Regional Municipality of Halton

Burloak Water Purification Plant Phase 2 Expansion Environmental Study Report

Prepared by:
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Halton Region Project Number:
W2581A

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Date:
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April 28, 2012

Mr. Teodor Kochmar, P.Eng., PMP
Regional Municipality of Halton
1151 Bronte Road
Oakville, ON
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Dear Mr. Kochmar:

Project No: 060114069 (2861114700)
Regarding: Environmental Study Report, Burloak Water Purification Plant Phase 2 Expansion

We are pleased to submit a copy of the Environmental Study Report entitled "Burloak Water Purification Plant (WPP) – Phase 2 Expansion." This report provides a description of each step of the decision making process followed during the Class Environmental Assessment Study for the Phase 2 expansion of the Burloak WPP. These steps include:

- Identification of water quality treatment objectives for the expansion
- Development of the evaluation methodology to be used during the development and evaluation of treatment technologies and treatment trains
- Assessment and evaluation of the different alternative solutions
- Selection of the preferred alternative design concept
- Summary of the preferred design concept, anticipated impacts and proposed mitigation measures
- Summary of agency and public consultation activities.

This document comprises the Environmental Study Report (ESR) of the Class EA Study. The ESR document will be available for 30 calendar days on the public record for review by the general public. A Notice of Study Completion will also be released to notify agencies and the public.

Sincerely,
AECOM Canada Ltd.

Sandra Rodriguez, M.Eng., P.Eng.
Project Engineer/EA Lead
Sandra.rodriguez@aecom.com

Encl.

Distribution List

# of Hard Copies	PDF Required	Association / Company Name
0	1	Teodor Kochmar - Regional Municipality of Halton

Revision Log

Revision #	Revised By	Date	Issue / Revision Description
0	SR/TH	January 26, 2012	Issue DRAFT No. 1/Internal QA/QC comments incorporated
1	HN/DK/SR	March 6, 2012	Issue DRAFT No. 2/Region's comments incorporated
2	SR	March 13, 2012	Issue DRAFT No. 3/Additional Region's comments incorporated
3	SR	April 25, 2012	Issue Final ESR/MOE and CH's comments addressed

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Executive Summary

1.1 Introduction and Background

The overall water supply strategy for the Region Municipality of Halton (Region) is established through the Region's Water and Wastewater Master Plan. The Master Plan identifies the growth needs of the Region and the corresponding water treatment capacity requirements at each of the Region's water purification plants including the Burloak Water Purification Plant (WPP).

The 2002 Halton Water and Wastewater Master Plan Review identified the need for a new water treatment plant to treat a future capacity of 220 ML/d in order to meet future water supply needs. The new plant would phase capacity expansions over time, based on Master Plan Review water demand projections derived from Best Planning Estimates, as well as to meet the Region's ability to finance the works. Each expansion phase would be subject to a Class Environmental Assessment (Class EA) study depending on the timing and the degree of expansion required.

The first phase of the new water treatment plant underwent a Class EA Study in 2004. CH2M HILL Canada Limited completed the study and identified the preferred location for the new water treatment plant, along with the preferred treatment technology for this new facility. The project proceeded to the detailed design and construction phase following approval of the Class EA study. The new water treatment plant, located on the south side of Rebecca Street and east of Great Lakes Boulevard, was named the "Burloak Water Purification Plant" to reflect the plant location at the boundaries between the City of Burlington and the Town of Oakville. The new Burloak Water WPP currently has a rated capacity of 55 ML/d.

The Halton Region Master Plan was updated in 2008 to reflect updated population and employment projections, with a focus on the infrastructure needs to 2021. The Halton Region Master Plan was further updated in 2011 under the Sustainable Halton process. The Sustainable Halton Water and Wastewater Master Plan was updated in response to the Province's Places to Grow Plan and in support of ROPAs 37, 38 and 39. Under the Sustainable Halton Master Plan, the available Best Planning Estimates were used to identify the servicing requirements to year 2031.

The preferred servicing strategy in the Sustainable Halton Master Plan identified that the Burloak WPP would require a capacity expansion from the current rated capacity of 55 ML/d to 165 ML/d (Phase 2) by year 2019. An expansion of the Burloak WPP is required to meet the additional water treatment needs of Greenfield and intensification growth across the Region's lake-based service area.

The Sustainable Halton Master Plan was completed under the Approach 2 for Master Plans which satisfied Phases 1 and 2 of the Municipal Class EA process for applicable projects. The Sustainable Halton Master Plan identified the Burloak WPP expansion as a Schedule C activity requiring a separate study to complete the remaining phases of the Municipal Class EA process.

As such, the Region initiated this Schedule C Class EA Study to provide the required additional treatment capacity of the Burloak WPP, also referred to as the Phase 2 expansion. AECOM was retained by the Region to complete this study process and prepare the conceptual design for the Phase 2 expansion of the Burloak WPP.

1.2 Municipal Class Environmental Assessment

All municipal infrastructure projects in Ontario must follow the Municipal Class Environmental Assessment (Class EA) process (Municipal Engineers Association, October 2000 as amended in 2007 and 2011) in order to meet the requirements of the *Environmental Assessment Act* (*EA Act*).

The Municipal Class EA process is a planning and consultation process that covers all aspects of the environment that should be considered during the planning and implementation phases of a project. Projects are put into categories depending on their degree of environmental impact.

The project team identified that an expansion of an existing water treatment plant beyond the existing rated capacity is considered to be a Schedule C project. Schedule C projects are considered to have the potential for greater environmental impacts, and must satisfy all five phases of the Class EA planning process. The phases are described below:

- Phase 1 Identification of the problem or opportunity
- Phase 2 Identification of alternative solutions to the problem or opportunity and their respective impacts to the environment. Evaluation of alternative solutions and selection of a preferred solution considering public and review agency input
- Phase 3 Identification and evaluation of alternative design approaches for the preferred solution. Selection of the preferred design concept based upon public and review agency input
- Phase 4 Documentation of the planning, rationale, design and consultation process in an Environmental Study Report (ESR). The ESR must be available to the public and review agencies.
- Phase 5 Implementation of the preferred alternative design concept and monitoring for environmental provisions and mitigation measures.

Master Plans and their respective updates must meet the requirements of Phases 1 and 2 of the Class EA process. Schedule C projects identified in the Master Plan must complete Phases 3 and 4 of the Class EA process before Phase 5 – Project Implementation can proceed.

Phase 3 of the Class EA process for this project has been completed. Phase 3 involved the assessment of alternative methods of carrying out the project, as well as public and agency consultation. Phase 4 of the Class EA process for this project has been completed and includes the preparation of an Environmental Study Report (ESR) that is filed for public review.

This document summarizes Phase 3 and Phase 4 of this Class EA process. This ESR will be placed on the public record for at least 30 calendar days for review by the general public. Notification to the public, stakeholders and government agencies will take place through the issuance of a Notice of Project Completion. Any concerns that cannot be resolved with the Region during the review period must be directed to the Minister of the Environment (MOE) as a part II Order request. Provided that no significant issues arise during the review period which cannot be resolved in consultation with the Region and that no Part II Order requests are received, the project is then approved and may proceed directly to implementation.

1.3 Water Quality Treatment Objectives

Water quality treatment objectives for the Burloak WPP were reviewed as part of this Class EA Study with consideration given to the water quality treatment objectives for the other two surface facilities in the Region, as well as the overall direction that regulatory agencies across North America are heading towards in terms of water drinking water standards and objectives.

In general, treatment objectives for Phase 2 expansion of the Burloak WPP were defined in terms of:

- Microbiological protection
- Water quality in the distribution system

- Emerging health concerns
- Aesthetics, colour and taste and odour control.

The proposed treatment objectives developed for Phase 2 expansion of the Burloak WPP were considered the minimum requirements that each treatment strategy needed to meet. The treatment objectives were developed to meet or exceed the Ministry of the Environment (MOE) Ontario Drinking Water Standards, Objectives and Guidelines. All treatment process trains considered by this study had to meet, as a minimum, the water quality treatment objectives established for the Burloak WPP.

1.4 Evaluation of Treatment Technologies

A long list of treatment technologies was developed during the early stages of the Class EA Study. Preliminary screening of these technologies was completed based on defined screening criteria, previously agreed upon by the project team. Treatment technologies were short-listed if they were considered feasible for the project and were carried forward for the development of treatment trains.

1.5 Development and Evaluation of Alternative Treatment Trains

The next step in the process was to develop treatment trains using different combinations of the short-listed technologies. Six different main process treatment trains and six residuals treatment trains were developed and evaluated in the next stages of the Class EA Study.

Each alternative treatment train was assessed relative to other options (within their own group) and evaluated against a set of criteria to identify the preferred option. Evaluation criteria were developed in consultation with the Region. The treatment train with the highest score was considered the preferred option that provides the most “Benefits” to this project.

1.6 Preferred Treatment Design Concept

The preferred treatment design concept for the Phase 2 expansion of the Burloak WPP has been selected based on relative evaluation of options, cost benefit analysis, sensitivity analysis and ease of integration with the existing treatment operations at the Burloak WPP. The preferred treatment design concept for the Phase 2 expansion of the Burloak WPP includes Main Process Option P4 with Residuals Option R1, as described below:

- Main treatment comprised of membrane filtration + UV year-round (UV with chlorine during non Taste & Odour season for disinfection and UV with ozone during Taste & Odour season for Taste & Odour control and disinfection)
- Residuals treatment comprised of Equalization Basins + Plate Settler Clarification/Thickening

A simplified process schematic and a plant site layout of the preferred treatment design concept for the Phase 2 expansion of the Burloak WPP is shown in **Figures ES-1** and **ES-2**, respectively.

The proposed plant layout shown in Figure **ES-2** has been developed based on the information available at a conceptual design level and Class EA Study, and may be subject to modifications and/or refinement during the detailed design phases.

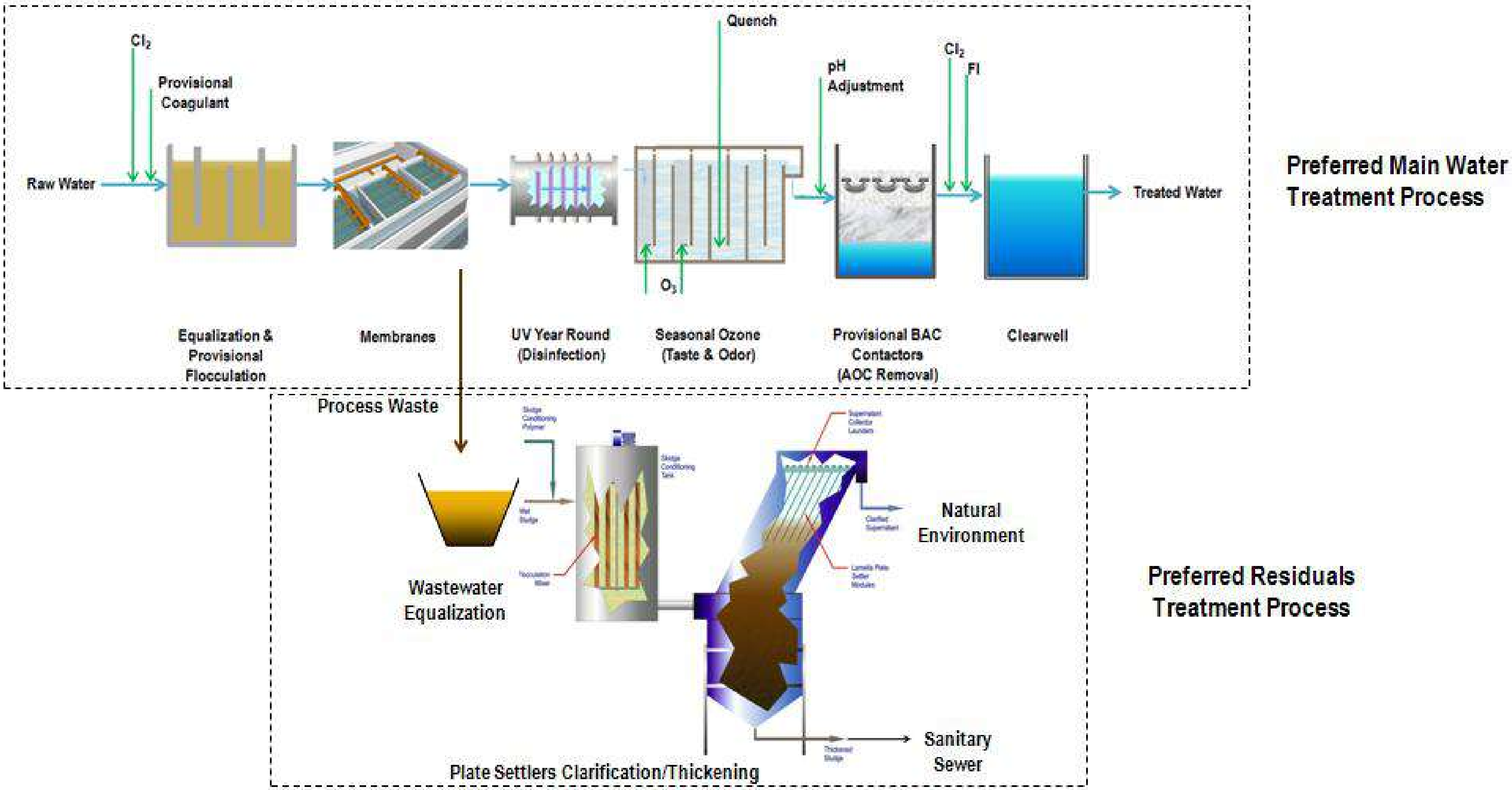

Figure ES-1 Preferred Treatment Design Concept for Phase 2 Expansion of Burloak WPP

Figure ES-2 Phase 2 Expansion of Burloak WPP Conceptual Plant Site Layout

The specific advantages that Option P4 + R1 offers are:

- The proposed main treatment train replicates the existing treatment process train at the Burloak WPP; making the best use of existing infrastructure and providing almost identical operational and maintenance requirements as the existing plant.
- In terms of operational flexibility, this option allows for the plant to operate at full capacity if the ozone system was to ever go down.
- UV can provide higher disinfection credits in the future, if ever required, with minimal effort and costs by simply increasing the UV dosage.

Should the permits/approvals for implementation of Option R1, which requires discharge to the East Sheldon Creek, is not obtained from regulatory agencies, alternate residuals treatment comprising secondary membranes may need to be revisited and reconsidered in the future.

1.6 Implementation Schedule

Based on the current Best Planning Estimates as well as currently known development staging requirements, it is projected that the Burloak WPP expansion will need to be completed in year 2019. On this basis, the anticipated implementation schedule is to commence the detailed design of the recommended Phase 2 expansion approach for the Burloak WPP in 2013 and be completed by 2016. It is anticipated that construction will start in 2016 and will be completed in 2019.

1.7 Proposed Mitigation of Potential Impacts Related to the Expansion Works

As with any other construction project, there will be some potential impacts to the public and environment during construction in areas such as noise, dust, vibration and visuals during the construction period. All construction work must be carried out in accordance with the Occupational Health and Safety Act (OHSA) and other local regulations; however, specific mitigation measures, as described below, are recommended for implementation to reduce the anticipated potential impacts.

1.7.1 Truck Traffic

Most of the construction activities will be limited to the existing site boundaries. Increased truck traffic will be experienced during the duration of construction from the delivery of construction equipment, construction materials and removal of excavated material from the site. The proposed mitigation measures include the following:

- Appropriate hours of work will be specified in the contract.
- Truck access to and from the site will be limited to the existing entrance on Rebecca Street, avoiding residential areas.
- Any lane closures will be completed in accordance with best practices to protect safety to the workers and to the general public.
- Residents in the area will be kept informed ahead of time of any road closures and anticipated timing, as well as the overall schedule of construction.
- All standard best practices for vehicle and pedestrian safety will be employed throughout the construction areas. All construction will adhere to strict safety guidelines.

1.7.2 Noise

Potential noise effects may occur due to construction traffic and construction equipment. Noise during operation of the expanded buildings is not expected to be different from the existing conditions. The proposed mitigation measures include the following:

- Ensuring all vehicles and construction equipment are equipped with effective muffling devices and are operated in a fashion too minimize noise in the project area.
- Throughout the construction period, the Region will ensure the contractors undertake measures to reduce noise disturbances as much as possible.

1.7.3 Dust and Mud

Construction traffic could create additional dust and mud. The proposed mitigation measures include the following:

- Dust control measures such as the application of water to be implemented as required.
- The Region will ensure that the contractor maintain public roadways clean and free of mud on a consistent basis.

1.7.4 Vibration

Based on the soil information available and the proposed expansion, excavation is expected to be carried out by drilling in the rock using large excavators to remove the rock. Some vibration may be felt; however, damage to structures or cosmetic damage is unlikely due to the distances of residences away from the site. Completing a pre-construction survey of the close dwellings and businesses prior to construction is recommended to avoid any future issues during or post-construction. In addition, drilling will be confined to the working hours permitted under the local by-laws.

1.7.5 Visual/Architectural

The proposed expanded buildings will be designed to complement the architectural style of the existing buildings and use same/similar features for the expansion including new wave roofs over expansion wings. The materials to be used will complement the facades of the existing buildings.

1.7.6 Landscaping

The site will be landscaped following construction of the expanded facilities. A detailed landscape concept will be developed during detailed design. The landscape plans will include adequate vegetated buffer areas with berms, where appropriate, and mature trees to block visibility to the site as much as possible.

1.7.7 Disturbance of Existing Natural Environment

There is limited vegetation on the existing site in the areas that are proposed for expansion. However, the proposed mitigation measures include the following:

- A buffer zone to protect the woodlot within the eastern boundaries of the plant site will be part of the design to ensure the area is not disturbed during construction.
- Construction areas will be re-planted and re-vegetated after the expansion is complete.
- Erosion and sedimentation control measures will be placed around the construction areas, where appropriate.

- A monitoring plan of the East Sheldon Creek will be developed during detailed design and submitted to Conservation Halton and the Town of Oakville for review and approval. The monitoring activities will be implemented at stages and frequencies specified in the approved monitoring plan.

1.7.8 Fuel Spills

Spills could potentially occur when refueling construction equipment. The proposed mitigation measures include the following:

- Proper construction techniques will be applied to reduce the risk of spills.
- A contingency plan for cleaning up fuel spills will be developed and ready for implementation, particularly when working in proximity to the East Sheldon Creek.
- Equipment required to clean up a spill will be contractually required to be on-site at all times.

1.7.9 Geotechnical Considerations

Based on the findings of the previous geotechnical investigation completed for Phase 1 of the Burloak WPP (July, 2005), the site conditions encountered during construction of Phase1, and the proposed works, the proposed mitigation measures include the following:

- A detailed geotechnical investigation will be carried out to assist during the design and construction of Phase 2 expansion.
- It is recommended that the top of the rock elevation across the remainder of the site is verified. The results of this investigation would provide an indication on whether the new facilities would be founded in the clay layer or in the rock, and determine whether additional boreholes need to be drilled around the new infrastructure.
- The new excavation may require drilling of the shale to facilitate removal, control of granular bedding below existing structures, shoring of existing structures and control of groundwater and surface water.
- Excavation dewatering is expected to be required from precipitation and ground water entering the excavation and/or entering the granular fill around the existing facilities.
- Based on the reported slow percolation rates through the rock and clay layers, a permit to pump is not expected to be required.
- The site should be graded to prevent run off from entering the excavation as much as possible with the remaining groundwater and precipitation to be removed by sump pumps around the perimeter of the excavation.
- Discharge will be directed to a temporary discharge siltation pond that will be sized to provide sufficient detention time before the water percolates through the soil. The temporary siltation pond will be located within the plant site and maintained during construction by removing silt build-up from time to time to keep its functionality.
- Dewatering operation will employ appropriate filter screens so that no soil or foundation material is removed, and to control solids concentrations in the discharge.
- Prior to trench or excavation, the locations and depths of existing underground utilities must be verified.

1.8 Public Consultation

Schedule C of the Class Environmental Assessment planning process requires that members of the public, interest groups and review agencies are given opportunities to provide input and comments from the early stages of the Class EA Study. The project team met this requirement by providing a Notification of Study Commencement and public notices for three separate public meetings. The public notices were distributed to residents in the vicinity of the Burloak WPP and placed for two consecutive publications in three separate local newspapers: the Burlington Post, Oakville Today and the Oakville Beaver. Information regarding the progress of the Burloak WPP Class EA Study for the Phase 2 expansion was provided at each public meeting.

General items discussed during the public meetings were in regards to the new buildings footprint and height, architecture of the new building, landscaping, and construction limits. The Region will address all issues related to landscaping, building footprint and the exterior look of the expanded facility during the following phases of the Class EA process, which relate to detailed design and project implementation.

A Notice of Study Completion will be published in the local newspapers and distributed to all in the project contact list. The Notice of Study Completion will include enough information to advice the public and review agencies of the locations where the Environmental Study Report will be filed for public review, the time period to provide comments, and the opportunities to raise any major concerns to the Ministry of Environment, if such concerns cannot be resolved with the Region during the review period.

Public consultation will continue to be of paramount importance during design and construction of this project. The Region will continue to inform the public and provide updates as the project progresses. The Region's website will be regularly updated with project details throughout the design and construction stages, and neighbouring residents will be kept informed throughout the stages of construction.

A communication program will be in place before and during construction to inform residents about future construction activities and possible road closures, if required. The communications program will include a dedicated contact person from the Region who would be available to respond to any immediate issues or concerns that may come up before or during construction.

Table of Contents

List of Figures

List of Tables

Appendices

1. Introduction

1.1 Background

The overall water supply strategy for the Region Municipality of Halton (Region) is established through the Region's Water and Wastewater Master Plan. The Master Plan identifies the growth needs of the Region and the corresponding water treatment capacity requirements at each of the Region's water purification plants including the Burloak Water Purification Plant (WPP).

The 2002 Halton Water and Wastewater Master Plan Review identified the need for a new water treatment plant to treat a future capacity of 220 ML/d in order to meet future water supply needs. The new plant would phase capacity expansions over time, based on Master Plan Review water demand projections derived from Best Planning Estimates, as well as to meet the Region's ability to finance the works. Each expansion phase would be subject to a Class Environmental Assessment (Class EA) study depending on the timing and the degree of expansion required.

The first phase of the new water treatment plant underwent a Class EA Study in 2004. CH2M HILL Canada Limited completed the study and identified the preferred location for the new water treatment plant, along with the preferred treatment technology for this new facility. The project proceeded to the detailed design and construction phase following approval of the Class EA study. The new Burloak WPP Phase 1 was commissioned in spring 2010 with a rated capacity of 55 ML/d.

The new water treatment plant is located at 3380 Rebecca Street in Oakville on the south side of Rebecca Street and east of Great Lakes Boulevard. It is named the "Burloak Water Purification Plant" to reflect the plant location at the boundaries between the City of Burlington and the Town of Oakville. The location of the Burloak WPP is shown on the map in Figure 1.

The Halton Region Master Plan was updated in 2008 to reflect updated population and employment projections and will focus on the infrastructure needs to 2021. The Halton Region Master Plan was further updated in 2011 under the Sustainable Halton process. The Sustainable Halton Water and Wastewater Master Plan was updated in response to the Province's Places to Grow Plan and in support of ROPAs 37, 38 and 39. Under the Sustainable Halton Master Plan, the available Best Planning Estimates were used to identify the servicing requirements to year 2031.

The preferred servicing strategy in the Sustainable Halton Master Plan identified that the Burloak WPP would require a capacity expansion from the current rated capacity of 55 ML/d to 165 ML/d (Phase 2) by year 2019. An expansion of the Burloak WPP is required to meet the additional water treatment needs of Greenfield and intensification growth across the Region's lake-based service area. All treatment processes in the Burloak WPP, with the exception of the intake structure, tunnel and pipe will need to be expanded to provide the future rated capacity of 165 ML/d.

The Sustainable Halton Master Plan was completed under the Approach 2 for Master Plans which satisfied Phases 1 and 2 of the Municipal Class EA process for applicable projects. The Sustainable Halton Master Plan identified the Burloak WPP expansion as a Schedule C activity requiring separate study to complete the remaining phases of the Municipal Class EA process.

As such, the Region initiated this Schedule C Class EA Study to provide the required additional treatment capacity of the Burloak WPP, also referred to as the Phase 2 expansion. AECOM was retained by the Region to complete this study process and prepare the conceptual design for the Phase 2 expansion of the Burloak WPP.

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Figure 1 Burloak Water Purification Plant Location

1.2 Objectives of the Class EA Study

The main objective of this Class EA Study is:

> "To objectively evaluate process options and identify the preferred treatment design concept to upgrade the existing Burloak WPP to a potable water production capacity of 165 ML/d. The preferred treatment design concept should be sustainable, technically and environmentally sound and economically mindful in terms of capital and operating costs."

Other Class EA objectives include:

- To provide extensive consultation with all affected and interested parties, including participation of a broad range of stakeholders to allow for the sharing of ideas, education, testing of creative solutions and developing alternatives
- To document the study process in compliance with all phases of the Municipal Class EA planning process.

This Environmental Study Report (ESR) completes Phases 3 and 4 of the Class EA requirements and provides a description of the preferred treatment design concept for the Phase 2 expansion of the Burloak WPP.

1.3 Objectives of the Environmental Study Report

The ESR describes the planning and decision making process followed during the Class EA Study for Phase 2 capacity expansion of the Burloak WPP. The ESR describes the:

- Various alternative solutions and design concepts considered for the plant expansion
- Evaluation methodology and evaluation criteria used to assess the different alternatives
- Anticipated potential impacts
- Proposed mitigation measures associated with the alternatives
- Rationale for the selection of the preferred solution and implementation plans.

The Class EA process also gives members of the public, interest groups and review agencies a chance to review the ESR during a 30-day review period. The 30-day review period gives individuals an opportunity to raise outstanding concerns regarding the project with the Region. If issues cannot be resolved by the Region during this period, an individual may request that Minister of the Environment takes action. The Minister will make an order for the project to comply with Part II of the *Environmental Assessment Act* by requiring the project to follow the requirements of an individual environmental assessment. The request must be submitted in writing to the Minister. If no Part II Order requests are received within the 30-day review period, the project will proceed through the detailed design and construction phases outlined in the ESR.

1.4 Report Outline

This report was prepared to meet the requirements of the Ontario Municipal Engineer's Association (MEA) Municipal Class EA Planning Process (October 2000, as amended in 2007 and 2011). This report combines all phases of the planning process under one cover and includes steps that are considered essential for meeting the requirements of the *Environmental Assessment Act* (EAA). The report includes the following sections:

Section 1: Introduction – Provides background information leading to the initiation of this study, provides the objectives of both the Class EA Study and the ESR, and describes the format of this report.

Section 2: Class Environmental Assessment Process – Provides a summary description of the framework and activities to be completed to meet the Municipal Class EA process requirements.

Section 3: Public Agency Consultation Process – Summarizes the public and agency consultation activities undertaken throughout the Class EA.

Section 4: Study Area Overview – Summarizes the existing environmental features within the study area, including natural environment, social environment, archaeological and geotechnical conditions of the site.

Section 5: Existing Plant Overview – Provides a brief description of the existing treatment plant processes.

Section 6 Design Criteria – Provides a summary of the flows and water quality treatment objectives considered as the basis for the Phase 2 expansion of the Burloak WPP.

Section 7: Evaluation Process – Details the evaluation methodology applied to the technology options for the main treatment process and the residuals treatment process.

Section 8: Overview of Treatment Technologies – Describes treatment technology options typically used at water treatment plants for both the main process and residual process streams.

Section 9: Preliminary Screening Results – Examines each treatment technology noted in Section 8 and eliminates those which are not feasible for the Burloak WPP.

Section 10: Development of Alternative Treatment Trains – Based on the technologies short-listed in Section 9, presents treatment trains for the main process and residuals treatment systems to be evaluated in further detail.

Section 11: Evaluation Criteria – Provides a summary of the evaluation criteria developed in consultation with the Region and used to evaluate the alternative treatment trains listed in Section 10.

Section 12: Alternative Treatment Trains Evaluation Results – Using the established evaluation criteria, assesses the treatment train options in Section 10, provides the results of the evaluation process including the benefit-to-cost ratio evaluation and the sensitivity analysis, ultimately providing a recommended treatment design concept.

Section 13: Evaluation of Alternative Discharge Options – Provides a summary of the evaluation completed to determine the preferred option for discharge.

Section 14: Preferred Treatment Design Concept – Explains the preferred treatment design concept, preliminary expansion layout and other process components. Also, provides implementation timeline of the preferred option as well as the associated permits and approval needed prior to start of construction.

Section 15: Proposed Mitigation of Potential Impacts and Monitoring – Summarizes the proposed mitigation measures recommended to be undertaken to minimize potential anticipated impacts.

2. Class Environmental Assessment Process

This section provides a brief overview of the Municipal Class EA process and the steps involved in bringing a municipal infrastructure project to the design and construction phases. These steps are identified for the Burloak WPP Phase 2 expansion project.

2.1 Municipal Class Environmental Assessment

This project was completed under the Class EA process developed by the Municipal Engineers Association for Municipal Water and Wastewater Projects. The Municipal Class Environmental Assessment (MEA, October 2000 as amended in 2007 and 2011) is an approved process that proponents of municipal infrastructure projects must follow in order to meet the requirements of the *Environmental Assessment Act* (*EA Act*). All municipal infrastructure and new water supply projects in Ontario are subject to the Municipal Class EA process.

The Municipal Class EA was created to ensure that all aspects of the environment are considered during the planning and construction phases of a project. The Class EA process outlines the steps that must be followed to satisfy the EA requirements for water, wastewater and road projects.

The various parts of the Municipal Class EA are described in Figure 2, located at the end of Section 2. In summary, the five phases are:

- Phase 1 Identification of the problem or opportunity
- Phase 2 Identification of alternative solutions to the problem or opportunity and their respective impacts to the environment. Evaluation of alternative solutions and selection of a preferred solution considering public and review agency input
- Phase 3 Identification and evaluation of alternative design approaches for the preferred solution. Selection of the preferred design concept based upon public and review agency input
- Phase 4 Documentation of the planning, rationale, design and consultation process in an Environmental Study Report (ESR). The ESR must be available to the public and review agencies.
- Phase 5 Implementation of the preferred alternative design concept and monitoring for environmental provisions and mitigation measures.

Public and agency consultation is an important part of the Class EA planning process. Gaining input from individuals and groups can help identify project concerns early, and to find ways to address concerns wherever possible. Public consultation is carried out at key stages of the Class EA process to allow time to review and provide input related to the project.

Projects subject to the Class EA process are classified into three possible "schedules" (or categories), depending on the degree of expected impacts:

- Schedule A or A+ projects; are minor, operational and maintenance activities and are approved without the need for further assessment.
- Schedule B projects require a screening of alternatives for their environmental impacts and Phases 1 and 2 of the planning process must be completed.
- Schedule C projects must satisfy all five phases of the Class EA planning process. These projects have the potential for greater environmental impacts. Phase 3 involves the assessment of alternative methods of carrying out the project, as well as public consultation on the preferred design concept. Phase 4 includes the preparation of an Environmental Study Report (ESR) that is filed for public review.

2.2 The Burloak WPP Phase 2 Expansion Class Environmental Assessment Process

The Municipal Class EA states that the "*expansion of an existing water treatment plant beyond the existing rated capacity*" is considered a Schedule C project. This matches the purpose of the Burloak WPP Phase 2 expansion and leads to a Schedule C-rated project. Master Plans and their updates must meet the requirements of Phases 1 and 2 of the Class EA process. Schedule C projects identified in the Master Plan should complete Phases 3 and 4 of the Class EA process before Project Implementation (Phase 5) can proceed.

Phase 3 for the Burloak WPP expansion project has been completed as part of this Class EA process. Phase 3 involved the assessment of alternative methods of carrying out the project, as well as public and agency consultation. Phase 4 includes the preparation of an Environmental Study Report (ESR) that is filed for public review. This document summarizes Phase 3 and Phase 4 of this Class EA process.

The ESR will be placed on the public record and will be available for review by the general public for at least thirty (30) calendar days. Agencies and the public will be notified through the issuance of a "Notice of Project Completion". Provided that no significant issues arise during the review period which cannot be resolved in consultation with the Region, and also that no Part II Order requests are received, the project will be approved and may proceed directly to implementation. Part II Order requests must be directed to the Minister of the Environment.

2.3 Information on Part II Order Requests

Under the Class EA planning process, there is an opportunity for the Minister or delegate to review the status of a project. Members of the public, stakeholders and review agencies may request the Minister or delegate to ask a proponent to comply with Part II of the Environmental Assessment Act (which addresses individual EAs), before proceeding with construction of a proposed project. This is known as a **Part II Order**.

The procedure for dealing with concerns which may result in the Minister to order a proponent to comply with Part II of the EA Act is as follows:

- Concerns regarding the project should be brought to the attention of the proponent during Phase 2 through Phase 4 of the planning process.
- If the concern is not resolved through discussions with the proponent, the person or party raising the objection must write to the Minister of the Environment and request a Part II Order. The written request shall be copied by the requester to the proponent at the same time that is submitted to the Minister.
- For Schedule C projects, a written request must be submitted to the Minister within the 30 calendar day review period after the proponent has filed the ESR in the public record for review and has issued the Notice of Project Completion. Requests made or received after the 30 calendar day review period will not be considered.

A request to the Minister must be in wiring and must address the following issues as they related to the concern:

- Environmental impacts of the project and their significance
- The adequacy of the planning process followed by the proponent
- The availability of other solutions to the project
- The adequacy of public communication and consultation program and opportunities given to the public for comments
- The nature of the specific concern that remains unresolved
- Details of any discussions between the requester and the proponent about the concern being raised

- The benefits of requesting the proponent to complete an individual environmental assessment
- Any other relevant information.

If a concern of a Part II Order request is resolved by the proponent to the satisfaction of the requester, it is the responsibility of the requester to withdraw the request. Withdrawals should be made in writing to the Minister and copied to the proponent.

The Minister considers the request and both sides of the argument and makes one of the following decisions:

- Deny the request
- Refer the request to mediation
- Order the proponent to comply with Part II Order to the EA Act.

2.4 Problem/Opportunity Statement

Phase 1 of the Class EA planning process requires the proponent of an undertaking to first document factors leading to the conclusion that the improvement is needed, and develop a clear statement of the problem/opportunity to be investigated.

The problem/opportunity statement for the Burloak WPP Municipal Class EA Study has been defined as follows:

> *The Region's Best Planning Estimates and corresponding water demand projections as set out in the Sustainable Halton Water and Wastewater Master Plan which was recently updated by the Region in 2011, have triggered the next expansion phase of the Burloak WPP. The next facility expansion from 55ML/day to 165 ML/day is required to provide additional water supply capacity for projected population and employment growth identified in the Best Planning Estimates. The expansion also provides the opportunity to design the project to achieve the Region's municipal service delivery objectives and further develop how the site is integrated with its neighbours and surrounding community.*

2.5 Alternative Solutions

The Halton Region Master Plan, including the 2002 Master Plan Review, 2008 Master Plan Update and 2011 Sustainable Halton Water and Wastewater Master Plan, has fulfilled Phases 1 and 2 of the Class EA planning process for the water treatment options.

Phase 2 of the 2002 Halton Water and Wastewater Master Plan Review included the evaluation of the following alternative planning solutions:

- WS-1: Provision of capacity through both an expansion of the Oakville WPP as well as a new plant in Halton
- WS-2: Provision of all of the needed capacity by a new plant in the Region
- WS-3: Provision of capacity through both an expansion of the Oakville WPP as well as servicing from the South Peel water system
- WS-4: Provision of all of the needed capacity from the South Peel water system.

Through evaluation of the above alternative planning solutions, the preferred water servicing alternative identified in the 2002 Master Plan Review was WS-2, provision of all of the needed capacity by a new plant in the Region. As documented in the master plan review, the new Burloak WPP was designed based on phased expansions, with the first phase of the plant commissioned in 2010.

Further review of the water supply strategy under the Sustainable Halton Master Plan identified a revision to the implementation approach for additional treatment capacity. A further assessment of the Oakville Water Purification Plant (WPP) determined that the Oakville WPP could be optimized from a process perspective to increase its production capacity, providing a timely and cost effective approach for provision of additional capacity. The Sustainable Halton Master Plan confirmed that overall implementation plan is based on expanding Oakville WPP followed by the Phase 2 expansion at the Burloak WPP.

2.6 Water Efficiency

2.6.1 Water Opportunities and Water Conservation Act

The *Water Opportunities and Water Conservation Act,* 2010 (Bill 71) was passed by the provincial government on November 29, 2010. The act establishes a framework to drive innovation, create economic opportunities, sustain water infrastructure and conserve Ontario's water. Municipalities are required to have a Municipal Water Sustainability Plan which includes:

- An asset management plan
- A financial plan
- A water conservation plan
- Strategies for maintaining and improving the municipal water service
- A risk assessment
- Other prescribed information.

Water Conservation Plans must include a summary of annual water use for each of the public agency's operations and track the progress towards targets established during agency consultation. The MOE encourages water conservation programs and targets that work well with the EA planning process and project design.

2.6.2 Halton Region Water Efficiency Program

Water efficiency programs are important for the long term planning of the water and wastewater systems. The Region continues to implement and support water efficiency efforts through its numerous initiatives such as:

- Rebate programs to encourage existing residents to retrofit homes and replace old fixtures with high efficiency models
- Water use optimization and reduction programs such as providing rain barrels or pilot programs to reduce water wastage
- Education and outreach programs including the annual Halton Children's Water Festival and Outdoor Water Use Strategy.

The Region continues to annually monitor the Regional water system supply capacity and demand to compare actual growth uptake with the theoretical growth projections. The Region also reviews the overall water servicing strategy every five years to make use of updated population and employment estimates and respond to changes in residential and employment water use in the Region. A detailed description of the Region's water efficiency strategy is provided in the 2011 Sustainable Halton Water and Wastewater Master Plan.

The water conservation and efficiency review under the Sustainable Halton Master Plan resulted in a 5% reduction in water demand projections.

