New Professionals Committee and

Student Design Competition Sub-Committee

In collaboration with

Regional Municipality of Durham

WEAO STUDENT DESIGN COMPETITION 2013

PROJECT STATEMENT

EXPANSION OF NEWCASTLE

WATER POLLUTION CONTROL PLANT

October 2012

WEAO Student Design Competition 2013

Project Statement

EXPANSION OF NEWCASTLE WATER POLLUTION CONTROL PLANT

BACKGROUND

The Regional Municipality of Durham, (Durham), is located in southern Ontario, east of Toronto within the Province of Ontario. It is a home to 622,000 residents that populate an area of 2,537 square kilometres (Figure 1). Durham includes eight local area municipalities: the cities of Pickering and Oshawa, the towns of Ajax and Whitby, the Municipality of Clarington, townships of Brock, Scugog and Uxbridge. The regional government headquarter is located in Whitby.

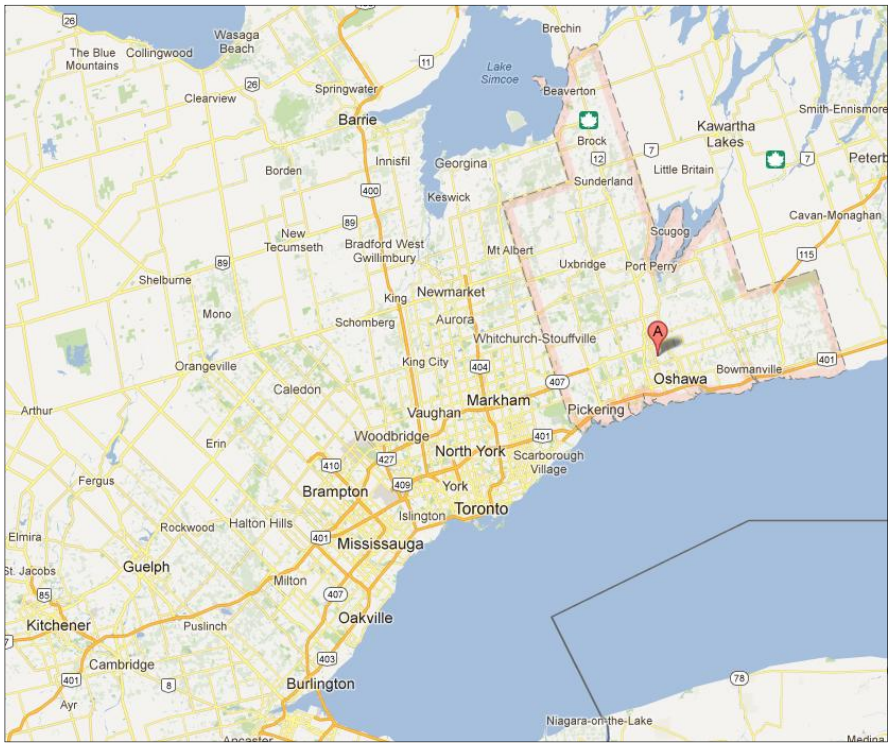

Figure 1. Map showing the Durham Region in relation to the Greater Toronto Area

Durham as the upper-tier level of government owns and operates the water treatment and supply and sanitary sewage collection and treatment systems. The sanitary sewage infrastructure comprising of 12 water pollution control plants, 51 sanitary sewage pumping stations, 2,044 km of sanitary sewers, all of which has an estimated value of $3.4 Billion.

Newcastle (formerly Wilmot Creek) Water Pollution Control Plant (WPCP) serves the urban area for the community of Newcastle in the Municipality of Clarington and is located at 1000 Toronto Street, Newcastle, Ontario. Figure 2 shows an aerial view of the existing facility.

