts would pose some amount of disruption during construction. Other than construction workers coming to site, and the delivery and removal of equipment and material, the disruption would be limited to on the WWTP site. Alternatives 2 and 4 would have less onsite construction than the other options.					
	6	8	6	8	6	6
Property Acquisition and Easement	No additional property would be required					
	8	8	8	8	8	8
Recreational Use and Users	Improvements associated with all design concepts would be located within the site boundary and would not impact nearby recreational uses.					
	8	8	8	8	8	8
Human Health and Well-Being	All concepts would be designed to meet air quality criteria and effluent quality requirements to protect human health and the environment. Concept 5 creates a biosolids product that would meet all beneficial use guidelines.					
	8	8	8	8	9	8
Existing and Future Adjacent Land Use Compatibility	G.E. Booth WWTP is bordered by residential areas to the north, residential planned for the west, and recreational areas to the east and south. Thus, none of the alternatives are compatible with adjacent existing and future planned land uses. However, noise and odour controls and visual site improvements will be implemented to mitigate impacts to neighbouring areas for all alternatives. Alternatives 2 and 4 were rated slightly lower than the others, due to the need to truck liquid sludge.					
	7	6	7	6	7	7
Archaeology/Natural Heritage	All alternatives would be located in the disturbed area of the site with has been cleared of having archaeological potential; no impacts anticipated.					
	9	9	9	9	9	9
Total Score (Out of 100)	76	69	76	69	76	78
Weight	25	25	25	25	25	25
Normalized Score (Total 25)	**19.0**	**17.3**	**19.0**	**17.3**	**19.0**	**19.5**

Criteria	Concept 1: Optimize and Expand Incineration	Concept 2: Optimize Incineration and Transport Additional Solids off-site for Management at Clarkson WWTP	Concept 3: Thermal Hydrolysis followed by Anaerobic Digestion Prior to Incineration	Concept 4: Optimize Incineration and Third-Party Management of Additional Solids	Concept 5: Anaerobic Digestion, Dewatering and Direct Thermal Drying	Concept 6: Anaerobic Digestion Prior to Incineration
Technical						
Effectiveness	All concepts would be designed to effectively manage biosolids. Design Concepts 2 and 4 involve transport of liquid sludge off site.					
	8	7	8	7	8	8
Long-term Sustainability	The design concepts that include incineration are a continuation of the current practice but have limited potential for end use market diversity. Design Concept 5 creates a fertilizer product, while Alternatives 3, 4 and 5 present opportunities to use both the ash products and beneficial land use. Alternative 6 has the added benefit of allowing more flexibility post 2041 to select among alternative technologies that best meet the needs of Peel and the community in the future. Alternative Concepts 2 and 4 may present more risks from a long-term sustainability perspective.					
	5	4	7	4	8	9
Ease of Operation	While all concepts would have some complexity to operation, concepts 1-4 and 6 maintain incineration at the WWTP. Alternatives 3 and 5 THP and drying, respectively, would add some operational complexity. THP in particular requires specially trained operators (stationary engineers) in addition to wastewater operators and would be the most complex to operate.					
	8	8	4	8	6	7
Ease of Implementation	Design concepts 2 and 4 would be the easiest to implement, others would require construction of more facilities.					
	8	9	8	9	8	8
Resiliency	All alternatives would be designed to have adequate levels of redundancy. Concepts with digestion have additional redundancy and flexibility.					
	6	6	8	6	8	8
Compatibility with Existing Infrastructure System	The design concepts that maintain incineration and require now new processes ranked the highest.					
	8	8	5	8	6	7
Geotechnical and Hydrogeology	All concepts would be designed according to the on-site geotechnical and hydrogeological conditions.					
	8	8	8	8	8	8
Contaminated Soils	All alternatives would be designed according to the on-site environmental and contamination conditions, which may be present in the proposed expansion area on the existing WWTP site.					
	8	8	8	8	8	8
Energy Use and Recovery	The alternatives with conventional mesophilic anaerobic digestion create the highest total volume of biogas that can be used for other plant processes. Therefore, alternatives that incorporate digestion have more energy recovery than those with alternatives with incineration only. Thermal drying (Design Concept 5), uses the most energy, but produces biogas.					
	4	4	7	4	6	7
Climate Change Adaptability	Climate change is not expected to have a significant impact on the biosolids management of any design concept. Design Concept 5 has the greatest flexibility in terms of end use options and would have slightly more potential to adapt to climate change. The concepts with significant of transportation requirements were ranked the lowest.					
	6	6	7	6	8	7
Permits and Approvals	Concepts 1, 2, 3 and 4 include continuation of the current incineration process. Alternative 1 increases the Incineration capacity yet maintains the operating capacity below the 400 dt/d ECA rated capacity for the system. Design concept 3 thermal hydrolysis followed by anaerobic digestion of a portion of the G.E. Booth solids prior to incineration and design concept 5 anaerobic digestion of all of the G.E. Booth solids prior to direct thermal drying and product distribution, will require some level of additional permitting.					
	8	8	7	8	7	8
Total Score (Out of 110)	77	76	77	76	81	85
Weight	25	25	25	25	25	25
Normalized Score (Total 25)	**17.5**	**17.3**	**17.5**	**17.3**	**18.4**	**19.3**

