City of Hamilton

Facility Upgrade Plan for Dundas Wastewater Treatment Plant (WWTP)

Summary of Facility Upgrade Options Technical Memorandum

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T001744A

CIMA+

500-5935 Airport Road
Mississauga, ON L4V 1W5
T 905 695 1005 **F** 905 695 0525
cima.ca

Contact

Gustavo Arvizu, M.Eng., P.Eng., ENV SP
Gustavo.Arvizu@cima.ca
T 905 695-1005, 5734

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Hamilton

Summary of Facility Upgrade Options

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Prepared by:

Emily Snoei, EIT

Verified by:

Gustavo Arvizu, M.Eng., P.Eng., ENV SP

Approved by:

Gustavo Arvizu, M.Eng., P.Eng., ENV SP

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1 Introduction

CIMA+ was retained by the City of Hamilton to develop a long-term plan and conceptual design to implement upgrades to the Dundas Wastewater Treatment Plant (WWTP).

The Dundas WWTP is a conventional activated sludge (CAS) facility with nitrification and tertiary filtration providing treatment to the community of Dundas. The facility is owned and operated by the City of Hamilton. The plant has a rated capacity of 18,200 m^3/d (MECP, 2001; MECP, 2010). The existing influent diversion chamber is designed to bypass all flows exceeding 42,200 m^3/d as per existing Certificate of Approval Number 3-1040-99-006 (MECP, 1999). The plant discharges to Cootes Paradise, via the Desjardin's Canal.

The plant consists of two treatment trains referred to as Plant A and Plant B constructed in 1962 and 1977, respectively. Per the Environment Compliance Approval (ECA) for the facility, Plant A has a rated capacity of 6,100 m^3/d, while Plant B has a capacity of 12,100 m^3/d (MECP, 2010). Peak flows exceeding the capacity of the plant are diverted to the Dundas Equalization Tank (HC060) to the catchment of the Woodward Avenue WWTP.

The Dundas WWTP is in poor physical condition and many assets are approaching the end of their expected service life. Due to the poor physical condition, the plant must be operated below its rated capacity. A desktop capacity assessment was completed for the major unit processes at the Dundas WWTP to evaluate the available capacity of the existing facility. The assessment found that most of the unit processes have theoretical capacities well below their rated capacities as stated in the ECA, and the primary clarifiers are responsible for the greatest hydraulic limitation at both Plants A and B (CIMA+, August 2024). Additionally, during peak flow events a large portion of the flow bypasses to the EQ tank. Therefore, due to poor physical condition and insufficient capacity, it is critical to upgrade the Dundas WWTP to ensure continued long-term operation.

Furthermore, the Hamilton Harbour Remedial Action Plan (HHRAP) Cootes-Grindstone Water Quality Targets Sub-Committee identified effluent quality targets for the Dundas WWTP to improve the water quality of Cootes Paradise. The effluent targets identified are more stringent than the effluent criteria defined in the plant's ECA and would require implementation of different processes to enhance treatment performance.

As part of this study, CIMA+ conducted an evaluation of various options to upgrade the facility. This included a review of best available technologies and various layout options to upgrade the facility while meeting more stringent effluent quality targets. The findings of the various reviews are documented in the various technical memoranda associated with this project.

This technical memorandum (TM) compares several upgrade options including the option of retrofitting the existing facility, replacing it with one with a “like-for-like” facility, or constructing a new facility meeting the more stringent effluent criteria.

2 Problem Statement

As noted above, the Dundas WWTP is in poor condition and has capacity limitations. Furthermore, the plant discharges to a sensitive water receiver (i.e., Cootes Paradise) and more stringent effluent criteria have been proposed by the HHRAP to improve the water quality in Cootes Paradise.