2.7 Alternative Design Concepts

Phase 3 of the Class EA process requires the identification and evaluation of alternative methods of implementing the preferred alternative solution with consideration given to the existing environment and input received from the public and review agencies. A number of treatment technologies and treatment trains were developed and evaluated in terms of technical merits, social considerations, and natural environmental and economic considerations. An evaluation methodology was developed and carried forward to help project team select the preferred option for the Phase 2 expansion of the Burloak WPP. Public and agency consultation was also completed at key stages of the project. A description of these activities and the results is provided in the following sections of this report.

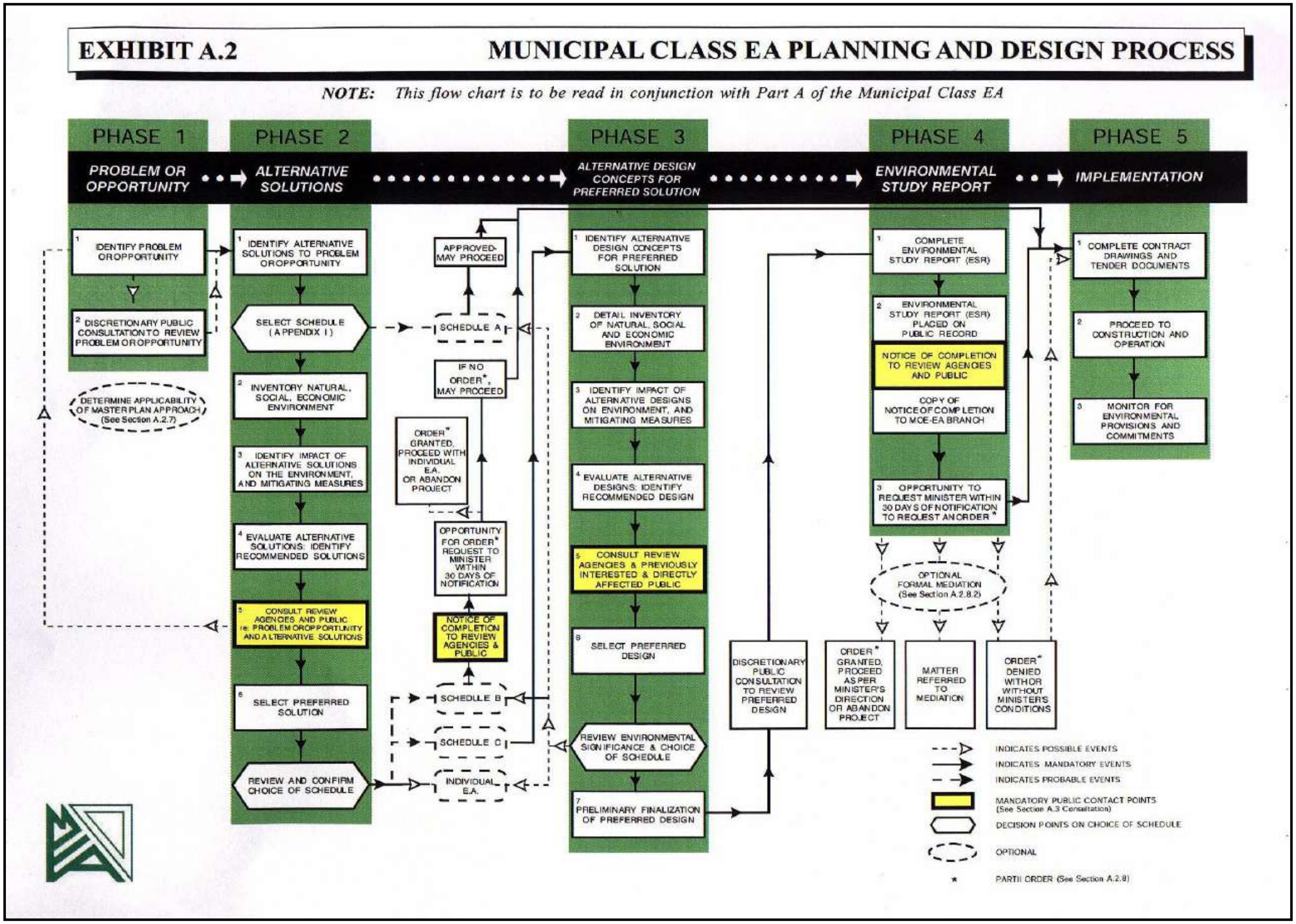


Figure 2 Municipal Class Environmental Assessment (EA) Planning and Design Process

3. Public and Agency Consultation Process

Public consultation is an important part of the Class EA Study process. Successful public consultation programs play an important part of building and maintaining community trust and credibility, improving project decision-making, and identifying community early. This Class EA Study made use of a public consultation that was created specifically to the needs and interests of this project.

The public and agency consultation activities undertaken at key stages of this Class EA Study are included in this section. For further reference, Appendices A and B provide additional details regarding agency and public consultation activities and events.

3.1 Public Consultation and Communication Program

The public consultation and communication program for the Burloak WPP Phase 2 expansion provided information and engagement opportunities for the community over the course of the Class EA Study. Consultation and communications occurred during the first phase of the construction of the facility and was carried on during the Phase 2 expansion process. The team was careful to support the Region's practice of providing opportunities for dialogue and participation by the public in a manner that is meaningful, fair and transparent.

The consultation program developed for this Class EA Study focused on both public education and public consultation.

- **Public Education** refers to the information sent to community members to explain the project, the need for the expansion, the process, timelines, how issues would be addressed, and to dispel myths or allay fears.
- **Public Engagement** refers to the active process of seeking and receiving comments from the general public (to be collected, read, and/or provided with a response).

3.1.1 Objectives of Public Consultation and Communication Program

The project team firmly believes that the quality of decisions would be improved by seeking out and acting on input from the public and stakeholders. The public consultation and communication program was designed to:

- Inform the interested public and stakeholders about the project and provide information that is timely and factual
- Facilitate and communicate opportunities for public input
- Promote a public consultation strategy that includes stakeholders as valued participants
- Tailor the consultation and communication program to the specific needs of the interested members of the public and stakeholder groups, while meeting and exceeding all legislated requirements
- Involve stakeholders by identifying appropriate mitigation measures and to assure them that these measures will be implemented.

3.1.2 Stakeholders

Various groups of stakeholders which may have an interest in the Burloak WPP Phase 2 Expansion Class EA were identified. These stakeholders groups were outlined below:

- Residents: this included residents that live within the immediate vicinity and in the greater community. Residents who live closest to the study area may have greater concerns about the project. It was anticipated that landowners within 300 metres of the plant site may have the greatest likelihood of experiencing potential impacts from the expansion. The project team used specific public consultation and communication efforts to reach residents within the 300 metres radius of the site including direct mailing of letters and invitations to the public meetings. Figure 3 shows the overall location of the plant site (highlighted in red) and the properties within a 300 metres radius of the plant site (highlighted in green).

- Regional and Local Ward Councillors
- Environmental stakeholders and conservation authorities
- Business owners near the Burloak WPP: There is a strip mall with a dozen businesses immediately to the west of the existing Burloak WPP.
- Review agencies: Provincial ministries and agencies, Federal Government departments and agencies, local area municipalities, district and planning boards, emergency services (fire, police, ambulance), school boards, transit, utilities (natural, gas, cable, telephone, etc.)
- Aboriginal groups: Provincial and Federal agencies such as the Ontario Ministry of the Attorney General, Indian and Northern Affairs Canada, the Ministry of Aboriginal Affairs, Ontario Secretariat of Aboriginal Affairs, and the Chiefs of Ontario. In addition, first nations groups such as Union of Ontario Indians Nipissing First Nation, Mississaugas of the New Credit, Métis Nation of Ontario, Association of Iroquois and Allied Indians, Six Nations of the Grand River Territory, Haudenosaunee Confederacy Chiefs Council, were also contacted.

The project team developed a comprehensive Project Contact List at the beginning of the Class EA Study to include all stakeholders considered to have an interest in the project. A copy of the Project Contact List is included in Appendix A for further reference.

3.1.3 Public Consultation, Communication Strategies and Tactics

The public consultation and communication program included a wide range of strategies to ensure that local residents and interested parties were informed about the project activities. The following activities were completed as part of this public consultation and communication effort:

- **Project Contact List:** The master project contact list included residents, members of community groups, representatives from relevant government and regulatory agencies, interested business, utilities, landowners, developers, and a number of technical review agencies and organizations. Interested members of the public were added to the project mailing list if requested and individuals and groups on the list were kept informed about project developments using direct mail outs. All individuals on the project list were contacted at the appropriate stages of the study to inform them about meetings and events.

- **Notice of Study Commencement:** A “Notice of Study Commencement” was placed in the Oakville Beaver newspaper on February 4, 2011. Copies of the notice were sent to all individuals and groups on the project mailing list. A copy of the Notice of Study Commencement is provided in Appendix C.

- **Neighbourhood Drop-in Meeting:** The first meeting for this project was the Neighbourhood Drop-in session held on April 19, 2011 from 7:00 p.m. to 9:00 p.m. The event was held at the Burloak WPP at 3380 Rebecca Street in Oakville, Ontario. This meeting was held at the project location in anticipation that the nearest neighbours and business owners would be most interested in the project plans and should be provided with a chance to learn more about the project. The meeting was held exclusively for nearby homeowners and local area business owners to meet members of the Class EA team, learn more about the project, tour the existing plant, and provide feedback on the information presented. The Town of Oakville Ward 1 Councillor was the only attendee at the neighbourhood drop-in session. Drop-in invitations for the Neighbourhood Drop-in were sent as postcards to residents and local businesses with a direct view of the existing plant on April 4, 2011. A copy of the Drop-in invites and information provided and displayed as part of this meeting is included in Appendix B.

- **Public Information Centre (PIC) No.1:** A second public meeting was held on April 28, 2011 from 7:00 p.m. to 9:00 p.m. at the Burloak WPP at 3380 Rebecca Street in Oakville, Ontario. Facility tours were conducted at 7:30

and 8:00 p.m. The meeting allowed all stakeholders that may have an interest in this project to learn more about the project, tour the existing plant, and provide feedback on the information presented. Approximately 17 people attended the meeting and two separate tours of the plant were given as requested by attendees. The project team felt that the atmosphere of PIC No.1 was fairly positive. More than one person commented informally that they appreciated the opportunity to learn more about the project and felt that their questions had been answered. The PIC No.1 Notice informing the public of the meeting was issued in the following local newspapers: Burlington Post (on February 4 and February 11, 2011), Oakville Today (on February 3 and February 10, 2011) and the Oakville Beaver (on February 4 and February 11, 2011). A direct invitation letter was sent to all individuals and groups on the project contact list on April 4, 2011. The Notification of PIC No.1 was also posted on the Region's website: www.halton.ca/EAs on February 2, 2011. A copy of the invitation letter and "Notice of PIC No.1" is provided in Appendix B.

- **Public Information Centre (PIC) No.2:** A third public meeting was held on November 30, 2011 from 6:30 p.m. to 8:30 p.m. at the Burloak WPP at 3380 Rebecca Street in Oakville, Ontario. The purpose of PIC No.2 was to present the preliminary preferred treatment design concept for the plant expansion to the general public. The meeting also identified the rationale used to evaluate and select the preliminary preferred treatment concept, and potential impacts and mitigation measures resulting from the preferred expansion approach. The next steps in the process were also discussed at the meeting. Approximately 11 people attended meeting No. 2. The PIC No.2 was advertised in the following local newspapers: the Burlington Post (on November 18 and November 25, 2011), Oakville Today (on November 16 and November 23, 2011) and the Oakville Beaver (on November 18 and November 25, 2011). A direct invitation letter was sent to all individuals and groups in the project contact list on November 11, 2011. A notification about PIC No.2 was also posted on the Region's website: www.halton.ca/EAs. The invitation letter and the "Notice of PIC No.2" is provided in Appendix B.

- **Notice of Study Completion:** A "Notice of Study Completion" notifying the public and agencies that the ESR has been placed on the public record for review has been issued. The Notice advises the general public about where to find the ESR, as well as their ability to place a Part II Order request with the Minister of the environment if they have outstanding concerns about the project that cannot be resolved by the Region during the given review period. The Notice of Study Completion will be advertised in the Burlington Post and the Oakville Beaver (on May 2, 2012 and May 6, 2012). The notice will also be posted on the Region's website www.halton.ca/EAs and sent to all required agencies and local associations. A copy of the Notice of Study Completion is included at the front of the ESR and in Appendix B.

3.1.4 Public Engagement Meeting Format

The Neighbourhood Drop-in session and the two PICs made use of a drop-in centre format featuring display panels which visually displayed project information. Project team members from the Region staff and AECOM's consulting team were available to speak one-on-one with the public during the meetings. The public meeting materials on-hand included:

- Display panels: Included information about the project using text, visuals and maps
- Comment sheets: Participants could fill these out to provide comments, suggestions or ask questions about the project or the Class EA Study process
- "Building a Better Halton" brochures: Provided information about the Class EA Study process, the anticipated project timelines, the next steps and how to reach project members was also available at the meetings
- Frequently Asked Questions (FAQ) sheets: Featured general questions expected to arise as a result of this project along with answers.

All meeting materials were posted on the project website at www.halton.ca/EAs. Copies of the display panels presented at the public meetings, as well as the other material available at the meeting are included in Appendix B.

Copies of all project notices issued as part of the Class EA Study are also included in Appendix C.

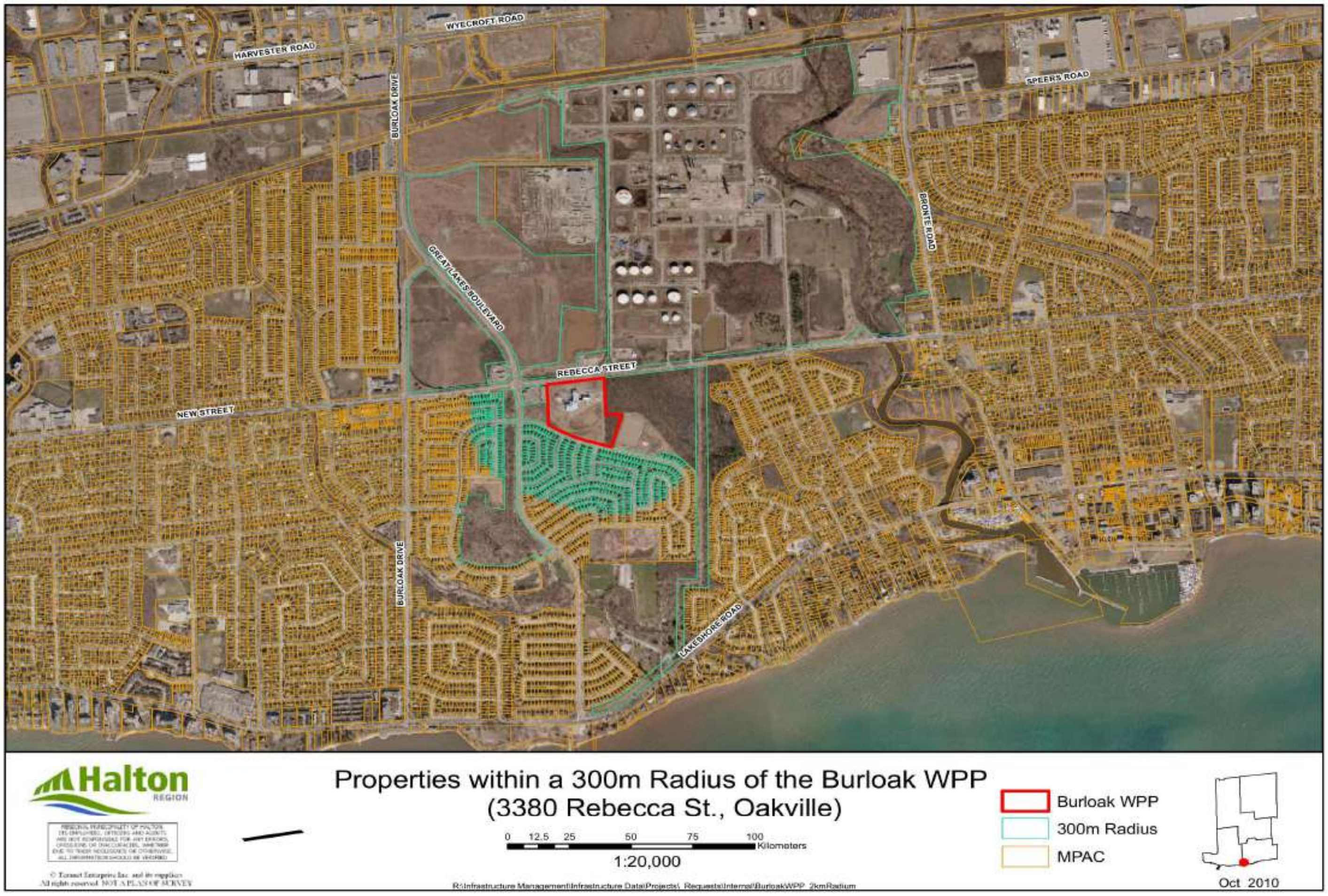


Figure 3 Burloak WPP Site and Surrounding Area Indentifying Local Residents

3.2 Summary of Public Issues, Comments and Concerns

No comment cards were filled out during or after the meetings (Drop-in and PICs) to log as part of the formal record. One written comment was received through the project's website after PIC No.1, while two written comments were received from separate members of the general public after PIC No. 2.

Verbal and written comments and concerns received from the public focused on the footprint, layout and appearance of the expanded building, as well as landscaping features. The main issues, comments and suggestions gathered from our public consultation approach have been included below:

- Minimize the expansion facility footprint as much as possible, and match the architectural features of the existing building, including height of existing buildings.
- Implement landscaping improvements by adding matures trees such as spruce or pine along with maple and oak trees to the site so that visibility to the site is blocked as much as possible. The landscape plans would include adequate vegetated buffer areas with berms, where appropriate.
- Ensure adequate capacity of the existing raw water intake pipe. The project team confirmed that existing raw water intake has sufficient capacity for the next expansions, so it will not have to be upgraded.

- Concerns about the capacity of the existing and future upgraded plant.
- Concerns about the proximity of the expanded buildings to Nautical Boulevard. The project team explained that the proposed location of the expanded facilities, above ground and underground, has been initially determined with consideration given to integration with the existing facilities, operational needs of the plant, as well as aesthetics. The final location of the expanded buildings will be reviewed and confirmed during the detailed design phase.
- Ozone emission into the atmosphere through the Liquid Oxygen (LOX) tanks blow-off. The project team explained that the existing ozone system is equipped with an ozone destruction unit which destroys any gaseous ozone residual present in the ozone contactor prior to being discharged to the atmosphere. In addition, any ozone concentration measured in the treated water is “quenched” or removed before the treated water is conveyed to the distribution system. Following the PIC, and in conversations with the plant operators, it was noted that the blow-off from the LOX tanks located outdoors is oxygen and not ozone, as presumed by the resident.

All public issues and comments, especially those related to landscaping and plant layout, will be addressed during the detailed design phase of this project to ensure that impacts to the nearby residents are minimized as much as practically and economically possible.

3.3 Agency Consultation

Consultation with government review agencies and the public is a necessary and important component of the Class EA process. To meet the Class EA consultation requirements for this study, the Region ensured that the public and review agencies were informed and given a chance to contribute during the study. This section outlines the agency consultation component of the study.

A list of agencies was prepared at the start of the project that included all relevant Region of Halton departments, Provincial Ministries, local municipalities and agencies, as well as local associations and utilities. Each party on the list of stakeholders was contacted to provide information or comments. The opportunity for these agencies to participate in the project was provided through the distribution of all study notices, direct letter mailings, and through direct invitations to participate in the two formal PICs. The complete list of all agencies contacted is included in Appendix A of this report.

3.3.1 Ontario Ministry of Environment

The Ontario Ministry of Environment (MOE) sent a letter to the project team in response to the “Notice of Study Commencement.” This letter, attached in Appendix A, provides general comments regarding a number of potential issues normally related to undertakings of this nature. Specific additional site investigations were completed as part of this Class EA Study to address the issues/concerns that apply to this specific expansion project. This information has been described throughout the subsequent sections of this ESR.

A copy of the Draft ESR was circulated to the MOE prior to public filing. A letter providing comments to the Draft ESR was received from the MOE on April 13, 2012. This letter, attached in Appendix A, requested some clarifications to be made in the ESR in terms of permits and approvals required prior to construction, and discharge to Sheldon Creek. Revisions to the ESR were made to address these comments. This information has been provided throughout the subsequent sections of this ESR.

3.3.2 Ontario Ministry of Natural Resources

A telephone conversation with the Ministry of Natural Resources (MNR) took place on April 18, 2012 regarding the need to consider this project in the context of the Great Lakes Charter (1985) and the Great Lakes – St. Lawrence

River Basin Sustainable Water Resources Agreement (2005). This issue was originally raised in the April 13, 2012 letter received from the MOE. As instructed by MOE staff, direct consultation with the MNR took place for clarification.

The MNR indicated that an analysis of consumptive use is generally undertaken when a proposal approaches the 19 ML/d threshold for consumptive use. For this specific project, applying a 15% municipal sector consumptive use coefficient to the proposed 110 ML/d increase in rated capacity, results in an estimated consumptive use of 16.5 ML/d, which is lower than the 19 ML/d threshold. As such, the MNR indicated that consultation with the other Great Lakes jurisdictions under the Great Lakes Charter/Agreement would not be anticipated. However, it was suggested that further consultation with the MNR takes places before MOE issuance of a permit to take water in the event that any modifications are made to the increased water taking volume. Written confirmation of this, in the form of an email was received from the MNR on April 19, 2012. A copy of the email is included in Appendix A for further reference.

3.3.3 Town of Oakville and Conservation Halton

The project team held a number of pre-consultation and coordination meetings with the Town of Oakville and Conservation Halton (CH) to discuss the need to discharge from the expanded Burloak WPP.

A meeting was held with the Town of Oakville officials on August 22, 2011 and included a discussion of the following items related to the project:

- The Town of Oakville understanding was that the stormwater pond would be used during commissioning of the plant (Phase 1) only, but not for routine operations.
- The design of the stormwater pond allows for sporadic overflowing of water from large storm events; however, it was never intended to provide overflow of continuous flow contributions.
- The original plant design intended for the backwash effluent water to be discharged to the stormwater system, eventually discharging into the stormwater pond when the total suspended solids (TSS) concentration is less than 15 mg/L.
- All backwash effluent water is currently discharged to the sanitary sewer system. Due to existing capacity limitations of the sanitary sewer system, an alternate discharge option would be needed for additional flows.
- Alternative discharge options from the plant into the East Sheldon Creek were identified, as shown in Figure 4. The East Sheldon Creek is a tributary to the main Sheldon Creek which ultimately discharges to Lake Ontario. This option would require approval/permit from CH.

Following the August 22, 2011 meeting with the Town of Oakville, additional meetings were held with CH and the Town of Oakville on October 19, 2011 and November 15, 2011 to further discuss the items raised in August 2011. The meetings focused on the following topics:

- The need for discharge
- The alternative discharge options available
- Identification of the feasibility for these options
- The need for additional studies
- To discuss the required investigations and permits needed.

Copies of the minutes from these meetings and all correspondence with CH and the Town of Oakville are included in Appendix A for further reference. The following is a brief summary of the pre-consultation with the Town and CH:

- CH understanding was that the stormwater pond would be used during commissioning of the original plant and not during routine operations.
- Discharge water quality and organic content is very important for CH. The plant currently experiences good raw water quality. Raw water is not chemically modified, although there is a provision available in case of raw water quality deterioration.
- Lake water turnover is generally not an issue and water quality is consistently good with minor variations due to the deep location of the raw water intake.
- Discharge water would not include algae.
- Due to the distant location to the lake from the plant, it would be very difficult from a technical perspective to direct the discharge water directly back to the lake. CH requested additional data on the discharge water quality, which was later submitted by the Region.
- The two alternate discharge options, as shown in Figure 4, were presented and discussed. Both options comprised discharging to the East Sheldon Creek at two different locations, one to the north of the plant and the other to the west of the plant.
- From a preliminary screening of both options, it was noted that due to the stability of the creek bed, proximity to outfall, operational ease, availability of manhole location and reduced interference with utilities, the discharge area to the west side of the plant was the favoured discharge location. Additional details on the assessment and evaluation results of the two discharge options are provided in Section 13.
- Modelling of the East Sheldon Creek was completed as part of this Class EA study. A separate technical memorandum documenting the findings and observations of the creek study was submitted to CH and the Town for their review. The technical memorandum is included in Appendix D for further reference.
- The modeling results indicate that the proposed backwash discharge from the expanded 165 ML/d Burloak WPP will not likely exceed the accepted velocity and allowable shear stress thresholds of the bed and banks downstream, based on existing estimated base flows.
- The site investigation did not reveal any critical areas of the creek. The fish habitat on main Sheldon Creek is considered poor to fair. Continuous flow is better than intermittent flow for fish habitat.

CH identified the available information and the specific investigations for the discharge and concluded that it is prepared to consider an outlet point from the 165 ML/d expanded Burloak WPP to the East Branch of Sheldon Creek. A Flow Attenuation/Mitigation Plan and a Monitoring Plan will be prepared and submitted to CH and the Town of Oakville for approval, at the early stages of detailed design phase. A detailed vegetative assessment will also be undertaken during the detailed design stages. Design drawings of the proposed outfall structure will be submitted to the Town of Oakville for approval.

CH and the Town of Oakville identified a number of permits that are required for the project, including a permit for altering a watercourse, a works permit from the Town of Oakville, and a Town of Oakville Site Plan Application. These permits will be required prior to work commencing. A Department of Fisheries and Oceans Permit may also be required subject to a letter of advice to be issued by CH.

A copy of the Draft ESR was circulated to the CH prior to public filing. A letter providing comments to the Draft ESR was received from CH on April 16, 2012. This letter, attached in Appendix A, provided comments regarding water system characterization of the Sheldon Creek and the East Sheldon Creek, suggestions regarding the discharge structure design, and requested further clarification of minor issues associated with chlorination at the intake structure. Revisions to the ESR and some of the reports appended to the ESR have been made to address these comments. Additional information presenting further clarification has also been provided throughout the subsequent sections of this ESR.

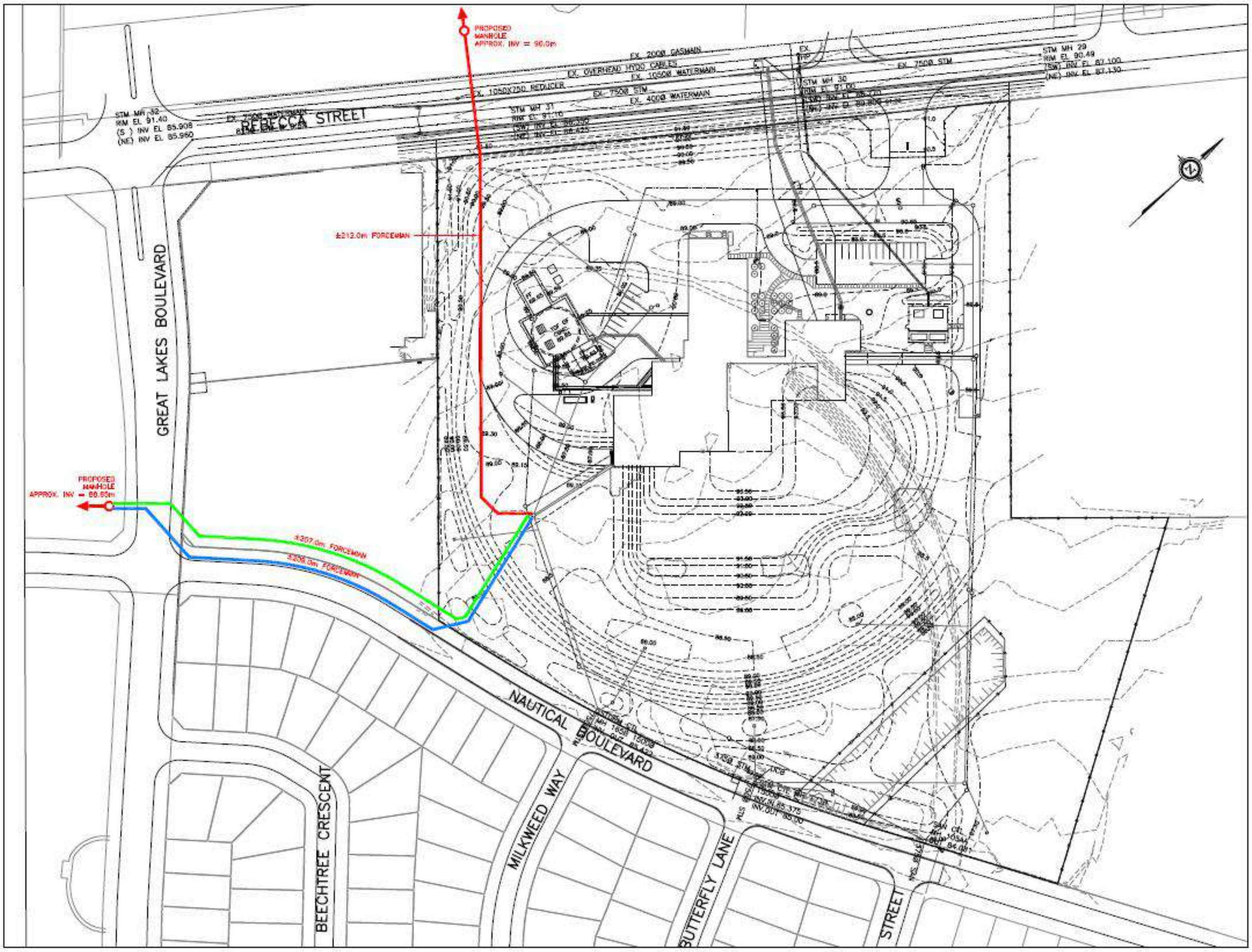


Figure 4 Alternative Discharge Options

3.3.4 First Nations and Aboriginal Groups

A letter was received on March 10, 2011from the Indian and Northern Affairs Canada (INAC), Litigation Management and Resolution Branch in response to the "Notice of Study Commencement." This letter, attached in Appendix A, indicates that there is no active litigation in the vicinity of the Burloak WPP but it suggests contacting the specific claims branch and the comprehensive claims branch within INAC. These two branches were contacted since the beginning of this project as they were part of the original agency contact list.

A separate letter was received on March 11, 2011from the Ministry of Aboriginal Affairs in response to the "Notice of Study Commencement." This letter, attached in Appendix A, advises to contact the Six Nations of the Grand River Territory and the Haudenosaunee Confederacy Chiefs Council as they could be impacted by our project, as well as two additional federal agencies (already in the original agency contact list). The two aboriginal groups were added to the project agency contact list, as recommended. Public notices and invitations to the project PICs were distributed to them through the remainder of the project. No correspondence was received from them.

An email was received on November 24, 2011 from INAC Specific Claims Branch in response to the Notice of PIC No.2 mailed to this agency. The email provides information regarding websites to assist with determining the First Nations groups with an interest in this project. The websites were visited to confirm the first nations groups that needed to be contacted on this specific project.

Other than the correspondence described above, no other correspondence was received from the first nations groups or representative provincial and federal agencies included the agency contact list. It is noted that copies of project notices as well as formal invitations to PICs, were mailed to these groups and agencies, as part of the communication and consultation plan in place for this project.

3.3.5 Other Review Agencies

Standards letters were received from some of the provincial and federal review agencies in response to the Notice of Study Commencement and the formal invitations to the PICs. The letters are included in Appendix A.

4. Study Area Overview

This section of the ESR describes the existing technical, social and natural environmental conditions of the study area defined for this Class EA study.

4.1 Study Area Location and Site Features

The study area for this project is located within the Regional Municipality of Halton. The project team has considered the Burloak WPP plant site, where most of the construction activities are most likely to occur, as well as those areas where the preferred design treatment concept components could potentially have some degree of impact. The boundaries of the study area are shown in Figure 5 below.

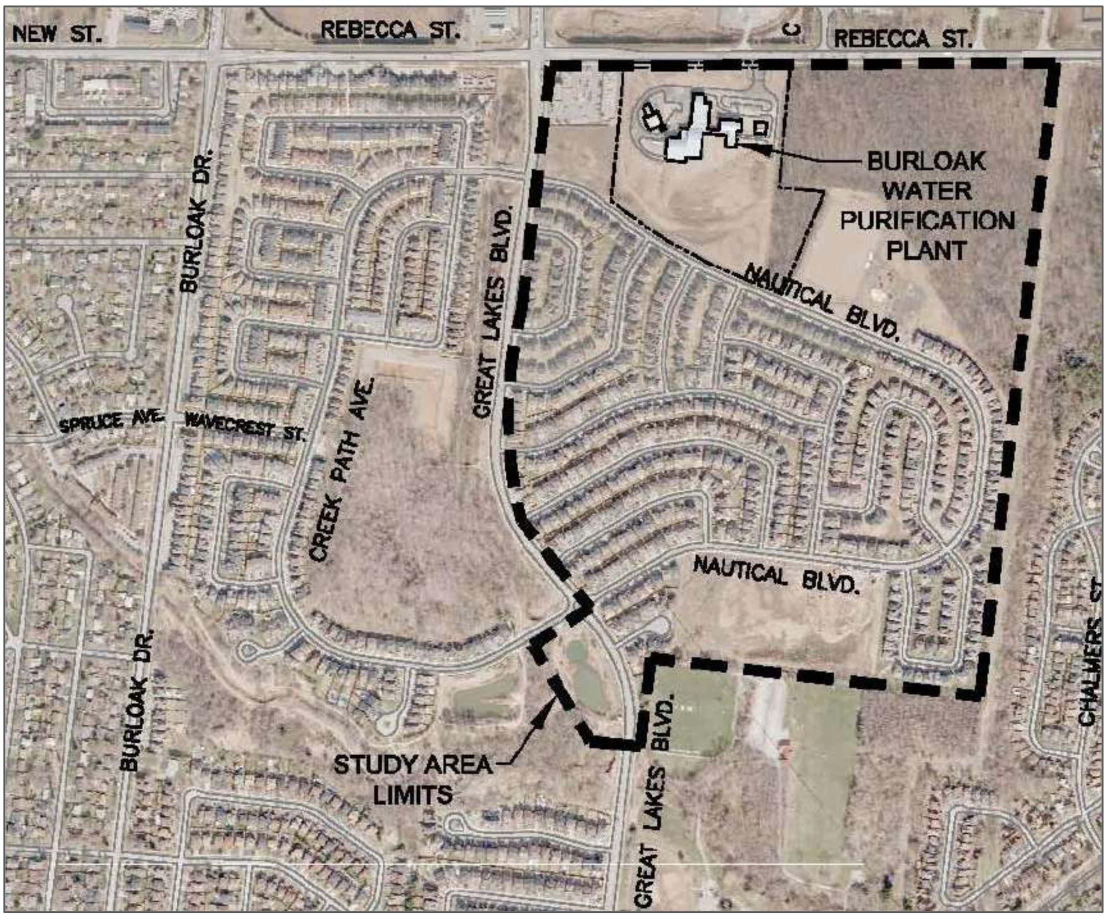


Figure 5 Study Area Map

Figure 5 identifies that the study area is bound by Rebecca Street to the north, Bronte Burloak Woods to the east (following the east property boundaries), the southern limits consists of the residential subdivision and an empty field, and Great Lakes Boulevard is located to the west of the project site. Two stormwater ponds located to the south of the intersection of Great Lakes Boulevard and Creek Path Avenue were also included within the study area limits since one of these ponds is part of the stormwater management system originally designed for the Burloak WPP.

Great Lakes Boulevard and Rebecca Street are minor arterial roads within the Region of Halton. Great Lakes Boulevard runs in north-south direction and is a two-lane road for most of its length before expanding into a four-lane road at the Rebecca Street intersection, in addition to one turning lane. Rebecca Street is a three-lane road running in an east-west direction along the north side of the Burloak WPP site. The three-lane road turns into a four-lane at its intersection with Great Lakes Boulevard, as it provides a dedicated turning lane to the north and the south bound.

Public communication and consultation efforts extended beyond the limits of the study area in order to include all properties within a 300m radius of the plant site. Direct mailed letters and invitations to the public meetings were carried out for this group of stakeholders within the 300m radius of the site. For more information on the area included in the public communication and consultation program, please refer to section 3.1.2.

4.2 Existing Site Services

The Burloak WPP site is a restricted site and it is completely fenced off with a double gate located on the access road facing Rebecca Street. All traffic to the plant is through Rebecca Street to minimize disturbances to the residents located off Nautical Boulevard.

The plant site has a number of buildings; including above ground and underground structures, located mostly to the north of the plant site since expansion is expected to occur mostly to the south of the existing site. A U-shaped berm running along the south edge of the plant site was constructed during Phase 1 with the intent of providing a visual barrier between the plant and the residential neighbourhood to the south. A number of trees have been planted on the south of the property following Phase 1 construction as part of the landscaping plan developed for that phase. A new landscape plan will be developed and incorporated as part of Phase 2 expansion which will consider the new site structures and comments received from the neighbours.

A 1050 mm diameter water distribution main, a 50 mm diameter gas line and the hydro line connect to the north-east end of the plant north to Rebecca Street. Stormwater and sanitary pipelines were installed onsite during Phase 1 construction of the Burloak WPP and generally running along the borders of the site.

Figure 6 shows the location of the overall site services within the Burloak WPP site.

4.2.1 Sanitary and Stormwater Management

The existing stormwater management system at the Burloak WPP site was reviewed in detail by AECOM as part of this Class EA Study. The site is generally divided into two drainage sections encompassing the west drainage section that drains to the existing stormwater manhole (STM MH) 165 B (on the west side) and the east drainage section that drains to the existing STM MH 173 B (on the east Side). Figure 6 shows the location of the manholes currently onsite and the flow distribution for the sanitary and stormwater management system.

The total allocation for STM MH 165B is 569 L/s, which includes 359 L/s for a drainage area of 2.58 ha suitable for a 100-year storm. The total allocation for STM MH 173 B is 562 L/s for a drainage area of 4.04 ha and a 100-year storm. The total combined allocation for the entire plant site is 1,131 L/s (569 L/s + 562 L/s), which includes 921 L/s (359 L/s + 562 L/s) from a 100-year storm flow and a spare capacity of 210 L/s.