Criteria	Concept 1: Optimize and Expand Incineration	Concept 2: Optimize Incineration and Transport Additional Solids off-site for Management at Clarkson WWTP	Concept 3: Thermal Hydrolysis followed by Anaerobic Digestion Prior to Incineration	Concept 4: Optimize Incineration and Third-Party Management of Additional Solids	Concept 5: Anaerobic Digestion, Dewatering and Direct Thermal Drying	Concept 6: Anaerobic Digestion Prior to Incineration
Economic						
Capital Cost ($ M)	$ 416 M	$ 258 M	$ 405 M	$ 256 M	$ 417 M	$436 M
	4	6	4	6	4	4
Annual Operating and Maintenance (O&M) Costs at 550 MLD ($ M)	$ 8.7 M	$ 7.6 M	$ 8.3 M	$ 7.7 M	$ 9.0 M	$ 7.0 M
	4	6	5	6	4	7
30-Year Life Cycle Costs (2032-2054)	$ 586 M	$ 407 M	$ 569 M	$ 410 M	$ 598 M	$569 M
	4	6	4	6	4	4
Total Score (Out of 30)	12	18	13	18	12	15
Weight	25	25	25	25	25	25
Normalized Score (Total 25)	10.0	15.0	10.8	15.0	10.0	12.5
Total Score	**63.5**	**66.0**	**65.3**	**66.0**	**67.4**	**69.8**

Appendix O:

New Outfall Alternatives

O1: Evaluation of Shaft Locations

O1. **Evaluation of Alternative Shaft Locations**

Criteria	Alternative 1 (East of the existing disinfection building)	Alternative 2 (Southeast of the existing ash storage pond)	Alternative 3 (Adjacent to the existing outfall shaft near Plant 3)
Environmental			
Terrestrial System	All alternatives will have potential to impact terrestrial features or species, and impacts must be mitigated. Alternative 3, however has more potential to encroach on JTLCA lands.		
	7	7	4
Aquatic System	Impacts to aquatic systems are expected to be low and will be mitigated. However, Alternative 3 has more potential to encroach on the JTLCA lands and therefore potentially poses a greater risk to aquatic systems.		
	7	7	4
Total Score (20)	14.0	14.0	8.0
Normalized Score (25%)	**17.5**	**17.5**	**10.0**
Social - Cultural			
Recreational Use and Users	All alternatives will have the potential to impact users of JTLCA during construction, and all impacts must be mitigated. Alternative 3, however has more potential to encroach on JTLCA lands.		
	7	7	5
Residential Land Uses and Users	Construction of alternatives has potential to impact Lakeview Development, but they will be short term and will be mitigated.		
	6	6	6
Archaeology/Natural Heritage & Aboriginal Interest	Based on the Stage 1 Archaeological Assessment, the area has been previously assessed and found to have very little risk of archaeological resources. No further Archaeological Assessments are recommended in the area of all shaft locations.		
	9	9	9
Total Score (30)	22	22	20
Normalized Score (25%)	**18.3**	**18.3**	**16.7**
Technical			
Ease of Implementation	Alternative 1 is close to an existing access road (East Dr.) and to existing outfall and conduits. Site grading is required. Alternative 2 requires new roads to access the shaft and the distance to the existing outfall and conduits can make their connections difficult.- Alternative 3 is the most challenging to implement given is configuration and size constraints.		
	7	5	3