3 Facility Upgrade Options

The following high-level options have been identified to address the problem:

1. Retrofit the existing facility by replacing equipment and piping
2. Replace the existing facility with a new facility with the same design capacity and the same effluent criteria as those in the current ECA
3. Replace the existing facility with one with the same rated capacity and with the same effluent criteria as those in the current ECA but designed to meet MECP guidelines for peak flow capacity
4. Replace the existing facility with one with the same rated capacity, designed to meet MECP guidelines for peak flow capacity and designed to meet more stringent effluent criteria

Each option is described below.

3.1 Option 1: Retrofit Existing Plant (Capacity of 18.2 MLD)

This option involves maintaining the existing conventional activated sludge process, reusing the existing process tanks and buildings but replacing existing equipment and process piping. This includes replacing the screening, grit removal, sludge collection mechanism, pumps, blowers, pipes, valves and other appurtenances. Electrical, instrumentation and control equipment would also be replaced. Other upgrades would include:

- Replacing the actuated gate in the Influent Diversion Chamber
- Equipment replacement in King St SPS

- Refurbishment of chemical systems
- Rehabilitation / replacement of sludge holding tanks and transfer pumps

The upgrades would not replace any structures or expand the footprint.

This option would extend the life of the existing facility. The plant would continue to have an average day flow capacity of 18.2 MLD. However, as noted above and in other technical memoranda, the facility has limited capacity to handle peak flows, requiring flows to be directed to the Equalization (EQ) tank during peak flow conditions. This option would not improve the effluent quality.

Furthermore, some of the existing buildings include Building Code and Electrical Safety Code non-compliances that would be able to be addressed. For example, the main power supply equipment for the plant is in a narrow basement in the Control Building of Plant B. This area has limited space and there are insufficient clearances between equipment, resulting in code non-compliances and health and safety concerns.

The issues associated with this option are summarized below:

- **Limited Capacity** – This option would not address existing capacity concerns. Peak flows would continue to be diverted to the Equalization Tank and eventually the Woodward Ave. WWTP catchment, which already has issues with overflows during wet weather flow conditions.
- **No Improvement to Water Quality Targets** – This option would not meet the agreed effluent quality objectives as per discussions with the Hamilton Harbour Remedial Action Plan (HHRAP) Committee.
- **Complex Construction Staging** – It would be extremely challenging to maintain operation of the Dundas WWTP during construction of this option. To accommodate the upgrades process trains would have to be taken out of service, requiring the plant to be de-rated and flows to be diverted to the Woodward Ave. WWTP an extended period.
- **Non-compliance with Building and Electrical Codes** – As this option would not involve expanding the footprint of existing buildings and structures, it would not possible to address the existing code non-compliance issues. The upgraded electrical design would not resolve the non-compliance issues due to the space limitations; therefore, it is highly unlikely the design would be approved by the Electrical Safety Authority (ESA).

For these reasons, this option is considered infeasible and is not considered further.

3.2 Option 2: New Facility with the Same Effluent Criteria and Design Capacity

This option would involve building a new conventional activated sludge facility utilizing available space in Martino Park.

The upgrades would include:

- Modifications to influent sewers
- Modifications to the existing Influent Diversion Chamber
- New Sewage Pumping Station (SPS) and forcemain
- New headworks complete with screening and grit removal
- New primary clarifiers, aeration tanks, and secondary clarifiers
- New tertiary filters and chemical disinfection
- New sludge handling facility and storage tanks
- New chemical systems
- New gravity sewer connection to existing outfall
- New administration building

The existing plant would remain in operation until the new plant is constructed, then the existing plant would be decommissioned. This option would not improve the effluent quality. The new plant capacity would remain 18.2 MLD. However, as part of this option, the process capacity would not be increased to handle peak flows, requiring flows to be directed to the EQ tank during peak flow conditions.

This option is deemed impractical given that it does not provide peak flow capacity and the incremental cost of constructing a new facility sized to handle peak flows would be relatively small. Therefore, this option is not considered further.