Flows from two stormwater manholes 165 B and 173 B ultimately drain to the Stormwater Pond B located at the intersection of Great Lakes Boulevard and Creek Path Avenue. Stormwater Pond B has been designed to treat the total runoff volumes from the 2.58 and 4.04 hectare areas. The storm sewers (or minor system) were sized to accommodate the 5-year peak flowrates of 359 and 562 L/s generated from those areas. The pond inlet (or sewer outlet) was also sized based on those flows. However, the pond's design does not consider those flowrates (as they are only peak flowrates).

AECOM completed preliminary calculations in an attempt to confirm that 921 L/s from a 100-year storm flow would be applicable for the project. The results confirmed that the total stormwater discharge allocated from the Burloak WPP is approximately 1,131 L/s, meaning that the major stormwater system can safely handle the flows from a 100-year storm. Stormwater Management Pond B was designed to treat the volume of runoff from a 25mm rain event occurring in its catchment area, which includes the Burloak WPP site (at a combined area of 6.62 Ha).

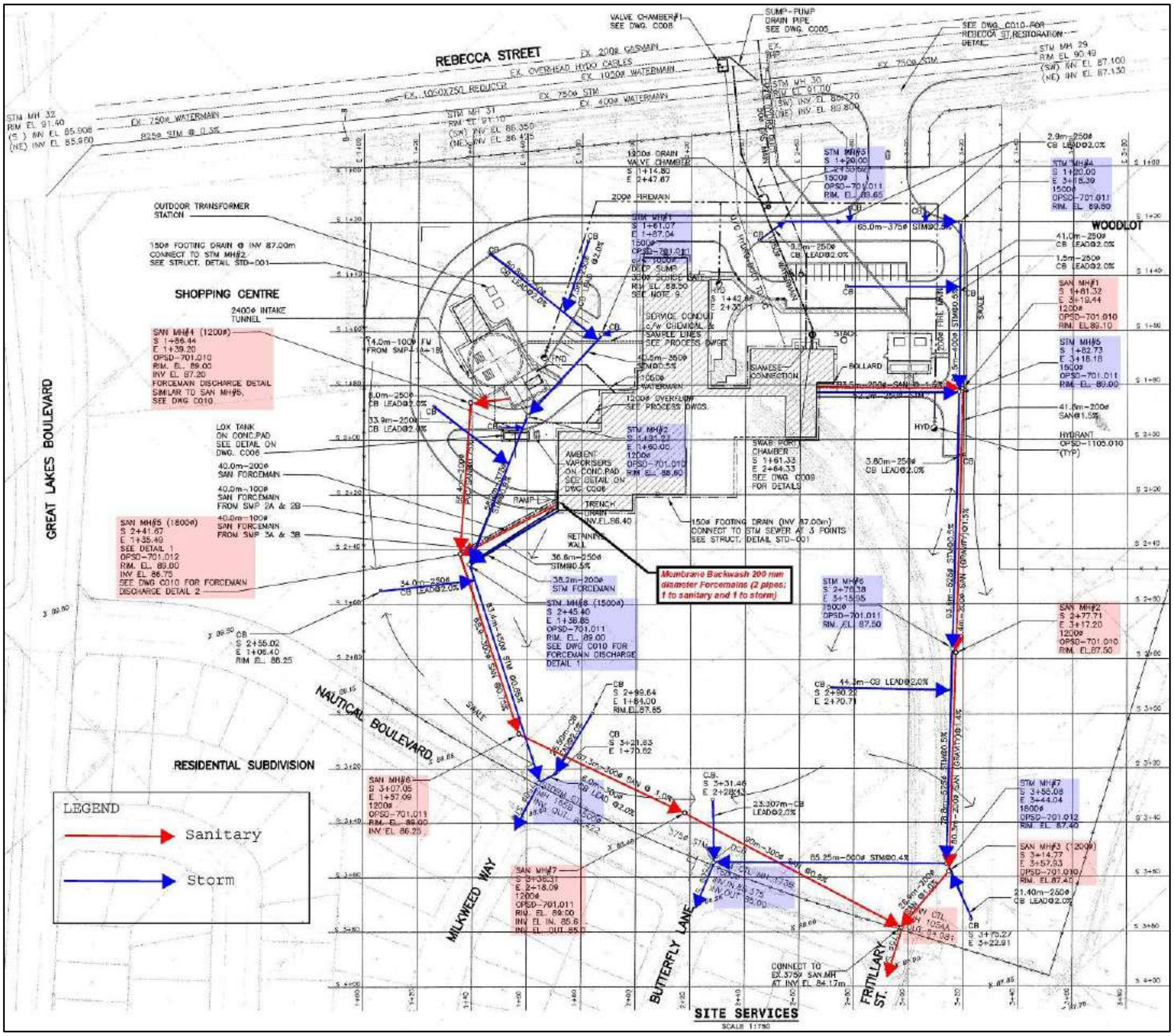


Figure 6 Burloak WPP Site Layout Showing Existing Site Services

4.3 Existing Natural Environment

An assessment of the natural environment within the boundaries of the Burloak WPP site was completed during the 2004 Class EA Study, completed by CH2M HILL Canada Limited. The overall location of the main natural environmental features near the site is shown in Figure 7 below, with a detailed description in the subsequent sections.

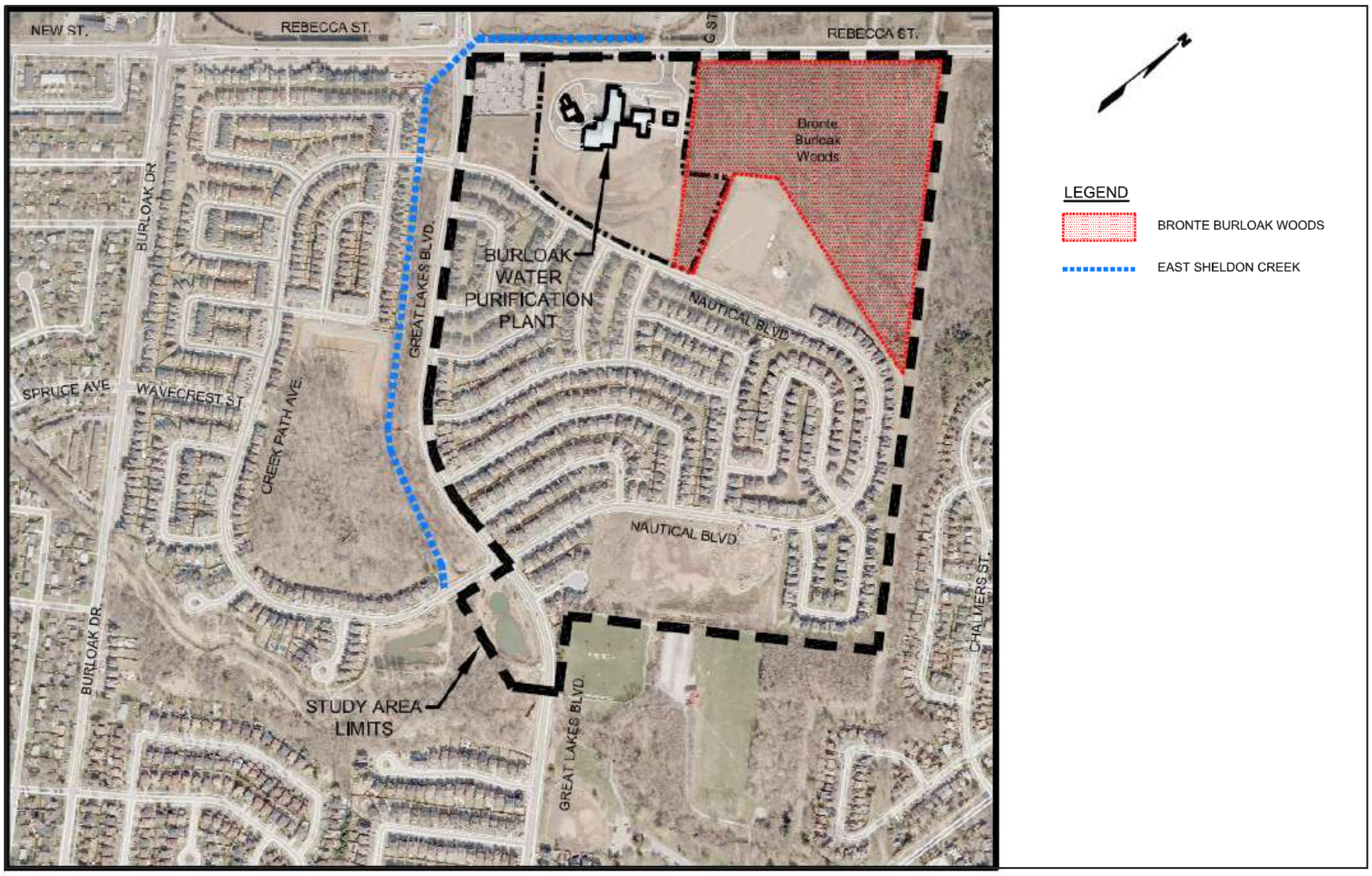


Figure 7 Existing Environmental Features

4.3.1 Bronte Burloak Woods

The Burloak WPP project site is bordered by the Bronte Burloak Woods to the east, as shown in Figure 7, an area designated as a Life Science Site according to the Natural Heritage Information Centre (NHIC) records. , There is limited vegetation near the project site other than the woodlot and a number of trees planted after construction of Phase 1. There are no watercourses within the plant site.

Based on the aquatic and terrestrial inventory performed during the original plant construction, the Bronte Burloak Woods has a large stand of maturing white pine (*Pinus strobes)* and white birch (*Betula papyifera)*, as well as an open deciduous swamp with thickets. At the time of the investigation, the woods contained a large diversity of plant species, most of which are native and characteristic to the California Life Zone. Bronte Burloak Woods may provide nesting and migration habitat to bird species and urban wildlife. No species considered rare, threatened or endangered were encountered in the study area.

At the time of the original plant construction, a buffer zone was created between the construction areas and the Bronte Burloak Woods to avoid disturbance to this area. Similar mitigation measures will be incorporated as part of Phase 2 construction to avoid any impacts to the woodlot.

4.3.2 East Sheldon Creek

East Sheldon Creek converges with the study area at Rebecca Street and Great Lakes Boulevard. The creek originates in the City of Burlington upstream of Upper Middle Road. The east tributary of Sheldon Creek flows through a variable landscape that includes open fields, residential, industrial, and commercially developed areas. The creek flows in a southerly direction on the west side of Great Lakes Boulevard to its confluence with the Main Branch before finally discharging into Lake Ontario.

The natural environment assessment completed in the 2004 Class EA Study revealed that the East Sheldon Creek upstream from the study area had undergone modifications, with a rural ditch profile through agricultural lands. Where the creek meets the main Sheldon Creek is just above a remnant bridge structure which was presumed to act as a seasonal barrier to bait fish.

A detailed investigation of the fluvial geomorphology of the Sheldon Creek – East Branch was undertaken by AECOM as part of this Class EA Study, as a result of the CH's request to provide supporting information for the new discharge from the plant. A copy of the Sheldon Creek – East Branch Assessment Report is included in Appendix D for further reference, with a brief summary provided in the following sections.

4.3.2.1 Terrestrial Features

A review of aerial photography and mapping of the east tributary of Sheldon Creek clearly reveals that the watercourse was previously straightened for possible historic agricultural land uses. Immediately upstream of Rebecca Street, a watercourse section of approximately 250 m in length was realigned, following principles of natural channel design as documented in the Parish Geomorphic (2002) design brief. An online plunge pool was created during land development south of Rebecca Street. The east Tributary of Sheldon Creek is contained within a narrow corridor that is flanked by a pedestrian trail and residential homes to west and Great Lakes Boulevard to the east. The creek emerges into a large wooded open space near Milkweed Way and extends to the main branch of Sheldon Creek.

Field investigations were undertaken on November 8, 2011 to assess the existing terrestrial conditions along Sheldon Creek. All floral species observed were noted along with a photographic record of the communities in relation to the Creek. It was identified that the terrestrial communities along Sheldon Creek range from early successional to mature forest. Starting at the confluence, plant species are founds such as the Manitoba maple (*Acer negundoi),* Norway maple (*Acer platanoides*), willow (*Salix sp.*), and black walnut (*Juglans nigra*). There is a prevalence of Norway maple in the area, especially in the area upstream of Nautical Boulevard where trees completely cover Sheldon Creek. Tree species are young ranging in height between 10 and 15 metres. Beyond this stand of Norway maple, the terrestrial conditions reflect a more natural state where a mature upland sugar maple (*Acer saccharum*) forest with white ash (*Fraxinus americana*), red oak (*Quercus rubra*), American beech (*Fagus grandifolia*) and shagbark hickory (*Carya ovata*) associates occur. Tree height within the forest community ranges between 20 and 25 metres. Shrub cover is low in this area as well as herb cover. Between Milkweed Way and Nautical Boulevard, the terrestrial conditions narrow to a thin strip of vegetation along the Creek. Tree species are similar to that found within the forest, although tree cover is less prevalent and shrub cover is increased and includes the invasive common buckthorn (*Rhamnus cathartica*). Beyond Nautical Boulevard, the creek widens with fringe cattail marsh communities along its banks and planted landscape trees along the slope.

The conditions of the vegetation within proximity of the creek are a mixture of invasive (Norway maple, Manitoba maple, common buckthorn) and common (sugar maple, red oak, American beech) plants typical of upland communities. Most of the conditions along Sheldon creek are comprised of species that are typical of disturbed areas that have a relatively high tolerance for varying conditions, in particular, water level fluctuations. The area where species are less tolerant of water level fluctuations is of the area where there is mature sugar maple forest (in particular between Springflower Way and Milkweed Way). Both red oak and sugar maple, the dominant trees along the creek within this portion, would be prone to mortality with increasing rise of water levels. It was noted that should water levels rise to a level which create waterlogged soils, it could result in poor gas exchange which consequently would deplete the soil of oxygen thereby preventing root system respiration.

4.3.2.2 Fish Habitat

An aquatic assessment of the East Sheldon Creek was also completed in November/December 2011 as part of this Class EA study. The purpose of the aquatic assessment was to identify the existing fish habitats conditions and the potential impacts associated with the proposed discharge to the East branch of Sheldon Creek. The aquatic assessment comprised a desktop study with sources from the Ministry of Natural Resources – Natural Heritage Information Centre (NHIC) Biodiversity Explorer, Conservation Halton (CH) and the Department of Fisheries and Oceans (DFO) Species at Risk Mapping (2011). The Sheldon Creek – East Branch Fish Habitat Conditions Technical Memorandum, documenting all findings and recommendations of the aquatic assessment is included in Appendix E.

According to comments provided in a letter by CH (April 16, 2012), “recently collected surface water temperature data during summer 2010 indicates that Sheldon Creek has a cool-warm water thermal regime”. The East Branch of Sheldon Creek originates south east of the Queen Elizabeth Parkway in the Town of Oakville and flows in a south easterly direction to Lake Ontario. Sheldon Creek has been largely impacted by urban development, stream alterations and storm water inputs.

The Shortnose Cisco (*Coregonus reighardi*) was identified through the NHIC search downstream of the study area in Lake Ontario at the mouth of Sheldon Creek. The Shortnose Cisco is designated as endangered under the Federal Species at Risk Act (SARA) and is potentially extinct from Lake Ontario. The last observation date in this area is greater than 20 years and is therefore considered a historical record. The Shortnose Cisco habitat preference is clear deep lakes, therefore it is highly unlikely this species is present within the study area.

No fish or mussel species at risk were identified within the study area from the DFO SAR mapping. CH identified two fish species Brook Stickleback (*Culaea inconstans*) and Creek Chub (*Semolitus atromaculatus*) in the east branch of Sheldon Creek north of Rebecca and east of Great Lakes Boulevard. Both species are classified as cool water (water temperature preferences of 18-25°C), and are common and widely distributed in Ontario. CH also identified the presence of Rainbow Trout (*Oncorhynchus mykiss*) and Brown Trout (*Salmo trutta*) in the main branch of Sheldon Creek where it flows under Spruce Avenue (one kilometer upstream of the confluence with the east branch). Fantail Darter (*Etheostoma flabellare*) are located within the main branch of Sheldon Creek downstream of the confluence of the east branch with the main stem. Common White Sucker (*Catostomus commersonii*), Blacknose Dace (*Rhinichthys atratulus*) and Fathead Minnow (*Pimephales promelas*) were also identified in the east branch of Sheldon Creek (CH, 2012).

The aquatic assessment indicates that direct fish habitat (as defined by DFO) is present within the east branch of Sheldon Creek, and likely can support migration, feeding, refuge and rearing for all fish species present, with some potential for spawning habitat, although not of high quality. It further identifies that the proposed discharge from the expansion of the Burloak WPP may cause short term and minor stress to fish and fish habitat. However, there are no expected long term impacts to fish and fish habitat associated with the proposed discharge and may provide a net benefit to the east branch of Sheldon Creek through improvements resulting from increased stream flow, improved water quality and a temporary provision of habitat for species that prefer cooler thermal regimes.

4.4 Existing Social Environment

The study area is located within the Town of Oakville's Bronte Community planning area. The Town of Oakville Official Plan from September 2006 designates the Burloak WPP site as "community facility/institutional," a designation which permits the Water Purification Plant. The following sections provided a summary of land use designations (as per the Town's OP) and existing uses for the lands surrounding the WPP.

Figure 8 shows an overall location of the features described in this section.

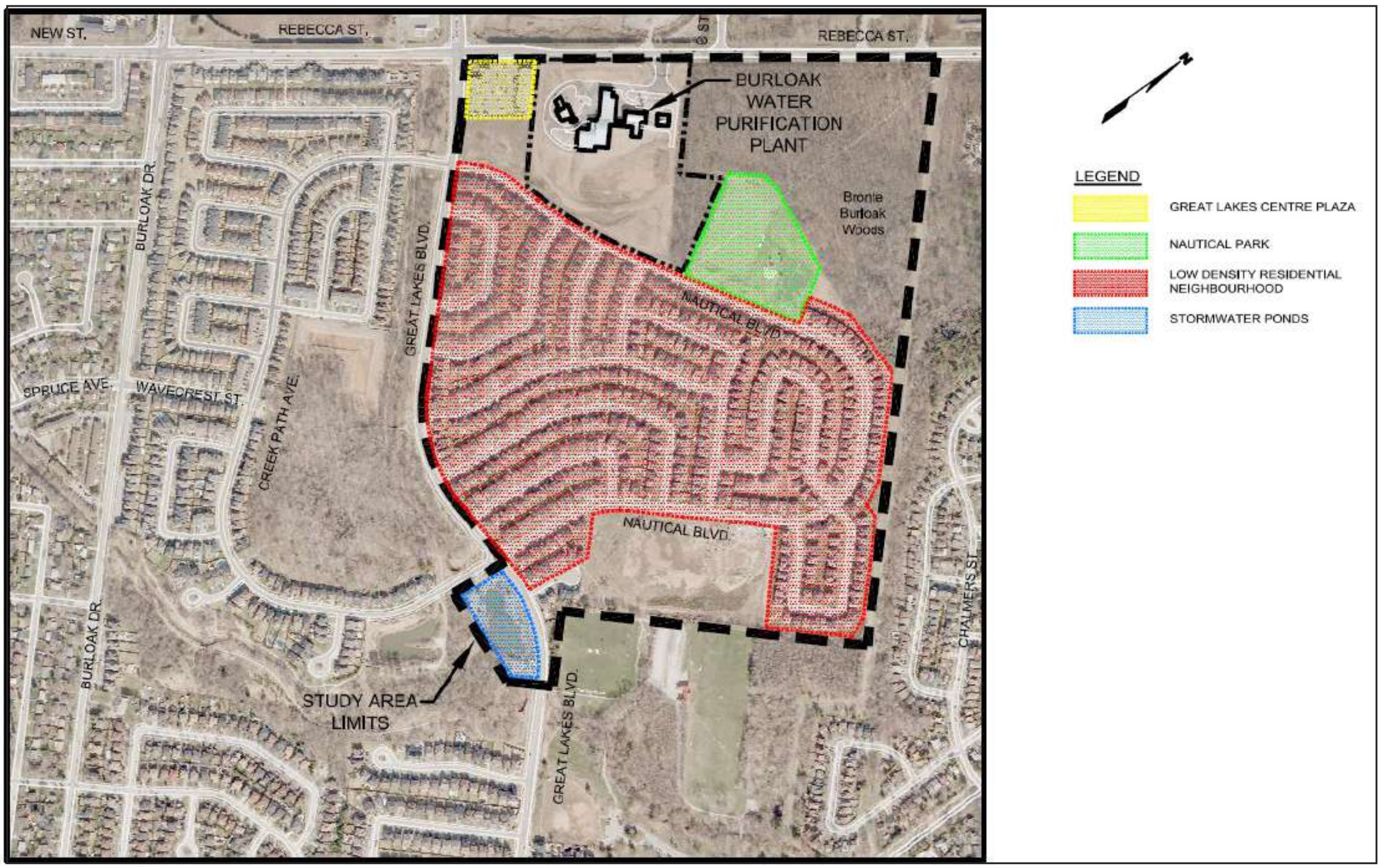


Figure 8 Existing Socio-Cultural Features

Lands directly adjacent to the west of the WPP, at the corner of Rebecca Street and Great Lakes Boulevard, are designated as neighbourhood commercial and are currently occupied by a vacant lot and the Great Lakes Centre Plaza that includes the following business types:

- Professional Service (e.g., financial, medical)
- Restaurants (e.g., take out/sit in)
- Convenience Retail (i.e., variety store)
- Recreation (e.g., fitness/training facilities)
- Institutional (i.e., preschool)
- Personal Service (e.g., Florist, Hair Salon and Dry Cleaners).

Adjacent to the east of the Burloak WPP is one open space area designated as "Parkland" and is named Nautical Park. This park is accessed from Nautical Boulevard and includes a children's playground including splash pad and soccer field.

Lands immediately to the south of the plant site are designated as "Low Density Residential" and consist of detached single family residential dwellings with those fronting on Nautical Boulevard having a direct view of the WPP. The characteristics of the residential neighbourhood to the south of the plant are shown in Figure 9.

Two stormwater retention ponds and a mixed-use trail are located at the corner of Great Lakes Boulevard and Creek Path Avenue, which is designated as parkland and forms part of Wilmot Park.

The lands on the north side of Rebecca Street (outside project study area) and across from the WPP are designated as "Employment Lands." The property includes a vegetation tree screen along the Rebecca Street frontage, a stormwater management pond and is presently vacant open space.

Figure 9 Residential Neighbourhood along Nautical Boulevard

In addition, the plant serves to act as a visual barrier between the residential community off of Nautical Boulevard and any industries developed north of Rebecca Street.

4.5 Archaeological and Heritage Features

An archaeological assessment of the area was previously conducted by Archaeoworks Inc. as part of a *Draft Plan of Subdivision 24T-0004* undertaken by Metrus Development Inc. in November 2000. This past archaeological assessment (stages 1 and 2) included the area for the Burloak WPP plant site. The findings of the archaeological assessments concluded that parts of the plant site were previously disturbed through past uses and that the lack of integrity suggested no archaeological potential remaining in the area. Low-lying wet areas were not assessed since they were considered to have low archaeological potential, while the other remaining areas were assessed by means of a pedestrian survey which revealed no archaeological potential.

4.6 Geotechnical and Hydrogeological Conditions

A geotechnical investigation was completed by Peto MacCallum Ltd. Consulting Engineers in July 2005. The investigation assessed the subsurface soil and groundwater conditions at the site to support the design and construction of Phase 1 of the Burloak WPP, as well as related building structures, roads and services. Twenty-one sample boreholes were drilled within the plant site in May 2005, and the large number drilled suggest that they remain representative of the overall soil and groundwater conditions for the plant site.

The 2005 geotechnical investigation revealed that the general area is characterized by shallow bedrock with two shale formations (Queenstone and Georgian Bay Formation) underlying the area. The shale bedrock is generally close to the ground surface, at a depth of about 1 to 3 m below the existing grades (at the time of the investigation) in the general area. The site was considered feasible for the construction of Phase 1 of the Burloak WPP, with all structures to be founded on shallow underlain bedrock. At the time of the investigation, free water and cave-ins were not observed in the boreholes upon completion of augering. Piezometric water levels in 10 boreholes were measured at depths about 4.4 and 6.4 m below existing grades, about 7 to 8 days after installation. Groundwater levels at the site are subject to seasonal fluctuations and rainfall patterns, and perched groundwater may be encountered in fill materials. Based on the investigation results, it was concluded that no major groundwater problems were expected for the anticipated excavation base levels during construction. Seepage was presumed to occur from precipitation and from perched water in the fill and would be able to be controlled by sump pumping.

Various recommendations were made for Phase 1 construction, including but not limited to foundations in shale bedrock, site grading, excavation and groundwater control, pipe bedding, foundation drainage, pavement design and construction. Construction of Phase 1 of the existing Burloak WPP resulted in very little groundwater from excavation, which was managed by pumping the water into a low lying area within the plant site, where the water percolated trough the soil.

For the purpose of this Class EA Study, it has been assumed that the conditions found during the 2005 geotechnical investigation continue to exist for the entire plant site; however, it is understood that a detailed geotechnical investigation will need to be carried out to assist during the design and construction of Phase 2 expansion.

5. Existing Plant Overview

5.1 Existing Treatment Components

The Burloak WPP draws raw water from Lake Ontario and pumps the treated water into the South Halton distribution system. Currently, the produced treatment capacity of the plant is currently 55 ML/d, with the main treatment processes at Burloak WPP including:

- A raw water intake and conveyance tunnel complete with pre-chlorination for zebra mussel control
- A low lift pumping station containing two traveling water screens and three variable speed low lift pumps
- A rapid mixing pump system for coagulation using Aluminum Chlorohydrate (ACH) when needed. Based on the consistently good raw water quality experienced at the plant since its commission and current operational practices, the use of coagulation has not been needed to this date and is not anticipated to be used for future expansions.
- Flocculation tanks providing retention time for the coagulation process to complete
- Four ultra-filtration immersed membrane trains (2 duty, 2 standby) with associated cleaning
- Four medium pressure UV reactors
- One ozone generator with ancillary equipment for intermittent operation during taste and odour events with sodium bisulphite for ozone quenching
- One ozone contact chamber to provide virus inactivation using chlorine gas or ozone depending on if ozonation is being practiced
- A clearwell for high lift equalization
- A high lift pumping station containing four fixed speed high lift pumps for delivery of treated water into the distribution system
- Fluoridation and touch-up chlorination on the high lift header with provision for pH control
- One standby generator to provide 100% standby power to the entire plant.

In terms of waste streams, the Burloak WPP wastewater handling system consists of the following main process:

- Two waste equalization tanks to equalize and store membrane backwash wastewater. The membrane backwash wastewater is conveyed from the equalization tanks to either the storm or sanitary sewer.
- Two neutralization/cleaning tanks to equalize and store membrane cleaning wastewater prior to the wastewater being neutralized which is then discharged to the sanitary sewer.

A simplified process schematic of the main process treatments at the Burloak WPP is shown in Figure 10.

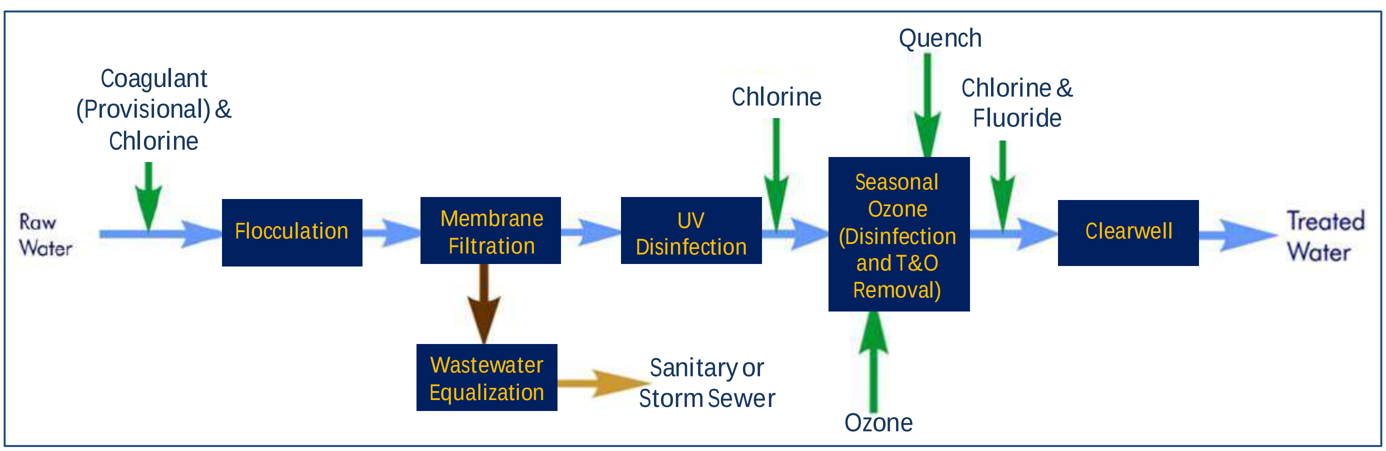


Figure 10 Simplified Process Schematic Burloak WPP

The current permits and approvals associated with the existing Burloak WPP and its operation, including the Municipal Drinking Water License, Drinking Water Works permit, Permit to Take Water, and the C of A are included in Appendix F for further reference.

5.2 Raw Water Quality

The objective of the raw water quality review was to provide guidance when establishing treatment objectives for the Burloak WPP Phase 2 expansion. Raw water quality data for selected physical and chemical parameters are summarized in Table 1.

Table 1 Predicted and Actual Raw Water Quality for Burloak WPP[3]

Parameter	Units	2004 EA Predictions given Other Sources[1]		Actual Burloak WPP Data[2]		Sources for 2004 EA Predictions
		Average	Range	Average	Range	
Alkalinity	mg/L $CaCO_3$	95	85 to 100	94	92 to 97	Typical of Lake Ontario
Bromide	µg/L	BDL	BDL to <30	47	47	Expected range typical of Lake Ontario
Chlorophyll-a	µg/L	N/A	1 to <10	N/A	N/A	Tracks with algal blooms (increases in May, decreases in August)
True Colour	TCU	N/A	< 1 to 10	2	2	Low colour water
Geosmin	ng/L	N/A	BDL to 130	N/A	N/A	Expected range based on data for Burlington and Oakville; elevated levels detected in late summer/early fall
MIB	ng/L	N/A	BDL <10	N/A	N/A	Based on data for Burlington and Oakville WPPs, detected June through October
Organics	mg/L as DOC	N/A	2 to 4	2.0	1.8 to 2.2	Expected range based on typical Lake Ontario DOC levels of approximately 2 mg/L. Dependent on the wind storm events that have the potential of mixing surface water into the intake, it was assumed that levels could range from 1.0 to 4.0 mg/L.
Organic Nitrogen	mg/L	0.2	0.1 to 0.4	-	<0.1 to 0.2	Expected range based on Burlington and Oakville WPPs
pH	-	N/A	7.3 to 8.6	7.81	6.57 to 8.88	Expected range based on Burlington and Oakville WPPs
Sodium	mg/L	13	10 to 19	18	12.5 to 80	Expected range based on Burlington WPP
Temperature	°C	N/A	1 to 15	10.54	1.5 to 21	Expected range based on Burlington and Oakville WPPs and considering lower depth of Burloak intake.
Total Coliform	Cfu/100mL	N/A	0 to 10,000	3	0 to 54	Expected range based on Burlington and Oakville WPPs
Total Dissolved Solids	mg/L	180	-	196	165 to 245	Average value typical of Lake Ontario
Total Hardness	As $CaCO_3$	N/A	112 to 137	130	125 to 139	Expected range based on Burlington and Oakville WPPs
Turbidity	NTU	< 2	BDL to >100	0.12	0.01 to 2.5	Although expected turbidity is low, expected frequent excursions >10 NTU occur during the spring and winter: >10 NTU on average 9 events/yr; >20 NTU on average 3 events/yr (Oakville) and 8 events/yr (Burlington)

Parameter	Units	2004 EA Predictions given Other Sources[1]	Actual Burloak WPP Data[2]	Sources for 2004 EA Predictions

Notes:

1. *Average and predicted values established in 2004 based on available data from Burlington and Oakville WPPs, as well as location of the new Burloak WPP intake.*
2. *Actual data obtained from Burloak WPP operating data for period between June 2009 and July 2010.*
3. *The following acronyms are used in the table:*
4. *N/A: data or values Not Available*
5. *BDL: below detection limit*

As shown in Table 1, the actual raw water quality experienced at the plant has been as good as or better than predicted in 2004.

The latest data revealed that values for hardness and organic nitrogen in the raw water exceeded the aesthetic objectives set out in the Ontario Drinking Water Quality (ODWQ) Standards, Objectives and Guidelines. These standards, objectives and guidelines apply only to treated water rather than raw water; however, they provide an indication of treatment requirements at the plant.

Hardness concentrations in the raw water were around 140 mg/L (as $CaCO_3$) and are levels of hardness that don't present any particular problems to pipelines or from excessive laundry soap usage. The organic nitrogen concentrations are slightly above the 0.15 mg/L objective, however, these levels are not expected to cause taste and odour effects in the distribution system given that these levels were detected in the raw water rather than the treated water.

The aesthetic objective for sodium according to the ODWQ Standards, Objectives and Guidelines is 200 mg/L. It is also required that the local Medical Officer of Health must be notified when the sodium concentration in treated water exceeds 20 mg/L to communicate to local physicians so they can pass on information to patients on sodium restricted diets. Sodium in the raw water was below 20 mg/L approximately 87% of the time, with average values of 18 mg/L between 2009 and 2010.

The raw water Dissolved Organic Carbon (DOC) levels averaged 2.0 mg/L, an expected value for Lake Ontario which suggests a low potential for the formation of disinfection by-products (DBPs) such as trihalomethanes (THMs). Ozonation is being practiced at the plant which provides an indication of low potential for the formation of assimilable organic carbon (AOC), which may promote the regrowth of bacteria in the water distribution system.

When examined overall, this study found that the raw water is considered of consistently of good quality, and with low turbidity (minimal turbidity variation) and low DOC levels.

5.3 Treated Water Quality

Treated water quality data was also reviewed as part of the Burloak WPP Class EA Study. The data was analyzed in terms of microbiological, physical and chemical parameters, and compared with the ODWQ Standards, Objectives and Guidelines. Treated water quality data for selected physical and chemical parameters have been summarized in Table 2.

Table 2 reveals that the majority of the parameters meet or exceed the ODWQ Standards, Objectives and Guidelines with a few exceptions. Sodium in the treated water, which is not affected by the current treatment provided, exceed the 20 mg/L limit for notification to the local Medical Officer of Health in few occasions. However, sodium concentrations in treated water were below the 20 mg/L limit about 85% of the time, with average values of 20.2 mg/L for the one-year monitoring period.

Bromate has reached a maximum value of 9 µg/L, which is slightly less than the maximum acceptable concentration of 10 µg/L. It is recommended that continuous monitoring of bromate should be practiced at the Burloak WPP when ozonation is in use.

As with the raw water data, the values for hardness in the treated water exceed the aesthetic objective since this specific parameter is not affected by the current treatment provided at the Burloak WPP. Hardness values around 130 mg/L do not present any particular problems for pipelines or excessive laundry soap usage.

Trihalomethanes (THMs) were another parameter studied for the Class EA Study. THMs reached a maximum of 118 µg/L, a level which exceeds the maximum acceptable concentration of 100 µg/L. THM concentrations appear to have been obtained from an individual sample collected on June 25, 2009, as opposed to an average value. Therefore, this value does not represent the four quarter moving annual average test results for which the 100 µg/L limit is based.

Bacteriological data obtained from the years 2009 and 2010 showed the absence of total coliforms and *E. coli* in the treated water samples. Physical and chemical data of treated water obtained for the period between 2009 and 2010 indicate that none of the health related parameters exceeded the maximum acceptable concentrations Maximum Acceptable Concentration (MAC) or Interim Maximum Acceptable Concentrations (IMAC) set out in the ODWQ Standards, Objectives and Guidelines.

Table 2 Burloak WPP – Treated Water Quality Data (Physical and Chemical Parameters)

Parameter [1]	Units	2009 – 2010				Ontario Drinking Water Standards, Objectives & Guidelines[2]	
		SC	Min.	Avg.	Max.	AO/OG[3]	Health-based Standard
Alkalinity (as $CaCO_3$)	mg/L	3	86	89.5	92.6	30-500	
Aluminum	mg/L	11	<0.004		0.12	0.1	
Bromate	µg/L	3	<3		9		10
Bromide[4]	µg/L	3	18	19	20		
Chloride	mg/L	3	27	33.5	43.6	250	
Colour	TCU	3	<1		1		
Dissolved Organic Carbon (DOC)	mg/L	3	1.7	1.73	1.8	5	
Fluoride	mg/L	33	0.11	0.31	0.74	0.5-0.8	1.5
Hardness (as $CaCO_3$)	mg/L	3	123	127	131	80-100	
Iron	mg/L	11	<0.005		<0.005	0.3	
Lead	mg/L	11	<0.001		<0.001		0.01 (at point of consumption)
Manganese	mg/L	11	0.0001	0.001	0.005	0.05	
Organic Nitrogen	mg/L	3	<0.1		0.1	0.15	
pH[5]		472	6.8	7.5	8.3	6.5-8.5	
Sodium	mg/L	33	13.8	20.2	85.5	200[6]	
Temperature[5]	^{o}C	696	1.6	10.2	20.5	15	
Trihalomethanes (THMs)	µg/L	8	8.3	33.8	118	100[7]	
Turbidity[5]	NTU	401	0.02	0.07	0.44	5 (at point of consumption)	1 (Adverse Water Quality Level)

Parameter [1]	Units	2009 – 2010				Ontario Drinking Water Standards, Objectives & Guidelines[2]	
		SC	Min.	Avg.	Max.	AO/OG[3]	Health-based Standard

Notes:

1. *Water quality data as per Halton Regional Laboratory records for Burloak WPP between June 2009 and July 2010, unless indicated otherwise.*
2. *From O. Reg. 169/03 and Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines (June 2003)*
3. *AO/OG – Aesthetic Objective or Operational Goal (not health-based).*
4. *One additional bromide result of1190 µg/L was obtained from a sample collected on March 18, 2010. As per discussions with the Region of Halton, this value is attributed to a sample error or contamination. As indicated by the Region, Lake Ontario average bromide levels are typically between 30-50 µg/L which is verified by their own routine sampling; therefore, this result has not been accounted for in the average calculation.*
5. *Water quality data as per Burloak WPP operating data records June 2009 and July 2010*
6. *The aesthetic objective for sodium in drinking water is 200 mg/L. The local Medical Officer of Health should be notified when the sodium concentration exceeds 20 mg/L so that this information may be communicated to local physicians for their use with patients on sodium restricted diets.*
7. *The maximum acceptable concentration of THMs in drinking water is 100 ug/L based on a running annual average of quarterly samples measured at point reflecting the maximum residence time in the distribution system.*

6. Design Criteria

6.1 Population Growth and Water Demand

The Lake Ontario based service area in the Region includes the urban areas of Burlington, Oakville, a large portion of Milton and parts of Halton Hills. The lake-based service area is and will continue to be supplied from the Burlington WPP, Oakville WPP and Burloak WPP. It has been determined through the Sustainable Halton Master Plan that the three WPPs with a focused expansion program at the Oakville WPP and Burloak WPP can provide sufficient water treatment capacity to meet the 2031 population and employment projections. The distribution system in the Region is already interconnected; however, there is limited ability for future expansions to the Burlington WPP and the Oakville WPP. The bulk of the required additional servicing capacity for the lake-based service areas will be provided through future expansions of the Burloak WPP and optimization upgrades of the Oakville WPP. This water supply strategy was outlined in the 2011 Sustainable Halton Water and Wastewater Master Plan.

