The New Professionals Committee (NPC) and

The Student Design Competition (SDC) Sub-Committee

In collaboration with

The Regional Municipality of Halton

WEAO Student Design Competition 2011

Project Statement

Expansion of the Acton Wastewater Treatment Plant

September 2010

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BACKGROUND

The Regional Municipality of Halton is located west of the City of Toronto along the shores of Lake Ontario. Halton Region comprises of the City of Burlington and the towns of Oakville, Milton and Halton Hills and is home to approximately 440,000 people. Halton Region owns and operates 7 wastewater treatment plants.

The Acton Wastewater Treatment Plant (WWTP) is located at 202 Churchill Road South in the community of Acton in the Town of Halton Hills within Halton Region. Figure 1 displays a map of Acton in relation to the Greater Toronto Area while Figure 2 displays an aerial view of the existing facility.

The Acton WWTP is a tertiary treatment plant consisting of screening, grit removal, flow splitting to primary clarification, nitrifying activated sludge, final clarification, traveling filters, an aluminium sulphate dosing system for phosphorus removal and dual stage anaerobic digestion. The final effluent is disinfected year-round using ultra-violet (UV) light before being discharged into Black Creek, which is classified as a cold water fishery and is environmentally sensitive to contaminant loads and temperature.

The existing Acton WWTP is rated for an average capacity of 4,545 m^3/day and a peak capacity of 13,410 m^3/d. The existing effluent limits and effluent objectives for the Acton WWTP as per the Ministry of the Environment Certificate of Approval are listed in Table 1 below.

Table 1. Existing Acton WWTP Certificate of Approval Effluent Objectives and Limits

Parameter	Effluent Objective	Effluent Limit
$CBOD_5$	2 mg/L	5 mg/L
TSS	3 mg/L	5 mg/L
Total Phosphorus	0.2 mg/L	0.3 mg/L
(Ammonia + Ammonium) Nitrogen Non-freezing period (May 1 – Nov 31): Freezing period (Dec 1 – April 30):	1.0 mg/L	 2.0 mg/L 4.0 mg/L
Un-ionized Ammonia (any single sample)	-	0.1 mg/L
Escherichia Coli (monthly geometric mean density)	100 organisms/100mL	150 organisms/100mL

Flow rate and laboratory analysis data for the final effluent from the Acton WWTP in 2008 are summarized in Table 2 and Table 3, respectively. For more information refer to the Regional Municipality of Halton Wastewater Treatment Systems 2008 Performance Report.

The Acton WWTP is currently operating near its peak capacity. Additional wastewater treatment capacity is required to accommodate the build-out of the urban envelope in Acton for the year 2031 and beyond. The short term capacity requirement (Phase 1) is 5,600 m^3/d while the ultimate required capacity (Phase 2) is 7,000 m^3/d.