Figure 2. Aerial View of the Existing Newcastle WPCP

In November 1991, TSH completed a Municipal Class Environmental Assessment (Class EA) to identify sewage treatment alternatives for the Newcastle urban area. The preferred design alternative was to construct a new WPCP, which would be initially operated using an extended aeration process, to treat the Stage 1 flow of 4,086 m^3/d. Expansion to the Stage 2 capacity of 8,172 m^3/d and beyond would entail conversion of this low rate process to some form of the Conventional Activated Sludge (CAS) process.

The Stage 1 plant design incorporated a primary clarifier with separate anaerobic/anoxic selector technology incorporated in the bioreactor design. For Stage 1, approval was obtained to haul unprocessed raw sludge to other Durham Region WPCPs for processing and disposal. During Stage 2 expansion and upgrades, on-site excess solids processing / disposal options at the Newcastle WPCP shall be investigated and implemented.

Newcastle WPCP was commissioned in 1996. The current service population is approximately 9,700. Based on growth, current sewage flow projections indicate that the Newcastle WPCP will reach its Stage 1 design capacity in 2014.

In order to meet various development requirements in Newcastle, a 4–stage plant expansion program is proposed as follows:

Table 1. Proposed implementation phases for Newcastle WPCP

Stage	Status	Rated Capacity (m^3/d)
Stage 1	Constructed in 1996	**4,086**
Stage 2	Planned to be constructed in 2014	**8,172**
Stage 3	Planned	**16,348**
Stage 4	Planned	**24,520**

The plant constructed in 1996 has a liquid design capacity of 8,172 m^3/d, but operates at only 4,086 m^3/d. Once the solids treatment capacity is provided as part of the Stage 2 upgrades, the existing plant could operate at 8,172 m^3/d.

This design project will involve selection of preferred alternatives for Newcastle WPCP expansion Stages 3 and 4 to be documented in a preliminary design report.

Newcastle WPCP is a secondary treatment plant consisting of raw sewage pumping, screening and grit removal, primary clarification, activated sludge bioreactor with fine bubble diffusion system and jet aeration, final clarification, phosphorus precipitation and a sludge holding tank. The final effluent is disinfected using sodium hypochlorite before being discharged into Lake Ontario through a plant effluent outfall. The activated sludge process can be operated in five configurations:

- Conventional Activated Sludge
- Extended Aeration
- Nitrification
- Nitrification-Denitrification
- Contact Stabilization (Sludge reaeration)

Newcastle WPCP is also equipped with a groundwater pumping system to control the groundwater level around structures. This system consists of an underground collection system and pumps discharging to an outfall chamber. For more information refer to the Wilmot WPCP Operations Manual.

The existing effluent limits and effluent objectives for Newcastle WPCP as per the Ministry of the Environment Certificate of Approval are listed in Table 2 below.

Table 1. Certificate of Approval Effluent Objectives and Limits

Parameter	Effluent Objectives	Effluent Limits
$cBOD_5$	15 mg/L	25 mg/L
TSS	15 mg/L	25 mg/L
Total Phosphorus	1.0 mg/L	N/A
Total Ammonia Nitrogen		
Summer (April 1 – September 30):	10 mg/L	15 mg/L
Winter (Oct 1 – March 30):	15 mg/L	20 mg/L
Total Chlorine Residual	0 mg/L	0.04 mg/L
Escherichia Coli (monthly geometric mean density)	200 organisms/100mL	N/A

Rated capacities and influent characteristics for Newcastle WPCP are summarized in Table 2 and Table 4, respectively. For more information refer to the attached plant performance reports (PDF for 2010 and 2011 attached) For more information refer to the Wilmot WPCP Operations Manual.