Based on the water demand projections presented in the 2011 Sustainable Halton Water and Wastewater Master Plan and the planned future infrastructure and new upgrades to the existing components of the Halton Distribution System, it has been established that the Burloak WPP will need to be expanded from its current 55 ML/d treatment capacity to a total of 165 ML/d by 2019.

6.2 Treatment Objectives

Treatment objectives for the Burloak WPP were originally defined in 2004 during the previous Class EA Study based on anticipated raw water quality. Given the availability of more than two years of raw and treated water quality data from the existing plant operations, the treatment objectives for the Burloak WPP Phase 2 expansion were developed to be in line with the Region's other two (2) water surface facilities' (Burlington and Oakville WPPs) treatment objectives. The treatment objectives also consider the overall direction that regulatory agencies across North America are heading towards in terms of water drinking water quality standards and objectives.

In general, treatment objectives for Phase 2 expansion of the Burloak WPP were defined in terms of:

- Microbiological protection
- Water quality in the distribution system
- Emerging health concerns
- Aesthetics, colour and taste and odour control.

The proposed treatment objectives developed for Phase 2 expansion of the Burloak WPP considered the minimum requirements against which each treatment strategy would be developed and evaluated. The proposed treatment objectives established for this Class EA Study are summarized in Table 3.

The proposed treatment objectives are the Region's self imposed minimum levels of performance. The levels will provide an operational margin of safety above the ODWQS and also address emergency issues. All treatment process trains considered as part of this Class EA Study have been developed under the premise that each one is designed to meet, at minimum, the treatment objectives shown in Table 3.

Table 3 Burloak WPP Treatment Objectives

Parameter	Ontario Drinking Water Quality Standards	Burloak WPP Proposed Treatment Objective[1]
Pathogen Control		
Turbidity	≤0.3 NTU (95% of time)	≤0.1 NTU 99% in individual filter effluent (FE) ≤0.3 NTU 100% in individual filter effluent (FE)
Cryptosporidium	2.0-log reduction	3.0-log reduction including ≥0.5 log inactivation
Giardia	3.0-log reduction[2]	4.0-log reduction including ≥0.5 log inactivation
Viruses	4.0-log reduction[2]	4.0-log reduction including ≥2.0 log inactivation
Heterotrophic Bacteria	≤ 500 cfu/mL	≤ 500 cfu/mL
E. coli	Zero	Zero
Faecal coliform	Zero	Zero
Disinfection By-products (DBPs) Control		
Trihalomethanes	≤100 µg/L	≤80 µg/L (based on a Locational Running Annual Average)
Haloacetic Acids	None yet defined	≤60 µg/L (based on a Locational Running Annual Average)
Aldehydes	None yet defined	Minimize
Bromate	≤10 µg/L	≤10 µg/L
Chlorite	≤1.0 mg/L	≤1.0 mg/L
Organics Control		
Total Organic Carbon	None yet defined	Minimize as needed
Biodegradable Organic Carbon	None yet defined	Minimize
Distribution System Water Stability		
Chlorine Decay Rate	Defined by disinfectant residuals across the system	Minimize rate of chlorine decay
Distribution System Regrowth	≤ 500 cfu/mL	≤ 500 cfu/mL
Corrosion By-products	Lead ≤0.010 mg/L[3] Copper ≤1.0[3] Iron ≤0.3 mg/L	Lead ≤0.010 mg/L[3] Copper ≤1.0[3] Iron ≤0.3 mg/L
Water Quality Discharged to the Distribution System	None yet defined	Compatible with other Region facilities treating surface water
Inorganics		
Aluminum	≤100 µg/L	≤100 µg/L (Operational Guideline)
Sodium[4]	200 mg/L	<20 mg/L[4]
Emerging Contaminants		
Synthetic Organic Compounds	None yet defined	Minimize if practical
Endocrine Disrupting Compounds	None yet defined	Minimize if practical
Algal Toxins	None yet defined	Minimize if practical
Aesthetics		
Colour	≤5 TCU	≤5 TCU
Taste and Odour	None yet defined	Minimize complaints

Notes:

1. *Burloak WPP Proposed Treatment Objectives established in consultation with the Region staff during workshop held on October 27, 2010 and meeting on November 29, 2010.*
2. *A minimum of 0.5-log removal/ inactivation of Giardia and 2-log removal/inactivation of viruses must be provided through disinfection regardless of the type of treatment provided (MOE Procedure for Disinfection of Drinking Water in Ontario).*
3. *At the point of consumption, assuming a flushed sample.*
4. *The aesthetic objective for sodium in drinking water is 200 mg/L. The local Medical Officer of Health should be notified when the sodium concentration exceeds 20 mg/L so that this information may be communicated to local physicians for their use with patients on sodium restricted diets.*

7. Evaluation Process

7.1 Project Goals/Objectives

Project goals/objectives were established in order to represent the specific nature of the project and factors that are expected to have an important influence in the decision making process. The success of the evaluation methodology will be measured by the extent to which the outcome of the evaluation process is able to achieve these goals/objectives at the end of the process.

The following project goals were developed at the initiation of this project for the preferred treatment design concept:

- The Phase 2 Expansion of the Burloak WPP plant will provide a safe and secure water supply that meets or exceeds the proposed treatment objectives for the plant in a fiscally and technically responsible manner.
- The concept for the expansion will be, to the greatest extent possible, compatible with the existing treatment systems and will therefore result in limited modifications to the existing processes. If modifications or upgrades to the existing processes are required, the benefit of these modifications/upgrades should offset the costs associated with their implementation.
- It will be capable of providing the required capacity of 165 ML/d within the timeline for construction as determined in the 2011 Sustainable Halton Water and Wastewater Master Plan.
- Construction and implementation will allow the Region to continue to meet water production and projected water demands within the stipulated timeframe, and interfering to a minimum with the current operation of the plant and the uninterrupted supply of water.
- It will enable the Region to operate the facility in a manner that is consistent with the availability of staff resources and in a way that is simple and fiscally responsible by balancing capital and operating costs.
- A residual management treatment process will be launched that is sustainable, technically sound, economically mindful in terms of capital and operating costs, and consistent with the existing limitations of the sanitary and storm sewer systems serving the facility.
  It will address in a responsible and practical manner all issues and concerns indentified by the different stakeholder groups identified throughout the process.

7.2 Evaluation Methodology

A well structured and comprehensible evaluation framework was used during the development and evaluation of alternative treatment process trains and residual treatment trains. The framework provides the basis for the selection of the preferred alternative design concept for the expansion of the Burloak WPP. The framework has been developed by the project team in consultation with the Region staff and is briefly summarized in this section.

The selection of the preferred approach to treatment will need to strike a balance between cost and technical factors, and has been summarized into four steps:

1. A **Decision Model** was developed to evaluate and select the preferred main process treatment train and the preferred residuals treatment train. Residuals refer to waste streams produced from the main treatment process with concentrated amounts of suspended solids, which are then treated further. The decision model has been constructed including consideration of factors or evaluation criteria not directly related to cost. Each option was rated against this model. If an option rates well against that factor, it effectively measures a relative benefit offered by that option compared to others. In other words, the decision modeling will be used to rate the “Benefits” offered by each option. Both evaluation tiers follow the same evaluation approach which includes the following steps:

- Development of a long list of viable treatment technologies for the expansion (including main process treatment and residuals treatment).
- A preliminary screening of a long list of treatment technologies. The purpose of the preliminary screening is to identify only those treatment technologies that are considered "feasible" for this project and eliminate those that are not, given the character and nature of this project. This step helps to avoid the need to carry unrealistic treatment technologies when developing alternative treatment trains. Preliminary screening has been completed based on preliminary screening criteria, previously agreed upon by the project team and the Region staff.
- Development of treatment trains incorporating a combination of the feasible treatment technologies.
- Detailed evaluation of treatment trains with consideration given to pre-established evaluation criteria and weight factors.

2. In parallel, **Conceptual Level Capital and O&M Costs** were generated for each option, which in turn was used to develop life cycle costs for each option.

3. The estimated life cycle costs were divided by the Benefits Score generated by the decision model, to produce a **"Benefit-to-Cost Ratio".** The option which scores the highest Benefit-to-Cost Ratio was selected as the preliminary preferred option.

4. **Sensitivity Analyses** were performed on the decision model and the cost estimates, to check that the results wouldn't change if small changes in scoring are made. This effectively verified that any decisions made using this process were robust and defendable.

The general evaluation decision-making process followed the structure identified in Figure 11 below.

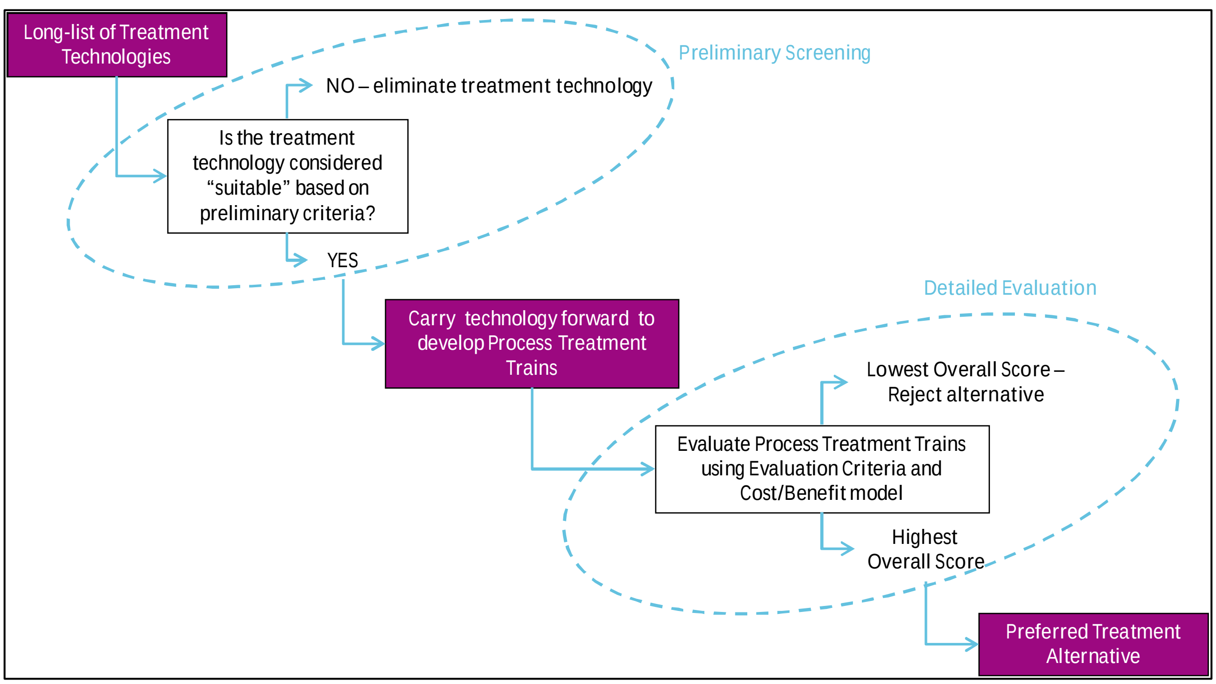


Figure 11 Schematic of the Evaluation Process

8. Overview of Treatment Technologies

The project team completed an early screening of the processes related to treatment technologies. Only “feasible” treatment technologies were considered for this project; other treatments options were eliminated based on the character and nature of this project. This avoids the need to carry out unrealistic treatment technologies when attempting to identify alternatives.

Section 8 provides a brief summary of each treatment technology considered.

8.1 Main Process Treatment Technologies

The main treatment technologies considered for this project were divided into three main groups. The categories are:

- Particulate Removal (Filtration) – remove the majority of suspended solids in raw water
- Primary Disinfection (Pathogen Removal) – virus and bacteria removal or inactivation
- Taste and Odour – address compounds which cause taste and odour problems in treated water.

8.1.1 Particulate Removal (Filtration)

Raw water can contain suspended solids or organic material which can include objects of various sizes and shapes. Generally the first stage of a water treatment process is filtering out the solids in solution through clarification (adding a coagulant (thickening) material which causes the particles to settle by gravity or to float). Filtration is then used to separate the settled or floating solids or organic material by passing the water through a medium which ‘captures’ the solid particles. The particulate removal processes are reviewed as part of this study and are summarized in Table 4.

8.1.2 Primary Disinfection (Pathogen Removal) Processes

Disinfection is designed to remove or inactivate bacteria, viruses or protozoa which may be cause diseases or other issues which can make water un-safe to drink. Disinfection takes place downstream of particle removal (filtration). Combining several processes provides a “multi-barrier” approach which offers a better solution as a treatment objective for the Burloak WPP Phase 2 Expansion. Disinfection processes include primary disinfection to remove viruses, bacteria and protozoa directly from the water. Secondary disinfection prevents bacterial growth in the distribution system.

The current Burloak WPP provides secondary disinfection using chlorine. This study assumes that chlorination will continue to be practiced as secondary disinfection. Primary Disinfection technologies were reviewed as part of this study and are summarized in Table 4.

8.1.3 Taste and Odour Control Processes

Taste and odour (T&O) in surface waters in Ontario are most commonly caused by the presence of algae. The algae can produce by-products such as 2- methylisoborneol (MIB) and Geosmin that cause undesirable tastes and odour in drinking water. The taste and odour processes reviewed as part of this study are summarized in Table 4.

Table 4 Main Process Treatment Technologies – Description

Main Process Treatment Technologies	Technology Description
Particulate Removal (Filtration) Technologies	
Conventional Filtration	Conventional treatment involves the combination of coagulation, flocculation, clarification and granular media filtration processes. • **Coagulation** involves adding material which removes the charge from particles in water • **Flocculation** is a stage where the water is mixed to cause the coagulated particles to bind together to form heavier, removable floc. • **Clarification** is a stage that allows the floc to either settle or float out of solution where they are removed, and granular filtration passes the water through a granular media which captures any remainder particles in the solution. One type of clarifier is ballasted floc clarification (Actiflo®). Ballasted floc clarifiers add a ballast, typically micro-sand with polymer, to the clarification process. This encourages the floc to adhere to the micro-sand, causing floc to settle out quickly. • **Granular media filtration** is the most common type of filtration used in water treatment. Water flows downward by gravity (or under pressure) through a media of one or more layers of granular material. The media is sized to trap particles, filtering the water. Over time, as particles accumulate in the filter, it is backwashed to flush and remove the particles out of the media bed.
Direct Granular Media Filtration	• The direct filtration process generally consists of chemical coagulation, flocculation, and granular media filtration to remove particles from the raw water. • Direct filtration removes the use of the clarification process so the filter material itself does all the straining of the water as shown schematically. • Filter design is typically with deeper, coarser beds being used than with conventional treatment to increase the solids holding capacity of the bed.
Low Pressure Membrane Filtration	• Low pressure membrane filtration (membrane filtration) is process where a pressure difference causes water to pass through a membrane with a very small pore size. As the pore sizes are between 0.01 – 0.1 micron (μm), any particles that are larger cannot pass through the membrane and are removed. • Bacteria such as *Giardia cysts* and *Cryptosporidium oocysts* are greater than 2 μm and are therefore removed through this physical straining. Membrane filtration can be pressurized filtration, where water is fed under pressure through the membrane held in tubes, or submerged, where water is pulled under pressure from a tank through the membranes. • While some membrane processes require upstream clarification, given the typically low turbidity of Lake Ontario upstream clarification is not required. The existing Burloak WPP uses membrane filtration.
Primary Disinfection (Pathogen Removal) Technologies	
Chlorination (alone)	• Chlorine is by far the most common disinfectant due to its low cost, ease of use, and relative effectiveness. • Chlorine is a powerful oxidant that works quickly on bacteria and viruses. It isn't particularly effective against some bacteria such as Giardia and Cryptosporidium. • Chlorine is fed to the water as gaseous chlorine or as liquid hypochlorite.
UV (Ultraviolet)	• UV is a physical process that uses ultraviolet irradiation to prevent the cellular replication of organisms so that they cannot reproduce and are therefore inactivated. • UV light is emitted through a series of lamps located in an enclosed contactors. • UV irradiation is especially effective against *Giardia* and *Cryptosporidium* though it is not effective for all viruses.
Chlorination and UV	• A potential primary disinfection technology is the combined system of chlorination and UV.
Ozonation	• The process of ozonation applies ozone to the water. Ozone is an unstable derivative of oxygen, which is formed on-site and immediately applied to the water. • It is a very strong oxidant and disinfectant and will quickly react with any pathogens in the water. The use of ozone can provide a taste and odour control benefit in addition to its disinfection benefit, as ozone will break down the natural compounds responsible for taste and odour problems.

Main Process Treatment Technologies	Technology Description
Taste & Odour Control Technologies	
Ozonation	• The use of ozone can provide a taste and odour control benefit in addition to a disinfection benefit, as ozone is both a strong oxidant and a disinfectant. This results in the direct oxidation of compounds such as MIB and Geosmin by ozone. • Ozone is generated on-site and is injected into the water to break down the natural compounds responsible for taste and odour problems. If needed, hydrogen peroxide can be injected into ozonated water to produce a powerful oxidizing agent called peroxone.
UV-Advanced Oxidation	• UV-Advanced oxidation uses UV irradiation with hydrogen peroxide, forming powerful free radicals able to rapidly destroy taste and odour causing compounds. It is possible to configure UV reactors with two separate banks of UV lamps, one to provide disinfection credit and the second with peroxide injection for taste and odour control.
Powdered Activated Carbon (PAC)	• Powdered activated carbon is a fine powder used to remove organic compounds, including taste and odour causing compounds, from the water by adsorption to the media. Water passes through the PAC filter and organics remain in the media. • PAC is a relatively expensive approach to taste and odour control, and is usually only practiced in situations where brief, seasonal taste and odour episodes occur. If taste and odour events of longer duration occur, the use of other techniques typically becomes more cost effective.
Granular Activated Carbon (GAC)	• Granular activated carbon (GAC) removes organic compounds from the water by adsorption to the media. GAC is typically used in contactor beds or filters through which water is passed through while the taste and odour causing compounds sticks to (adsorbs to) the GAC. • GAC has a finite capacity and over time will need to be replaced or regenerated.

8.2 Residuals Treatment Technologies

The main treatment process removes suspended solids from water, resulting in a waste stream with higher solids. The Residuals Treatment is required on a site-specific basis and involves separating the waste into either a high solid concentration such as a sludge cake, or into a low solids concentration. The high solids residuals are discharged into sanitary sewers for treatment at the wastewater treatment plant, while the low solids stream can be discharged into the storm water system or the environment. A consideration must be made as to the end goal of the residuals. Thickening the waste stream lowers the volume of waste going to the sanitary sewer, if capacity is limited, or saves on operational cost by reducing the water content, and therefore weight and volume, of sludge to the landfill.

Residuals treatment generally includes some or all of equalization, to provide storage and buffers variations in waste flow, thickening which separates out a thicker sludge layer, dewatering which removes water from the thickened sludge to produce a dry solid suitable for a landfill, or secondary membrane filtration to further concentrate the waste stream. These can be combined into stages:

- Equalization alone
- Equalization, clarification/thickening
- Equalization, clarification/thickening and dewatering/drying
- Equalization, secondary membrane filtration.

Residuals treatment process selection is performed on a site-specific basis. The existing Burloak WPP Drinking Water License requires that process wastewater discharged to the stormwater sewer system has a total suspended solids (TSS) not exceeding 15 mg/L; otherwise it must be discharged to the sanitary sewer, which has limited capacity. Due to the relatively low volume of residuals currently generated, all the process waste is presently discharged to the sanitary sewer. However, with this discharge limitation, it was concluded that equalization alone is unfeasible for the Phase 2 Expansion and further thickening is required. All other treatment trains noted above, with the exception of equalization alone, were considered when developing potential residuals treatment trains.

The residuals treatment technologies reviewed as part of this study are summarized in Table 5.

Table 5 Residuals Treatment Technologies – Description

Residuals Treatment Technologies	Technology Description
Clarification/Thickening Technologies	
Crude Sedimentation	• Concrete basins providing equalization and settlement of the sludge. • Wastewater sludge is discharged in batches to the basins, where it is allowed to settle. This allows a clarified supernatant layer to form on top of the basins, while the solids settle to the bottom. • The basins are designed with a sloped floor towards a sump and are fitted with a means to decant clarified water from near the water surface. • The base of the basins can be fitted with sludge scrapers to move thickened sludge to a central sump.
Crude Sedimentation/Thickening	• Concrete basins are used to provide equalization and settlement of the sludge. • Wastewater sludge is discharged in discrete batches to the basins, where it is allowed to settle and form a clear clarified supernatant on the top layer • The process will overflow a weir, and the thickened solids layer settling at the bottom of the basins is removed.
Gravity Sedimentation/Thickening	• Involves the same fundamental principle used for crude sedimentation, except that it is done in a more controlled fashion. • The process uses a thickener basin of uniform shape and will be in continuous operation. • Polymer is added to wastewater and is fed at a constant rate to the thickener where it is continuously settled and thickened. • Supernatant would continually overflow into a set of effluent launders and be removed. • A sludge scraper and a sloped floor will move thickened sludge to a central sump, from where the sludge is removed by pumps.
High Rate Clarification/Thickening	• Uses plate or tube packs fitted within the clarification portion of the basin to increase the amount of wastewater which can be handled. • The process reduces the effective distance solids need to settle before being effectively removed. • High rate settling modules allow for a consistently good supernatant quality to be achieved, while allowing the thickener to be designed at a much higher surface loading rate and a lower footprint.
Dissolved Air Flotation (DAF) Clarification/Thickening	• Introduces fine air bubbles to the liquid phase to induce solids-liquid separation by causing the fine material to float to the top of the basin. • In a DAF system used for clarification, water supersaturated with air under pressure is mixed with coagulated and flocculated water entering the clarifier. • The release of the supersaturated water, and the resultant loss of pressure this entails, results in the precipitation of enormous quantities of micro-bubbles. These micro-bubbles stick to particulate matter and float to the surface of the clarifier to form a layer of sludge . The layer is scrapped off the surface to physically separate the solids from the water.
Ballasted clarification/thickening	• Follows the same principle of an ACTIFLO unit, but with a smaller footprint requirement. • The volume of the process to be treated is less. • ACTIFLO is a physical-chemical settling process where microsand is added to the coagulated raw water to form sturdy ballasted flow with high settling velocities to enhance gravity settling.
Dewatering/Drying Processes	
Sand Drying Beds	• A shallow basin is used with a network of perforated piping covered by sand and gravel. • Sludge is applied to the beds, and water is removed through decanting, through infiltration to the perforated pipes, and evaporation. • Dewatering time can range from 1.5 to 4 days in the summer, however in the winter low temperatures will not allow for dewatering. • As the areas are large, significant operator time is required to remove the sludge.
Solar Drying Beds	• Similar to sand drying beds, except that the floor of the bed is impervious, so that the water is only removed through decanting and evaporation. • Typically used in warm climates.

Residuals Treatment Technologies	Technology Description
Sludge Dewatering Lagoons	• Lagoons sized for months of storage. • Natural settling occurs over a period of time, and the clarified supernatant is decanted. • Lagoons are periodically decanted down to expose the sludge layer, which then dries through evaporation. • Dewatering lagoons are usually designed with impervious floors to allow for heavy machinery to till the sludge.
Freeze/thaw Lagoons	• Very similar to a sludge dewatering lagoon, except that the sludge freezes over during the winter months, which changes its characteristics from a gelatinous semi-solid to a granular material, from which water can drain freely once the sludge is thawed. • Sludge particles remain consolidated during a thaw and do not dissolve. • During warmer seasons the drying beds operate as conventional sand drying beds with the solids allowed to accumulate. The accumulated sludge is removed annually after the thaw in late winter.
Centrifuges	• Centrifuges dewater sludge by applying centrifugal force to thickened sludge which has been conditioned with polymer. • Thickened sludge is introduced into a spinning bowl which causes the sludge-water matrix to separate with the solids fraction forced to the outside of the bowl, and the water to remain closer to the centre. The sludge cake is forced out a discharge chute, while the centrate is drained at the opposite end.
Belt Filter Presses	• Belt filter presses have double moving belts to continuously dewater thickened sludge through a combination of drainage and compression. • Solids entering the press are chemically conditioned with organic polymer to enhance flocculation. • The flocculated solids are spread onto a porous traveling belt where water is allowed to drain. • The sludge is squeezed between two porous belts as it winds past a series of bends and drums. The dewatered cake is discharged into a hopper at the end of the press.
Static Filter Presses	• Involves the squeezing of conditioned, thickened sludge between two porous filter cloths; • Rather than being configured as a continuous belt, the filter cloths are attached inside a number of concave plates, each of which are mounted on a frame. • The static filter press operates in discrete batches.
Secondary Membrane Filtration Process	
Membrane Filtration	• A membrane filtration system, similar to that described in Table 4, treats backwash wastewater to produce a high quality treated water which is discharged back to the head of the plant or into the distribution system. Different jurisdictions in North America (e.g., the state of California) will not allow discharge into the distribution system unless additional treatment is installed to provide the target disinfection goal for the raw water source. • In the Province of Ontario, discharge of secondary membrane filtrate into the distribution system is allowed. • With Burloak WPP having a treatment objective of 3.0-log reduction of Cryptosporidium and 4.0-log reduction of Giardia, if secondary membrane filtration is to be discharged to the distribution system, it will first be treated with UV water to achieve at least 1.5-log inactivation of Cryptosporidium and 2.5-log inactivation of Giardia, assuming credits of 1.5-log removal of Cryptosporidium and Giardia are provided to the secondary membrane filtration system.

9. Preliminary Screening Results

9.1 Overview

The preliminary screening step was used to study all of the treatment technologies described in Section 8. This section describes how the screening was conducted. Treatment technologies that met all the preliminary screening criteria were considered “feasible” and short-listed for further consideration in the development of alternative treatment trains. Other treatment technologies were eliminated during this step and not considered further in the evaluation process if at least one of the preliminary criteria was not met by the technology in question.

9.2 Preliminary Screening – Main Process Treatment Technologies

Preliminary screening of the main process treatment technologies described in the preceding sections has been completed by applying preliminary screening criteria, established in consultation with the Region staff and shown in Table 6**.** The results of the preliminary screening for particulate removal, disinfection and taste and odour control technologies are summarized in Table 7. A more detailed description of the assessment of the each technology, can be found in Appendix G.

Table 6 Main Process Treatment Technologies – Preliminary Screening Criteria

Preliminary Screening Criteria	Description
Compliance	Ability to continuously meet or exceed the proposed treatment objectives and provide a multi-barrier approach
Technical Feasibility	• Compatibility with existing infrastructure (potential impact on overall construction requirements) • Compatibility with existing treatment processes (operating risk, system reliability, maintenance and monitoring requirements) • Ability for the project to be completed within the specified timeframe
Capacity	Ability to meet the required design capacity for the projected demand as established in the Master Plan Review.

Table 7 Main Process Treatment Technologies – Preliminary Screening Results

Alternative Technologies	Preliminary Screening Criteria Main Observations and Comments	Short-Listed Yes	 No
Particulate Removal Technologies			
Conventional Filtration (coagulation/flocculation/ clarification followed by granular media filtration)	Conventional treatment is able to satisfy the preliminary screening criteria in terms of compliance and technical feasibility. ***However, with respect to capacity and assuming that plate settlers will be used for clarification purposes, the use of conventional treatment will not allow the Region to meet the design and ultimate site capacity within the existing site boundaries. Alternatively, based on the assumption that ballasted floc clarifiers will be used in the clarification step, then conventional treatment will be able to meet the design and ultimate site capacity within the existing site boundaries. Therefore, conventional treatment using ballasted floc clarifiers will be considered as a feasible particulate removal technology.***	✓	
Direct Filtration (coagulation/flocculation followed by granular media filtration)	Consistent with the turbidity results reported by Gartner Lee Limited in August 2003, it can be concluded that the pathogen barrier would not be robust and that production targets would not be able to be maintained during potential episodes of high raw water turbidity, thus, system reliability during these episodes may be compromised. ***Therefore, direct filtration will not be considered a feasible particulate removal technology for this project and is eliminated from further consideration.***		×

Alternative Technologies	Preliminary Screening Criteria Main Observations and Comments	Short-Listed	
		Yes	No
Membrane Filtration	Membrane filtration is able to meet all the preliminary screening criteria in terms of compliance, technical feasibility and capacity. Considering that the existing Burloak WPP already has membrane technology as the filtration process, there are embedded technical and operational benefits that this technology has to offer if implemented for the future capacity expansions of the plant. ***Therefore, membrane filtration will be considered as a feasible particulate removal technology.***	✓	
Primary Disinfection Technologies			
Chlorination (alone)	Chlorination <u>alone</u> cannot meet the multi-barrier treatment objective for Cryptosporidium inactivation, and thus, cannot be considered as an option for primary disinfection.		×
UV Irradiation (alone)	UV irradiation <u>alone</u> cannot meet the treatment objective for virus inactivation, and thus, cannot be considered as a feasible primary disinfection technology.		×
UV Irradiation (with chlorine)	UV irradiation in combination with chlorination as a primary disinfection technology allows the project to meet comfortably the criteria from a compliance, technical and capacity requirements perspective. ***Therefore, UV irradiation in combination with chlorination will be considered as a feasible primary disinfection technology.***	✓	
Ozonation (alone)	Ozonation as a primary disinfection technology allows the project to meet comfortably the criteria from a compliance, technical and capacity requirements perspective. ***Therefore, it will be considered as a feasible primary disinfection technology.***	✓	
Taste & Odour Control Technologies			
Ozonation	Ozonation as a T&O control technology allows the project to meet comfortably the criteria from a compliance, technical and capacity requirements perspective. ***Therefore, it will be considered as a feasible T&O control technology.***	✓	
UV-Advanced Oxidation (UV with Hydrogen Peroxide)	UV-Advanced oxidation as a T&O control technology allows the project to meet comfortably the criteria from a compliance, technical and capacity requirements perspective. ***Therefore, it will be considered as a feasible T&O control technology.***	✓	
Powdered Activation Carbon (PAC)	There are significant limitations offered by this technology in terms of technical issues. The overall impact to the residuals management facility due to the large quantities of sludge produced as well as the increased operational difficulty resulting from handling of this chemical are major considerations that render this option unfeasible. In addition, PAC could potentially foul/stress membranes if membrane filtration is selected as the preferred technology. ***As a result, PAC will not be considered as a feasible T&O control technology.***		×
Granular Activated Carbon (GAC)	The continuous operation of the GAC filters results in constant depletion of GAC adsorption capacity, which in turn may result in scenarios where the appropriate level of T&O control cannot be provided. ***As such, the ability to continuously meet or exceed the proposed treatment objective for T&O and provide a multi-barrier approach could be compromised from a Region's compliance perspective due to the potential for the GAC capacity to be used up at times of T&O episodes, and thus, cannot be considered as an option for T&O control.***		×

9.3 Preliminary Screening – Residuals Treatment Technologies

There is a large number of residual treatment technologies available for the treatment of waste streams. To be consistent with the evaluation approach proposed for the main process treatment trains, a step-wise evaluation approach was followed when assessing residuals treatment technologies and selecting the preferred residuals treatment train.

A preliminary screening of the broad range of residuals treatment technologies assisted the project team by eliminating options that are not suitable for the Burloak WPP. The preliminary screening of the residuals technologies measured each option according to the initial screening criteria developed with the Region staff, and shown in Table 8. The results of the preliminary screening for the residuals treatment technologies are summarized in Table 9, while a detailed description is available Appendix G.

Table 8 Residuals Treatment Technologies – Preliminary Screening Criteria

Preliminary Screening Criteria	Description
Technical Feasibility	• Ability to operate under existing climatic conditions • Ability to provide operational flexibility • Ability to be implemented within the site boundaries • Ability to provide a proven track record

Table 9 Residuals Treatment Technologies – Preliminary Screening Results

Alternative Technologies	Preliminary Screening Criteria Main Observations and Comments	Short-Listed	
		Yes	No
Sludge Clarification/Thickening Technologies			
Crude Sedimentation	Crude sedimentation would require a very large footprint to provide proper sludge settling. Besides crude sedimentation basins, an additional thickening system needing additional footprint will be required. ***Given the space limitations on-site and the large footprint requirement, this option is eliminated from further consideration.***		×
Gravity Sedimentation/ Thickening	Gravity sedimentation/thickening technology is able to satisfy all screening criteria in terms of ability to operate under existing climatic conditions, required footprint, proven track record, and ease of operation. However, since available space within the site is such an important constraint in this project, it has been judged that better benefits would be obtained by using plate settlers' clarification/thickening; which is a similar technology that would provide similar performance at a comparable cost but with smaller footprint requirements. ***On this basis, gravity sedimentation/thickening technology is excluded and will not be considered a feasible clarification/thickening technology.***		×
Plate Settlers Clarification/Thickening	Plate settlers' clarification/thickening technology is able to satisfy all screening criteria in terms of ability to operate under existing climatic conditions, required footprint, proven track record, and ease of operation. ***As such, plate settlers' clarification/thickening technology will be considered a feasible clarification/thickening technology.***	✓	
Dissolved Air Flotation (DAF) Clarification/Thickening	DAF clarification/thickening technology is able to satisfy all screening criteria in terms of ability to operate under existing climatic conditions, required footprint, proven track record, and ease of operation. ***As such, DAF clarification/thickening technology will be considered a feasible clarification/thickening technology.***	✓	
Actiflo® Clarification/Thickening	The watery composition of the raw waste resulting from the Actiflo® Clarification/Thickening means that an additional thickening system is needed that will provide additional footprint. Since this technology relies on the use of polymers and micro-sand for performance, it hinders the recycling of the supernatant as a viable option for this project for the existing membrane treatment train. ***Given the space limitations on-site and the large footprint requirement as well as the potential for recycling of supernatant, this option is eliminated from further consideration.***		×
Sludge Dewatering/Drying Technologies			
Sand Drying Beds	Sand drying beds as a dewatering/drying technology present significant limitations in terms of their ability to perform well under all weather conditions as well as the large footprint requirement. ***On this basis, sand drying beds will not be considered a feasible dewatering/drying technology.***		×
Solar Drying Beds	Solar drying beds as dewatering/drying technology present significant limitations in terms of their ability to perform well under all weather conditions as well as the large footprint requirement. ***On this basis, Solar drying beds will not be considered a feasible dewatering/drying technology.***		×

Alternative Technologies	Preliminary Screening Criteria Main Observations and Comments	Short-Listed	
		Yes	No
Sludge Dewatering Lagoons	Sludge dewatering lagoons as dewatering/drying technology present significant limitations in terms of their ability to perform well under all weather conditions as well as the large footprint requirement. ***On this basis, sludge dewatering lagoons will not be considered a feasible dewatering/drying technology.***		×
Freeze/Thaw Lagoons	Freeze/Thaw lagoons as a dewatering/drying technology are not a viable technology for this project since the Halton winters are not long enough to ensure complete freezing of the layers. Additionally, this technology presents significant limitations in terms of the large footprint requirement. ***On this basis, freeze/thaw Lagoons will not be considered a feasible dewatering/drying technology.***		×
Centrifuges	Centrifuges as a dewatering/drying technology is able to satisfy all screening criteria in terms of ability to operate under existing climatic conditions, required footprint, proven track record, and ease of operation. ***As such, this technology will be considered a feasible dewatering/drying technology.***	✓	
Belt Filter Presses	Belt filter presses as a dewatering/drying technology is able to satisfy all screening criteria in terms of ability to operate under existing climatic conditions, required footprint, proven track record, and ease of operation. ***As such, this technology will be considered a feasible dewatering/drying technology.***	✓	
Static Filter Presses (Plate and Frame)	Static filter presses as dewatering/drying technology present significant limitations for this project in terms of their operational complexity as well as the lack of track proven record in Canada. ***On this basis, static filter presses will not be considered a feasible dewatering/drying technology.***		×
Membrane Filtration Technology			
Secondary Membrane Filtration	Secondary membrane filtration technology is able to satisfy all screening criteria in terms of ability to operate under existing climatic conditions, required footprint, proven track record, and ease of operation. ***As such, this technology will be considered as a feasible residual technology.***	✓	

9.4 Summary

The preliminary screening conducted by the project team eliminated a number of technologies that were not feasible for the Burloak WPP. Table 10 lists the feasible candidate technologies.