3.3 Option 3: New Facility with the Same Effluent Criteria but Rated to Handle Peak Flows

This option would involve building a new conventional activated sludge facility utilizing available space in Martino Park. The new plant would have an average day capacity of 18.2 MLD but would have a peak instantaneous capacity of 42 MLD. Plant A and the Filtration Building would remain in operation and Plant B would be decommissioned and demolished to accommodate construction of the new plant. Once the new plant is commissioned, Plant A would be decommissioned and demolished to make room for the new Tertiary Filtration and Disinfection Building. The upgrades would include:

- Modifications to influent sewers

- Modifications to the existing Influent Diversion Chamber
- New Sewage Pumping Station (SPS) and forcemain
- New headworks complete with screening and grit removal
- New primary clarifiers, aeration tanks, and secondary clarifiers
- New tertiary filters and UV disinfection
- New sludge handling facility and storage tanks
- New chemical systems
- New gravity sewer connection to existing outfall
- New administration building

This option would not improve the effluent quality.

The conceptual site plan for Option 3 is shown in **Figure 3-1.**

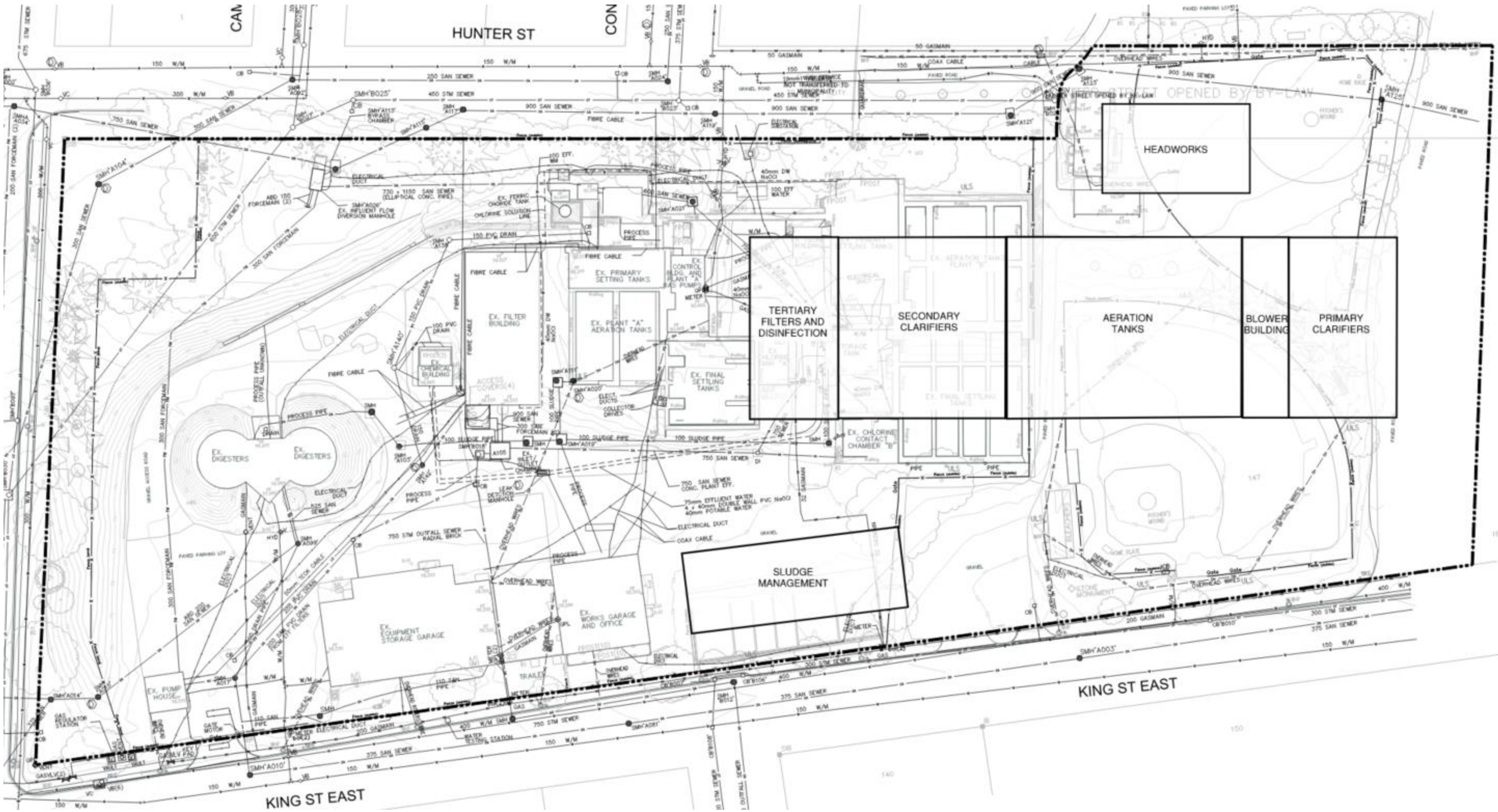

Figure 3-1: Conceptual Site Plan for Option 3

3.4 Option 4: New Plant with Improved Treatment Process

This option would involve constructing a new facility utilizing available space in Martino Park. The new plant would have an average day capacity of 18.2 MLD and a peak instantaneous capacity of 42 MLD. The facility would utilize an MBR process with UV disinfection per the concept described in the Conceptual Design Report. The facility would meet more stringent effluent criteria to improve the water quality of Cootes Paradise.

The existing plant would remain in operation until the new plant is constructed, then the existing plant would be decommissioned. The upgrades would include:

- Modifications to influent sewers
- Modifications to the existing Influent Diversion Chamber
- New Sewage Pumping Station (SPS) and forcemain
- New Headworks Facility complete with screening and grit removal
- New Odour Control Facility
- New Chemical Storage
- New Membrane Bioreactor (MBR) trains (including aeration tanks and membrane
- filtration system)
- New UV disinfection system
- New sludge handling facility and storage tanks
- New gravity sewer connection to existing outfall
- New Administration Building/Center of Excellence