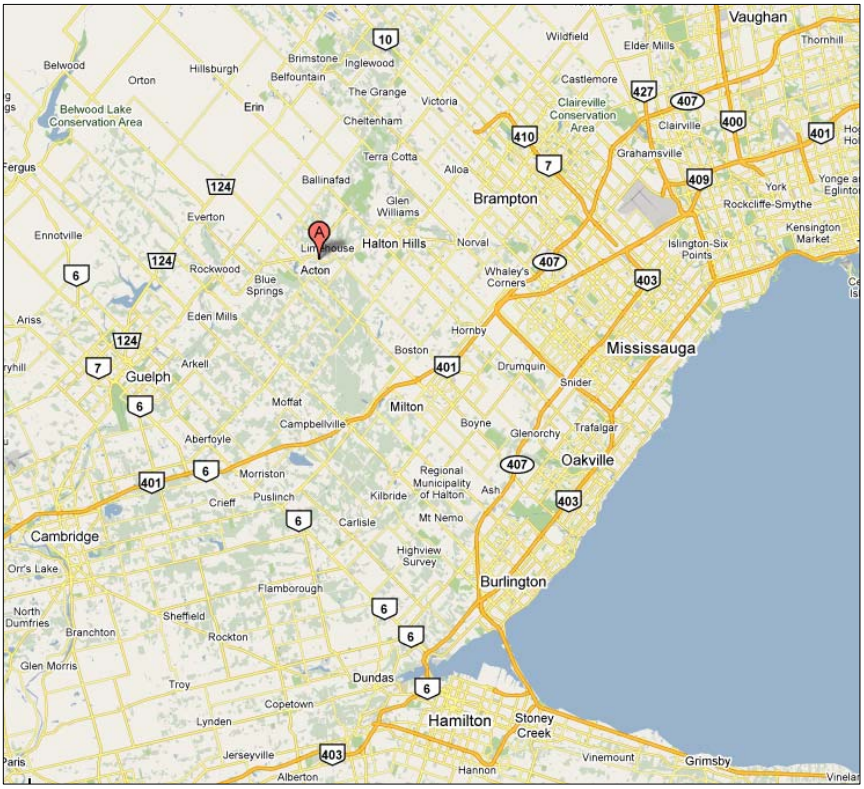

Figure 1. Map of the Greater Toronto Area showing the location of the community of Acton in Halton Hills

Figure 2. Aerial View of the Existing Acton Wastewater Treatment Plant

Table 2. Flow Rate Data at the Acton WWTP in 2008

Parameter	Value
Average Daily Flow	4,610 m^3/day
Maximum Daily Flow	6,160 m^3/day
Instantaneous Peak Flow	15,980 m^3/day
Minimum Daily Flow	4,000 m^3/day
Number of days with flows exceeding 90% of design flow	24 days
Total volume of digested biosolids generated in 2008	8,816 m^3

Table 3. Final Effluent Quality at the Acton WWTP in 2008

Parameter	Annual Average Concentration	Annual Average Loading	Effluent Objective	Effluent Limit
$CBOD_5$	1.41 mg/L	6.64 kg/day	2 mg/L	5 mg/L
TSS	1.56 mg/L	7.35 kg/day	3 mg/L	5 mg/L
TP	0.43 mg/L	2.08 kg/day	0.2 mg/L	0.3 mg/L
Total NH_3-N	0.78 mg/L	3.76 kg/day	1.0 mg/L	2.0 mg/L (Summer) 4.0 mg/L (Winter)
Unionized NH_3	0.002 mg/L	-	-	0.1 mg/L
NO_3-N	14.4 mg/L	-	-	-
NO_2-N	0.12 mg/L	-	-	-
TKN	1.4 mg/L	-	-	-
PO_4^{3-}	0.05 mg/L	-	-	-
pH	7.44	-	-	-
E. Coli	1 CFU/100 ml	-	100 organisms/ 100 ml	150 organisms / 100 ml

CLASS EA STUDY

In May 2006, Halton Region initiated a Class Environmental Assessment (EA) study to identify the preferred alternative for addressing immediate and long-term wastewater treatment servicing for the community of Acton. The preferred alternative must satisfy the anticipated long-term demand in an economical and sustainable way, with minimal impacts on the environment, including Black Creek and groundwater.

To date, the Class EA study has evaluated a number of alternative solutions to addressing the need for increased wastewater treatment capacity in Acton. The preferred alternative has been identified as the construction of additional plant capacity at the existing site. This alternative is less costly and has less impact on natural environmental features than the construction of a new WWTP.

The preferred alternative is being investigated further to identify the preferred design concept for the plant expansion. The preferred design concept for the plant expansion has not yet been confirmed. Some of

the alternative design concepts which are being evaluated for the different wastewater unit processes are listed below:

1. Inlet works: mechanical screens and grit chambers
2. Primary clarification
3. Secondary Treatment (Biological treatment process including aeration and secondary clarification):
    - Activated Sludge Process
    - Membrane Bioreactor
    - Biological Nutrient Removal
    - Sequencing Batch Reactor
    - Rotating Biological Contactor
    - Moving Bed Biofilm Reactors/Integrated Fixed-Film Activated Sludge

4. Total Phosphorus (TP) removal:
    - Expand the existing shallow bed filters
    - Series operation - Dual Filtration Using Existing Filters followed by new deep bed filters.
    - Dual Filtration with existing shallow bed filters decommissioned
    - High-rate Physical-Chemical Treatment upstream of existing shallow bed filters
    - Standalone High-rate Physical-Chemical Treatment
    - Membrane Bioreactor System

5. UV disinfection: Expansion of the existing UV disinfection process has been identified as the most suitable alternative. Chlorination/dechlorination has been dismissed due to the sensitivity of the receiver, Black Creek. Ozonation has also been dismissed due to lack of full scale operating data.

