7. DEVELOPMENT AND EVALUATION OF DESIGN CONCEPTS FOR WOODWARD AVENUE WWTP

7.1 MAJOR PROCESSES REQUIRING EXPANSION AND UPGRADE

A detailed review of the existing plant capacity, condition and limitations was completed to identify those plant components that require upgrade, replacement, retrofit or expansion to provide capacity for growth, wet weather treatment and meet the performance objectives for the 2031 planning period. The following major process upgrades were identified:

- **Raw wastewater pumping station:** Upgrade to address operational limitations and provide firm capacity equivalent to the capacity of the incoming trunk sewers.
- **Primary treatment:** Upgrade and/or expand to provide a firm capacity of 1,300 ML/d.
- **Secondary treatment:** Expand the capacity from 409 ML/d average day and 614 ML/d peak, to 500 ML/d average day and 1,000 ML/d peak, and upgrade to provide year round nitrification.
- **Tertiary treatment:** New processes to provide tertiary suspended solids and phosphorus removal for the full plant capacity.
- **Disinfection:** Expand the disinfection capacity for the full plant capacity, and provide processes to eliminate chlorine residual.
- **Outfall:** Expand the outfall capacity to be equivalent to the capacity of the raw wastewater pumping station.
- **Biosolids:** Upgrades, including decommissioning of the South digesters, relocation of the WAS thickening facilities, and expansion of the dewatering and cake pumping processes.
- **Power:** Upgrades to provide the power supply for all existing and new processes at the Woodward Avenue WWTP.

7.2 CRITERIA AND CONSTRAINTS FOR EVALUATING DESIGN CONCEPTS

This section presents an overview of the existing facilities that will need to be upgraded, expanded or modified to implement the preferred servicing strategy, and the criteria and constraints to be considered in developing a preferred design concept for implementation of the recommended strategy.

7.2.1 Criteria

Table 10 presents the proposed design and operating objectives for effluent from the expanded and upgraded Woodward Avenue WWTP. Rationale for the design objectives are presented in Appendix 2.
Table 10 Proposed Effluent Quality Objectives for the Woodward Avenue WWTP

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Proposed Design Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total suspended solids (TSS)</td>
<td>3 mg/L (monthly average)</td>
</tr>
<tr>
<td>Total phosphorus</td>
<td>0.15 mg/L (monthly average)</td>
</tr>
<tr>
<td>Ammonia-N</td>
<td></td>
</tr>
<tr>
<td>May to Nov</td>
<td>2 mg/L (monthly average)</td>
</tr>
<tr>
<td>Dec to Apr</td>
<td>5 mg/L (monthly average)</td>
</tr>
<tr>
<td>Carbonaceous Biochemical oxygen demand (CBOD5)</td>
<td>5 mg/L (monthly average)</td>
</tr>
<tr>
<td>E. Coli</td>
<td>200 org/100 mL (monthly geometric mean)</td>
</tr>
</tbody>
</table>

7.2.2 Considerations and Constraints

There are a number of factors, shown in Figure 10, that can affect how the Woodward Avenue WWTP can be upgraded. These constraints include:

- The site capacity is constrained on four sides, by Woodward Avenue to the west, Brampton Street to the south, and by the Woodward Avenue Water Treatment Plant (WTP) to the north. There is an old landfill to the east, which limits the ability to expand in this direction.

- There is a rail spur used to take chlorine gas to service the Woodward Avenue WTP and WWTP and, which travels across the north-east area of the site. This line would need to be relocated if new facilities were to use this area.

- The secondary effluent channel runs from east to west across the site, between the North Plant and digesters. If primary effluent were to be directed to the north-east side of the site for a new secondary treatment plant, this outfall would need to be relocated.

- Controlling odour from the site is required to minimize impacts to residents to the south and west of the site.

- The Biosolids Master Plan (2007) has tentatively identified that the south digesters would not be required in the future, and this land could be available for new liquid processes.

- The existing dewatering and biosolids building area provides capacity for any future on-site processing of biosolids, although some minor expansion may be required.

- The existing power supply to the Woodward Avenue WWTP is insufficient for existing plant processes and requires upgrade in order to accommodate increased flows to the plant.
Figure 9    Woodward Avenue WWTP Site Considerations and Constraints

7.3    RAW WASTEWATER PUMPING

7.3.1    Description of Existing System
The existing Woodward Avenue Wastewater Pumping Station is a manually controlled circular pumping station with a firm capacity of 1,330 ML/d, consisting of seven (7) duty pumps and one (1) standby pump in a wet well/dry pit configuration. Three pumps are equipped with variable frequency drive (VFD) motors and the remaining five are constant speed.
### 7.3.2 Criteria and Constraints

Although 1,300 ML/d is required to be treated, to ensure that all flows that can potentially reach the pumping station can be pumped in emergency situations, pumping station alternatives were based on providing firm capacity equivalent to 1,700 ML/d, which is the total conveyance capacity of the inlet trunk sewers. This will provide operations staff with confidence that the pumping station will not be flooded under high flow, wet weather conditions.