Table 2. Newcastle WPCP - Plant Rated Capacity

Stage	Average Flow		Peak Flow	
	L/s	m^3/d	L/s	m^3/d
1	47	4,086	142	12,300
2	94.5	8,172	255.7	22,100
3	189	16,344	454	39,300
4	283	24,516	652	56,400

Table 3. Newcastle WPCP Influent Characteristics

Parameter	Average Flow (mg/L)
BOD_5	150
TSS	180
TP	10
TKN	35

ADDITIONAL CHALLENGE (VALUE ADDED)

The new approach to wastewater management has shifted in recent years from pollution treatment to resource recovery. Biosolids generated from wastewater treatment can be further treated through anaerobic digestion to generate high value fertilizers. Biogas generated from anaerobic digestion can be used to produce electricity and heat to offset energy costs at the treatment plant.

The proposed expansion design should consider currently available options to retrieve energy from biosolids through cogeneration or similar technologies. In addition, the proposed design should provide alternatives for biosolids management and disposal. The design should summarize technical literature and market research and provide recommendations for a particular technology to be considered by Durham Region for further evaluation.

OBJECTIVES

The design team is required to provide the following:

- Preliminary design and layout for Wilmot Creek WPCP for Stage 3 expansion, including evaluation of biosolids handling options and energy recovery from biosolids
- Conceptual layout for Wilmot Creek WPCP expansion for Stage 4 expansion

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 flows and influent characteristics for Stages 3 and 4 can be assumed to follow the design basis that was established during construction of Stage 1 (refer to Tables 3 and 4).

The assumed effluent objectives and limits for the Newcastle WPCP expansion are summarized below in Table 5.

Table 5. Proposed Effluent Objectives and Limits for Newcastle WPCP

Parameter	Design Objectives	Compliance Limits
$CBOD_5$	10 mg/L	15 mg/L
TSS	10 mg/L	15 mg/L
Total Phosphorus	0.5 mg/L	0.8 mg/L
(Ammonia + Ammonium) Nitrogen Summer(April 1 – September 30): Winter (Oct 1 – March 30):	 9.0 mg/L 15.0 mg/L	 15.0 mg/L 19.0 mg/L
Total Chlorine Residual	Not Detectable	0.02 mg/L
Escherichia Coli (monthly geometric mean density)	150 cfu/100mL	200 cfu/100mL

SCOPE OF WORK

The design of the Newcastle WPCP expansion/upgrade should address the following elements:

- Optimization and/or expansion of the liquid train to accommodate increased flows
- Provisoin of solids treatment capacity
- Upgrades to automatic control and instrumentation systems; and,
- Review of Biosolids management and energy recovery options including recommendations to Durham Region.

DESIGN REPORT REQUIREMENTS

The design team is challenged to provide a design report for the proposed expansion. Please refer to the WEAO SDC Guidelines for the acceptable format of the report. The design report should 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 for wastewater and solids;
- Selection of the preferred treatment process (including a decision matrix);
- Preliminary sizing of major equipment (aeration basins, clarifiers… etc.);
- Incorporating information from different manufacturers;
- Description of the process control logic (instrumentation system);
- Noise and odour controls;
- Minimizing environmental impact during construction;

- Preliminary capital cost estimate for Stage 3 expansion;
- Operating and Maintenance Cost for Stage 3 expansion over a 13 year period (2013-2026); and
- Implementation (construction) schedule for Stage 3 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 input data and 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 Stage 3 expansion (solid line), and the general layout for Stage 4 (discontinuous line), in relation to the existing facility (light print);
2. Hydraulic profile for the entire plant based on Stage 3 flows;
3. Process and instrumentation diagram (P&ID) for Stage 3;

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 Durham Region to aid in the preparation of the design report:

- Wilmot Creek WPCP Addendum to ESR (May 1992)
- Wilmot WPCP Stage 1 Contract No. D94-11 – set of drawings
- Wilmot Creek WPCP Operations Manual (August 1996)
- Wilmot Creek WPCP Process Overview (October 1996)
- Newcastle (Wilmot Creek) WPCP Certificate of Approval No. 3-2189-87-946 (July 1994)
- Newcastle WPCP Annual Performance Report 2010
- Newcastle WPCP Annual Performance Report 2011