The existing Acton WWTP consists of two plant sections, Plant A (approximately 25% of rated capacity) and Plant B (approximately 75% of rated capacity). It is understood that Plant A will be decommissioned as part of a plant expansion due to the poor structural condition of this treatment section. The existing tankage in section Plant B will be reused as part of the plant expansion to maximize the use of existing infrastructure and reduce expansion requirements.

It is understood that the design of Acton WWTP expansion will accommodate the addition of an anoxic zone to provide nitrification, and potentially denitrification in the future. This will enhance sludge settling and performance.

It is important to note that the activated sludge process must be supplemented with a tertiary filtration technology to provide removal of TP, while the Membrane Bioreactor process does not.

EXPANSION OF INLET WORKS

The existing inlet works at the Acton WWTP are in poor condition and are causing increasing operational and maintenance challenges to operators. Hence, Halton Region is currently upgrading the existing inlet works at the Acton WWTP, which includes the following:

- Construction of two screen channels, each with a design flow of 14,500 m^3/d.
- Installation of one mechanical rotating drum screen in one of the two channels with a design capacity of 14,500 m^3/d and 6 mm openings.
- Installation of one manual screen in the second channel to operate as by-pass of the mechanical screen. The manual screen has a design capacity of 14,500 m^3/d and 6 mm openings.
- Construction of one vortex type grit chamber complete with grit classifier, designed for the future peak wet weather flow of 21,452 m^3/d.
- Construction of a diversion chamber upstream of the rotating drum screens and another diversion chamber downstream of the grit chamber to divert excess flows to a temporary holding tank.

In the future, the inlet works facilities will be upgraded as follows:

- The manual screen in the second channel will be replaced with a mechanical rotating drum screen with a design capacity of 14,500 m^3/d.
- The 6 mm screens in both rotating drums will be replaced with finer, 2 mm openings.

OBJECTIVES

The design team is required to provide the following:

- Preliminary design and layout for Phase 1 (5,600 m^3/day) to meet capacity demand to 2021; and
- Conceptual layout for Phase 2 (7,000 m^3/day) expansion to meet the ultimate capacity requirement in 2031 and beyond.

The upgraded plant must be constructed within the limits of the existing site and meet the effluent objectives described in the design criteria.

DESIGN CRITERIA

The design flows and effluent objectives for Phase 1 and Phase 2 expansion of the Acton WWTP are summarized in Table 4 and Table 5, respectively.

Table 4. Design Criteria for Phase 1 and Phase 2 Expansion

Parameter	Phase 1 Expansion	Phase 2 Expansion
Average Daily Flow (dry weather)	5,600 m^3/day	7,000 m^3/day
Maximum Daily Flow (dry weather)	9,690 m^3/day	14,307 m^3/day
Instantaneous Peak Flow (wet weather)	14,955 m^3/day	21,452 m^3/day

Table 5. Proposed Acton WWTP Effluent Objectives and Limits for Phase 1 and Phase 2 Expansions

Parameter	Effluent Objective	Effluent Limit
$CBOD_5$	2 mg/L	5 mg/L
TSS	3 mg/L	5 mg/L
Total Phosphorus	0.1 mg/L	0.2 mg/L
(Ammonia + Ammonium) Nitrogen Non-freezing period (May 1 – Nov 31): Freezing period (Dec 1 – April 30):	1.0 mg/L	 2.0 mg/L 4.0 mg/L
Un-ionized Ammonia Nitrogen (monthly avg.) Un-ionized Ammonia Nitrogen (single sample)	--	0.016 mg/L 0.08 mg/L
Escherichia Coli (monthly geometric mean density)	100 organisms/100mL	150 organisms/100mL

DESIGN ALTERNATIVES

Design teams can use any of the design alternatives identified in the Class EA Study. The Region of Halton will most likely be recommending the following design alternative:

- Inlet works: rotating drum screens and vortex type grit chamber (already being implemented)
- Primary clarification
- Conventional activated sludge (suspended growth) including nitrification process

- Tertiary filtration technology using existing filters followed by new deep bed filters (series operation)
- UV Disinfection
- Anaerobic digestion of biosolids

Design teams are allowed to provide alternative treatment processes as long as the proposed treatment process complies with the design objectives. Irrespective of the design option selected, the design team *must provide a clear discussion of the selection process and summarize the results in a decision matrix.*

It should be noted that *capital and operating cost are critical factors* in the design of the expansion WWTP. The proposed expansion should take into account minimizing construction, operating and maintenance costs of the plant as well as utilizing proven technology (operating in full scale for at least 5 years, achieving desirable results on a regular basis, installed in a similar climate and at a plant with hydraulic capacity similar to the Acton WWTP).

The design of the plant expansion must take into account the current upgrades to inlet works (rotating drum screens and vortex grit chamber). In addition, the design must allow for the existing plant to continue operating during construction and eventually integrate the expanded units with the existing plant facilities.

SCOPE OF WORK

As a minimum, the design of the Acton WWTP should address the following:

- Expansion of the existing inlet works;
- Expansion of the biological treatment processes (secondary and tertiary treatment);
- Expansion of the effluent UV disinfection facility;
- Expansion of the anaerobic handling facility (biosolides are shipped off site);
- Expansion of electrical and standby power facilities; and
- Upgrades to the instrumentation and SCADA system.

DESIGN REPORT REQUIREMENTS

The design team must provide a design report for the proposed expansion. Please refer to the WEAO SDC Guidelines for the acceptable format of the report. As a minimum, the design report must address the following points:

- Population analysis to determine design flow rates;
- Wastewater characteristics;
- Existing plant process units and auxiliary systems;
- Discussion of alternative treatment processes;
- Selection of the preferred treatment process (including a decision matrix);
- Preliminary sizing of major equipment (aeration basins, clarifiers… etc.) for Phase 1;
- Incorporating information from different manufacturers;
- Preliminary sizing of primary and standby power supply for Phase 1;
- Description of the process control logic (instrumentation system);
- Noise and odour controls;
- Minimizing environmental damage during construction;

- Required upgrades to utility supply;
- Preliminary capital cost estimate for Phase 1 and 2 expansion;
- Operating and Maintenance Cost for Phase 1 expansion over a 10 year period (2011-2021); and
- Implementation (construction) schedule for Phase 1 expansion.

There is no limit for the number of appendices attached to the design report. However, the appendices must contain, as a minimum, the following:

- Process design and hydraulic calculations for all unit processes. Include all calculation spreadsheets;
- Manufacturer data sheets and catalogues of all major equipment; and
- Design drawings (see below for details).

Design teams may use modeling software, although it is ***not required*** for the project. If used, the output of modeling software must be included as an appendix and attached to the design report.

DESIGN DRAWINGS REQUIREMENTS

Design drawings must be provided that clearly show the layout of plant expansion and process flow. As a minimum, the following three drawings must be included:

1. Site Plan, showing all unit processes and yard piping for Phase 1 expansion (solid line), and the general layout for Phase 2 (discontinuous line), in relation to the existing facility (light print);
2. Hydraulic profile for the entire plant based on Phase 1 flows;
3. Process and instrumentation diagram (P&ID) for Phase 1 and Phase 2;

The drawings must be printed on 11” x 17” landscape sheets, folded and included as an appendix in the design report.

SUPPORTING INFORMATION

The following documents are provided by the Halton Region to aid in the preparation of the design report:

- Draft memo from Dillon Consulting to Halton Region dated July 12, 2010 for the preliminary evaluation of alternative solutions to the Acton WWTP Class EA – will be revised by November 2010.
- Conceptual Design of Inlet Works, Final Report by Dillon Consulting, dated November 13, 2008.
- Regional Municipality of Halton Wastewater Treatment Systems 2008 Performance Report.
- Record Drawings of the Acton WWTP, 2001.
- Tender Drawings of the Acton WWTP Inlet Works Expansion, 2010.