Some deficiencies have been identified with the existing raw wastewater pumping station, including:

- The station has been designed as a single cell wet well which does not permit maintenance and cleaning.
- The station has limited operational wet well capacity, resulting in difficulty controlling the pumps and regular surcharge events to the upstream trunk sewers during normal operations.
- The type of motors installed are designed to operate in dry conditions, however are installed below grade. During abnormally high flow conditions that exceed the capacity of the station, there is a risk of surcharging the wet well and flooding to the elevation of the motors. Similarly if there was a failure of any of the piping, the pump area could flood. Flooding of the motors would result in a catastrophic failure of the entire raw wastewater pumping station.
- The raw wastewater pumping station was constructed nearly fifty years ago and is nearing the end of its useful service life.

### 7.3.3 Description of Alternatives

Three alternatives were identified for providing the required capacity, as described in Table 11.

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS1</td>
<td>New pumping station for Western Interceptor, upgrade existing pumping station with dry pit mounted immersible pumps.</td>
<td>Construct new pumping station for Western Interceptor flows with a capacity of 812 ML/d. Upgrade existing pumping station for flows from Eastern and Red Hill Interceptor with capacity of 916 ML/d, based on dry pit mounted submersible pumps (equipped with immersible motors) in the existing wetwell/dry pit configuration.</td>
</tr>
<tr>
<td>PS2</td>
<td>New pumping station for Western Interceptor, upgrade existing pumping station with dry pit shaft pumps.</td>
<td>Construct new pumping station for Western Interceptor flows with a capacity of 812 ML/d. Upgrade existing pumping station for flows from Eastern and Red Hill Interceptor with capacity of 916 ML/d, based on extension of the long shaft of the existing pump to the at-grade finished floor level of the existing building.</td>
</tr>
<tr>
<td>PS3</td>
<td>One new pumping station for all flows.</td>
<td>Construct a new raw wastewater pumping station to handle 1,700 ML/d consisting of a wet well/dry pit configuration. Decommission the existing raw wastewater pumping station.</td>
</tr>
</tbody>
</table>
7.3.4 Evaluation of Alternatives and Selection of Preferred

A detailed memorandum highlighting the raw wastewater pumping options and evaluation is provided in Appendix 5. Option PS3 was selected as the preferred solution, for the following reasons:

- Only one pumping station will ensure simplest and most reliable operation, and least maintenance.
- Simplest option to construct since it can be constructed off-line and there is no requirement for retrofit of existing structures while still maintaining plant operations.
- Meets all criteria at low capital and life-cycle costs (less than 0.01% higher costs than lowest cost alternative).

The new raw wastewater pumping station is proposed to be constructed on the site of the existing chlorine contact tank, which will require relocation of the contact tank and decommissioning of the existing chlorine contact tank and raw wastewater pumping station.

7.4 PRIMARY TREATMENT

7.4.1 Description of Existing System

There are twelve primary clarifiers at the Woodward Avenue WWTP, providing a total surface area of 11,400 m². The City completed an optimization study in 2005 that showed the clarifiers have a total capacity at flows up to 1,300 ML/d. However, due to limitations in the channels conveying flow to the clarifiers, the capacity was limited to the peak plant capacity of 614 ML/d. The City has since proceeded with upgrades needed to relieve these constraints. That project is scheduled for completion in 2009. The project also identified that adding ferric chloride, with the ability to add polymer, would help to maintain good primary treatment performance under peak flow conditions to meet RAP and F-5-5 treatment objectives.

The City initiated a design and construction project in 2006, to address limitations in the existing clarifiers, so that the full capacity of 1,300 ML/d could be treated. This project also includes pilot evaluation of chemically enhanced primary treatment with ferric chloride and polymer. In addition, sludge pumping equipment is being upgraded to ensure good primary performance into the future.

7.4.2 Criteria and Constraints

The preferred strategy for wet weather treatment recommended a firm peak primary treatment capacity of 1,300 ML/d. During extreme peak flow periods, up to 1,000 ML/d will be treated in primary clarifiers followed by secondary and tertiary treatment, while excess flow, up to 300 ML/d could receive only primary treatment prior to being bypassed.