The conceptual site plan for Option 3 is shown in **Figure 3-2.**

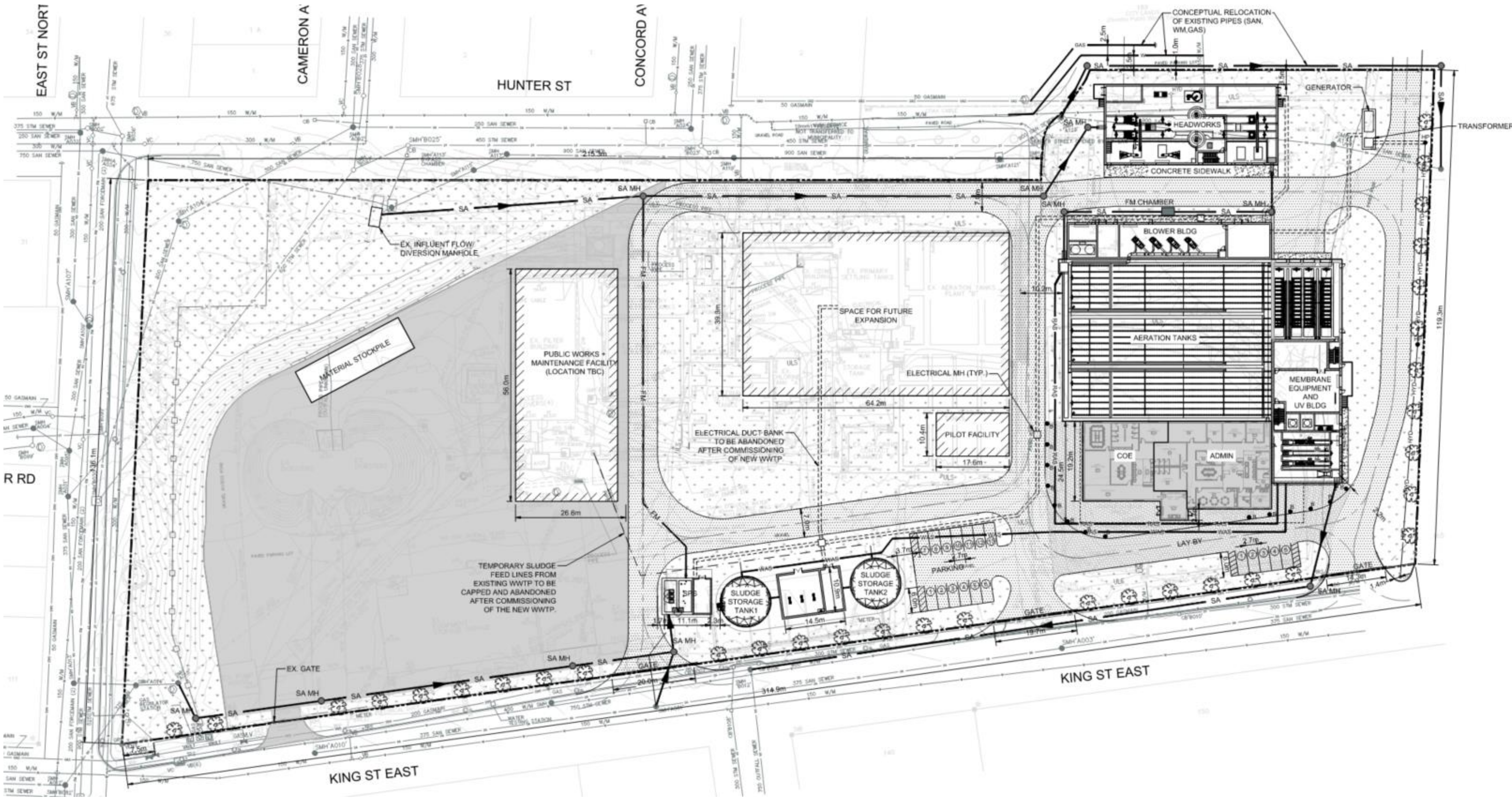

Figure 3-2: Conceptual Site Plan for Option 4

3.5 Cost Estimating Approach

A 30-year Net Present Value (NPV) cost analysis was completed for each feasible option, including estimated capital and operation and maintenance (O&M) costs. The cost analysis is based on the following assumptions:

- It is assumed that construction of the expansion would span a period of four years starting in 2029 and the commissioning would occur in 2033. Capital costs were prorated proportionally across the four years.
- It is assumed that engineering would start with detailed design in 2025 and would continue through construction to 2033.
- Capital cost estimates are Class D, based on recent project experience in Ontario at similar facilities and vendor information. The capital cost estimates include engineering fees and 30% project contingency. The capital cost estimates do not include costs associated with relocation of Martino Park.
- Operating costs include items such as energy use for aeration, mixing, pumping, chemical consumption, biosolids handling, equipment maintenance/replacement, and labour.
- Operating costs were assumed to start in 2033. Energy and chemical use costs were prorated based on the projected future average day flows to Dundas WWTP.
- Assumed electricity costs based on $0.10/kWh (based on weighted average of electricity costs across 24 hours) (Ontario Energy Board, 2023).
- Assumed $0.82/L ferric sulphate, $1.10/L sodium hypochlorite, and $6.70/L citric acid based on unit costs from reference facilities.
- Labour and equipment maintenance costs are estimated as 3% of the capital costs.
- Life cycle costs were calculated based on a 30-year planning horizon with a 5% inflation rate and 5% discount rate.