Criteria	Alternative 1 (East of the existing disinfection building)	Alternative 2 (Southeast of the existing ash storage pond)	Alternative 3 (Adjacent to the existing outfall shaft near Plant 3)
Constructability	Geotechnical and hydrogeologic conditions will be similar for all three alternative shaft locations. Alternative 2 requires the most material removal and grading. Alternative 3 would require the longest tunnel, as well as more constructability challenges given its configuration and size.		
	7	5	3
Ability to connect to existing infrastructure	Alternatives 1 and 3 are closest to the existing shaft locations, with Alternative 2 requiring construction of the conduit under and/or around the ash storage ponds. Alternative 2 is closest to the DEC, followed closely by Alternative 1. Alternative 3 is the furthest from the DEC which poses challenges for a connection. Overall, Alternative 1 is the most central with the most advantages for connecting to all infrastructure.		
	8	6	4
Total Score (30)	22	16	10
Normalized Score (25%)	**18.3**	**13.3**	**8.3**
Economic			
Costs and Schedule	Alternative 1 location would cost the least and incur the shortest construction duration to complete the project. Alternative 3 location would have the highest costs given longer length of outfall, constructability challenges, and distance to connect to the DEC.		
	6	4	2
Total Score (10)	6	4	2
Normalized Score (25%)	**15.0**	**10.0**	**5.0**
Total Score	**69.1**	**59.1**	**40.0**

Appendix O:

New Outfall Alternatives

O2: Evaluation of Outfall Alignments

O**2. Evaluation of Alternative Outfall Alignments**

Criteria	Alternative Alignment A (North)	Alternative Alignment B (Central, parallel to existing outfall)	Alternative Alignment C (Central, south of Alternative B)	Alternative Alignment D (South)
Environmental				
Aquatic System	Although there no significant aquatic habitats have been identified in the study area, DFO's No Net Loss Policy must be met. For all alternative alignments, outfall construction would be done through tunneling to minimize impacts to aquatic fish species or habitat, and to the natural features in the JTLCA. Other measures will be implemented through construction to mitigate impacts and meet DFO requirements.			
	7	7	7	7
Water Quality	Mitigation measures will be put in place to reduce the risks of construction on Lake Ontario water quality for all alternatives. The outfall and diffusers will be designed to meet dilution and Provincial Water Quality Objectives (PWQO) such that water quality in Lake Ontario is not adversely affected.			
	9	9	9	9
Total Score (20)	16.0	16.0	16.0	16.0
Normalized Score (25%)	**20.0**	**20.0**	**20.0**	**20.0**
Social - Cultural				
Source Water Protection (IPZ)	Alternatives A and D are closest to the IPZ-1 boundaries, thereby increasing the risk of plumes entering the respective zones, while Alternatives B and C are located more centrally. Therefore, Alternatives A and D were less preferable compared to B and C. Alternative D is closest to IPZ 1.			
	4	7	7	3
Shoreline Uses and Users	Construction may temporarily affect users of the JTLCA. Measures to mitigate impacts to the extent possible will be implemented. The outfall and diffusers will be designed to meet dilution and PWQO such that water quality in Lake Ontario is not adversely affected and shoreline and water uses, and users are protected. However, Alternative A would be closer to the shoreline and potentially result in the plume impinging on the shoreline on more occasions.			
	4	6	6	6
Marine Archaeological Resources	No marine archaeological resources have been identified in the area.			
	9	9	9	9

Criteria	Alternative Alignment A (North)	Alternative Alignment B (Central, parallel to existing outfall)	Alternative Alignment C (Central, south of Alternative B)	Alternative Alignment D (South)
Total Score (30)	17	22	22	18
Normalized Score (25%)	**14.2**	**18.3**	**18.3**	**15.0**
Technical				
Geotechnical Conditions	Geotechnical conditions are anticipated to be similar for all alternatives. Existing geotechnical information indicates that sound bedrock is anticipated in the entire area and tunneling methods can be used for construction. Additional geotechnical investigations will be required to confirm conditions to support design and construction.			
	7	7	7	7
Water Depths (Bathymetry)	Alternatives B and D reach greater water depths at a shorter distance than Alternatives A and C, thereby reducing the potential length of the outfall and diffuser. Alternative A has the shallowest water depth and as such would require the longest outfall.			
	3	7	5	7
Diffuser Effectiveness (Currents)	Currents are predominantly east to west, moving parallel to shore. Alternatives B, C, and D are generally perpendicular to current direction, yielding optimal diffuser direction compared to Alternative A, the least preferred.			
	5	8	8	8
Total Score (30)	15	22	20	22
Normalized Score (25%)	**12.5**	**18.3**	**16.7**	**18.3**
Economic				
Costs and Schedule	Slight cost savings and shorter schedules may be anticipated with Alternatives B and D as the outfall length would be potentially shorter. Alternatives A and D are also closer to the existing IPZ so may be more difficult to approve, adding time to the schedule.			
	5	6	5	5
Total Score (Out of 10)	5	6	5	5
Normalized Score (25%)	**12.5**	**15.0**	**12.5**	**12.5**
Total Score	**59.2**	**71.6**	**67.5**	**65.8**