While the existing clarifiers may provide the full rated capacity, the capacity is reduced when clarifiers are out of service for maintenance identifying the need for additional firm capacity.
7.4.3 Description of Alternative Design Concepts

Five alternative design concepts were evaluated for providing primary treatment capacity for the study period. With the on-going upgrades, the plant will have capability to practice chemically enhanced primary treatment (CEPT). Therefore, two CEPT approaches were considered, as follows:

- Use of CEPT only during peak flow, primary bypassing events to maintain primary treated bypass effluent quality
- Continual use of CEPT, to provide improved primary effluent quality on a continuous basis, and to reduce the size of downstream secondary treatment processes.

Five primary treatment design concepts were identified, as shown in Table 12, and evaluated using the criteria and weights presented in Section 6.

### Table 12 Primary Treatment Design Concepts

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>Existing primary clarifiers</td>
<td>Maintain and operate existing primary clarifiers to provide a peak capacity of 1,300 ML/d and firm capacity of 1,100 ML/d (with two clarifiers off-line), with use of CEPT only during wet weather.</td>
</tr>
<tr>
<td>P2</td>
<td>Existing primary clarifiers with continuous chemically enhanced primary treatment (CEPT)</td>
<td>Maintain and operate existing primary clarifiers with continuous use of CEPT, to reduce size of downstream secondary treatment processes and maintain firm capacity of 1,300 ML/d (with two clarifiers off-line).</td>
</tr>
<tr>
<td>P3</td>
<td>Expand primary clarifier capacity with 2 new clarifiers</td>
<td>Construct 2 new clarifiers to increase the firm capacity to 1,300 ML/d, and use CEPT only during wet weather.</td>
</tr>
<tr>
<td>P4</td>
<td>Expand primary clarifier capacity with a 300 ML/d new high rate treatment facility (using CEPT)</td>
<td>This option is the same as P3, except that additional capacity would be provided by a new high rate treatment facility (that would use CEPT), using less land area.</td>
</tr>
<tr>
<td>P5</td>
<td>Construct a new high rate primary treatment plant (1,300 ML/d)</td>
<td>This option would replace the existing primary treatment tanks with a new high rate primary treatment plant that would use CEPT on a continuous basis. This new plant would require less land area than the existing primary clarifiers, leaving land or tankage available for other processes.</td>
</tr>
</tbody>
</table>

7.4.4 Evaluation of Alternatives and Selection of Preferred

Appendix 5 contains detailed evaluation matrixes for the selection of preferred design concepts for primary treatment.

Option P1 scored lower because it would not provide firm capacity, while Options P4 and P5 were considerably more expensive and would introduce hydraulic bottlenecks, considering the elevations of upstream headworks and downstream secondary processes.

Option P5, a new high-rate treatment plant, was carried forward specifically as compatible with one secondary treatment option (discussed further in Section 7.5).

Based on the evaluation, two design concepts were carried forward and combined with secondary treatment options for evaluation (presented in Section 7.5). These two include:
P2: Use of the existing primary clarifiers with continuous CEPT, thereby reducing the size of downstream secondary treatment processes

P3: Expansion with two new primary clarifiers, and use of CEPT only during peak flow periods.

7.5 SECONDARY/TERTIARY TREATMENT

7.5.1 Description of Existing System

The North Plant has eight rectangular aeration tanks that feed to eight square secondary clarifiers with a circular sludge collection mechanism. Currently, the North aeration tanks are operated as plug flow reactors; however, they can be operated in step feed. Return activated sludge (RAS) is pumped from the secondary clarifiers to the aeration tanks using Archimedes screw pumps.

The South Plant has four square aeration tanks that operate as completely mixed reactors. Downstream of the aeration tanks are four rectangular secondary clarifiers. RAS is pumped to the aeration tanks. The effluent from the North and South secondary treatment systems is combined prior to discharge.

7.5.2 Criteria and Constraints

The preferred strategy is based on providing an average secondary treatment capacity of 500 ML/d and a peak capacity of 1,000 ML/d. The treatment process will also require upgrading to achieve:

- Year round nitrification to remove ammonia
- Tertiary phosphorus removal.

A detailed process capacity review of the existing North and South plants was completed to determine their capacity to achieve ammonia removal and provide peak flow capacity. That review found that the existing secondary plant would only have capacity for 270 ML/d, down-rated from the existing rated capacity of 409 ML/d.

In addition, several deficiencies with respect to the existing North and South plants were identified, including:

- Difficulty in controlling flow distribution to the North tanks
- Constraints in balancing air supply and aeration gates
- Inability to drain aeration tanks
- Hydraulic bottlenecks due to South plant configuration
- Flow control and balancing of the secondary clarifier inlet flows, including limitations with inlet and effluent channel baffles
- RAS balancing and flow monitoring.
In addition, tertiary treatment is required to achieve improved separation of solids from the wastewater (which removes precipitated phosphorus) to meet treatment objectives.