Cost estimates are provided in **Table 3-1** of **Section 3.6**. Additional details related to the cost estimates can be found in **Appendix A**.

3.6 Evaluation of Upgrade Options

Table 3-1 compares the characteristics and impacts of the feasible upgrade options.

Table 3-1: Evaluation of Feasible Options

Criteria	Option 3: New Plant with the Same Effluent Criteria but Rated to Handle Peak Flows	Option 4: New Plant with Improved Treatment Process
Capacity	The plant would have a rated capacity of 18.2 MLD and a peak instantaneous flow capacity of 42 MLD. Flows exceeding this capacity would be diverted to the EQ tank. ✓	The plant would have a rated capacity of 18.2 MLD and a peak instantaneous flow capacity of 42 MLD. Flows exceeding this capacity would be diverted to the EQ tank. ✓
Treatment Performance	The conventional treatment process would not meet the effluent objectives agreed with HHRAP. ✗	The MBR would meet the effluent objectives agreed with HHRAP. ✓
Surface Water Quality and Source Water Protection	The effluent would not meet objectives agreed with HHRAP and would not provide the desired level of protection and preservation of the receiver, Cootes Paradise. ✗	The effluent would meet objectives agreed with HHRAP and would provide the desired level of protection and preservation of the receiver, Cootes Paradise. ✓
Required Footprint	The new plant would have an approximate footprint of 11,500 m^2. To accommodate construction some tanks and buildings would have to be constructed on Martino Park and some in the area currently occupied by Plant B. Once the new plant is constructed, there would be limited space available for future expansions. ✗	The new plant with MBR would have an approximate footprint of 5,300 m^2 and most components would fit within the boundaries of Martino Park. The area where the existing plant is located would be available for future expansion. ✓
Opportunity for Expansion, Denitrification, etc.	This option provides limited opportunity for future expansion or to add enhanced denitrification to the treatment process. ✗	This option provides a large area for future expansion and/or to add enhanced denitrification to the treatment process. ✓
Construction Complexity	Plant B would need to be demolished to make space for the new plant, so the plant would operate at reduced capacity and a significant portion of the flow would need to be diverted to Woodward WWTP for an extended period. ✗	The new plant would be constructed offline while the existing plant remains in service. Once the new plant is commissioned, the existing plant would be demolished. There would be no loss of capacity during construction. ✓

Criteria	Option 3: New Plant with the Same Effluent Criteria but Rated to Handle Peak Flows	Option 4: New Plant with Improved Treatment Process
Additional Studies – Class Environmental Assessment (EA)	According to the "Municipal Water and Wastewater Projects for Sewage Treatment Facilities" projects involving the expansion, refurbishment, or upgrade of sewage treatment plants up to their existing rated capacity where no land acquisition is required are exempted from EA requirements (MECP, 2023). Therefore, a Class EA would not be required.	According to the "Municipal Water and Wastewater Projects for Sewage Treatment Facilities" projects involving the expansion, refurbishment, or upgrade of sewage treatment plants up to their existing rated capacity where no land acquisition is required are exempted from EA requirements (MECP, 2023). Therefore, a Class EA would not be required.
Impact to Existing Certificate of Approval (C of A)	An ECA amendment would be required.	An ECA amendment would be required.
Initial Capital Cost (2024 CAD)	The construction and engineering costs are estimated at $276.3 and $31.2M, respectively, for a total capital cost of $308M.	The construction and engineering costs are estimated at $226.3 and $25.5M, respectively, for a total capital cost of $252M.
Annual O&M Cost (2024 CAD)	The annual O&M cost would be $4.4M. Although less chemical is required, there is a greater energy requirement / cost due to the larger aeration tanks, and a greater cost associated with equipment maintenance and replacement due to greater number and size of the assets (i.e. clarifiers).	The annual O&M cost would be $3.8M. Although more chemical is required, there is a lower energy requirement / cost and equipment maintenance and replacement cost associated with this process.
Life Cycle Cost (30-year NPV) (2024 CAD)	The 30-year NPV cost would be $411M, for which the capital cost is $308M and the lifecycle O&M cost is $102M.	The 30-year NPV cost would be $342M, for which the capital cost is $252M and the lifecycle O&M cost is $89M.