Table 10 Short-listed Candidate Technologies for the Burloak WPP Expansion

Process	Short-listed Candidate Technology
Main Process Treatment	
Particulate Removal	Conventional treatment (Coagulation, ballasted flocculation/clarification and filtration) Membrane filtration
Pathogen Removal (Disinfection)	UV with chlorine Ozone
Taste & Odour Control	Ozone UV-Advanced oxidation (with or without hydrogen peroxide)
Residuals Treatment	
Clarification/Thickening	Plate settlers clarification/thickening DAF clarification/thickening
Dewatering/Drying	Centrifuges Belt filter presses
Membrane Filtration	Secondary membrane filtration

The next step in the process was to develop treatment trains using different combinations of the short-listed technologies shown in Table 10. The results of this next step are discussed in the following section.

10. Development of Alternative Treatment Trains

10.1 Overview

An important aspect of the Class EA process is the assessment of alternative treatment trains for a given project. This section presents the options considered in more detail for the Burloak WPP Phase 2 expansion project. The options were developed under the assumption that each individual train is able to consistently meet and/or exceed the water quality treatment objectives developed for the Phase 2 expansion of the Burloak WPP.

10.2 Main Process Treatment Trains

The project team developed six different treatment trains to be further evaluated in the next stages of the Class EA Study based on the main process treatment technologies short-listed in Section 1 of this document. The six alternative main process treatment trains are summarized below in Table 11 and are graphically illustrated in the following Figures (Figure 12 to Figure 17).

Table 11 Main Process Treatment Train Options

Option	Particulate Removal	Disinfection	Taste and Odour Control
P1	Conventional Treatment (ballasted flocculation/clarification followed by dual-media filtration)	UV w/chlorine during non-T&O season and w/ozone during T&O season	Ozone
P2	Conventional Treatment (ballasted flocculation/clarification followed by dual-media filtration)	UV w/chlorine year round	UV-Advanced Oxidation
P3	Conventional Treatment (ballasted flocculation/clarification followed by dual-media filtration)	Ozone year round	
P4	Membrane Filtration (with provisional coagulation & flocculation/pre-equalization prior to membrane system)	UV w/chlorine during non-T&O season and w/ozone during T&O season	Ozone
P5	Membrane Filtration (with provisional coagulation & flocculation/pre-equalization prior to membrane system)	UV w/chlorine year round	UV-Advanced Oxidation
P6	Membrane Filtration (with provisional coagulation & flocculation/pre-equalization prior to membrane system)	Ozone year round	

An important consideration when examining these technologies is that each of the above six options will also include the following additional processes/components:

- Chlorination at the intake for zebra mussel control
- Low lift pumping station
- High lift pumping station
- Secondary disinfection with chlorine for maintenance of residual in the distribution system
- Other works.

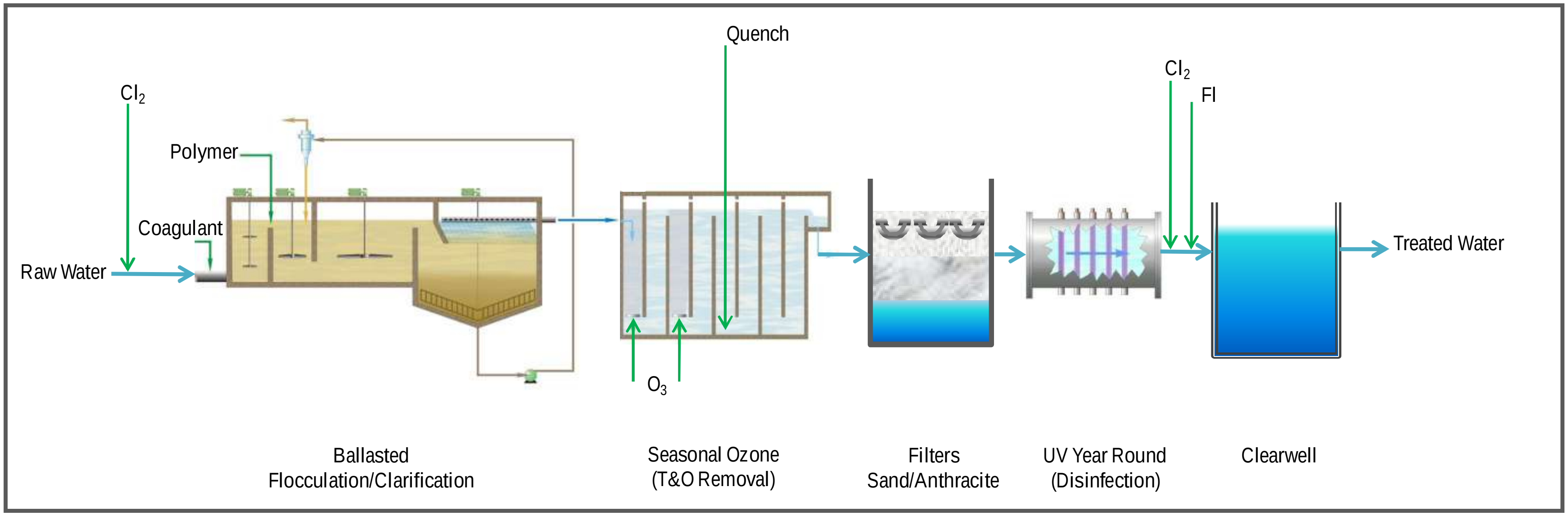


Figure 12 Schematic Diagram Option P1 – Ballasted Flocculation/Clarification + UV w/chlorine or w/ozone + Ozone

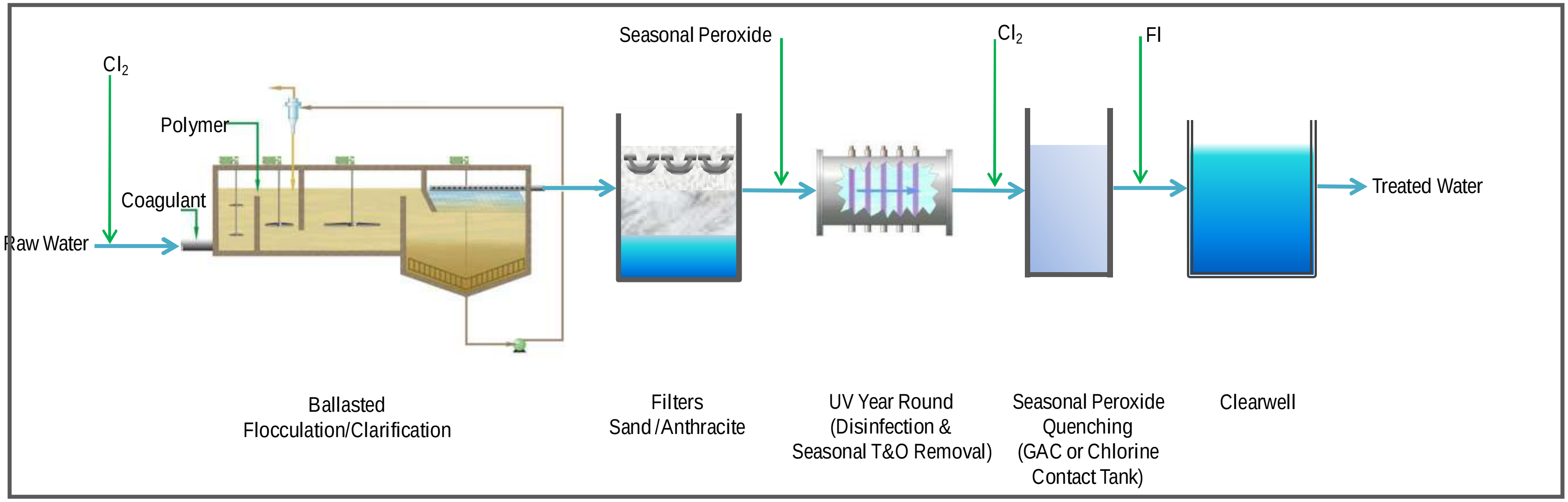


Figure 13 Schematic Diagram Option P2 – Ballasted Flocculation/Clarification + UV w/ chlorine + UV-Advanced Oxidation

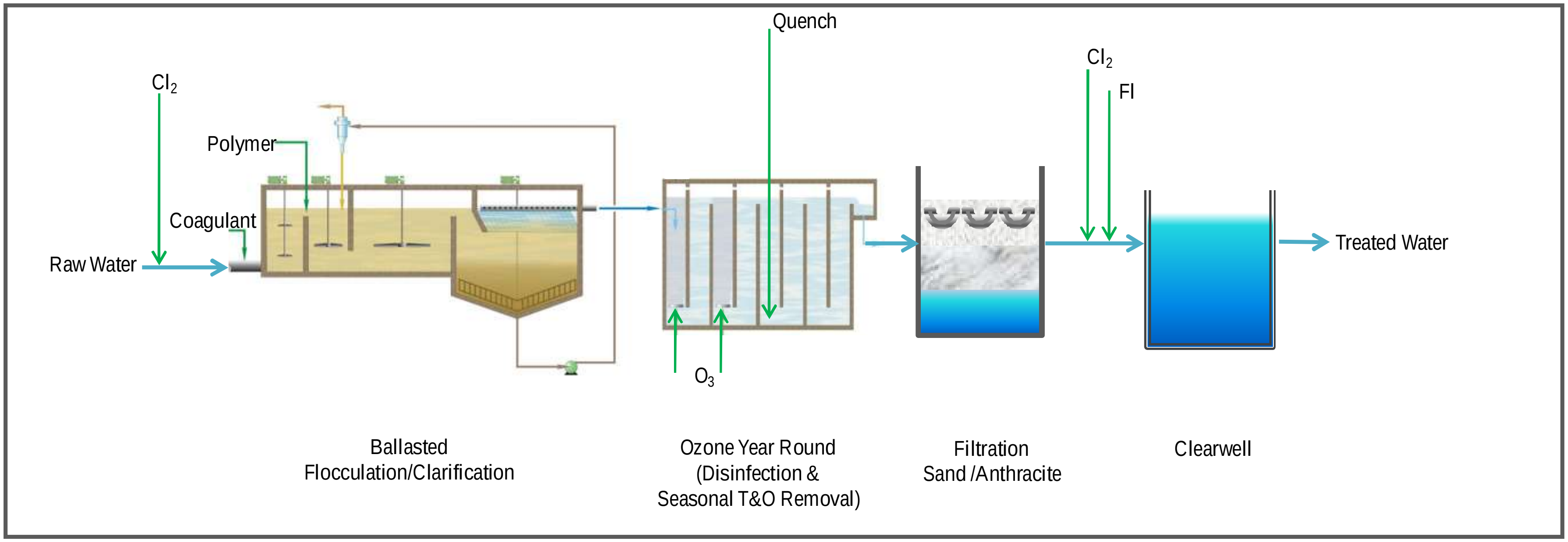


Figure 14 Schematic Diagram Option P3 – Ballasted Flocculation/Clarification + Ozone

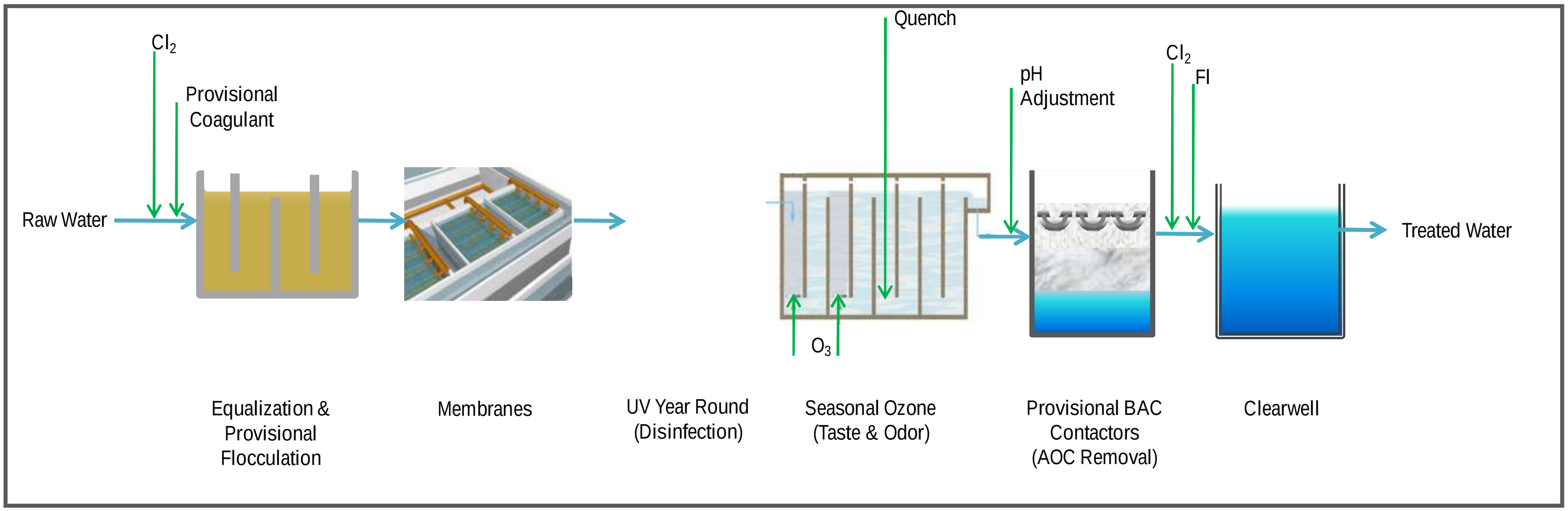


Figure 15 Schematic Diagram Option P4 – Membrane Filtration + UV w/chlorine or w/ozone + Ozone

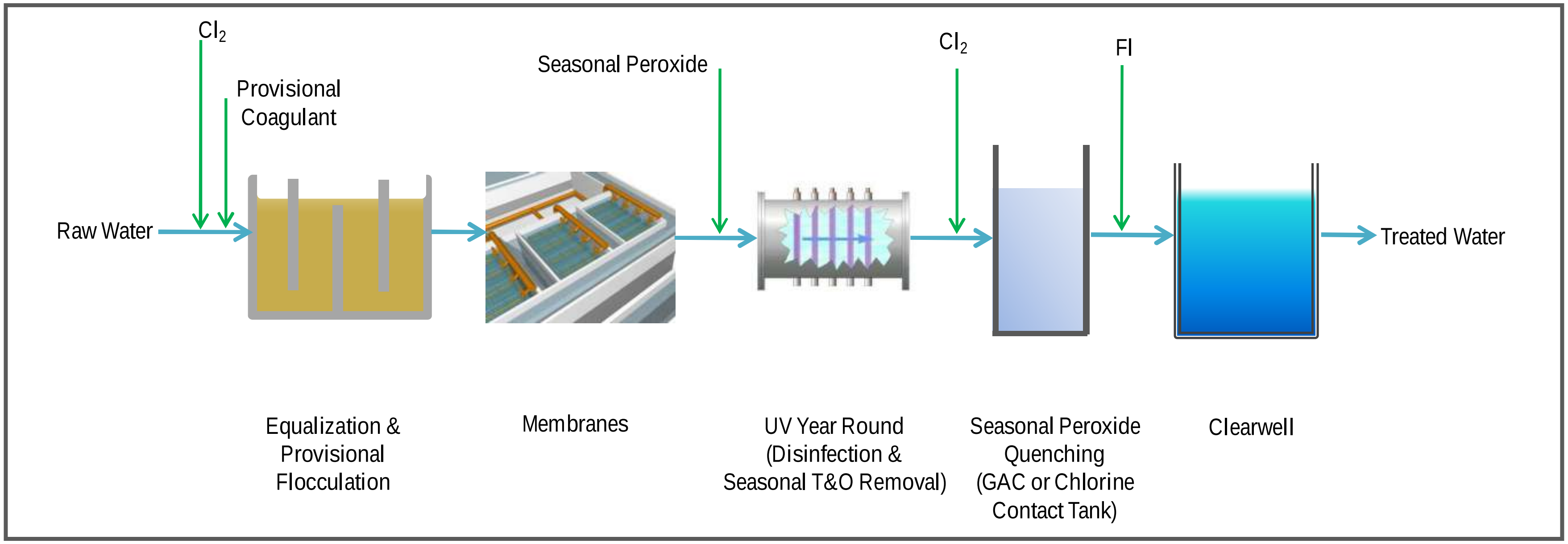


Figure 16 Schematic Diagram Option P5 – Membrane Filtration + UV w/ chlorine + UV-Advanced Oxidation

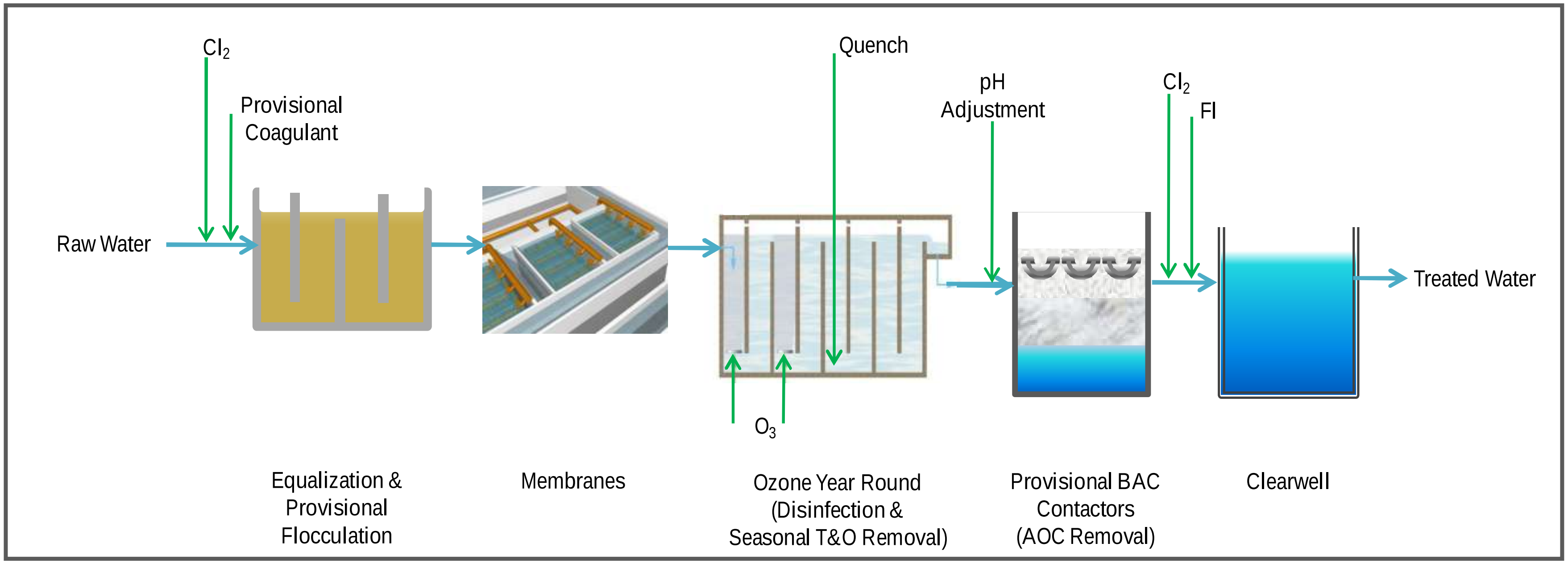


Figure 17 Schematic Diagram of Option P6 – Membrane Filtration + Ozone

10.3 Residuals Treatment Trains

The short-listed residuals treatment technologies have been incorporated into different residual treatment trains that reflect the three following possible combinations:

- Equalization and clarification/thickening
- Equalization, clarification/thickening and dewatering/drying
- Equalization and secondary membrane filtration.

It was anticipated that when comparing the Benefit-to-Cost ratio of the residual treatment trains, using centrifuges or belt filter presses as the dewatering/drying technology in the "equalization, clarification/thickening and dewatering/drying" train, would not provide significant differences. As a result, and in order to reduce the amount of residual treatment trains to compare in the Class EA process, centrifuges were considered as the dewatering/drying technology. During detailed design, if the "equalization, clarification/thickening and dewatering/drying" train is preferred from the Class EA process, a more detailed evaluation between centrifuges and belt filter presses will be conducted.

The project team developed six different residuals treatment trains to be further evaluated in the next stages of the Class EA study. The alternative residuals treatment trains are summarized below in Table 12 and are graphically illustrated in the following Figures (Figure 18 through Figure 23).

Table 12 Residuals Treatment Train Options

Option	Residuals Treatment Train Description				
R1	Equalization Basins	+	Plate Settlers Clarification/Thickening		
R2	Equalization Basins	+	DAF Clarification/Thickening		
R3	Equalization Basins	+	Plate Settlers Clarification/Thickening	+	Centrifuges
R4	Equalization Basins	+	DAF Clarification/Thickening	+	Centrifuges
R5	Equalization Basins	+	Secondary Membrane Filtration		Discharge to head of plant or storm sewer
R6	Equalization Basins	+	Secondary Membrane Filtration	+	UV Irradiation with discharge to distribution system

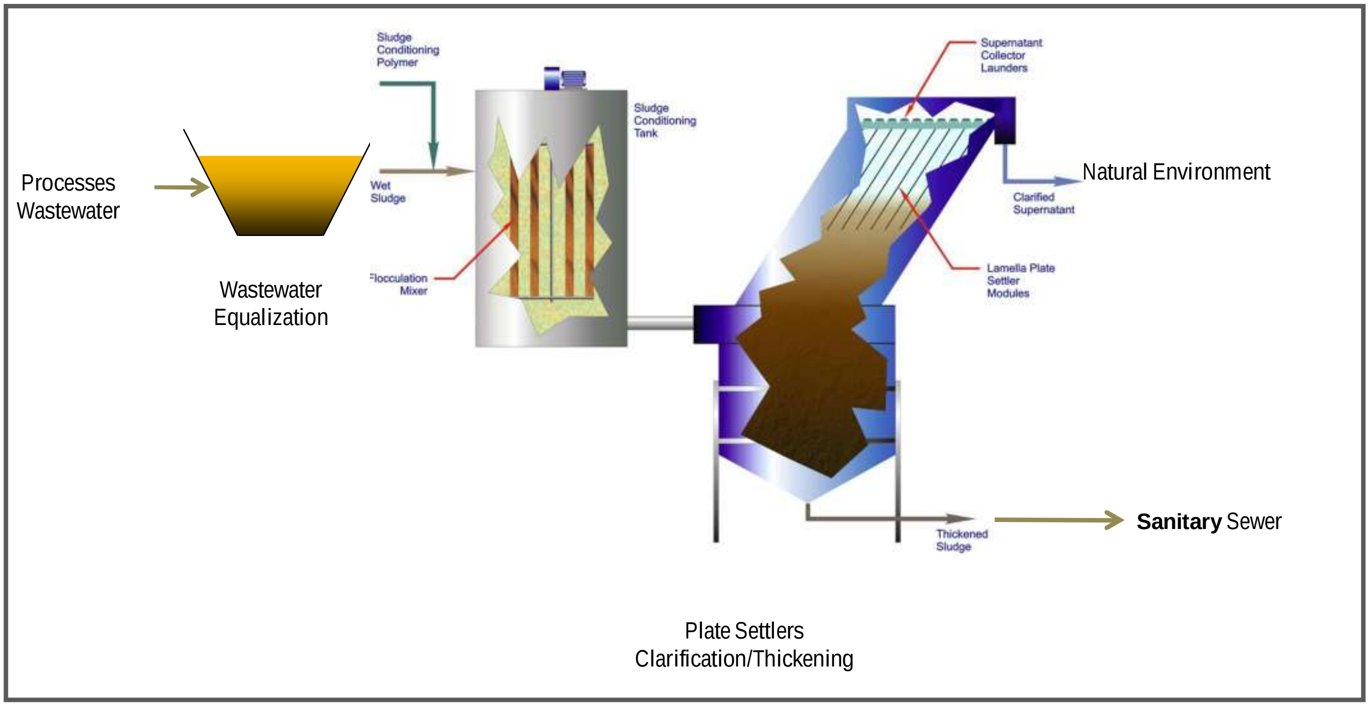


Figure 18 Schematic Diagram of Option R1 – Equalization + Plate Settlers Clarification/Thickening

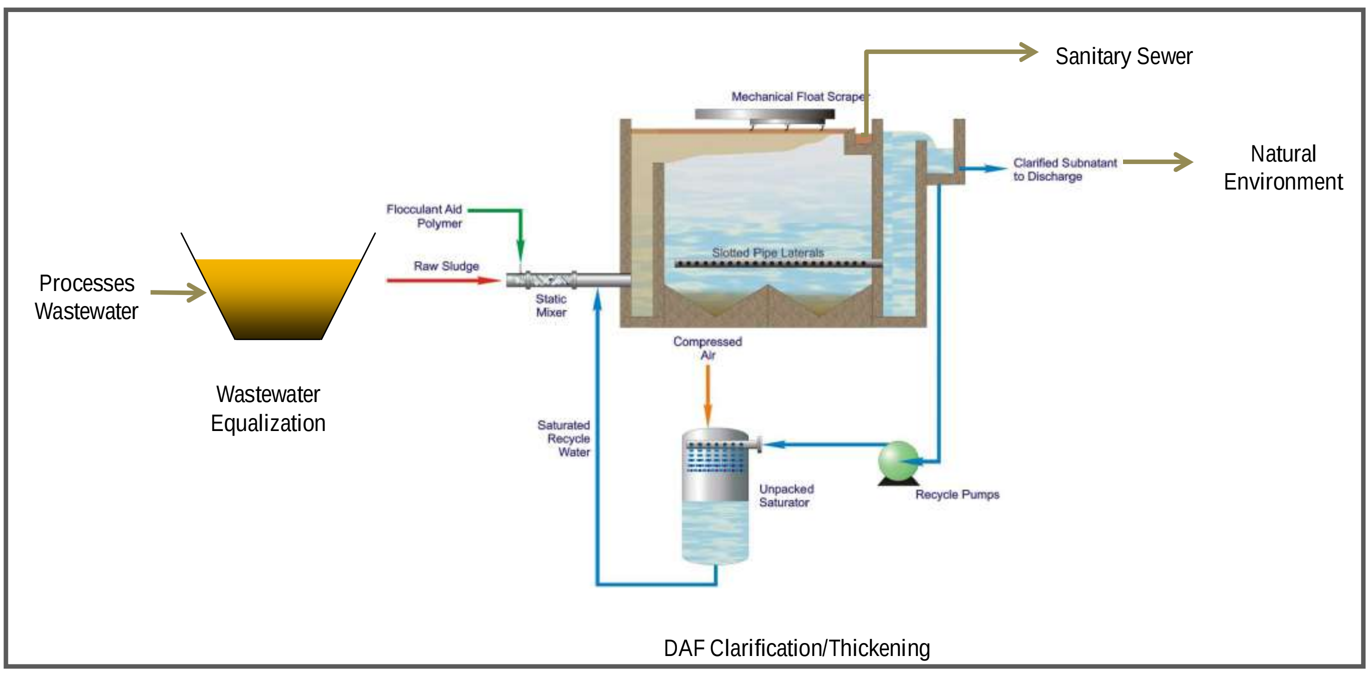


Figure 19 Schematic Diagram of Option R2 – Equalization + DAF Clarification/Thickening

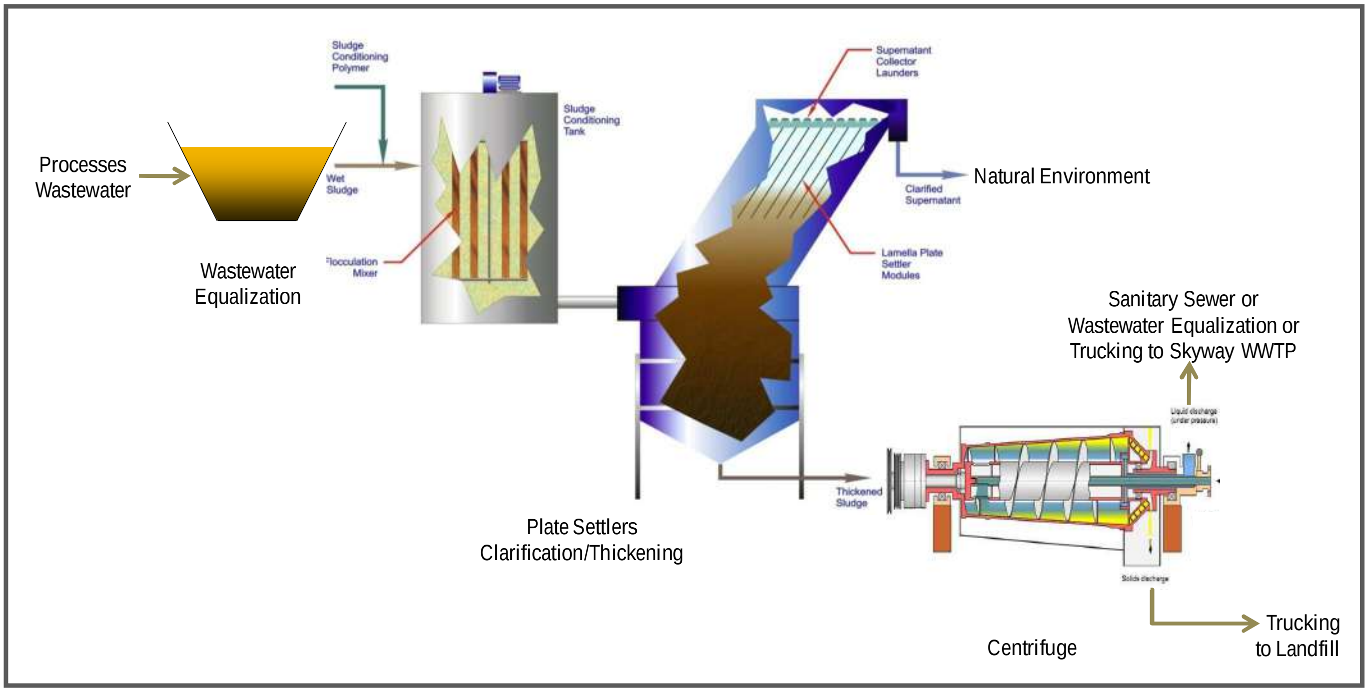


Figure 20 Schematic Diagram of Option R3 – Equalization + Plate Settlers Clarification/Thickening + Centrifuges

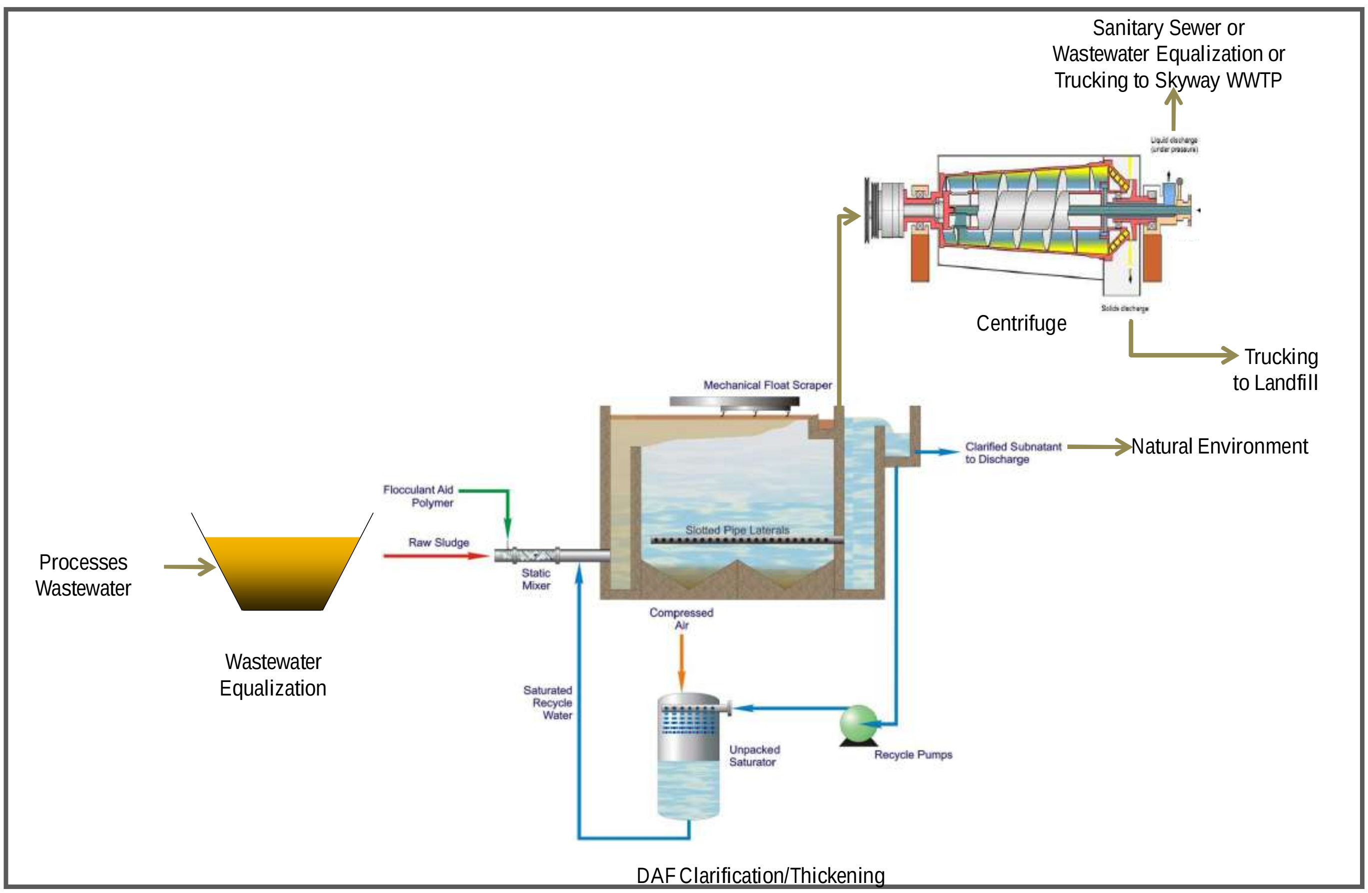


Figure 21 Schematic Diagram of Option R4 – Equalization + DAF Clarification/Thickening + Centrifuges

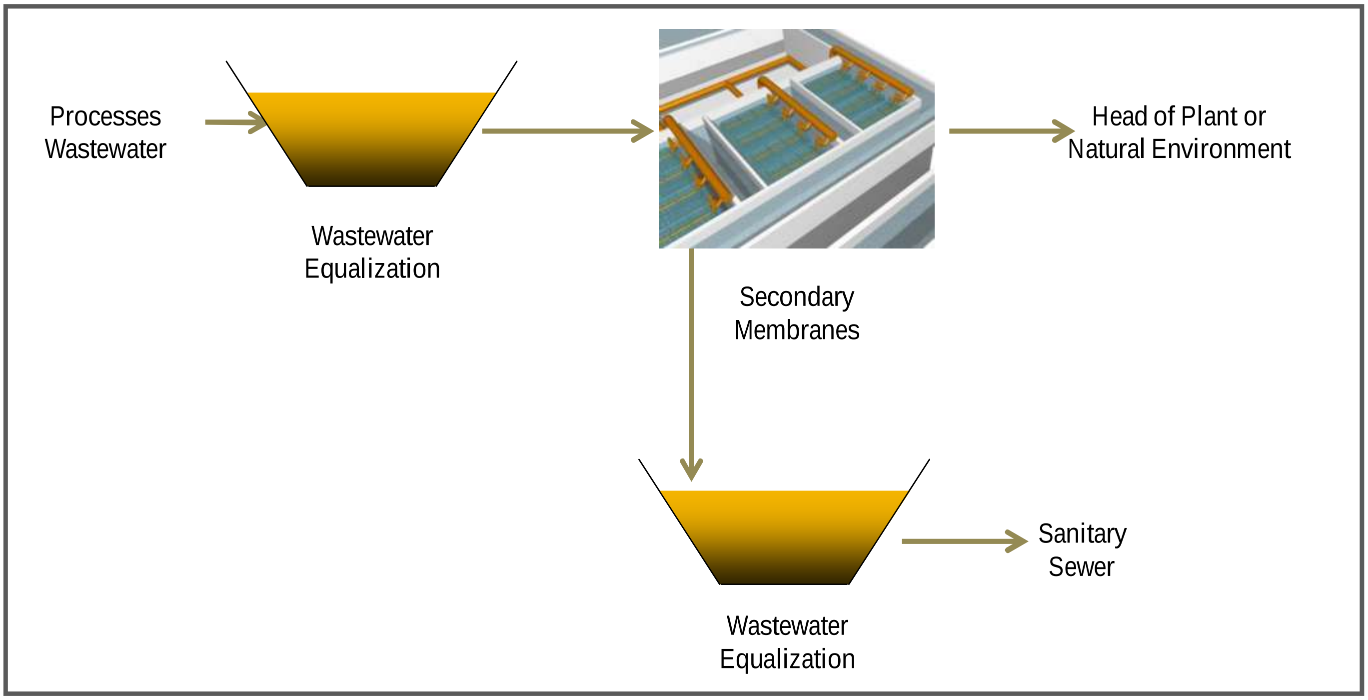


Figure 22 Schematic Diagram of Option R5 – Equalization + Secondary Membrane Filtration

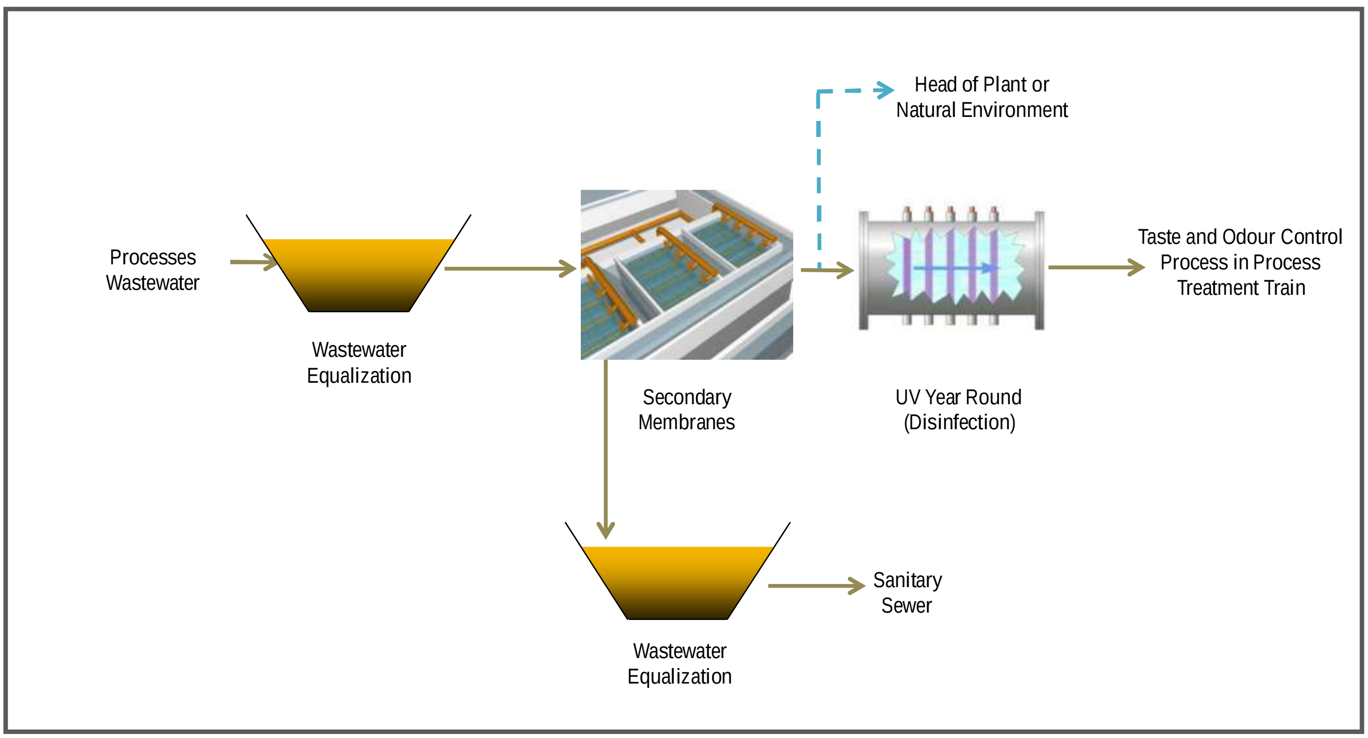


Figure 23 Schematic Diagram of Option R6 – Equalization + Secondary Membrane Filtration + UV Disinfection with Discharge to Distribution System

11. Evaluation Criteria

This section summarizes the detailed evaluation criteria that were developed to represent all aspects or factors of importance to identifying the preferred treatment train alternative.