7.5.3 Long List of Alternatives and Screening

Based on the capacity review, additional secondary treatment capacity is required, as well as a tertiary phosphorus removal process.

On December 6, 2005, an ‘expert panel’ workshop was held, with the following goals:

- To create a long list of potential technological concepts to upgrade and expand the Woodward Avenue WWTP
- Using a set of must meet criteria, condense list to feasible concepts
- Via a double weighted matrix, condense the list to 3 or 4 potential technologies that will be brought forward to a more thorough conceptual design.

Participants at the workshop included City staff from Engineering and Plant Operations, members of the KMK and CH2M Hill project team, and industry experts in wastewater treatment process engineering and treatment plant construction. Materials and summary notes from the workshop are provided in Appendix 6.

A detailed review of a full range of technology concepts were considered for upgrading and expanding the Woodward Avenue WWTP. Using a matrix-based evaluation, three general technology concepts were short-listed as the most cost-effective, as follows:

- Conventional activated sludge (CAS), and tertiary filtration using granular media filters
- CAS and tertiary filtration using membrane filters
- Membrane bioreactors (which provide both secondary and tertiary treatment).

Following the workshop, these three concepts were developed further to create six different secondary treatment options, as presented in Table 13. Preliminary site plans were prepared for the six secondary/tertiary options alternatives to determine site capacity and requirements for each. These preliminary layouts are included in Appendix 5.

The six concepts were combined with the two short-listed primary treatment options. Option 56 was unique, in that it was combined with the high-rate primary treatment option (PS) as being the only compatible primary treatment alternative. As a result, a total of 11 primary/secondary treatment options were defined.

Of the options, membrane technology for tertiary MBR (TMBR) and membrane filtration (MF) has not been widely used in the wastewater treatment industry. Recognizing this, the City initiated a parallel pilot evaluation of these processes. The pilot study demonstrated effective treatment using both TMBR and MF, and provided information on design parameters that could be used to refine design requirements using these processes.
Table 13  Secondary/Tertiary Treatment Design Concepts

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>Conventional activated sludge (CAS) with tertiary granular media filtration</td>
<td>Existing plant will be derated to 270 ML/d (to accommodate peak flows and new nitrification requirement). A new 230 ML/d CAS plant will be constructed to operate in parallel. A new tertiary filtration facility will be constructed for the full capacity.</td>
</tr>
<tr>
<td>S2</td>
<td>CAS with tertiary membrane filtration (MF).</td>
<td>This option is similar to S1. Tertiary treatment will be provided by a new membrane filtration facility.</td>
</tr>
<tr>
<td>S3</td>
<td>Existing CAS with tertiary granular media filters and parallel membrane bioreactor (MBR).</td>
<td>Existing plant will be derated to 270 ML/d (to accommodate peak flows and new nitrification requirement). A new tertiary filtration facility will be constructed for the CAS plant. A new 230 ML/d MBR plant will be constructed to operate in parallel.</td>
</tr>
<tr>
<td>S4</td>
<td>Existing CAS with tertiary MF and parallel membrane bioreactor (MBR).</td>
<td>This option is similar to S3. Tertiary treatment for the CAS plant will be provided by a new MF facility.</td>
</tr>
<tr>
<td>S5</td>
<td>CAS with tertiary MBR (TMBR).</td>
<td>The existing CAS plant will be base loaded to provide carbonaceous BOD removal. It will be derated to 315 ML/d (at a peak factor of 1.6) because of the limiting size of the secondary clarifiers. Effluent from the CAS plant, plus bypassed primary effluent will be directed to a tertiary MBR processes sized for the total plant flow.</td>
</tr>
<tr>
<td>S6</td>
<td>High rate treatment with CAS and TMBR.</td>
<td>This option is similar to S5; however, primary treatment would be provided by a new high rate treatment facility, reducing the loading to the existing CAS plant. This will enable the CAS plant to provide some degree of nitrification. With this, and better quality of primary effluent bypassed directly to the TMBR, the TMBR facility design can be optimized. Sub-options could consider elimination of the CAS plant, and/or retrofitting the existing primary tanks for the TMBR process.</td>
</tr>
</tbody>
</table>

As noted, MBR and MF processes are relatively new to the wastewater industry, and while there are a growing number of applications in North America, there are few facilities of the scale of the Woodward Avenue WWTP. To confirm the process selection for this Class EA process, members of City staff and the project team completed due diligence tours of operating facilities, to gain an understanding of the construction, operation and maintenance requirements. As a result of the tours, the City confirmed the preferred technology concept identified through the evaluation. Appendix 7 contains the tour report.