4 Preferred Facility Upgrade Option

Based on **Table 3-1**, the preferred upgrade option is to construct a New Plant with an Improved Treatment Process to meet HHRAP targets. This is recommended as it would increase the plant's capacity to handle peak flows, enhance effluent quality and protection of Cootes Paradise, aligning with the City's goal to be a leader in environmental stewardship. This option would also have a lower initial capital cost and life cycle cost than the option of replacing the existing facility but maintaining the same effluent criteria. This option would also be easier to implement as it would not require de-rating the existing plant during construction and diverting flows to the Woodward Ave. WWTP.

5 Bibliography

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A

Appendix A: Opinion of Probable Cost

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Conceptual Cost Estimate (Class D)
Dundas WRRF

New WWTP (MBR)

1) CONSTRUCTION COSTS		
Cost Estimate Summary by Area		**Estimated Cost (Total)**
Division 01 - General Requirements		$27,200,000
Division 02 - Site Work Total		$13,000,000
Sewage Pumping Station		$5,000,000
Headworks Building		$14,000,000
Blower Building		$6,500,000
Aeration Tanks		$11,000,000
MBR & UV Building		$30,000,000
Sludge Storage		$9,300,000
Administration Building		$7,000,000
COE		$3,000,000
Soil Anchors		$10,000,000
1A. Construction Cost		**$136,000,000**
1B. Construction Contingency (Steel Price, Concrete price, etc.)	15%	$20,400,000
1C. Project Contingency and Estimating Allowance (Exchange Rate, Tariff Uncertainty & Labour U	30%	$40,800,000
SUB TOTAL CONSTRUCTION COST = 1A + 1B + 1C		$197,200,000
1D. Inflation Rate	3.5%	
1E. Number of Years	4	
Project Construction Inflation		$29,100,000
TOTAL CONSTRUCTION COST		$226,300,000
2) CONSULTANT COSTS (SOFT COSTS)		
2A. Engineering Design and Contract Administration	15%	$20,400,000
2B. Investigative Services	0%	$0
2C. Permits and Approvals	0%	$0
2D. Utility Connections and Relocations		$0
2E. Sub-total Consultant Costs (Soft Costs) = 2A + 2B + 2C + 2D		$20,400,000
Project Contingency	25%	$5,100,000
SUB TOTAL CONSULTANT COST = 2E + 2F		$25,500,000
2G. Inflation Rate	0.0%	
2E. Number of Years	1	
Project Consultant Inflation		$0
TOTAL CONSULTANT COST		$25,500,000
3) LAND COSTS		
3a. Land Acquisition		$0
3B. Legal / Real Estate	10%	$0
3C. Sub-total Consultant Costs (Soft Costs) = 3A + 3B		$0
Project Contingency		$0
SUB TOTAL CONSULTANT COST = 2E + 2F		$0
3E. Inflation Rate	0.0%	
3F. Number of Years	0	
Project Land Inflation		$0
TOTAL LAND COST		$0
TOTAL PROJECT COST		**$252,000,000**
Note: Tax is excluded.		