11.1 Main Process Treatment Train – Evaluation Criteria and Weights

The evaluation criteria and weighting factors were modified from the 2004 Class EA Study for Phase 1 of the Burloak WPP, as the characteristics of this project are different from those when the plant was originally planned and designed (e.g., Greenfield vs. existing site, meaning no treatment vs. existing processes).

In general, four primary criteria have been established including:

- Water Quality
- Technical Considerations
- Social Considerations
- Natural Environmental Considerations.

Secondary criteria or sub-criteria were identified within each primary criterion. The secondary criteria describe specific aspects of the criteria being evaluated. Weighting factors match the degree of importance within the overall evaluation and were assigned to each of the criteria based on project team judgment and previous experience in similar projects.

A description of each of the evaluation criteria to be used during the assessment of the main process treatment train is shown in Table 13. In addition, the proposed criteria and respective weighting factors used during the evaluation of the main process treatment trains are shown in Table 14.

Table 13 Main Treatment Process Trains – Evaluation Criteria Description

Primary Criteria	Secondary Criteria	Criterion Description
Water Quality	Pathogen control	Ability for control of *Crypto*, *Giardia*, Viruses and Bacteria.
	Minimize Disinfection By-Products and Maximize Organic removal	Ability to minimize formation of THMs, HAAs, Aldehydes, Bromate, Chlorite. Ability to remove TOC and BDOC.
	Water stability in distribution system	Ability to reduce the potential for water quality deterioration in distribution system.
	Minimize aluminum residuals	Ability to minimize residual aluminum left over from use of a coagulant.
	Flexibility to respond to Emerging Contaminants (EDCs & PPCPs)	Ability to remove emerging contaminants, in other words, how effectiveness of the treatment train at providing treatment of these contaminants.
	Ability to meet Aesthetics Objectives (AOs) including Taste & Odour	Effectiveness of the treatment train is at providing Taste & Odour control.
	Flexibility for future objectives	Ability to comply with more stringent objectives of known contaminants/pathogens.
	Flexibility to respond to variable raw water quality	Ability to provide consistent treated water quality independent of variations in quality (i.e., temp., turbidity, pH) of source water.
Technical Considerations	Compatibility with existing system	How similar process treatment train is with respect to existing system. Ability to take advantage of existing infrastructure.
	Flexibility for expansion (future phases)	Ability for the treatment train to integrate future treatment required for future expansion.
	Operation and maintenance requirements	Operational and maintenance procedures for effective functioning of equipment, monitoring requirements.
	Process complexity (including chemical systems)	Need for control of the processes and equipment to ensure effective performance.
	Proven track record	Experience with technology within the Region.
	Safety requirements	Potential health and safety concerns associated with use of chemicals and equipment.
	Ability to maximize ultimate site capacity/compatibility with existing site	Ability to maximize ultimate site capacity/compatibility with existing site.
	Ease of implementation (construction schedule)	Ability to facilitate construction in terms of footprint which ties into construction schedule. The bigger the area, the more construction is needed, and the longer it may take.
	Process robustness (multi-barrier treatment) and redundancy	Ability of the treatment train to continue to operate adequately despite any abnormalities experienced by one or more than one treatment process.
Social Considerations	Minimize footprint and site impacts /architectural aesthetics (plant appearance)	Minimize footprint and site impacts /Architectural aesthetics (plant appearance).
	Minimize truck traffic (during operation)	Ability to minimize the number of trucks delivering chemicals to the site and removing residuals from plant.
	Minimize noise (during operation)	Consider neighbours complaints (notwithstanding meeting MOE requirements).
	Minimize odour (during operation)	Minimize odour (during operation)
Natural Environmental Considerations	Minimize on-site air emissions	On-site air emissions associated with number and size of chemical systems (air changes in chemical rooms and storage tank venting)
	Minimize residuals impacts	Minimize residuals impacts

Table 14 Main Treatment Process Trains – Evaluation Criteria and Weights

Primary Criteria	Weight	Secondary Criteria	Relative Weight	Absolute Weight
Water Quality	30	Pathogen control	30	9
		Minimize Disinfection By-Products and Maximize Organic removal	10	3
		Water stability in distribution system	5	1.5
		Minimize aluminum residuals	5	1.5
		Flexibility to respond to Emerging Contaminants (EDCs & PPCPs)	5	1.5
		Ability to meet Aesthetics Objectives (AOs) including Taste & Odour	20	6
		Flexibility for future objectives	5	1.5
		Flexibility to respond to variable raw water quality	20	6
Maximum Sub-total Score – Water Quality				30
Technical Considerations	40	Compatibility with existing system	25	10
		Flexibility for expansion (future phases)	10	4
		Operation and maintenance requirements	10	4
		Process complexity (including chemical systems)	10	4
		Proven track record	5	2
		Safety requirements	5	2
		Ability to maximize ultimate site capacity/compatibility with existing site	15	6
		Ease of implementation (construction schedule)	5	2
		Process robustness (multi-barrier treatment) and redundancy	15	6
Maximum Sub-total Score – Technical Considerations				40
Social Considerations	20	Minimize footprint and site impacts /architectural aesthetics (plant appearance)	45	9
		Minimize truck traffic (during operation)	25	5
		Minimize noise (during operation)	25	5
		Minimize odour (during operation)	5	1
Maximum Sub-total Score – Social Considerations				20
Natural Environmental Considerations	10	Minimize on-site air emissions	20	2
		Minimize residuals impacts	80	8
Maximum Sub-total Score – Natural Environmental Considerations				10
			Total Overall Maximum Score	**100**

The project team developed each of the treatment process trains under the premise that every single train must meet, as a minimum, the Burloak WPP treatment objectives. This will ensure that treated water quality objectives will always be achieved by all the options. The purpose of having water quality as a separate evaluation criterion offers a way to determine the treatment train providing superior water quality performance when compared to the others.

Treatment process trains have been assessed relative to each other and evaluated against all criteria shown in Table 13. The performance of each treatment train against the various sub-criteria used a score from 0-100 basis with higher scores given to better performing options. This allows the various options to be compared in an easier format.

11.2 Residuals Treatment Trains – Evaluation Criteria and Weights

Table 15 lists the proposed evaluation criteria and weighting factors using during the detailed evaluation of the residuals treatment. The table identifies the proposed criteria for the residuals treatment trains in eight different categories (with no sub-categories).

Table 15 Residual Treatment Process – Evaluation Criteria and Weights

Criteria	Weight
Process robustness and susceptibility to failure	20
Ability to reduce aesthetic concerns (footprint and building height)	20
Ability to perform given existing limitations (sewer and storm water systems)	20
Ability to minimize odours, noise, truck traffic	10
Operational and maintenance requirements	10
Discharge water quality and quantity	10
Ability to minimize chemical usage	5
Ability to recycle to head of plant	5
Total Maximum Score	**100**

The residual treatment process that scored the highest number would be considered the option that provides the most “benefits” to this project. This follows the method used to evaluate the main treatment process.

The overall benefit score for each process was divided by its estimated life cycle cost, resulting in a “benefit-to-cost” ratio. The option with the highest “benefit-to-cost” ratio would offer the greatest value, meaning that it would be selected as the preferred residual treatment alternative for the Phase 2 expansion of the plant. The preferred residual treatment alternative has also been carried forward as the common residual management option for all treatment process trains under evaluation. By incorporating the residuals management option to each alternative treatment train, the evaluation model is able to assess the implications of treating process water volumes generated by each treatment train from a financial perspective.

12. Alternative Treatment Train Evaluation Results

This section describes the results of the detailed evaluation process including the benefits evaluation, economic evaluation and cost benefit analysis. All of the residuals treatment trains and main process treatment trains were examined using these tools.

The residuals treatment options were studied first, before selecting the main process treatment trains. This approach allowed the model to assess the financial issues that arise from treating the process water volumes generated by each treatment train (complete with process and residuals treatment). The assessment results are provided in the following sections to provide more information about the alternative treatment train.

12.1 General Assumptions

The following assumptions were made when comparing the various treatment trains:

- Cost estimates are based on current 2011 construction costs. Inflation and escalation to account for actual expected prices at the time of tendering cannot be accounted for at this time.
- Estimates of probable capital costs have been developed based on prices obtained from suppliers and from data in AECOM's possession from similar projects. This is a **relative** economic evaluation with all options under consideration, and prices should change proportionally.
- Operating costs are based upon an average daily flow ratio of 72% of the maximum daily flow as well as average chemical dosages.
- All taxes (including the 13% HST) have been excluded.
- Life cycle costs have been estimated based on:
  - A 20-year amortization period
  - An inflation rate of 2% and an interest rate of 6% to give a market/discount rate of 4%.

12.2 Residuals Process Treatment Trains – Evaluation Results

12.2.1 Benefits Evaluation Results

The detailed evaluation process followed in this step is consistent with the evaluation methodology developed for this project. Each treatment was assessed under each criterion and assigned a score out of 100. The score represents how well the specific alternative treatment train meets the criterion under consideration, meaning that a higher score was given to options with a higher ability to perform or meet the criteria. The treatment train that scored the highest is the option that provides the most "benefits" to this project, and is the option selected by this report.

The various treatment trains were compared to each other and evaluated against criteria. The criteria were designed to represent all aspects or factors of importance for determining the preferred alternative. The evaluation criteria for the residual treatment trains included eight different categories (with no sub-categories). The evaluation criteria, as well as the weighting factors used to represent the degree of importance within the overall evaluation scheme, were previously assigned based on project team judgment and past experiences in similar projects.

The decision model was created to include a consideration of all factors that were not directly related to costs. Instead, all economic considerations (capital and operation & maintenance costs) were developed separately for every option and used during the cost benefit analysis.

The benefit scoring for the residuals treatment trains is shown in Table 16 to describe the rankings. This information can also be seen in Figure 24. Details about the complete evaluation of the alternative residuals treatment trains and scoring reasoning can be found in Table 17. The individual scores for each treatment train were assigned in collaboration with the Region.

Table 16 Residuals Treatment Trains – Benefit Scoring Results

Option ID	Residual Treatment Train Description	Benefit Score (Points out of 100)	Ranking (1 to 6)
R1	Equalization Basins + Plate Settlers Clarification/Thickening	71.5	3
R2	Equalization Basins + DAF Clarification/Thickening	69.0	4
R3	Equalization Basins + Plate Settlers Clarification/Thickening + Centrifuges	62.0	5
R4	Equalization Basins + DAF Clarification/Thickening + Centrifuges	61.5	6
R5	Equalization Basins + Secondary Membrane Filtration	85.5	1
R6	Equalization Basins + Secondary Membrane Filtration + UV Disinfection	85.5	1

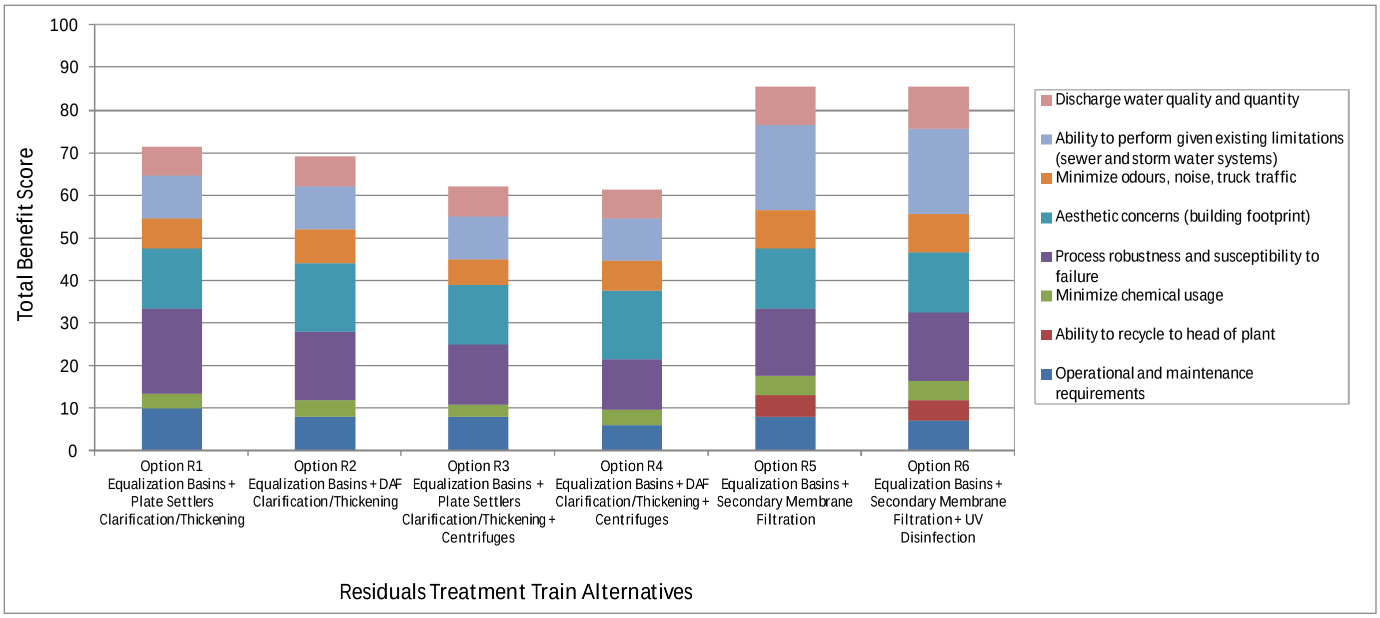


Figure 24 Residuals Treatment Trains – Benefit Evaluation Scoring Results

Table 17 Residuals Treatment Trains – Detailed Benefits Evaluation Scoring and Results

Evaluation Criteria	Absolute Weight	Option R1 Equalization Basins + Plate Settlers Clarification/Thickening			Option R2 Equalization Basins + DAF Clarification/Thickening			Option R3 Equalization Basins + Plate Settlers Clarification/Thickening + Centrifuges			Option R4 Equalization Basins + DAF Clarification/Thickening + Centrifuges			Option R5 Equalization Basins + Secondary Membrane Filtration			Option R6 Equalization Basins + Secondary Membrane Filtration + UV Disinfection w/ Discharge to Distribution System		
		Rationale	Score 1 to 100	Absolute Weight	Rationale	Score 1 to 100	Absolute Weight	Rationale	Score 1 to 100	Absolute Weight	Rationale	Score 1 to 100	Absolute Weight	Rationale	Score 1 to 100	Absolute Weight	Rationale	Score 1 to 100	Absolute Weight
Operational and maintenance requirements	10	Plate settlers require very little operator intervention. It may take a day or more for the system to reach a steady state operation.	100	10	DAF requires more operational and maintenance intervention compared to plate settlers. The start-up of a DAF system is less intensive than that of plate settlers - hours compared to days.	80	8	Plate settlers require very little operator intervention. It may take a day or more for the system to reach a steady state operation. Addition of the centrifuges adds some operational and maintenance complexity.	80	8	DAF requires more operational and maintenance intervention compared to plate settlers. The start-up of a DAF system is less intensive than that of plate settlers - hours compared to days. Addition of centrifuges adds some operational and maintenance complexity.	60	6	Secondary membranes require very little maintenance intervention (no LRV/MIT requirements). Operating modes (frequent backwashing, MCs and CIPs) add to complexity and additional operational requirements.	80	8	Secondary membranes require very little maintenance intervention (no LRV/MIT requirements). Operating modes (frequent backwashing, MCs and CIPs) add to complexity and additional operational requirements. UV has little operational involvement, but more frequent replacement of parts (not difficult to replace though), and maintenance involvement.	70	7
Ability to recycle to head of plant	5	Resulting supernatant will have an increased amount of pathogens going to the head of the plant which will result in an increased burden on the main treatment process. Recycled sedimentation polymer can foul existing membranes.	0	0	Resulting supernatant will have an increased amount of pathogens going to the head of the plant which will result in an increased burden on the main treatment process. DAF polymer dosages will be small resulting in minimal potential for fouling existing membranes.	0	0	Resulting supernatant will have an increased amount of pathogens going to the head of the plant which will result in an increased burden on the main treatment process. Recycled sedimentation and centrifuge polymer can foul existing membranes.	0	0	Resulting supernatant will have an increased amount of pathogens going to the head of the plant which will result in an increased burden on the main treatment process. DAF polymer dosages will be small resulting in minimal potential for fouling existing membranes. Recycled centrifuge polymer can foul existing membranes.	0	0	Membrane filtrate will be of high quality such that it can be recycled to the head of the plant.	100	5	Membrane filtrate will be of high quality such that it can be recycled to the head of the plant.	100	5
Minimize chemical usage	5	Sedimentation uses polymer.	70	3.5	DAF uses less small dosages of polymer (significantly less than sedimentation).	80	4	Sedimentation uses polymer. Centrifuges use polymer.	60	3	DAF uses less small dosages of polymer (significantly less than sedimentation). Centrifuges use polymer.	70	3.5	Membranes use cleaning chemical, but intermittently - not as much as continuous use of polymer.	90	4.5	Membranes use cleaning chemical, but intermittently - not as much as continuous use of polymer.	90	4.5
Process robustness and susceptibility to failure	20	Plate settlers equipment is relatively simple with not too many components, so less opportunity for failure.	100	20	There is more equipment for DAF than plate settlers, thus there is a chance for more equipment to fail. DAF is considered very robust.	80	16	Plate settlers equipment is relatively simple with not too many components, so less opportunity for failure. Centrifuges provide more opportunity for failure.	70	14	There is more equipment for DAF than plate settlers, thus there is a chance for more equipment to fail. DAF is considered very robust. Centrifuges provide more opportunity for failure.	60	12	Membrane fibres can break reducing process robustness. However secondary membrane treatment is not as sensitive to fibre breakages as primary treatment.	80	16	Membrane fibres can break reducing process robustness. However secondary membrane treatment is not as sensitive to fibre breakages as primary treatment. UV process is robust.	80	16
Aesthetic concerns (footprint and building height)	20	The building footprint is directly dependant on the main treatment process train selected. The required footprint considering conventional treatment and membrane filtration as the main treatment process in the plant would be approximately 1,064 m^2 and 1,330 m^2, respectively.	70	14	The building footprint is directly dependant on the main treatment process train selected. The required footprint considering conventional treatment and membrane filtration as the main treatment process in the plant would be approximately 672 m^2 and 840 m^2, respectively.	80	16	The building footprint is directly dependant on the main treatment process train selected. The required footprint considering conventional treatment and membrane filtration as the main treatment process in the plant would be approximately 1,672 m^2 and 1,338 m^2, respectively.	70	14	The building footprint is directly dependant on the main treatment process train selected. The required footprint considering conventional treatment and membrane filtration as the main treatment process in the plant would be approximately 883 m^2 and 1,104 m^2, respectively.	80	16	The required building footprint would be approximately 1,320 m^2.	70	14	The required building footprint would be approximately 1,369 m^2.	70	14
Minimize odours, noise, truck traffic	10	There will be little odours and noise generated from this option as all equipment will be contained in its	70	7	There will be little odours and noise generated from this option as all equipment will be contained in its	80	8	There will be little odours and noise generated from this option as all equipment will be contained in its own	60	6	There will be little odours and noise generated from this option as all equipment will be contained in its own	70	7	There will be little odours and noise generated from this option as all equipment will be contained in its	90	9	There will be little odours and noise generated from this option as all equipment will be contained in its	90	9

Evaluation Criteria	Absolute Weight	Option R1 Equalization Basins + Plate Settlers Clarification/Thickening			Option R2 Equalization Basins + DAF Clarification/Thickening			Option R3 Equalization Basins + Plate Settlers Clarification/Thickening + Centrifuges			Option R4 Equalization Basins + DAF Clarification/Thickening + Centrifuges			Option R5 Equalization Basins + Secondary Membrane Filtration			Option R6 Equalization Basins + Secondary Membrane Filtration + UV Disinfection w/ Discharge to Distribution System		
		Rationale	Score 1 to 100	Absolute Weight	Rationale	Score 1 to 100	Absolute Weight	Rationale	Score 1 to 100	Absolute Weight	Rationale	Score 1 to 100	Absolute Weight	Rationale	Score 1 to 100	Absolute Weight	Rationale	Score 1 to 100	Absolute Weight
		own building. Additional noise will be present from trucking polymer in. Waste/sludge will be discharged into the storm or sanitary sewer, eliminating the need for trucking out sludge.			own building. Additional noise will be present from trucking polymer in but less than for sedimentation. Waste/sludge will be discharged into the storm or sanitary sewer, eliminating the need for trucking out sludge.			building. Additional noise will be present from trucking polymer in and trucking sludge out.			building. Additional noise will be present from trucking polymer in but less than for sedimentation and trucking sludge out.			own building. Additional noise will be present from trucking cleaning chemicals in but less than for sedimentation or DAF. Waste/sludge will be discharged into the storm or sanitary sewer, eliminating the need for trucking out sludge.			own building. Additional noise will be present from trucking cleaning chemicals in but less than for sedimentation or DAF. Waste/sludge will be discharged into the storm or sanitary sewer, eliminating the need for trucking out sludge.		
Ability to perform given existing limitations (sewer and storm water systems)	20	The maximum capacities of the storm and sanitary sewers are 210 L/ and 72 L/s respectively, thus restricting the amount of clarified supernatant that can be discharged to the storm and/or sanitary sewers. The concentration of the thickened sludge can reach 20,000 mg/L TSS, which exceeds the sanitary sewer by-law of 350 mg/L TSS.	50	10	The maximum capacities of the storm and sanitary sewers are 210 L/ and 72 L/s respectively, thus restricting the amount of clarified supernatant that can be discharged to the storm and/or sanitary sewers. The concentration of the thickened sludge can reach 20,000 mg/L TSS, which exceeds the sanitary sewer by-law of 350 mg/L TSS.	50	10	The maximum capacities of the storm and sanitary sewers are 210 L/ and 72 L/s respectively, thus restricting the amount of clarified supernatant that can be discharged to the storm and/or sanitary sewers. The concentration of the centrifuge centrate can reach 2,400 mg/L TSS, which exceeds the sanitary sewer by-law of 350 mg/L TSS.	50	10	The maximum capacities of the storm and sanitary sewers are 210 L/ and 72 L/s respectively, thus restricting the amount of clarified supernatant that can be discharged to the storm and/or sanitary sewers. The concentration of the centrifuge centrate can reach 2,400 mg/L TSS, which exceeds the sanitary sewer by-law of 350 mg/L TSS.	50	10	With the membrane filtrate going to the head of the plant or to the distribution system, there is no dependence on the sanitary sewer system. The flowrate and TSS of the secondary membrane backwash wastewater as well and primary and secondary membrane neutralized chemical waste going to the sanitary sewer are within its capacity and sewer by-law.	100	20	With the membrane filtrate going to the head of the plant or to the distribution system, there is no dependence on the sanitary sewer system. The flowrate and TSS of the secondary membrane backwash wastewater as well and primary and secondary membrane neutralized chemical waste going to the sanitary sewer are within its capacity and sewer by-law.	100	20
Discharge water quality and quantity	10	The clarified supernatant would have an increased concentration of pathogens than the raw water to the main treatment process. It can also contain residual chemicals (e.g., polymers) and TSS concentration typical less than 15 mg/L. This process would produce similar clarified water quality and quantity as the other residual options, except for the secondary membrane filtration option.	70	7	The clarified supernatant would have an increased concentration of pathogens than the raw water to the main treatment process. It can also contain residual chemicals (e.g., polymers) and TSS concentration typical less than 15 mg/L. This process would produce similar clarified water quality and quantity as the other residual options, except for the secondary membrane filtration option.	70	7	The clarified supernatant would have an increased concentration of pathogens than the raw water to the main treatment process. It can also contain residual chemicals (e.g., polymers) and TSS concentration typical less than 15 mg/L. This process would produce similar clarified water quality and quantity as the other residual options, except for the secondary membrane filtration option.	70	7	The clarified supernatant would have an increased concentration of pathogens than the raw water to the main treatment process. It can also contain residual chemicals (e.g., polymers) and TSS concentration typical less than 15 mg/L. This process would produce similar clarified water quality and quantity as the other residual options, except for the secondary membrane filtration option.	70	7	Secondary membrane filtration will provide an extremely high removal of pathogens, and will contain no polymer and minimal TSS concentrations.	90	9	Secondary membrane filtration will provide an extremely high removal of pathogens, and will contain no polymer and minimal TSS concentrations. UV allows for discharging directly into distribution system.	100	10
TOTAL BENEFIT SCORE	**100**	**-**	**-**	**71.5**	**-**	**-**	**69.0**	**-**	**-**	**62.0**	**-**	**-**	**61.5**	**-**	**-**	**85.5**	**-**	**-**	**85.5**
RANKING BASED ON TOTAL BENEFIT SCORE	**1 TO 6**	**-**	**-**	**3**	**-**	**-**	**4**	**-**	**-**	**5**	**-**	**-**	**6**	**-**	**-**	**1**	**-**	**-**	**1**

12.2.2 Cost Benefit Analysis Results

The cost benefit analysis is a tool that includes costs in the evaluation process. The cost benefit analysis is carried out as follows:

- Total benefit score obtain for each residuals treatment train, as presented in Section 9.2 is carried forward.
- A 20-year life cycle cost or Net Present Value (NPV) is calculated for each residuals treatment train, with consideration to capital and operating and maintenance costs.
- Total benefit scores are divided by the calculated life cycle costs, resulting in a value indicator measured in "points achieved per dollar spent". The value indicator is referred to as the "benefit-to-cost ratio".

The results of the cost benefit analysis are shown in Table 18 and Table 19 for ballasted flocculation/clarification and membrane treatment as the main treatment process, respectively.

Table 18 Cost Benefit Analysis Results – Residuals Treatment Trains for Ballasted Flocculation/clarification (Actiflo®)

Option ID	Treatment Train Description ACTIFLO + (Residuals Treatment Train)	Net Present Value 2011 $Millions	Total Benefit Score (Points out of 100)	Benefit-to-Cost Ratio (Points/$Million)
R1 with Actiflo®	Actiflo® + (Equalization Basins + Plate Settlers Clarification/Thickening)	$8.4	71.5	8.5
R2 with Actiflo®	Actiflo® + (Equalization Basins + DAF Clarification/Thickening)	$8.5	69.0	8.1
R3 with Actiflo®	Actiflo® + (Equalization Basins + Plate Settlers Clarification/Thickening + Centrifuges)	$13.3	62.0	4.7
R4 with Actiflo®	Actiflo® + (Equalization Basins + DAF Clarification/Thickening + Centrifuges)	$13.3	61.5	4.6
R5 with Actiflo®	N/A[1]	-	85.5	-
R6 with Actiflo®	N/A[1]	-	85.5	-

Notes:

1. *N/A: Not Applicable. The use of secondary membrane for the treatment of residuals resulting from conventional treatment processes is not considered feasible from a technical perspective due to the nature of the wastewater produced by these types of processes; therefore, costs have not been estimated.*

Option R1 comprising Equalization + Plate Settler Clarification/Thickening offers the highest benefit per dollar spent, when ballasted flocculation/clarification (Actiflo®) is considered the main particulate removal treatment process. The main advantages of Option R1 are:

- It needs minimal operation and maintenance since the equipment is relative simple and demands very little operation intervention
- It provides the flexibility to make operational changes in the system, if required
- It requires minimal footprint
- It eliminates the need to truck wastes out of the site, which consequently results in minimal social impacts in terms of additional odours, noise and truck traffic.

Table 19 Cost Benefit Analysis Results – Residuals Treatment Trains for Membrane Filtration

Option ID	Treatment Train Description Membranes + (Residuals Treatment Train)	Net Present Value 2011 $Millions	Total Benefit Score (Points out of 100)	Benefit-to-Cost Ratio (Points/$Million)
R1 with Membranes	Membranes + (Equalization Basins + Plate Settlers Clarification/Thickening)	$8.2	71.5	8.7
R2 with Membranes	Membranes + (Equalization Basins + DAF Clarification/Thickening)	$8.0	69.0	8.7
R3 with Membranes	Membranes + (Equalization Basins + Plate Settlers Clarification/Thickening + Centrifuges)	$12.1	62.0	5.1
R4 with Membranes	Membranes + (Equalization Basins + DAF Clarification/Thickening + Centrifuges)	$11.7	61.5	5.3
R5 with Membranes	Membranes + (Equalization Basins + Secondary Membrane Filtration)	$10.8	85.5	7.9
R6 with Membranes	Membranes + (Equalization Basins + Secondary Membrane Filtration + UV Disinfection)	$11.4	85.5	7.5

The results of the cost benefit analysis as shown in Table 19 reveals that two residuals treatment options offered the same values, or points achieved per dollar spent, when membrane filtration is considered the main particulate removal treatment process. These are:

- Option R1: Equalization + Plate Settler Clarification/Thickening
- Option R2: Equalization + DAF Clarification/Thickening.

Upon closer analysis of these two options, Option R1 is favoured over Option R2 since the system is relatively simple to operate and provides less opportunity for failure.

Option R1 requires discharge of the clarified supernatant into the environment; the East Sheldon Creek in this particular case. Any discharge of this nature must meet the requirements of regulatory agencies and corresponding approvals must be secured. Pre-consultation meetings with Conservation Halton and the Town of Oakville have already been initiated to obtain approval for this discharge. More information about the pre-consultation discussions can be found in Section 3.3.2. Discharge approval is subject to further submissions which are to be completed early in the detailed design/permitting stages of this project.

In light of the above, the residuals options that do not require discharge into the environment, that is; Options R5 and R6 comprising secondary membranes, may need to be revisited if obtaining the required permits/approval for Option R1 is not successful.

12.3 Main Process Treatment Trains – Evaluation Results

12.3.1 Benefits Evaluation Results

The main process treatment trains were evaluated using a methodology that was consistent with the residuals treatment system evaluation. The main process treatment trains were assessed against each other and against a set of criteria that represented all aspects or factors of importance for identifying the preferred alternative. The evaluation criteria for the main process treatment trains were grouped into four main categories (with sub-categories), namely:

- Water quality considerations
- Technical considerations
- Social considerations
- Natural environmental considerations.

The decision model was created to consider all factors that are not directly related to cost. The following general assumptions were made when assessing the treatment trains amongst each other:

- Under normal operations, coagulation is not practiced with membranes
- Under normal operations, seasonal operation is not practiced year round
- UV power output can be adjusted to achieve desired inactivation (similarly to ozone dosage adjustment).