7.5.4 Evaluation of Alternatives and Selection of Preferred

A detailed evaluation of the 11 primary/secondary/tertiary options was completed using the evaluation criteria and weighting developed in Section 6. The preliminary evaluation was presented again to the expert panel on May 28, 2007, and input from the panel was used to finalize the evaluation. The detailed matrixes and cost breakdowns are included in Appendix 5.

As a result of the evaluation, the preferred design concept was identified, to include the following:

- Expansion of the primary clarifiers with two new primary clarifiers
Upgrading of the existing North and South secondary treatment plants, to optimize performance, and down-rating the plant capacity to 270 ML/d (average day flow) and 540 ML/d (peak flow) to provide nitrification. Upgrades include South plant reconfiguration to alleviate hydraulic bottlenecks; replacement or upgrade of the aeration system, including air balancing, aeration gates and provision of additional aeration capacity; and conversion of aeration tanks to 3-pass plug flow configuration to eliminate flow control and RAS balancing problems.

Construction of a new membrane filtration (MF) facility with capacity of 270 ML/d (average) and 540 ML/d (peak) to provide tertiary treatment to secondary effluent from the existing CAS.

Construction of a new membrane bioreactor (MBR) facility, that will run parallel with the existing CAS and new MF plant, to be located in the same facility as the new MF process, to provide secondary and tertiary treatment with a capacity of 230 ML/d (average) and 460 ML/d peak.

As an alternative, the membrane facility could be operated as a tertiary MBR process, where flow from the existing North and South plants would be directed after secondary treatment. Those secondary plants would be operated to provide treatment for organics removal, and secondary effluent would flow to the tertiary membrane bioreactor system for nitrification and tertiary solids and phosphorus removal.

Note: Either membrane configuration is achievable, using the same infrastructure, at the same approximate cost and both are being kept as options moving forward. For costing purposes, the MBR and MF option was carried throughout the report.

The new primary clarifiers will be located to the north of the existing clarifiers.

The location of the new MBR and MF facility will be north of the existing secondary plant. Based on recommendations from the Biosolids Master Plan (2007), the south digesters will be decommissioned, and the new facility will be located in this general area. This will require relocation of the waste activated sludge thickening facilities.

Rationale for selection of this option is as follows:

- Use of the existing CAS plant allows for reuse of existing infrastructure
- The parallel MBR plant has a small footprint, relative to a CAS plant, and can be expanded modularly in the future, whereas the CAS options would use full site capacity
- With a parallel MBR plant, there are two separate process trains, allowing flexibility in operation when tanks must be taken out of service, or if there is a process upset in one side of the plant
- Use of MF rather than granular media filters offers the advantage of shared ancillary equipment between the MBR and MF facilities
- Based on the evaluation, this option ranked among the top 3 in the categories of Environmental and Social criteria.
The process provides adequate tankage and with simple modifications could also be flexible to operate in TMBR mode should the City decide to pursue this configuration at pre-design stage based on pilot study results.

7.6 OUTFALL

7.6.1 Description of Existing System

Currently, raw wastewater bypasses, primary effluent and secondary effluent are combined and conveyed to an outfall that discharges to Red Hill Creek just upstream of Windermere Basin. A hydraulic capacity analysis of the existing outfall had identified that at high Lake level, capacity is limited to about 1,100 ML/d. To provide total capacity for the raw wastewater pumping station firm capacity, approximately 800 metres of the existing outfall, starting from the chlorine contact tank would require replacement or expansion through twinning.

7.6.2 Criteria and Constraints

As discussed in Section 7.2.2, the existing secondary effluent channel runs from east to west across the site, between the North Plant and Digesters. With the recommended secondary treatment concept, primary effluent must be directed to the north side of the site for a new secondary treatment plant. Due to elevations, it is not possible to cross this new primary effluent conveyance to the north side of the site with the existing secondary outfall. Therefore, relocation of the secondary effluent channel is required.

A total outfall capacity equivalent to the raw wastewater pumping capacity of 1,700 ML/d is required.

7.6.3 Description of Alternatives

Two alternatives were identified for providing outfall capacity, as presented in Table 14. Both alternatives are based on relocating the secondary effluent channel, to avoid conflict with the new primary effluent channel to the north of the site. In Alternative O1, the new secondary/tertiary effluent channel would be constructed from the west and across the north of the site, and would connect to the existing outfall, which would be expanded by adding a second channel. Alternative O2 is based on using the existing effluent outfall only for wet weather flows, while constructing a new outfall for secondary/tertiary effluent that would discharge about 900 m upstream in Red Hill Creek. Figure 10 and Figure 11 present schematics of outfall Option O1 and Option O2, respectively.