Conceptual Cost Estimate (Class D)

Dundas WRRF

New WWTP (MBR)

4) O&M COSTS		
Cost Estimate		**Estimated Cost (Total)**
Energy (Aeration)		$230,000
Energy (Mixing)		$10,000
Energy (Recirculation)		$30,000
Energy (Membrane Filtration)		$170,000
Energy (UV)		$40,000
Chemical Consumption (Ferric Sulphate)		$210,000
Chemical Consumption (Citric Acid)		$180,000
Chemical Consumption (Sodium Hypochlorite)		$30,000
Biosolids Handling		$30,000
Equipment Maintenance / Replacement		$2,280,000
Labour		$530,000
TOTAL O&M COST		$3,800,000
5) LIFECYCLE COST		
30-year Life Cycle Cost (NPV) for Capital		$227,000,000
30-year Life Cycle Cost (NPV) for Consultant Services		$26,000,000
30-year Life Cycle Cost (NPV) for O&M		$89,000,000
		$342,000,000

Conceptual Cost Estimate (Class D)
Dundas WRRF

Like-for-Like Replacement of Existing WWTP

1) CONSTRUCTION COSTS		
Cost Estimate Summary by Area		**Estimated Cost (Total)**
Division 01 - General Requirements		$33,100,000
Division 02 - Site Work Total		$13,000,000
Sewage Pumping Station		$5,000,000
Headworks Building		$11,000,000
Blower Building		$6,500,000
Primary Clarifiers		$4,200,000
Aeration Tanks		$22,000,000
Secondary Clarifiers		$11,400,000
Tertiary Filtration & UV Building		$30,000,000
Sludge Storage		$9,300,000
Administration Building		$7,000,000
COE		$3,000,000
Soil Anchors		$10,000,000
1A. Construction Cost		**$166,000,000**
1B. Construction Contingency (Steel Price, Concrete price, etc.)	15%	$24,900,000
1C. Project Contingency and Estimating Allowance (Exchange Rate, Tariff Uncertainty & Labour U	30%	$49,800,000
SUB TOTAL CONSTRUCTION COST = 1A + 1B + 1C		$240,700,000
1D. Inflation Rate	3.5%	
1E. Number of Years	4	
Project Construction Inflation		$35,600,000
TOTAL CONSTRUCTION COST		$276,300,000
2) CONSULTANT COSTS (SOFT COSTS)		
2A. Engineering Design and Contract Administration	15%	$24,900,000
2B. Investigative Services	0%	$0
2C. Permits and Approvals	0%	$0
2D. Utility Connections and Relocations		$0
2E. Sub-total Consultant Costs (Soft Costs) = 2A + 2B + 2C + 2D		$24,900,000
Project Contingency	25%	$6,300,000
SUB TOTAL CONSULTANT COST = 2E + 2F		$31,200,000
2G. Inflation Rate	0.0%	
2E. Number of Years	1	
Project Consultant Inflation		$0
TOTAL CONSULTANT COST		$31,200,000
3) LAND COSTS		
3a. Land Acquisition		$0
3B. Legal / Real Estate	10%	$0
3C. Sub-total Consultant Costs (Soft Costs) = 3A + 3B		$0
Project Contingency		$0
SUB TOTAL CONSULTANT COST = 2E + 2F		$0
3E. Inflation Rate	0.0%	
3F. Number of Years	0	
Project Land Inflation		$0
TOTAL LAND COST		$0
TOTAL PROJECT COST		**$308,000,000**
Note: Tax is excluded.		

Conceptual Cost Estimate (Class D)

Dundas WRRF

Like-for-Like Replacement of Existing WWTP

4) O&M COSTS		
Cost Estimate		**Estimated Cost (Total)**
Energy (Aeration)		$460,000
Energy (Recirculation)		$10,000
Energy (Effluent Pumping)		$100,000
Energy (UV)		$40,000
Chemical Consumption (Ferric Sulphate)		$210,000
Biosolids Handling		$20,000
Equipment Maintenance / Replacement		$2,990,000
Labour		$530,000
TOTAL O&M COST		$4,400,000
5) LIFECYCLE COST		
30-year Life Cycle Cost (NPV) for Capital		$277,000,000
30-year Life Cycle Cost (NPV) for Consultant Services		$32,000,000
30-year Life Cycle Cost (NPV) for O&M		$102,000,000
		$411,000,000