A summary of the benefit scoring for the main process treatment trains is shown in Table 20 and graphically presented in Figure 25. The scoring rationale and the complete evaluation of the main process treatment trains can be found in Table 21**.**

Table 20 Main Process Treatment Trains – Detailed Benefits Evaluation Scoring Results

Option ID	Main Process Treatment Train Description	Benefit Score (Points out of 100)	Ranking (1 to 6)
P1	Conventional (ballasted flocculation/clarification followed by dual-media filtration) + UV w/chlorine during non T&O season and w/ozone during T&O season + Ozone	72.1	4
P2	Conventional (ballasted flocculation/clarification followed by dual-media filtration) UV w/chlorine year round + UV Advanced Oxidation	68.2	6
P3	Conventional (ballasted Flocculation/clarification followed by dual-media filtration) + Ozone year round	71.3	5
P4	Membranes (with provisional coagulation & flocculation/pre-equalization prior to membrane system) + UV w/chlorine during non T&O season and w/ozone during T&O season + Ozone	89.9	1
P5	Membranes (with provisional coagulation & flocculation/pre-equalization prior to membrane system) + UV w/chlorine year round + UV Advanced Oxidation	86.0	3
P6	Membranes (with provisional coagulation & flocculation/pre-equalization prior to membrane system) + Ozone year round	89.1	2

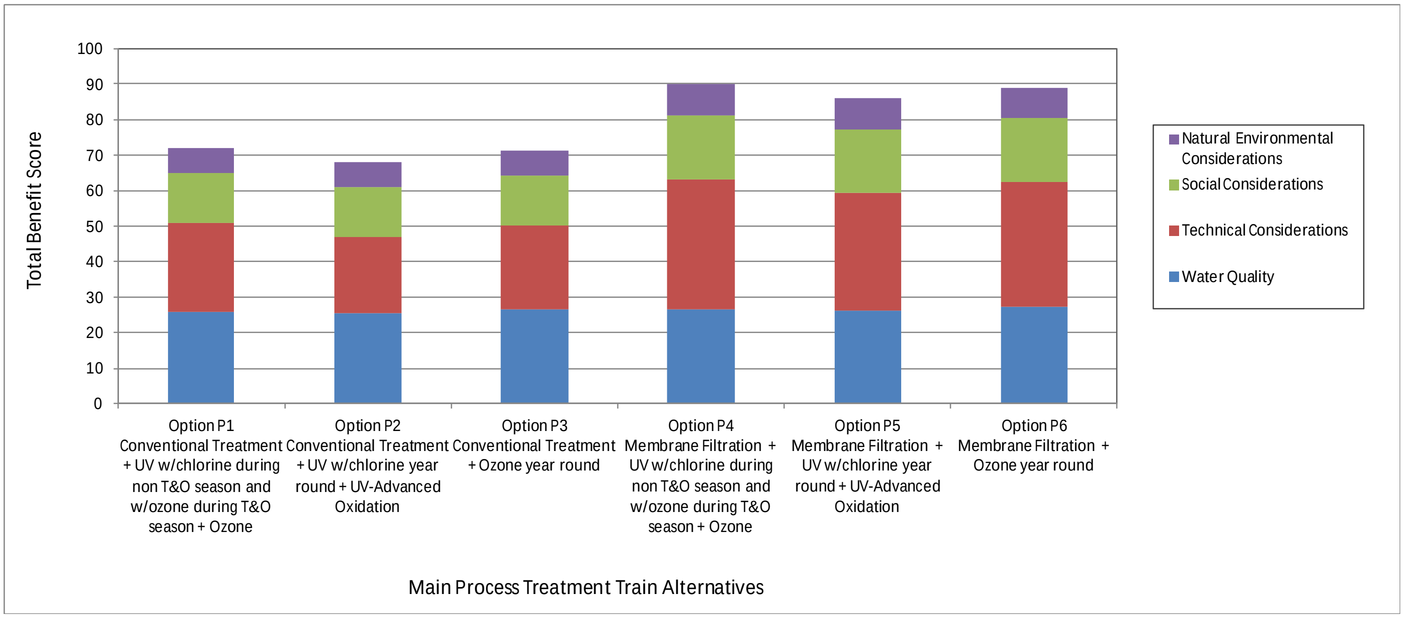


Figure 25 Main Process Treatment Trains – Benefit Evaluation Scoring Results

Table 21 Main Process Treatment Trains – Detailed Benefits Evaluation Scoring and Results

	Evaluation Criteria	Relative Weight	Absolute Weight	Option P1 Conventional Treatment + UV w/chlorine during non T&O season and w/ozone during T&O season + Ozone			Option P2 Conventional Treatment + UV w/chlorine year round + UV-Advanced Oxidation			Option P3 Conventional Treatment + Ozone year round			Option P4 Membrane Filtration + UV w/chlorine during non T&O season and w/ozone during T&O season + Ozone			Option P5 Membrane Filtration + UV w/chlorine year round + UV-Advanced Oxidation			Option P6 Membrane Filtration + Ozone year round		
				Rationale	Score 1 to 100	Absolute Weight	Rationale	Score 1 to 100	Absolute Weight	Rationale	Score 1 to 100	Absolute Weight	Rationale	Score 1 to 100	Absolute Weight	Rationale	Score 1 to 100	Absolute Weight	Rationale	Score 1 to 100	Absolute Weight
Water Quality (Weight = 30 Points)	Pathogen control	30	9	Conventional Treatment Process and UV meet all objectives except Virus requirement. Chlorine provides Virus inactivation.	90	8.1	Conventional Treatment Process and UV meet all objectives except Virus requirement. Chlorine provides Virus inactivation.	90	8.1	Conventional Treatment and ozone process meet all objectives.	90	8.1	Membrane Treatment Process and UV meet all objectives except Virus requirement. Chlorine provides Virus inactivation. Membranes provide more consistent pathogen control as compared to conventional treatment.	90	8.1	Membrane Treatment Process and UV meet all objectives except Virus requirement. Chlorine provides Virus inactivation. Membranes provide more consistent pathogen control as compared to conventional treatment.	90	8.1	Membrane Treatment and ozone process meet all objectives. Membranes provide more consistent pathogen control as compared to conventional treatment.	90	8.1
	Minimize Disinfection By-Products and Maximize Organics Removal	10	3	Conventional Treatment with UV limits DBP formation. Seasonal ozone use has the potential to create further DBP's (bromates). Chlorine has the potential to create DBP's (TTHM, HAA). Currently DBP formation is not an issue on Halton's source water due to low DOC.	90	2.7	Conventional Treatment with UV limits DBP formation. Chlorine has the potential to create DBP's (TTHM, HAA). Currently DBP formation is not an issue on Halton's source water due to low DOC.	100	3.0	Conventional Treatment limits DBP formation. Ozone applied all year round has the potential to create further DBP's (bromates). Chlorine has the potential to create DBP's (TTHM, HAA). Currently DBP formation is not an issue on Halton's source water due to low DOC.	90	2.7	Membranes without coagulation does not reduce DOCs and hence, the DBP formation potential. Seasonal ozone use has the potential to create further DBP's (bromates). Chlorine has the potential to create DBP's (TTHM, HAA). Currently DBP formation is not an issue on Halton's source water due to low DOC.	80	2.4	Membranes without coagulation does not reduce DOCs and hence, the DBP formation potential. Chlorine has the potential to create DBP's (TTHM, HAA). Currently DBP formation is not an issue on Halton's source water due to low DOC.	90	2.7	Membranes without coagulation does not reduce DOCs and hence, the DBP formation potential. Ozone applied all year round has the potential to create further DBP's (bromates). Chlorine has the potential to create DBP's (TTHM, HAA). Currently DBP formation is not an issue on Halton's source water due to low DOC.	80	2.4
	Water stability in distribution system	5	1.5	Conventional Treatment limits AOC formation which causes water quality deterioration in distribution system. Seasonal ozone process can potentially form some AOC.	90	1.4	Conventional Treatment limits AOC formation which causes water quality deterioration in distribution system. Seasonal UV-Advanced Oxidation process could potentially form some AOC (same as ozone).	90	1.4	Conventional Treatment limits AOC formation which causes water quality deterioration in distribution system. Year round ozone process can potentially form some AOC.	80	1.2	Membranes without coagulation do not contribute to AOC formation. Seasonal ozone process can potentially form some AOC.	90	1.4	Membranes without coagulation do not contribute to AOC formation. Seasonal UV-Advanced Oxidation process can potentially form some AOC (same as ozone).	90	1.4	Membranes without coagulation do not contribute to AOC formation. Year round ozone process can potentially form some AOC.	80	1.2
	Minimize aluminum residuals	5	1.5	This option practices coagulation (on year round basis) using aluminum based coagulant. Therefore high potential for aluminum residual.	80	1.2	This option practices coagulation (on year round basis) using aluminum based coagulant. Therefore high potential for aluminum residual.	80	1.2	This option practices coagulation (on year round basis) using aluminum based coagulant. Therefore high potential for aluminum residual.	80	1.2	This option is expected to be operated without the use of coagulants, thus no potential for aluminum residual.	100	1.5	This option is expected to be operated without the use of coagulants, thus no potential for aluminum residual.	100	1.5	This option is expected to be operated without the use of coagulants, thus no potential for aluminum residual.	100	1.5
	Flexibility to respond to Emerging Contaminants (EDCs & PPCPs)	5	1.5	The use of seasonal ozone has the ability to provide removal of emerging contaminants.	70	1.1	The use of seasonal advanced oxidation has the ability to provide removal of emerging contaminants (same as ozone).	70	1.1	Year round operation of ozone provides consistent ability to remove emerging contaminants.	80	1.2	The use of seasonal ozone has the ability to provide removal of emerging contaminants.	70	1.1	The use of seasonal advanced oxidation has the ability to provide removal of emerging contaminants (same as ozone).	70	1.1	Year round operation of ozone provides consistent ability to remove emerging contaminants.	80	1.2
	Ability to meet Aesthetics Objectives (AOs) including Taste & Odour	20	6	The use of seasonal ozone has the ability to provide removal of Taste & Odour compounds and meet aesthetic objectives.	90	5.4	The use of advanced oxidation has the ability to provide removal of Taste & Odour compounds and meet aesthetic objectives (less than ozone).	80	4.8	Year round operation of ozone provides consistent removal of Taste & Odour compounds and aesthetic Objectives.	90	5.4	The use of seasonal ozone has the ability to provide removal of Taste & Odour compounds and meet Aesthetic objectives.	90	5.4	The use of advanced oxidation has the ability to provide removal of Taste & Odour compounds and meet aesthetic objectives (less than ozone).	80	4.8	Year round operation of ozone provides consistent removal of Taste & Odour compounds and Aesthetic Objectives.	90	5.4
	Flexibility for future objectives	5	1.5	Conventional treatment does not provide flexibility to meet future more stringent objectives. UV provides additional flexibility. Seasonal ozone operation would provide additional flexibility.	80	1.2	Conventional treatment does not provide flexibility to meet future more stringent objectives. UV provides additional flexibility. Seasonal advanced oxidation operation would provide additional flexibility.	80	1.2	Conventional treatment does not provide flexibility to meet future more stringent objectives. Year round ozone provides additional flexibility.	80	1.2	Membrane Treatment provides additional flexibility to meet future more stringent objectives. UV provides additional flexibility. Seasonal ozone operation provides additional flexibility.	90	1.4	Membrane Treatment provides additional flexibility to meet future more stringent objectives. UV provides additional flexibility. Seasonal advanced oxidation provides additional flexibility.	90	1.4	Membrane Treatment provides additional flexibility to meet future more stringent objectives. Year round ozone provides additional flexibility.	90	1.4

	Evaluation Criteria	Relative Weight	Absolute Weight	Option P1 Conventional Treatment + UV w/chlorine during non T&O season and w/ozone during T&O season + Ozone			Option P2 Conventional Treatment + UV w/chlorine year round + UV-Advanced Oxidation			Option P3 Conventional Treatment + Ozone year round			Option P4 Membrane Filtration + UV w/chlorine during non T&O season and w/ozone during T&O season + Ozone			Option P5 Membrane Filtration + UV w/chlorine year round + UV-Advanced Oxidation			Option P6 Membrane Filtration + Ozone year round		
				Rationale	Score 1 to 100	Absolute Weight	Rationale	Score 1 to 100	Absolute Weight	Rationale	Score 1 to 100	Absolute Weight	Rationale	Score 1 to 100	Absolute Weight	Rationale	Score 1 to 100	Absolute Weight	Rationale	Score 1 to 100	Absolute Weight
	Flexibility to respond to variable raw water quality	20	6	Conventional treatment provides excellent performance, however more process control changes are required to respond to changes in raw water quality. Seasonal ozone use requires additional time for commissioning and decommissioning.	80	4.8	Conventional treatment provides excellent performance, however more process control changes are required to respond to changes in raw water quality. Seasonal advanced oxidation use requires additional time for commissioning and decommissioning, but would be quicker then seasonal ozone.	80	4.8	Conventional treatment provides excellent performance, however more process control changes are required to respond to changes in raw water quality. Year round operation of ozone provides flexibility to respond consistently.	90	5.4	Membrane treatment provides excellent performance, and does not require as much process control changes as conventional treatment. Seasonal ozone use requires additional time for commissioning and decommissioning.	90	5.4	Membrane treatment provides excellent performance, and does not require as much process control changes as conventional treatment. Seasonal advanced oxidation use requires additional time for commissioning and decommissioning, but would be quicker then seasonal ozone.	90	5.4	Membrane treatment provides excellent performance, and does not require as much process control changes as conventional treatment. Year round operation of ozone provides flexibility to respond consistently.	100	6.0
Sub-Total Water Quality Score			30			25.8			25.5			26.4			26.6			26.3			27.2
Technical Considerations (Weight = 40 Points)	Compatibility with existing system	25	10	Conventional treatment is not compatible with the existing system. Additional infrastructure, chemicals and programming would be required. UV and Ozone are similar to the existing processes.	50	5.0	Conventional treatment is not compatible with the existing system. Additional infrastructure, chemicals and programming would be required. UV is compatible. Additional chemical system would have to be added for advanced oxidation.	30	3.0	Conventional treatment is not compatible with the existing system. Additional infrastructure, chemicals and programming would be required. Year round ozone use is compatible. There is one less process (UV) to operate.	40	4.0	Proposed treatment train is identical to the existing system.	100	10.0	Proposed treatment train is compatible with existing system with the exception of the seasonal advanced oxidation. Additional chemical system would have to be added for advanced oxidation.	80	8.0	Proposed treatment train is essentially identical to the existing system, with one less process (UV) to operate.	90	9.0
	Flexibility for expansion	10	4	Option requires a significantly large footprint of approx. 4,220 m^2 which limits potential for future expansions.	50	2.0	Option requires a significantly large footprint of approx. 4,721 m^2 which limits potential for future expansions.	40	1.6	Option requires a significantly large footprint of approx. 4,121 m^2 which limits potential for future expansions.	50	2.0	Option requires a relative smaller footprint of approx. 1,754 m^2, which leaves site space for additional expansion if required.	100	4.0	Option requires a footprint of approx. 2,255 m^2, which leaves some site space for additional expansion if required.	90	3.6	Option requires a relative smaller footprint of approx. 1,655 m^2, which leaves site space for additional expansion if required.	100	4.0
	Operation and Maintenance requirements	10	4	Process requires the use of chemical systems and supporting mechanical systems for the sedimentation and filter process resulting in significant operational, maintenance and monitoring requirements. UV has less operations involvement than ozone, but more frequent replacement of parts (not difficult to replace though) and maintenance involvement. Seasonal ozone requires operations and maintenance involvement.	70	2.8	Process requires the use of chemical systems and supporting mechanical systems for the sedimentation and filter process resulting in significant operational, maintenance and monitoring requirements. UV has less operations involvement than ozone, but more frequent replacement of parts (not difficult to replace though) and maintenance involvement. Seasonal advanced oxidation requires operations and maintenance involvement same as ozone.	70	2.8	Process requires the use of chemical systems and supporting mechanical systems for the sedimentation and filter process resulting in significant operational, maintenance and monitoring requirements. Year round ozone requires operations and maintenance involvement year round.	80	3.2	Process requires the use of chemical systems and supporting mechanical systems for the membrane filtration process resulting in increased maintenance and monitoring requirements compared to conventional treatment. UV has less operations involvement, than ozone, but more frequent replacement of parts (not difficult to replace though) and maintenance involvement. Seasonal ozone requires operations and maintenance involvement.	70	2.8	Process requires the use of chemical systems and supporting mechanical systems for the membrane filtration process resulting in increased maintenance and monitoring requirements compared to conventional treatment. UV has less operations involvement, than ozone, but more frequent replacement of parts (not difficult to replace though) and maintenance involvement. Seasonal advanced oxidation requires operations and maintenance involvement but less then seasonal ozone.	70	2.8	Process requires the use of chemical systems and supporting mechanical systems for the membrane filtration process resulting in increased maintenance and monitoring requirements compared to conventional treatment. Year round ozone requires operations and maintenance involvement year round.	80	3.2
	Process Complexity (including chemical systems)	10	4	Conventional treatment requires continuous process control which adds complexity to the overall process. Seasonal operation of ozone adds to the complexity because of the requirement for commissioning and decommissioning. UV requires minimal control	70	2.8	Conventional treatment requires continuous process control which adds complexity to the overall process. The complexity associated with seasonal ozone operation is not present, but a seasonal advanced oxidation adds some complexity. UV requires minimal control changes.	70	2.8	Conventional treatment requires continuous process control which adds complexity to the overall process. Year round operation of ozone and removal of UV reduces complexity.	80	3.2	Membrane filtration does not require continuous process control, but the complexities exist within the maintenance and cleaning of the membranes including extensive piping and valving. Seasonal operation of ozone adds to the complexity because of the requirement for	80	3.2	Membrane filtration does not require continuous process control, but the complexities exist within the maintenance and cleaning of the membranes including extensive piping and valving. The complexity associated with seasonal ozone operation is not present, but a seasonal	80	3.2	Membrane filtration does not require continuous process control, but the complexities exist within the maintenance and cleaning of the membranes including extensive piping and valving. Year round operation of ozone and removal of UV reduces complexity.	90	3.6

	Evaluation Criteria	Relative Weight	Absolute Weight	Option P1 Conventional Treatment + UV w/chlorine during non T&O season and w/ozone during T&O season + Ozone			Option P2 Conventional Treatment + UV w/chlorine year round + UV-Advanced Oxidation			Option P3 Conventional Treatment + Ozone year round			Option P4 Membrane Filtration + UV w/chlorine during non T&O season and w/ozone during T&O season + Ozone			Option P5 Membrane Filtration + UV w/chlorine year round + UV-Advanced Oxidation			Option P6 Membrane Filtration + Ozone year round		
				Rationale	Score 1 to 100	Absolute Weight	Rationale	Score 1 to 100	Absolute Weight	Rationale	Score 1 to 100	Absolute Weight	Rationale	Score 1 to 100	Absolute Weight	Rationale	Score 1 to 100	Absolute Weight	Rationale	Score 1 to 100	Absolute Weight
				changes.									commissioning and decommissioning. UV requires minimal control changes.			advanced oxidation adds some complexity. UV requires minimal control changes.					
Technical Considerations (Weight = 40 Points)	Proven track record	5	2	Conventional treatment has a proven track record within Halton. The use of UV for disinfection has a proven track record, and the use of ozone for taste and odour removal has a proven track record within Halton.	100	2.0	Conventional treatment has a proven track record within Halton. The use of UV for disinfection has a proven track record; however the use of advanced oxidation for taste and odour removal does not.	80	1.6	Conventional treatment has a proven track record within Halton. The use of ozone for disinfection and taste and odour removal has a proven track record within Halton.	100	2.0	Membrane treatment has a proven track record and used within Halton. The use of UV for disinfection has a proven track record, and the use of ozone for taste and odour removal has a proven track record within Halton.	90	1.8	Membrane treatment has a proven track record and used within Halton. The use of UV for disinfection has a proven track record; however the use of advanced oxidation for taste and odour removal does not.	70	1.4	Membrane treatment has a proven track record and used within Halton. The use of ozone for disinfection and taste and odour removal has a proven track record within Halton.	90	1.8
	Safety requirements	5	2	There are H&S concerns associated with treatment chemicals handling. The use of ozone poses H&S concerns at the site due to LOX storage and handling, ozone gas leaks and ozone destruction.	70	1.4	There are H&S concerns associated with treatment chemicals handling. Hydrogen peroxide, which is needed for the UV oxidation process, poses H&S concerns and requires extra care.	70	1.4	There are H&S concerns associated with treatment chemicals handling. The use of ozone poses H&S concerns at the site due to LOX storage and handling, ozone gas leaks and ozone destruction.	70	1.4	There are H&S concerns associated with cleaning chemicals handling. The use of ozone poses H&S concerns at the site due to LOX storage and handling, ozone gas leaks and ozone destruction.	70	1.4	There are H&S concerns associated with cleaning chemicals handling. Hydrogen peroxide, which is needed for the UV oxidation process, poses H&S concerns and requires extra care.	70	1.4	There are H&S concerns associated with cleaning chemicals handling. The use of ozone poses H&S concerns at the site due to LOX storage and handling, ozone gas leaks and ozone destruction.	70	1.4
	Ability to maximize ultimate site capacity/Compatibility with existing site	15	6	Similar to foot print. Structures can be designed to achieve similar features to the other options.	50	3.0	Similar to foot print. Structures can be designed to achieve similar features to the other options.	40	2.4	Similar to foot print. Structures can be designed to achieve similar features to the other options.	50	3.0	Similar to foot print. Structures can be designed to achieve similar features to the other options.	100	6.0	Similar to foot print. Structures can be designed to achieve similar features to the other options.	90	5.4	Similar to foot print. Structures can be designed to achieve similar features to the other options.	100	6.0
	Ease of implementation (construction schedule)	5	2	Conventional filtration requires larger footprint than membrane filtration, which results in bigger areas for excavation and construction therefore construction schedule may be longer. Ozonation has more process equipment than UV-Advanced Oxidation adding to the construction schedule.	90	1.8	Conventional filtration requires larger footprint than membrane filtration, which results in bigger areas for excavation and construction therefore construction schedule may be longer.	80	1.6	Conventional filtration requires larger footprint than membrane filtration, which results in bigger areas for excavation and construction therefore construction schedule may be longer. Ozonation has more process equipment than UV-Advanced Oxidation adding to the construction schedule; however, there is no UV equipment.	90	1.8	Membrane filtration requires smaller footprint than conventional filtration, which results in smaller areas for excavation and construction therefore construction schedule may be shorter. However, submerged membrane systems require tanks with special coatings which add to the construction schedule. Ozonation has more process equipment than UV-Advanced Oxidation adding to the construction schedule.	100	2.0	Membrane filtration requires smaller footprint than conventional filtration, which results in smaller areas for excavation and construction therefore construction schedule may be shorter. However, submerged membrane systems require tanks with special coatings which add to the construction schedule.	90	1.8	Membrane filtration requires smaller footprint than conventional filtration, which results in smaller areas for excavation and construction therefore construction schedule may be shorter. However, submerged membrane systems require tanks with special coatings which add to the construction schedule. Ozonation has more process equipment than UV-Advanced Oxidation adding to the construction schedule; however, there is no UV equipment.	100	2.0
	Process robustness (multi-barrier treatment) and redundancy	15	6	The performance of this system relies heavily of the effectiveness of the coagulation/flocculation process. UV w/chlorine with ozone (when practiced) provides two additional disinfection barriers when compared to UV alone or ozone alone.	70	4.2	The performance of this system relies heavily of the effectiveness of the coagulation/flocculation process. UV w/chlorine provides one disinfection barrier; however, there is no back-up if the UV system completely shuts down. Multiple UV reactors, compared to two ozone contactors, maintain a large plant capacity when one component fails.	70	4.2	The performance of this system relies heavily of the effectiveness of the coagulation/flocculation process. Ozone provides one disinfection barrier; however, there is no back-up if two ozone contactors are out-of-service or the entire ozone system shuts down because of an ozone gas leak for example.	50	3.0	The performance of membranes is more robust than conventional treatment as it requires less operational control to maintain performance. UV w/chlorine with ozone (when practiced) provides two additional disinfection barriers when compared to UV alone or ozone alone.	90	5.4	The performance of membranes is more robust than conventional treatment as it requires less operational control to maintain performance. UV w/chlorine provides one disinfection barrier; however, there is no back-up if the UV system completely shuts down. Multiple UV reactors, compared to two ozone contactors, maintain a large plant capacity when one component fails.	90	5.4	The performance of membranes is more robust than conventional treatment as it provides more consistent treatment and requires less operational control to maintain performance. Ozone provides one disinfection barrier; however, there is no back-up if two ozone contactors are out-of-service or the entire ozone system shuts down because of an ozone gas leak for example.	70	4.2
Sub-Total Technical Considerations Score			40			25.0			21.4			23.6			36.6			33.0			35.2

	Evaluation Criteria	Relative Weight	Absolute Weight	Option P1 Conventional Treatment + UV w/chlorine during non T&O season and w/ozone during T&O season + Ozone			Option P2 Conventional Treatment + UV w/chlorine year round + UV-Advanced Oxidation			Option P3 Conventional Treatment + Ozone year round			Option P4 Membrane Filtration + UV w/chlorine during non T&O season and w/ozone during T&O season + Ozone			Option P5 Membrane Filtration + UV w/chlorine year round + UV-Advanced Oxidation			Option P6 Membrane Filtration + Ozone year round		
				Rationale	Score 1 to 100	Absolute Weight	Rationale	Score 1 to 100	Absolute Weight	Rationale	Score 1 to 100	Absolute Weight	Rationale	Score 1 to 100	Absolute Weight	Rationale	Score 1 to 100	Absolute Weight	Rationale	Score 1 to 100	Absolute Weight
Social Considerations (Weight =20 Points)	Minimize footprint and site impacts /Architectural aesthetics (plant appearance)	45	9	Conventional filtration will provide a larger footprint and thus have the most aesthetic impacts to the site. However, the plant appearance of the expansion will match existing structures.	70	6.3	Conventional filtration will provide a larger footprint and thus have the most aesthetic impacts to the site. However, the plant appearance of the expansion will match existing structures. The removal of ozone from the process reduces the overall footprint.	70	6.3	Conventional filtration will provide a larger footprint and thus have the most aesthetic impacts to the site. However, the plant appearance of the expansion will match existing structures.	70	6.3	Membrane filtration will provide the smallest footprint and overall impact. The plant appearance of the expansion will match the existing foot print and structures.	90	8.1	Membrane filtration will provide the smallest footprint and overall impact. The plant appearance of the expansion will match the existing foot print and structures. The removal of ozone from the process also reduces the foot print.	90	8.1	Membrane filtration will provide the smallest footprint and overall impact. The plant appearance of the expansion will match the existing foot print and structures.	90	8.1
	Minimize truck traffic (during operation)	25	5	Truck traffic is associated with chemical deliveries and removal of process residuals. Conventional treatment consumes more chemicals and results in greater residue generation then membrane treatment.	70	3.5	Truck traffic is associated with chemical deliveries and removal of process residuals. Conventional treatment consumes more chemicals and results in greater residue generation then membrane treatment. Additional deliveries of hydrogen peroxide (to form hydroxyl radicals) and sodium hypochlorite (for quenching the peroxide) will be required.	70	3.5	Truck traffic is associated with chemical deliveries and removal of process residuals. Conventional treatment consumes more chemicals and results in greater residue generation then membrane treatment.	70	3.5	Truck traffic is associated with chemical deliveries and removal of process residuals. Membrane treatment consumes fewer chemicals and results in lesser residue generation than conventional membrane treatment.	90	4.5	Truck traffic is associated with chemical deliveries and removal of process residuals. Membrane treatment consumes less chemicals and results if lesser residue generation than conventional treatment. Additional deliveries of hydrogen peroxide (to form hydroxyl radicals) and sodium hypochlorite (for quenching the peroxide) will be required.	90	4.5	Truck traffic is associated with chemical deliveries and removal of process residuals. Membrane treatment consumes fewer chemicals and results in lesser residue generation than conventional treatment.	90	4.5
	Minimize noise (operation)	25	5	The primary cause of noise during operation is associated with the number of trucks delivering chemicals to the site and transporting waste volumes out of the site for further processing/disposal. Neighbours may complain about pumps/blowers.	70	3.5	The primary cause of noise during operation is associated with the number of trucks delivering chemicals to the site and transporting waste volumes out of the site for further processing/disposal. Neighbours may complain about pumps/blowers.	70	3.5	The primary cause of noise during operation is associated with the number of trucks delivering chemicals to the site and transporting waste volumes out of the site for further processing/disposal. Neighbours may complain about pumps/blowers.	70	3.5	The primary cause of noise during operation is associated with the number of trucks delivering chemicals to the site and transporting waste volumes out of the site for further processing/disposal. Neighbours may complain about pumps/blowers.	90	4.5	The primary cause of noise during operation is associated with the number of trucks delivering chemicals to the site and transporting waste volumes out of the site for further processing/disposal. Neighbours may complain about pumps/blowers.	90	4.5	The primary cause of noise during operation is associated with the number of trucks delivering chemicals to the site and transporting waste volumes out of the site for further processing/disposal. Neighbours may complain about pumps/blowers.	90	4.5
	Minimize odour (operation)	5	1	There are no odours expected from water treatment works.	100	1.0	There are no odours expected from water treatment works.	100	1.0	There are no odours expected from water treatment works.	100	1.0	There are no odours expected from water treatment works.	100	1.0	There are no odours expected from water treatment works.	100	1.0	There are no odours expected from water treatment works.	100	1.0
Sub-Total Social Considerations Score			20			14.3			14.3			14.3			18.1			18.1			18.1
Natural Environmental Considerations (Weight =10 Points)	Minimize on-site air emissions associated with number and size of chemical systems (air changes in chemical rooms and storage tank venting)	20	2	Conventional filtration using a number of different new chemicals will result in more emissions. Also, the vents associated with use of ozone (on seasonal basis only) will contribute to air emissions. Emergency back-up generator air emissions will meet MOE requirements.	70	1.4	Conventional filtration using a number of different new chemicals will result in more emissions. Emergency back-up generator air emissions will meet MOE requirements.	70	1.4	Conventional filtration using a number of different new chemicals will result in more emissions. Also, the vents associated with use of ozone year round will contribute to air emissions. Emergency back-up generator air emissions will meet MOE requirements.	70	1.4	Membranes using a number of different cleaning chemicals will result in air emissions. Also, the vents associated with use of ozone (on seasonal basis only) will contribute to air emissions. Emergency back-up generator air emissions will meet MOE requirements.	70	1.4	Membranes using a number of different cleaning chemicals will result in air emissions. Emergency back-up generator air emissions will meet MOE requirements.	70	1.4	Membranes using a number of different cleaning chemicals will result in air emissions. Also, the vents associated with use of ozone year round will contribute to air emissions. Emergency back-up generator air emissions will meet MOE requirements.	70	1.4
	Minimize residuals impacts	80	8	Use of coagulants, polymers and microsand in conventional treatment generates greater residue flows and loadings then compared to membranes and will exclude secondary membrane filtration as a residual treatment alternative.	70	5.6	Use of coagulants, polymers and microsand in conventional treatment generates greater residue flows and loadings then compared to membranes and will exclude secondary membrane filtration as a residual treatment alternative.	70	5.6	Use of coagulants, polymers and microsand in conventional treatment generates greater residue flows and loadings then compared to membranes and will exclude secondary membrane filtration as a residual treatment alternative.	70	5.6	Membrane filtration has smaller residue flows and loadings than compared to conventional treatment. The cleaning solution waste will be neutralized prior to disposal.	90	7.2	Membrane filtration has smaller residue flows and loadings than compared to conventional treatment. The cleaning solution waste will be neutralized prior to disposal.	90	7.2	Membrane filtration has smaller residue flows and loadings than compared to conventional treatment. The cleaning solution waste will be neutralized prior to disposal.	90	7.2

Evaluation Criteria	Relative Weight	Absolute Weight	Option P1 Conventional Treatment + UV w/chlorine during non T&O season and w/ozone during T&O season + Ozone			Option P2 Conventional Treatment + UV w/chlorine year round + UV-Advanced Oxidation			Option P3 Conventional Treatment + Ozone year round			Option P4 Membrane Filtration + UV w/chlorine during non T&O season and w/ozone during T&O season + Ozone			Option P5 Membrane Filtration + UV w/chlorine year round + UV-Advanced Oxidation			Option P6 Membrane Filtration + Ozone year round		
			Rationale	Score 1 to 100	Absolute Weight	Rationale	Score 1 to 100	Absolute Weight	Rationale	Score 1 to 100	Absolute Weight	Rationale	Score 1 to 100	Absolute Weight	Rationale	Score 1 to 100	Absolute Weight	Rationale	Score 1 to 100	Absolute Weight
Sub-Total Natural Environmental Considerations Score		10			7.0			7.0			7.0			8.6			8.6			8.6
TOTAL BENEFIT SCORE – MAX 100 POINTS	**100**		**-**	**-**	**72.1**	**-**	**-**	**68.2**	**-**	**-**	**71.3**	**-**	**-**	**89.9**	**-**	**-**	**86.0**	**-**	**-**	**89.1**
RANKING BASED ON TOTAL BENEFIT SCORE	**1 TO 6**		**-**	**-**	**4**	**-**	**-**	**6**	**-**	**-**	**5**	**-**	**-**	**1**	**-**	**-**	**3**	**-**	**-**	**2**

12.3.2 Cost Benefit Analysis Results

Using the methodology described in the previous sections, a cost benefit analysis was carried out to calculate the value indicator, or benefit-to-cost ratio for each alternative under consideration. The residuals treatment system for the selected Option R1 comprising Equalization + Plate Settler Clarification/Thickening was carried forward as the preferred residuals treatment train. This option was identified earlier in the report as the preferred residuals treatment train.

The results of the cost-benefit analysis are shown in Table 22.

Table 22 Cost Benefit Analysis Results – Main Process & Residuals Treatment Trains

Option ID	Treatment Train Description		Net Present Value 2011 $Millions	Total Benefit Score (Points out of 100)	Benefit-to-Cost Ratio (Points/$Million)
	Main Process Treatment Train	Residuals Treatment Train			
P1 + R1	Conventional Treatment (Actiflo®) + UV w/chlorine during non T&O season and w/ozone during T&O season + Ozone	Equalization Basins + Plate Settler Clarification/Thickening	$45.0	72.1	1.6
P2 + R1	Conventional Treatment (Actiflo®) + UV w/chlorine year round + UV-Advanced Oxidation	Equalization Basins + Plate Settler Clarification/Thickening	$51.2	68.2	1.3
P3 + R1	Conventional Treatment (Actiflo®) + Ozone year round	Equalization Basins + Plate Settler Clarification/Thickening	$43.7	71.3	1.6
P4 + R1	Membrane Filtration + UV w/chlorine during non T&O season and w/ozone during T&O season + Ozone	Equalization Basins + Plate Settler Clarification/Thickening	$43.6	89.9	2.1
P5 + R1	Membrane Filtration + UV w/chlorine year round + UV-Advanced Oxidation	Equalization Basins + Plate Settler Clarification/Thickening	$49.8	86.0	1.7
P6 + R1	Membrane Filtration + Ozone year round	Equalization Basins + Plate Settler Clarification/Thickening	$42.4	89.1	2.1

The benefit-to-cost ratio results indicate that there are two treatment train options that provide very comparable results, within the accuracy of the conceptual cost estimates. These options are:

- Main Treatment Option P4 plus Residuals Treatment Option R1:
  - Main Process Treatment comprised of membrane filtration + UV year round (UV with chlorine during non Taste & Odour season for disinfection and UV with ozone during Taste & Odour season for Taste & Odour control and disinfection, plus
  - Residuals Treatment comprised of Equalization Basins + Plate Settler Clarification/Thickening.

- Main Treatment Option P6 plus Residuals Treatment Option R1:
  - Main Process Treatment comprised of membrane filtration + ozone year round for Taste & Odour control and disinfection, plus
  - Residuals Treatment comprised of Equalization Basins + Plate Settler Clarification/Thickening.

Table 22 shows that there is no real difference between the benefit-to-cost ratios for both options. Consequently, the two options are considered equally good from a cost benefit perspective.

Should the approval for implementation of Option R1, which requires discharge to the East Sheldon Creek, is not obtained from CH and the Town of Oakville, alternate residuals treatment Options R5 and R6 comprising secondary membranes may need to be revisited and reconsidered in the future.

12.4 Sensitivity Analysis

The project team took other steps to gain more confidence in their chosen options by using a sensitivity analysis. The sensitivity analysis helps to verify the robustness of the evaluation process and the consistency of the evaluation results when variables of the evaluation methodology are subjected to extreme modifications. This test ensures that the preliminary preferred treatment train is appropriate before making final decisions.

The model was run for two additional scenarios, each with different benefit weighting factors applied to the main four groups of evaluation criteria. The two new scenarios reflected conditions very different to what was originally developed. For example, under the original benefit scenario developed for the evaluation of the main process treatment trains, water quality and technical considerations criteria were more geared towards technical aspects and had a combined total weighting score of 70%, whereas social and natural environmental considerations criteria were more geared towards socio-cultural aspects and had a combined total weighting score of 30%. The sensitivity analysis tipped these benefit weighting factors to the complete opposite, such that water quality and technical considerations had a combined score of 30% and social and natural environmental considerations had a combined score of 70%, allowing the project team to observe whether these changes had an effect on the original results.

The original and additional scenarios under which the sensitivity analysis was run for the different treatment train options are shown in Table 23.

Table 23 Benefit Criteria Weights for Sensitivity Analysis

Primary Criteria Group	Scenario No. 1 – Original		Scenario No. 2		Scenario No. 3	
	Original Overall Balance	Original Weighting	Tipped Balance	Tipped Weighting	Tipped Balance	Tipped Weighting
Water Quality	70	30	30	13	50	21
Technical Considerations		40		17		29
Social Considerations	30	20	70	47	50	33
Natural Environmental Considerations		10		23		17
TOTAL	100	100	100	100	100	100

The alternate weights for scenarios No. 2 and No. 3, as shown in Table 23, were applied to the benefit scores presented in Table 21. The NPV previously calculated for these treatment trains was used for the calculation of the revised Benefit-to-Cost ratio, with results tabulated in Table 24.

From the sensitive analysis results, it was concluded that under any of the three different scenarios, the two trains consisting of: Main Process Option P4 with Residuals Option R1; and Main Process Option P6 with Residuals Option R1; continue to provide the highest overall Benefit-to-Cost ratio amongst all six options.

The project team agreed that the preferred option should be the one that is most compatible and facilitates the integration with the existing Burloak WPP treatment process. For this reason, it was established that Main Process

Option P4 with Residuals Option R1 was the preliminary preferred option for the Phase 2 expansion of the Burloak WPP.

Main Process Option P4 with Residuals Option R1 uses membrane filtration, UV year-round (UV with chlorine during non Taste & Odour season and UV with ozone during Taste & Odour season) as the main treatment process and equalization basins and plate settler clarification/thickening for the treatment of residuals. The specific advantages of this option are:

- The proposed main treatment train replicates the existing treatment process train currently operating at the Burloak WPP; thus, it makes the best use of existing infrastructure and provides almost identical operational and maintenance requirements as the existing ones.
- In terms of operational flexibility, this option allows for contingency of keeping the plant operating at full capacity if the ozone system was to ever go down because of operational or maintenance issues.
- UV can provide higher disinfection credits in the future, if ever required, with minimal effort and costs by simply increasing the UV dosage (without limitations given bromate formation concerns).

Table 24 Sensitivity Analysis Results

Option ID	Train Description		Scenario No. 1 70/30 (Original Weighting)		Scenario No. 2 30/70		Scenario No. 3 50/50	
	Main Process Treatment Train	Residuals Treatment Train	Benefit-to-Cost Ratio (Points/$M)	Overall Ranking	Benefit-to-Cost Ratio (Points/$M)	Overall Ranking	Benefit-to-Cost Ratio (Points/$M)	Overall Ranking
P1 + R1	Conventional Treatment (Actiflo®) + UV w/chlorine during non T&O season and w/ozone during T&O season + Ozone	Equalization Basins + Plate Settler Clarification/ Thickening	1.6	4	1.6	4	1.6	4
P2 + R1	Conventional Treatment (Actiflo®) + UV w/chlorine year round + UV-Advanced Oxidation		1.3	6	1.4	6	1.3	6
P3 + R1	Conventional Treatment (Actiflo®) + Ozone year round		1.6	4	1.6	4	1.6	4
P4 + R1	Membrane Filtration + UV w/chlorine during non T&O season and w/ozone during T&O season + Ozone	Equalization Basins + Plate Settler Clarification/ Thickening	2.1	1	2.0	2	2.1	1
P5 + R1	Membrane Filtration + UV w/chlorine year round + UV-Advanced Oxidation		1.7	3	1.8	3	1.7	3
P6 + R1	Membrane Filtration + Ozone year round		2.1	1	2.1	1	2.1	1

13. Evaluation of Alternative Discharge Options

This ESR has discussed the technologies available for the residuals treatment and main process treatment options for the Burloak WPP. It is important to discuss the alternative discharge options that were analyzed by the project team.

13.1 Overview

As discussed in previous sections, discharge of clarified supernatant resulting from the new residuals management system needs to be discharged outside of the plant site, as the existing stormwater pond collecting runoff from the plant has not been designed to receive additional flows from the plant.

Currently, all membrane backwash discharge flows from the existing 55 ML/d Burloak WPP are discharged to the sanitary sewer. As plant capacity increases, the membrane backwash discharge flows will increase accordingly. Increased membrane backwash discharge flows for future expansions of the plant cannot continue to be discharged to the sanitary sewer system due to current capacity limitations in the system. In addition, previous consultation with the Town of Oakville and CH established that discharge to the on-site storm sewer system would not be allowed at any time given that the stormwater pond was not designed to handle plant process wastewater. As such, membrane backwash discharge flows need to discharge somewhere else.

13.2 Discharge Water Quality

Environmental discharge parameters, sample time, sample frequency and monitoring location(s) will be developed in consultation with MOE during detailed design. All conditions for the environmental discharge parameters will be reflected in the amended Municipal Drinking Water License, which will be carried out as part of detailed design task.

13.2.1 Total Suspended Solids

Discharges to Sheldon Creek at either location would need to be limited to stream with low solids concentrations. The objective of the new residuals treatment processes, proposed for the expansion of the Burloak WPP is to produce a supernatant with a TSS concentration less than 15 mg/L, so that the supernatant can be discharged to Sheldon Creek.

13.2.2 Chlorine Residual

A dechlorination system using sodium bisulphite will be used to de-chlorinate any discharge water going into Sheldon Creek to prevent any release of chlorinated water into the natural environment.

13.2.3 Aluminum Residual

The existing treatment process at the Burloak WPP allows for provisional coagulation. Although, the use of a coagulant has not been needed at the plant due to the consistently good raw water quality experienced since the plant's commission, the proposed water treatment process for the expansion will continue to assume the provisional addition of a coagulant.

13.3 Expected Discharge Flows

Anticipated discharge flows are based upon the membrane recovery rate, which has been assumed as 90% and 95% under peak and average conditions, respectively. The membrane recovery rate will be confirmed in consultation with the membrane supplier during detailed design. Preliminary calculations provide an estimate of the anticipated flows to be discharged under both scenarios as shown in Table 25 below.

Table 25 Expected Discharge Flows

Plant Capacity	Expected Average Discharge Flows[1] (95% Recovery)	Expected Peak Discharge Flows[2] (90% Recovery)
Phase 2 Expansion – 165 ML/d	101 L/s	212 L/s

Note:

1. *Average discharge flow calculated as (165 ML/d /0.95) x (1-0.95)*
2. *Peak discharge flow calculated as (165 ML/d /0.90) x (1-0.90)*

13.4 Discharge Options Evaluation Results

Two alternative discharge options were initially indentified during a pre-consultation meeting with the Town of Oakville, as discussed in Section 3.3.2. The two options, as shown previously in Figure 4, include discharging into the East branch of Sheldon Creek, at one of two separate locations to the north of, or to the west of the Burloak WPP.