For the Red Hill Creek (Option O2), the Red Hill Valley Project Team, including specialists in water resources engineering, stream morphology, fisheries and terrestrial ecology reviewed the potential feasibility of O2, evaluated the feasibility and developed conceptual design requirements for this option, to mitigate impacts on stream erosion, fisheries and terrestrial habitats. The team identified upgrades and modifications that would be required to the Red Hill Creek downstream of the proposed outfall to accommodate the higher flows. The detailed feasibility review carried out by this team is included in Appendix B.
Table 14  Outfall Design Concepts

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>O1</td>
<td>Existing outfall for total flow.</td>
<td>Construct a new secondary/tertiary effluent channel, and expand the existing outfall for a total flow of 1,700 ML/d: 1,000 ML/d secondary/tertiary effluent and 700 ML/d wet weather bypass flow.</td>
</tr>
<tr>
<td>O2</td>
<td>New outfall for tertiary treated effluent and existing outfall for wet weather bypass flow.</td>
<td>Construct a new outfall for tertiary treated effluent with a 1,000 ML/d capacity, and maintain the existing outfall for wet weather bypass flows (i.e. raw wastewater and primary effluent) of 700 ML/d.</td>
</tr>
</tbody>
</table>

Additionally, discussions were held with the Ministry of Transportation (MTO) to ensure that any concerns regarding potential impacts to the Queen Elizabeth Way (QEW) Highway, which runs alongside the Red Hill Creek at the location of proposed upgrades are addressed and mitigated to achieve the best possible result for all involved parties. The MTO identified several requirements that must be met in order to allow the implementation of Option O2. Correspondence with the MTO is included in Appendix 9.

The Ministry of the Environment (MOE) was also consulted throughout the project regarding all aspects of the project and correspondence with the MOE is included in Appendix 9.
Figure 10  Option O1: Existing Outfall for Total Flow
Figure 11  Option O2: New Outfall for Tertiary Treated Effluent Flow, Existing Outfall for Wet Weather Bypass Flow

7.6.4 Evaluation of Alternatives and Selection of Preferred

A detailed evaluation matrix for the outfall options is provided in Appendix 5, along with detailed cost breakdowns. Option O2 was selected as the preferred solution, for the following reasons:

- Eliminates the need to relocate the existing secondary effluent channel that currently runs from east to west across the site

- Allows the opportunity to improve the Red Hill Creek upstream of the proposed new outfall in conjunction with the modifications and upgrades required to accommodate the higher flows from this outfall

- The operation of two outfalls under peak wet weather flow conditions provides operational reliability and minimizes the possibility of hydraulic restrictions while also allowing for separate monitoring of bypasses
Eliminates the risk of running an outfall channel in extremely close proximity to the Woodward Avenue Water Treatment Plant

Meet all criteria at lowest capital and life-cycle costs.

As discussed, the MTO provided several criteria that must be met in order to proceed with the preferred solution. The City is confident that these criteria can be met, however, should there be circumstances that do not allow the implementation of the preferred solution, the City will proceed with implementation of Option O1, to utilize the existing outfall for all flows.

7.7 DISINFECTION

7.7.1 Description of Existing System

Currently, raw wastewater bypasses, primary effluent and secondary effluent are combined for discharge to Red Hill Creek. Effluent is disinfected seasonally, from May 15 to October 15, using chlorine. Chlorine gas is brought in by rail car, which is also used by the Woodward Avenue WTP for drinking water disinfection.

7.7.2 Criteria and Constraints

As discussed in Section 7.6, the preferred strategy for the plant is to construct a new outfall for tertiary treated effluent, and to use the existing outfall for wet weather bypass flows (i.e., raw wastewater and primary effluent). While outfall capacity is required for all bypass flows, raw wastewater bypasses in excess of the primary treatment capacity will not receive disinfection and therefore disinfection capacity is required for the following:

- Existing outfall: 300 ML/d
- Secondary/tertiary outfall: 1,000 ML/d

As part of the Class EA study, Hamilton Public Health was contacted to review the requirements for disinfection. The agency recommended that the Woodward Avenue WWTP practice year round disinfection. Related correspondence is provided in Appendix 9.

In addition, under the Canadian Environmental Protection Act (CEPA), elimination of chlorine residual, which is toxic to aquatic life, is required by 2009.

7.7.3 Description of Alternatives

Table 15 and Table 16 present disinfection alternatives evaluated, based on the recommended outfall configurations presented in Section 7.6. For secondary/tertiary effluent, chlorination/dechlorination and ultraviolet (UV) disinfection were evaluated and for the bypass outfall, only chlorination/dechlorination was considered, as with the poorer quality of the bypass flows, UV would not be effective. A new chlorine contact tank is required for the bypass stream, as the new raw wastewater pumping station will be located in the area of the existing station.
All options were based on continued use of the rail car to supply chlorine gas. Dechlorination using both gas and liquid solution systems was evaluated.

<table>
<thead>
<tr>
<th>Table 15: Disinfection Process Design Concepts – Bypass Outfall</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Option</strong></td>
</tr>
<tr>
<td>D1</td>
</tr>
<tr>
<td>D2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 16: Disinfection Process Design Concepts – Secondary/Tertiary Outfall</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Option</strong></td>
</tr>
<tr>
<td>D1</td>
</tr>
<tr>
<td>D2</td>
</tr>
<tr>
<td>D3</td>
</tr>
</tbody>
</table>

7.7.4 Evaluation of Alternatives and Selection of Preferred

Detailed evaluation matrices for the disinfection options are provided in Appendix 5. Option D1 was selected as the preferred solution for both the bypass outfall and the secondary/tertiary outfall, for the following reasons:

- Chlorine gas is currently utilized on site for the Woodward Avenue WTP, and can therefore continue to be used for the Woodward Avenue WWTP with ease and with economy in purchasing bulk quantities.

- Membrane processes achieve high E-coli removal levels and therefore chlorine doses could be reduced for the secondary/tertiary effluent disinfection.

- Meets all criteria at lowest capital and life-cycle costs.

7.8 SLUDGE AND BIOSOLIDS

To serve the expansion and upgrade of the Woodward Avenue WWTP to provide 500 ML/d capacity, the following will be required:

- Relocation and upgrade of the waste activated sludge (WAS) thickening facilities, and decommissioning of the South digesters, so that the site can be used to locate the new MBR and MF facility

- Expansion of the dewatering and biosolids cake pumping facilities

- Relocation of the receiving facilities for biosolids that are hauled to Woodward Avenue WWTP from the Dundas WWTP and Waterdown WWTP (scheduled to be decommissioned).

The City is undertaking a separate Class EA Phase 3 and 4 study to select a preferred design concept for the thermal reduction facilities and associated ash handling process
recommended in the Biosolids Master Plan (2007). The existing building can accommodate these facilities, however minor expansion may be required.

7.9 POWER SUPPLY

7.9.1 Description of Existing System
The Woodward Avenue Water Treatment Plant (WTP) and Woodward Avenue WWTP facilities are currently connected to the Horizon Utilities Corporation’s (HUC’s) distribution systems through two service substations. One substation is located at the Woodward Avenue WTP and one substation is located at the Woodward Avenue WWTP.

The Woodward Avenue WWTP service substation is supplied by two primary HUC feeders that originate from Hydro One’s Beach TS. The Woodward Avenue WWTP primary HV system is 13.8 kV and the secondary system operates at 4.16 kV. The standby power system operates at 4.16 kV and primarily supports the raw sewage pumping station. Similar to the WTP infrastructure, the switchgear and transformers at the existing WWTP are aging. This equipment will need to be replaced and re-sized to accommodate the future WWTP loads.

7.9.2 Future Needs
The existing power supply is insufficient for the increased power demands of the new membrane filtration and membrane bioreactor processes, as well as additional processes and upgrades at the Woodward Avenue WWTP. Additionally, as previously mentioned, the switchgear and transformer equipment are aging and require replacement.

For the Woodward Avenue WWTP, additional conceptual level power requirements for the Woodward Avenue WWTP for new processes, and processes that will be expanded and/or upgraded have been estimated through the Class EA process. At this level, power requirements can be considered within ±15% accuracy, and will be refined through preliminary and detailed design.

Based on demand and anticipated equipment sizing based on expansion of the plant to provide an average daily flow capacity of 500 ML/d, a peak secondary treatment capacity of 1,000 ML/d and a peak raw wastewater pumping capacity of 1,700 ML/d, the additional power demand is estimated to be approximately 17,000 kW.

7.9.3 Preferred Strategy
The preferred strategy is to construct a electrical substation and new power supply and distribution facilities for the site. The new station will be supply power to the Woodward Avenue WWTP and Woodward Avenue WTP.

7.10 ODOUR CONTROL
Currently, odour is controlled at Woodward Avenue WWTP with odour removal systems at the headworks (grit and screening facilities). The City is also installing odour control equipment at the biosolids cake truck loading facility.
In recognition of the community values and concerns, the City committed to odour management for the expansion so that there will be minimal potential for impact to the community. To this end, the expansion project includes measures for odour control.

An approach to odour control was developed as follows:

1. Technologies with minimal potential for odour generation: Odour potential was an important criterion in evaluating all of the technology options and design concepts for the expansion. All existing and new processes will be designed with adequate treatment capacity and contingency to minimize the potential for odour generation.