A preliminary assessment of the two discharge options was conducted in order to determine the option that would provide the least environmental impacts. Each option was rated relative to each other on a most to least preferred scale represented graphically by a full circle, half circle, empty circle, etc. A full circle denotes an alternative that would have minimum or negligible effects to the environment under evaluation, while an empty circle denote an alternative which would have significant negative effects to the environment under evaluation. Alternatives rated with a half full circle symbolize those that would result in moderate negative effects to the environment, and so on.

The results of the overall comparative evaluation of the two options, indicating the major advantages and disadvantages in terms of each criterion, are shown in Table 26.

Based on the preliminary evaluation of the two options, as shown in Table 26, it was concluded that due to the stability of the creek bed, proximity to outfall, operational ease, availability of manhole location and reduced interference with utilities, the discharge area to the west side of the plant was the favoured discharge location.

Additional pre-consultation meetings were held with CH and the Town of Oakville in order to define the acceptability of the discharge at the location for Option No.2. Further studies and modeling were undertaken by AECOM to demonstrate any criticalities and impacts to the creek from the proposed discharge and address some issues brought up by CH and the Town. The results of these additional investigations and the anticipated impacts and proposed mitigation measures are described in Section 4.3.2 and Section 15 respectively.

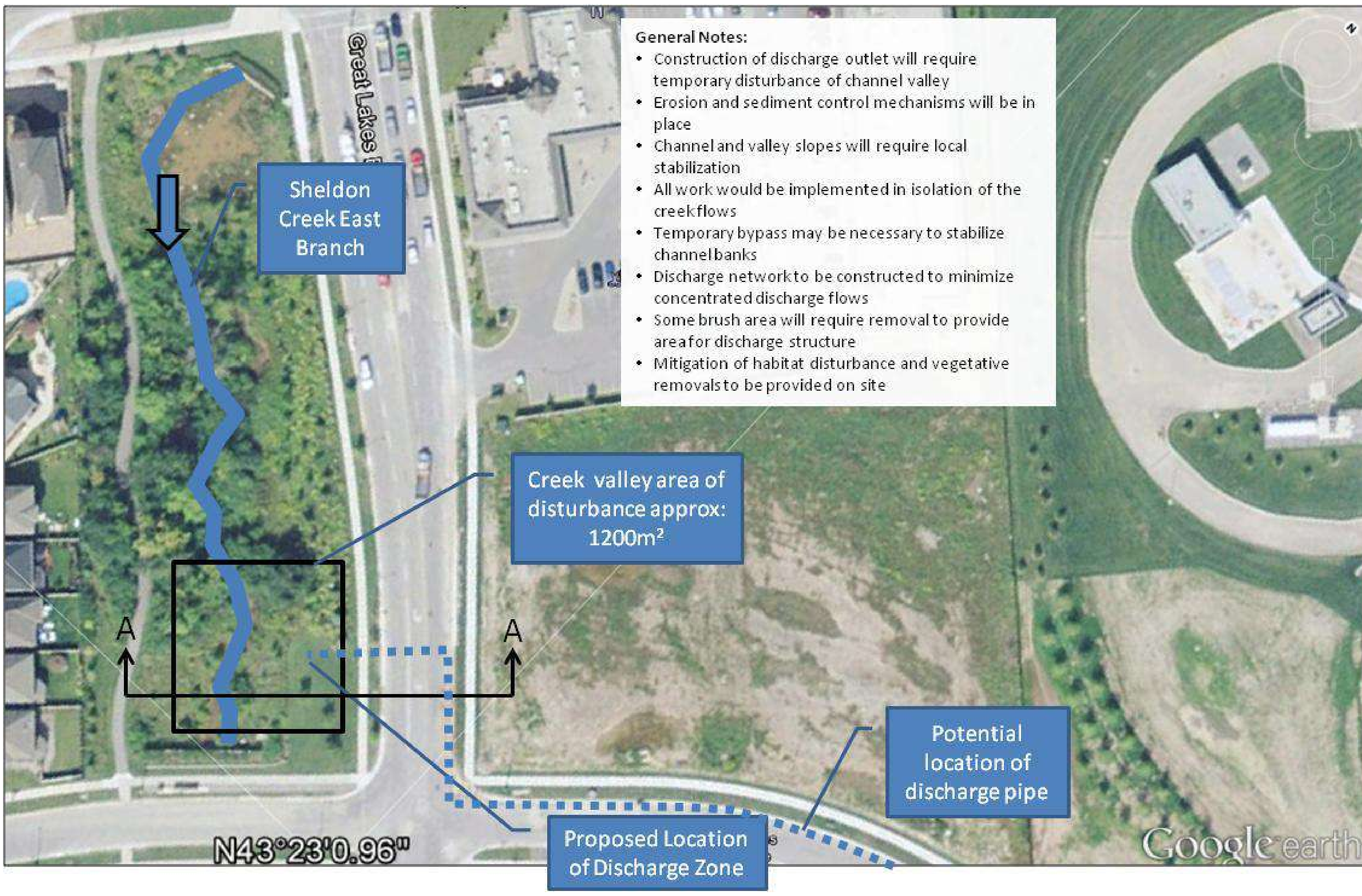
Discharge Option No.2 is considered for an expansion of the Burloak WPP up to a rated capacity of 165 ML/d. For additional discharge beyond the 165 ML/d plant capacity, additional consultation with CH and the Town of Oakville will be needed similar to the consultation completed during this Class EA study.

Figure 26 will be carried forward to help develop a conceptual design of the preliminary preferred treatment option for the Burloak WPP Phase 2 expansion. A plan view of the general discharge location and a section illustrating the preliminary concept of the discharge structure are shown in Figure 27.

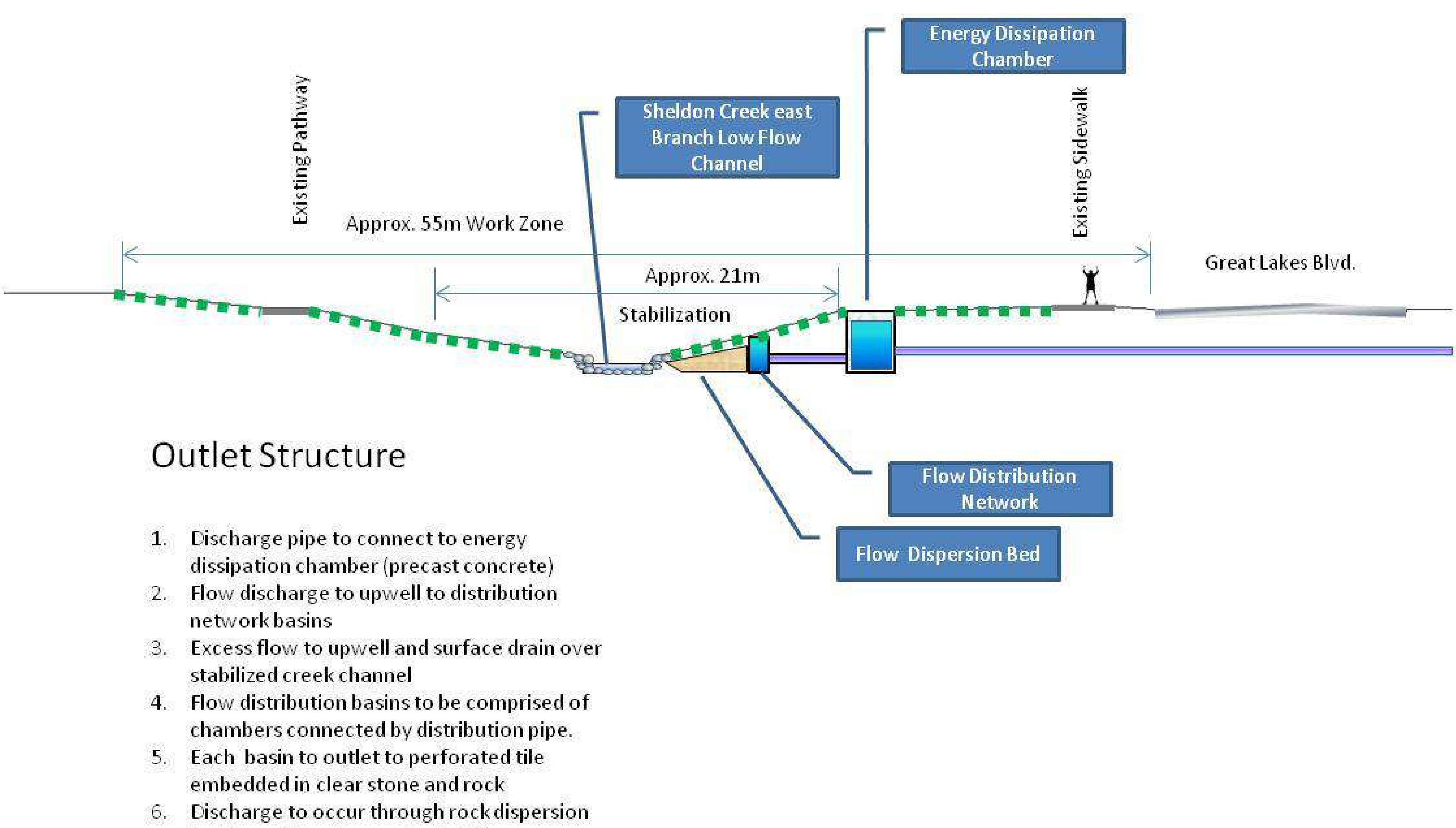
Table 26 Evaluation of Alternative Discharge Options

Criteria	Discharge Options	
	Option No.1 **Discharge location to the north of Burloak WPP, across Rebecca Street**	**Option No.2** **Discharge location to the west of Burloak WPP, across Great Lakes Boulevard**
Natural Environment • Significance of surface water crossings • Effects on ESAs, wetlands, woodlots • Effects on fisheries and aquatic resources • Displacement or disruption of topographical features	• Some vegetation removal expected on the limits of the property across Rebecca Street where the discharge structure is to be located. The property limit facing Rebecca Street is lined with mature trees. • The creek area for discharge seems to be more naturalized. • Effects on fisheries and aquatic habitat would be the same for either option. • No watercourse crossings required. • Outfall structure would have the same features and characteristics at both locations. • Less stability of the creek bed when compared to Option No.2.	• Minor vegetation removal expected or highly impacted, vegetation is limited to existing grass and two small trees. Proposed area for outfall structure is clear of vegetation. • Effects on fisheries and aquatic habitat would be the same for either option. • No watercourse crossings required. • Outfall structure would have the same features and characteristics at both locations. • Visual observation revealed more stability of the creek bed at this location.
Natural Environment Ranking	◑	◕
Socio- Cultural Environment Effect of construction to: • adjacent residents/neighbourhood • local businesses • recreation • traffic • safety • utilities • noise, dust • street parking	• Major disruption during construction on residential and local traffic on two busy and minor arterial roads, Rebecca Street and Great Lakes Boulevard. • Minor impacts of noise and dust during construction to the business located west of the plant. • Minor impact on business activities business activities. • Major impact o numerous existing utilities located on Rebecca Street.	• Some disruption during construction on residential traffic on a residential road, Nautical Boulevard and a minor arterial road, Great Lakes Boulevard. • Impacts of noise and dust during construction to 11 properties on the south of the plant along the proposed route for the forcemain. • Some impacts during the duration of construction (approx. 3-4 months) to residents using Nautical Boulevard to gain access to their properties; however, other nearby access residential roads (i.e. Milkweed Way, Timeless Drive) can continue to be used to provide access to these properties. • Minor impact on business activities business activities. • Minor impact on existing utilities.
Socio-Cultural Ranking	◔	◑
Technical and Operations • Forcemain length and depth • Impact on operations during construction and long term • Construction technique and technology • Ease of construction • Effects on operations • Property acquisition, permits required. • Construction constraints (restricted places, stream crossings, etc.)	• Approximate length of forcemain: 212 m • Depth of forcemain would need to be much deeper on Rebecca Street in order to avoid conflict with numerous existing utilities. • Crossing of Rebecca Street would likely require the use of trenchless technology due to the numerous existing utilities and the volume of traffic using the road. • Difficult accessibility to the outfall structure for maintenance after construction. • Some area restrictions for construction of the outfall structure and discharge manhole. • Permit to access private property would be required during construction and for maintenance after construction.	• Approximate length of forcemain: 208 m • Forcemain would be located on existing ROW of Nautical Boulevard. Depth expected to be within approximately 2 m . • Crossing of Great Lakes Boulevard would be expected to be by open cut as there are few utilities and moderate traffic volume. • No difficulties accessing the outfall structure for maintenance after construction. • Open area available for construction of the outfall structure and discharge manhole. • No permit to access private property would be required during construction and for maintenance after construction. • Proximity to the outfall facilitates maintenance activities after construction.
Technical and Operations Ranking	◔	◕
Overall Ranking	**2**	**1**
Legend:	least preferred ○ ⟶ most preferred ●	

Figure 26 Proposed Discharge Location at East Brach of Sheldon Creek



PLAN VIEW - GENERAL DISCHARGE LOCATION



SECTION A – A
NOT TO SCALE

Figure 27 East Sheldon Creek Proposed Discharge Location – Plan View and Section

14. Preferred Treatment Design Concept

14.1 Process Overview

The preferred treatment design concept for the Phase 2 expansion of the Burloak WPP has been selected with consideration given to the existing treatment processes and the results of the evaluation process. The results of the detailed evaluation, cost benefit analysis and sensitivity analysis support the selection of the **Main Process Option P4 with Residuals Option R1** as the preferred treatment design concept. A simplified process schematic of the preferred treatment design concept for the Phase 2 expansion of the Burloak WPP is shown in Figure 28.

The preferred option comprises the following processes:

- Main treatment comprised of membrane filtration + UV year round (UV with chlorine during non Taste & Odour season for disinfection and UV with ozone during Taste & Odour season for Taste & Odour control and disinfection
- Residuals treatment comprised of Equalization Basins + Plate Settler Clarification/Thickening.

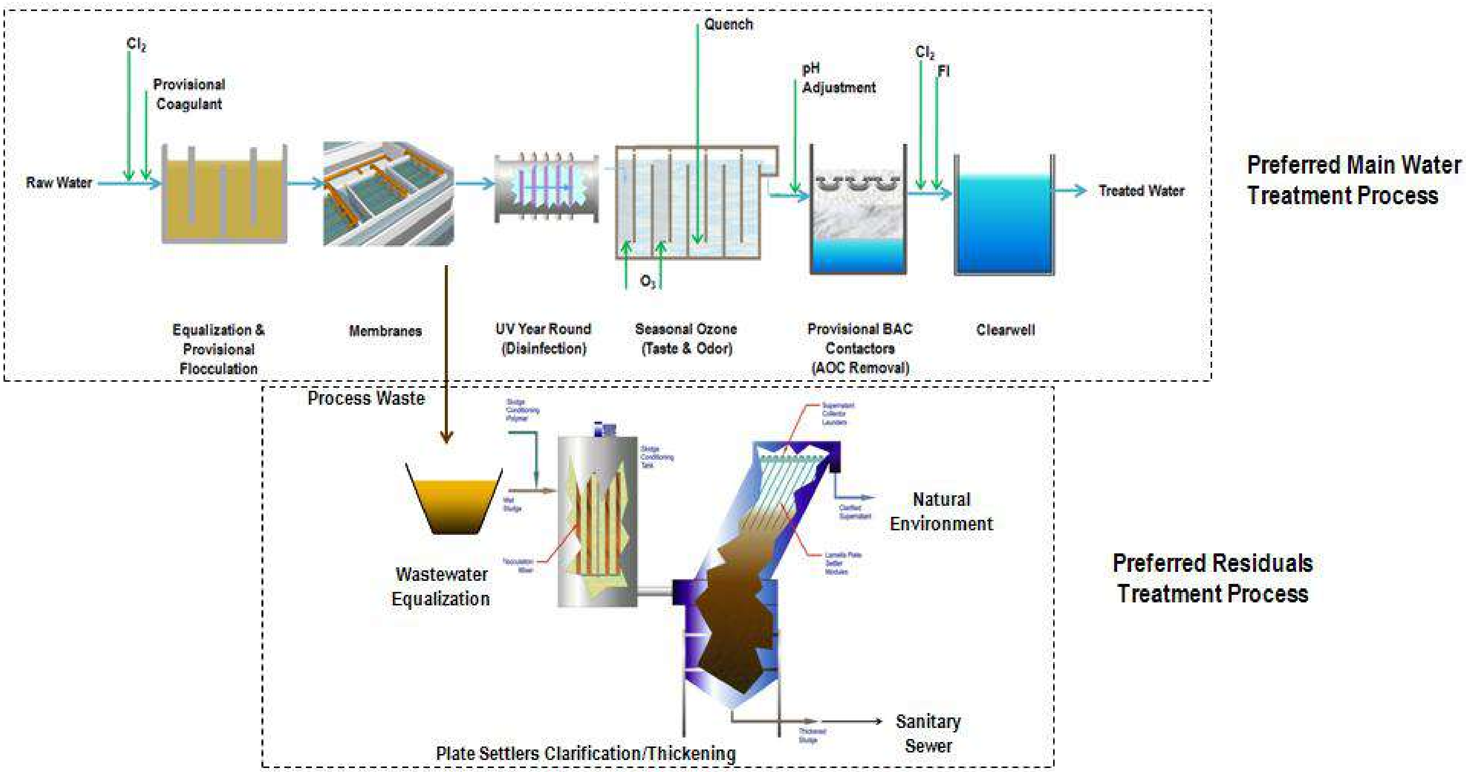


Figure 28 Simplified Process Schematic – Preferred Treatment Design Concept

The recommended design concept and the rationale for its selection were presented for comments at the second PIC held on November 30, 2011. This option was considered and officially presented to the public at PIC No.2 as the preliminary preferred option for the Phase 2 expansion of the Burloak WPP, subject to any comments or input received from the public and/or any regulatory agency. Since no comments were received in regards to the preliminary preferred option, subsequent to PIC No.2, the project team confirmed the treatment design concept as the preferred option for the next expansion of the Burloak WPP.

Should the approval for implementation of Option R1, which requires discharge to the East Sheldon Creek, is not obtained from CH and the Town of Oakville, alternate residuals treatment Options R5 and R6 comprising secondary membranes may need to be revisited and reconsidered in the future.

The capacity of the Burloak WPP will be expanded from the existing capacity of 55 ML/d to 165 ML/d. After the Phase 2 expansion is complete, the Burloak WPP will incorporate both the existing treatment processes as described in Section 5.1, and the new treatment processes to provide treated potable water at a design capacity of 165 ML/d to the Halton water distribution system.

The preferred treatment design concept for the Burloak WPP Phase 2 expansion will include:

- Provisional coagulant addition
- Provisional equalization and flocculation
- Membrane filtration system
- UV year round, UV with chlorine during non-Taste & Odour season for primary disinfection, and UV with ozone during Taste & Odour season for Taste & Odour control and primary disinfection
- Seasonal ozone for taste and odour control
- Provisional biological activated carbon (BAC) contactors for assimilable organic carbon (AOC) removal. Provided that the organic content in the raw water for the plant has been found to be minimal, AOC formation during the ozonation process is considered negligible, rendering the need for BAC contactors unnecessary at this time. Space for future BAC contactors has been allocated within the plant site, should the quality of the raw water deteriorate in the future.
- Clearwell to store treated water and allow sufficient contact time for secondary disinfection.

The preferred residuals treatment process will treat both residuals (waste stream) from the treatment process in the plant expansion, as well as residuals produced within the existing membrane treatment system. The preferred residuals treatment process includes:

- Wastewater equalization
- Plate settler clarification and thickening
- Supernatant equalization
- Supernatant discharge to the East Branch of Sheldon Creek (with chlorine and turbidity monitoring and energy dissipation at creek)
- Sludge equalization
- Sludge discharge to the sanitary sewer.

14.2 Proposed Conceptual Site Layout

The proposed conceptual site layout of the Phase 2 expansion of the Burloak WPP is shown in Figure 29. It includes the existing buildings, equipment and infrastructure. A new paved road will need to be built to provide truck access to the new buildings. Site access will continue to be provided only through Rebecca Street to avoid disturbances on the residential streets.

The existing plant will continue to operate and provide safe water to the Region throughout construction. Sequencing will be an important component of the detailed design and construction to ensure that little to no interruption to the produced potable water supply will be experienced.

The proposed location of the new infrastructure within the plant site was developed based on the following considerations:

- All underground tanks would need to be positioned between the existing and future above-ground structures. It was established that having the above-ground buildings on the outside would prevent any trucks from driving on top of the underground structures (i.e., clearwells and ozone contractors). Locating the above-ground buildings on the outside results in the need to locate the new above ground level infrastructure closer to the residential area on the south of the property.
- The location of the new ozone contactor (underground infrastructure) would be immediately to the south of the existing ozone contactor to make the best use of the existing piping gallery. The gallery was originally built to be shared with the future contactor.
- Due to the location of the existing high lift headers, it makes sense to have the new high lift pumping station (HLPS) south of the existing one. This also allows sharing the existing over bridge crane between the existing and the new HLPSs.
- The need for the new ozone contactor and HLPS also contributes to some of the above ground level buildings to be pushed further south.
- The proposed location of the new infrastructure provides ease of integration between the existing and the new treatment processes.

The proposed plant layout, as shown in Figure 29, has been developed based on the information available at a conceptual design level and Class EA Study, and it may be subject to modifications and/or refinement during the detailed design phases.

14.3 Additional Processes/Components

In addition to the selected treatment processes, the following additional processes/components will be included:

- Low lift pumping station
- High lift pumping station
- Electrical systems
- Yard piping
- Chlorination at the intake for zebra mussel control will continue to be provided as currently practiced
- Secondary disinfection with chlorine for maintenance of residual in the distribution system will continue to be provided as currently practiced.

14.3.1 Low Lift Pumping Station

The existing low lift pumping station was originally designed to accommodate six vertical turbine pumps with their own suction and discharge headers. Three pumps were installed as part of Phase 1 with a firm pump net capacity (capacity with the largest pump out of service) of 64 ML/d. The existing low lift pumping station will accommodate two additional vertical turbine pumps in order to provide a total firm pump net capacity of 165 ML/d.

A new electrical room (and associated mechanical room) for the new low lift pumps will be built on the north-west corner of the plant site, near the existing electrical room (and associated mechanical room). These new rooms will be built as an addition to the existing electrical/mechanical rooms, under one shared roof, maintaining the existing aesthetics.

14.3.2 High Lift Pumping Station

The existing high lift pumps deliver water to the Region's reservoirs through one 1050 mm high lift header/watermain to Rebecca Street. A 600 mm watermain connecting to the 1050 mm watermain on Rebecca Street has been installed at the valve chamber on the Burloak WPP site. The high lift pumping station is equipped with four vertical turbine pumps with a firm pumping capacity (capacity with the largest pump out of service) of 74 ML/d. A new high lift pumping station will be built within the existing site to accommodate the new pumps that will deliver treated water to the Region's reservoir through a second 1050 mm high lift header/watermain to Rebecca Street.

The new high lift pumping station will accommodate three additional vertical turbine pumps with this construction in order to provide a total firm pump net capacity of 184 ML/d. The new high lift pumping station will provide sufficient space to accommodate one additional pump in the future.

A new electrical room (and associated mechanical room) for the new high lift pumps will be built immediately adjacent to the new high lift pumping building on the north-east corner of the plant site.

14.3.3 Chlorination for Zebra Mussel Control

The existing treatment train at the Burloak WPP includes chlorination at the intake location for zebra mussel control. Chlorination at the intake location is designed to minimize operational problems associated with zebra mussels which cause biological slime formation on filters, pipes and tanks and potentially taste and odour problems. As such, this will continue to be provided as currently practiced.

The chlorine application for zebra mussel control is tied into the operation of the low lift pumps, such that chlorine is only added at the intake location when the pumps are drawing water from the lake into the plant. This ensures that the chlorine is drawn into the intake pipe and prevents the dispersion of chlorine into the lake.

14.3.4 Yard Piping

The Phase 2 expansion will include several new tie-ins to the existing sanitary and stormwater system. The yard piping required as a result of the Phase 2 expansion includes installation of new pipe and pipe works as described in Table 27.

Table 27 Burloak Phase 2 Expansion Yard Piping

Line	Diameter (mm)	Gravity/Pumped	Origin	Destination
Clearwell Overflow	1200	Gravity	Clearwell	Low Lift Pump Header with tie-ins for tank overflows
Membrane Cleaning Wastewater	300	Gravity	Membrane and UV Building	Sanitary Sewer
Backpulse Tank Overflow	600	Gravity	Membrane and UV Building	Clearwell overflow line
Supernatant Forcemain	400	Pumped	Residuals Building	East Sheldon Creek
UV Drain and Bypass (UV and Supernatant)	750	Gravity	Residuals Building	Clearwell overflow line
Supernatant Equalization Tank Overflow and Waste Equalization Tank Overflow	750	Gravity	Residuals Building	Clearwell overflow line
Thickened Sludge Forcemain	150	Pumped	Residuals Building	Sanitary
Thickened Sludge and Recirculation/ Neutralization Tanks Overflow	400	Gravity	Residuals Building	Stormwater

Note:

1. ***Overflow discharge to stormwater system to be verified during design, if stormwater system capacity is insufficient overflow discharge will be to clearwell overflow line***

A 1200 mm overflow line will be installed in the expanded clearwell to connect the clearwell to the low lift wet well.

The overflow line will travel along the south side of the site, outside the ring road and berm, in order not to impede on site space for any future plant expansions. A backflow preventer will prevent untreated water from flowing into the clearwell. During the detailed design, if dictated by capacity limitations of the stormwater and sanitary sewer system, tank overflows from the residuals system will tie-in to direct overflows back to the low lift wet well, the beginning of the plant, during emergency situations only (not during regular plant operations). The overflow line will include several flanged connections for potential future tie-ins based on future plant expansion.

A 400 mm diameter supernatant forcemain will transport this material from the residuals building south to Nautical Boulevard. The forcemain will run from the north side of Nautical Boulevard to the East Sheldon Creek.

14.3.5 Standby Generator

The plant is currently equipped with a bi-fuel diesel generator that will supply backup power in case of general failure of the utility source (hydro). Three new generators, similar to the one already installed, will be required to provide 100% backup power to the new loads.

An expansion to the existing standby generator building on the northeast side of the plant site will be required to fit the new generators. The option of having newer generators with higher efficiencies, as well as reduced footprint requirements will be investigated further during detailed design.

Figure 29 Burloak WPP – Phase 2 Expansion Conceptual Site Layout

14.4 Implementation Schedule

Based on the current Best Planning Estimates as well as currently known development staging requirements, it is projected that the Burloak WPP expansion will need to be completed in year 2019. On this basis, the anticipated implementation schedule is to commence the detailed design of the recommended Phase 2 expansion approach for the Burloak WPP in 2013 and be completed by 2016. It is anticipated that construction will start in 2016 and will be completed in 2019.

14.5 Required Permits and Approvals

Permits and approvals required as a result of the Burloak WPP Phase 2 Expansion are shown in Table 28.

Table 28 Burloak Phase 2 Expansion Required Permit and Approvals

Approval Agency	Permit/Approval Required
Ministry of the Environment	• Amendment to Drinking Water Works Permit • Amendment to Drinking Water License • Amendment to Permit to Take Water • Certificate of Approval for Air Emission Discharge
Ministry of Natural Resources	• Consultation with MNR will be required to confirm the need for prior notice and consultation requirements under the Great Lakes Charter. Consultation will be carried out prior to the Amendment to Permit to Take Water.
Conservation Halton	• Permit for Altering a Watercourse
Town of Oakville	• Works Permit • Site Plan Approval • Building Permit
Department of Fisheries and Oceans (DFO)	• Permit for Harmful Alteration, Disruption or Destruction of fish habitat (HADD), subject to recommendation made by Conservation Halton

14.6 Preliminary Cost Estimate

As established in the Sustainable Halton Water and Wastewater Master Plan, 2011 the preliminary cost for the Phase 2 expansion of the Burloak WPP has been estimated at $109,760,000. This cost estimate will be refined and confirmed during the next stages of this project.

15. Proposed Mitigation of Potential Impacts and Monitoring

The following section provides a description of some of the potential impacts anticipated during construction as a result of the implementation of the preferred treatment design concept, described in this report, as well as some mitigation measures proposed to minimize or avoid such anticipated impacts.

As with any other construction project, there will be some potential impacts to the public and environment in areas such as noise, dust, vibration and visuals during the construction period. All construction work must be carried out in accordance with the Occupational Health and Safety Act (OHSA) and other local regulations. Specific mitigation measures, as described below, are recommended for implementation to reduce anticipated potential impacts.

15.1 Truck Traffic

Most of the construction activities associated with the Phase 2 expansion of the plant will be contained within the site property limits, with the exception of the discharge pipeline on the right-of-way (ROW) of Nautical Boulevard and its associated outlet structure in the vicinity of East Sheldon Creek, as shown in Figure 27. Increased truck traffic will be experienced during the duration of construction from the delivery of construction equipment, construction materials and removal of excavated material from the site. The proposed mitigation measures include the following:

- Appropriate hours of work will be specified in the contract.
- Truck access to and from the site will be limited to the existing entrance on Rebecca Street, avoiding residential areas.
- Any lane closures will be completed in accordance with best practices to protect safety to the workers and to the general public.
- Residents in the area will be kept informed ahead of time of any road closures and anticipated timing, as well as the overall schedule of construction.
- All standard best practices for vehicle and pedestrian safety will be employed throughout the construction areas.

15.2 Noise

Potential noise effects are anticipated in connection with construction traffic and construction equipment. Noise during operation of the expanded buildings is not expected to differ from the existing conditions. The proposed mitigation measures include the following:

- Ensuring all vehicles and construction equipment are equipped with effective muffling devices and are operated in a fashion too minimize noise in the project area.
  Throughout the construction period, the Region will ensure the contractors undertake measures to reduce noise disturbances as much as possible.

15.3 Dust and Mud

Construction traffic could create additional dust and mud. The proposed mitigation measures include the following:

- Dust control measures such as the application of water to be implemented as required.
- The Region will ensure that the contractor maintains public roadways clean and free of mud on a consistent basis.

15.4 Vibration

Based on the soil information available and the proposed expansion, excavation is expected to be carried out by drilling in the rock using large excavators to remove the rock. Some vibration may be felt; however, damage to structures or cosmetic damage is unlikely due to the distances of residences away from the site. Completing a pre-construction survey of the close dwellings and businesses prior to construction is recommended to avoid any future issues during or post-construction. In addition, drilling will be confined to the working hours permitted under the local by-laws.

15.5 Visual/Architectural

The proposed expanded buildings will be designed to complement the architectural style of the existing buildings and use same/similar features for the expansion including new wave roofs over expansion wings. The materials to be used will complement the facades of the existing buildings.

15.6 Landscaping

The site will be landscaped following construction of the expanded facilities. A detailed landscape concept will be developed during detailed design. The landscape plans will include adequate vegetated buffer areas with berms, where appropriate, and mature trees to block visibility to the site as much as possible.

15.7 Disturbance of Existing Natural Environment

There is limited vegetation on the existing site in the areas that are proposed for expansion. The proposed mitigation measures include the following:

- A buffer zone to protect the woodlot within the eastern boundaries of the plant site will be part of the design to ensure the area is not disturbed during construction.
- Construction areas will be re-planted and re-vegetated after the expansion is complete.
- Erosion and sedimentation control measures will be placed around the construction areas, where appropriate.
- A monitoring plan of the East Sheldon Creek will be developed during detailed design and submitted to Conservation Halton and the Town of Oakville for review and approval. The monitoring activities will be implemented at stages and frequencies specified in the approved monitoring plan.

Before construction of the Burloak WPP Phase 1, the site was the location of a refinery. The site was remediated to meet relevant Environmental Standards and Regulations prior to construction of Phase 1 of the Burloak WPP. As such, there are no records of contaminated soil during the Phase 1 plant construction. It is not anticipated that any contaminated soil will be excavated during the Phase 2 expansion of the plant; however, if any are encountered they will be disposed of as per *Part XV.1 of the Environmental Protection* Act and Ontario Regulation 153/04.

15.7.1 Sheldon Creek

Membrane backwash water is proposed to be discharged into the east tributary of the East Sheldon Creek. The discharge to Sheldon Creek will be limited to supernatant from the residuals clarification and thickening with low solids concentrations.

The creek assessment completed as part of this Class EA Study revealed that the existing channel is in state of transition. Development has impacted the channel and it is currently in the process of response to those impacts. The response has resulted in bed incision and channel widening.

The proposed discharge average and peak flows, for the expanded 165 ML/d plant capacity, of approximately 100 L/s and 200 L/s, under 95% and 90% recovery rates, respectively, are not expected to have a significant adverse effect to the creek channel integrity, with the understanding that controls will be implemented to manage the peak discharge values. From a flood perspective, i.e., crossing capacity or frequent flooding, the modeling demonstrated that overtopping elevations will not significantly change, (i.e., 0.03 m above the 2 year event).

The proposed mitigation measures related to Sheldon Creek include the following:

- Discharge peak flows, under any expansion, should be attenuated prior to discharge so that the wetting and drying effect on the channel banks is minimized. A hydraulic analysis would need to be carried out during detailed design to determine the optimal alternative to producing continuous flow and minimization of surge effects.
- The proposed discharge structure will be located at or near the Sheldon Creek East Branch channel bank, immediately north of Nautical Boulevard. The structure is proposed to receive flow from the plant via pump action and gravitational flow of the conduit is not required. The structure should incorporate a primary energy dissipation chamber that can function to maximize the weir effect at discharge to achieve a well distributed outflow. In addition, a flow dispersion structure should be considered to minimize local erosion or flow concentrations.
- A monitoring program to characterize the thermal inputs from the discharge is recommended to monitor the potential change in temperatures in the east branch of Sheldon Creek. This would require the installation of temperature loggers upstream of the discharge, near the outfall location, and downstream prior to its confluence with the main branch of Sheldon Creek. It is recommended that loggers are installed prior to construction to obtain baseline information, and then monitored at regular intervals during- and post-construction.
- Monitoring of the channel flows and channel integrity are also recommended to take place for the establishment of detailed design parameters. In concert with flow monitors, it is recommended that erosion pins be installed at critical areas to measure the change in bed and bank geometry and characteristics.
- Turbidity and chlorine will be continuously monitored to ensure water quality parameters meet the discharge permit requirements.
- The supernatant will be fed from an equalization tank to ensure continual, and not intermittent, flow to the creek. Flow will be continuously monitored to ensure an even flow regime.

In addition, and as identified during pre-consultation activities with CH and the Town of Oakville, a flow attenuation/mitigation plan and a monitoring plan should be developed in the early stages of detailed design and submitted to CH and the Town of Oakville for review and approval, prior to implementation. Also, a detailed vegetative assessment needs to be undertaken during the detailed design stages.

15.8 Fuel Spills

Spills could potentially occur when refueling construction equipment. The proposed mitigation measures include the following:

- Proper construction techniques will be applied to reduce the risk of spills.
- A contingency plan for cleaning up fuel spills will be developed and ready for implementation, particularly when working in proximity to the East Sheldon Creek.
- Equipment required to clean up a spill will be contractually required to be on-site at all times.

15.9 Geotechnical Considerations

A detailed geotechnical investigation will be carried out to assist during the design and construction of Phase 2 expansion. The extent of the geotechnical investigation and the location of the required boreholes will be confirmed in the next stages of the project. Nevertheless, based on the findings of the previous geotechnical investigation completed for Phase 1 of the Burloak WPP, by Peto MacCallum Ltd. Consulting Engineers (2005), the site conditions encountered during construction of Phase1, and the proposed works, the proposed mitigation measures include the following:

- It is recommended that the top of the rock elevation across the remainder of the site is verified. The results of this investigation would provide an indication on whether the new facilities would be founded in the clay layer or in the rock, and determine whether additional boreholes need to be drilled around the new infrastructure.
- Construction of the new facilities within the site is anticipated to be at or below elevation 82m requiring excavation of shale. The new excavation may require drilling of the shale to facilitate removal, control of granular bedding below existing structures, shoring of existing structures and control of groundwater and surface water.
- Construction of Phase 1 of the existing Burloak WPP resulted in very little groundwater from excavation, which was managed by pumping the water into a low lying area within the plant site, where the water percolated trough the soil. The conditions encountered during construction of Phase 1 were as anticipated from the results of the preliminary geotechnical investigation. Similarly, and with consideration to the additional information available from the 2005 geotechnical investigation, excavation dewatering is expected to be required from precipitation and ground water entering the excavation and/or entering the granular fill around the existing facilities.
- Based on the reported slow percolation rates through the rock and clay layers, a permit to pump is not expected to be required. However, pumping discharges should conform to the MOE, Region of Halton, and other relevant agencies including CH.
- The site should be graded to prevent run off from entering the excavation as much as possible with the remaining groundwater and precipitation to be removed by sump pumps around the perimeter of the excavation.
- It is anticipated that discharge be directed to a temporary discharge siltation pond, to be sized to provide sufficient detention time before the water percolates through the soil. The temporary siltation pond would be located within the plant site and maintained during construction by removing silt build-up from time to time to keep its functionality. The anticipated groundwater to be discharged, as well as the discharge method, will be confirmed during the detailed geotechnical investigation, which will be completed during detailed design.
- Dewatering operation will employ appropriate filter screens so that no soil or foundation material is removed, and to control solids concentrations in the discharge.
- Prior to trench or excavation, the locations and depths of existing underground utilities must be verified.

15.10 Public Consultation

Public consultation will continue to be of paramount importance during design and construction of this project. The Region will continue to inform the public and provide updates as the project progresses. The Region's website will be regularly updated with project details throughout the design and construction stages, and neighbouring residents will be kept informed throughout the stages of construction.

A communication program will be in place before and during construction to inform residents about future construction activities and possible road closures, if required. The communications program will include a dedicated contact person from the Region who would be available to respond to any immediate issues or concerns that may come up before or during construction.