2. City’s commitment to optimization of operations: The City is committed to maintaining good operations at its treatment plants.

3. Collection and treatment of odours: existing headworks and truck loading facilities have odour control measures in place and additional odour control measures will be identified during detailed design.

7.11 OVERVIEW OF RECOMMENDED WOODWARD AVENUE WWTP UPGRADE AND EXPANSION CONCEPT

7.11.1 Description

Figure 12 shows the preferred design concept for the expansion and upgrade of the Woodward Avenue WWTP to provide reliable capacity and performance for the 2031 planning period. Major components of the design concept are:

- Construction of a new raw wastewater pumping station to replace the existing station, with a firm capacity of 1,700 ML/d
- Expansion of the primary treatment system with two new primary clarifiers to provide a firm primary capacity of 1,300 ML/d
- Upgrading of the existing North and South secondary treatment plants, to optimize performance, and down-rate the plant capacity to 270 ML/d (average day flow) and 540 ML/d (peak flow) to provide nitrification
- Construction of a new membrane filtration (MF) facility with capacity of 270 ML/d (average) and 540 ML/d (peak) to provide tertiary treatment to secondary effluent from the existing conventional activated sludge plant
- Construction of a new membrane bioreactor (MBR) facility, that will run parallel with the existing CAS and new MF plant, to be located in the same facility as the new MF process, to provide secondary and tertiary treatment with a capacity of 230 ML/d (average) and 460 ML/d peak. Alternatively, the MBR facility could be operated as a tertiary MBR facility, in series with the existing secondary treatment plant, using essentially the same process equipment and tanks.
- Construction of a new outfall to deliver tertiary treated, disinfected effluent to the Red Hill Creek
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DESIGN CONCEPTS FOR WOODWARD AVENUE WWTP

- Modifications to approximately 900 m of Red Hill Creek, including stream widening, construction of aquatic and terrestrial habitat improvements

- Construction of two new chlorine contact tanks, one for primary effluent bypasses, and a second for tertiary treated effluent, and new facilities for dechlorination of all chlorinated effluent to meet MOE and CEPA requirements

- Biosolids upgrades, including decommissioning of the South digesters, relocation of the WAS thickening facilities, and expansion of the dewatering and cake pumping processes.

- Power upgrades to provide the necessary power supply for all existing and new processes at the Woodward Avenue WWTP.

New thermal reduction and ash handling facilities recommended through the Biosolids Master Plan are being planned through a separate Phase 3 and 4 Class EA process.
7.11.2 Woodward Avenue WWTP Upgrade Costs

Table 17 presents a capital cost breakdown for the preferred Woodward Avenue WWTP expansion and upgrade design concept.

<table>
<thead>
<tr>
<th>Process</th>
<th>Capital Cost¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw Wastewater Pumping Station</td>
<td></td>
</tr>
<tr>
<td>‣ New Pumping Station</td>
<td>$50,400,000</td>
</tr>
<tr>
<td>‣ Demolition of Existing Pumping Station</td>
<td>$3,000,000</td>
</tr>
<tr>
<td>Primary Treatment</td>
<td></td>
</tr>
<tr>
<td>‣ Channel Upgrades</td>
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</tr>
<tr>
<td>‣ New Primary Clarifiers (2)</td>
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</tr>
<tr>
<td>Secondary/Tertiary Treatment</td>
<td></td>
</tr>
<tr>
<td>‣ Existing North and South Plant Upgrades</td>
<td>$45,000,000</td>
</tr>
<tr>
<td>‣ New Membrane Filtration Facility</td>
<td>$51,900,000</td>
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<tr>
<td>‣ New Membrane Bioreactor</td>
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<tr>
<td>New Bypass Chlorine Contact Tank and Disinfection Facilities</td>
<td>$6,200,000</td>
</tr>
<tr>
<td>New Secondary/Tertiary Chlorine Contact Tank and Disinfection Facilities</td>
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</tr>
<tr>
<td>New Outfall and Red Hill Creek Improvements</td>
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</tr>
<tr>
<td>‣ Outfall</td>
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</tr>
<tr>
<td>‣ Red Hill Creek Improvements</td>
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<tr>
<td>Relocation of WAS Facility</td>
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<tr>
<td>Demolition of South Digesters</td>
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<tr>
<td>Dewatering Process Expansion</td>
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<tr>
<td>Power Supply and Electrical Upgrades</td>
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</tr>
<tr>
<td><strong>Total Capital Cost</strong></td>
<td><strong>$491,400,000</strong></td>
</tr>
</tbody>
</table>

Notes:
1. Includes allowance for engineering, contingency, bonding and inflation.