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	Name, Title	Signature	Date
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A1-1 Doc. No. 285380 – 06 – 109 – 0001(Rev1), Pump Stations – Emergency Electrical Power Supply Design Criteria

Appendix 2

A2-1 Doc. No. 285380 – 03 – 109 – 0005(Rev1), Structures Design Criteria for Pump Stations & Generator Buildings

Appendix 3

A3-1 PS 5, 90% MTO Submission, List of Drawings

1 Overview

1.1 Design Package Description

This Technical Appraisal Form accompanies the Pumping Stations 5, Mechanical, Electrical and Structural 90% MTO Design Submission.

1.2 Project Agreement References

The Project Agreement schedule 15_2, subsection 7.3, Clause (xi), sentence 'C', requires each pump station design to convey the 100 year storm peak and that the number of pumps provide 100% peak flow redundancy. Each station is to have a minimum of four (4) pumps, allowing for two (2) duty, one (1) on standby and one (1) in repair.

The Project Agreement schedule 15_2, subsection 7.3, Clause (xi), sentence 'E', requires provision of an emergency power supply for each pump station in the event of power failure.

2 Pump Station Design

2.1 Peak Flow Rate

Pump Station 5 (PS 5) is designed to convey the 100 year incoming storm water peak flow rate of 1,850 L/s to Pond No. 3.

This peak flow rate is in accordance with that presented in submitted Document No. 285380–70–119–0001, Rev D, July 2012, titled 'Highway and Drainage Design Report – Phase 1'.

2.2 Pump Station Configuration

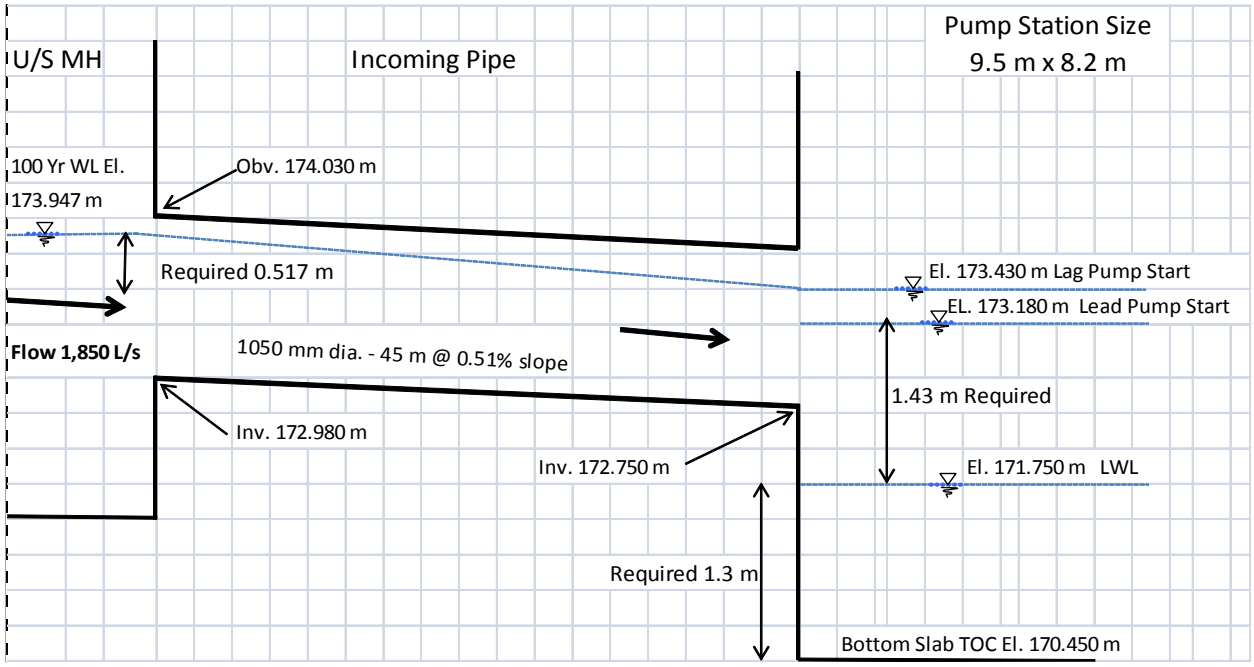
Storm water entering each pump station will have undergone pre-treatment through oil and grit separators (OGS) and spill containment units (SCU) located up stream. Refer to Document No. 285380 – 70 – 127 – 0001, Rev A, October 2012, titled 'Drainage – Pumping Station Pre-Treatment and Spill Containment'.

In the event that incoming flow bypasses the pre-treatment, each pump station is equipped with a trash basket located at the storm water sewer inlet to the station, to capture debris. The bar spacing is 50mm.
The incoming storm water enters the pumping station through a 1050 mm storm sewer, subsequently flows through the trash basket and enters a baffle. The baffle serves to dissipate excessively high and irregular velocities before entering the inlet chamber area. The flow then enters the pump station inlet chamber through slots in the floor of the baffle and flows evenly toward the pump inlet sumps.

The pump sumps are equipped with fillets and benching to smooth the flow and minimize water swirl prior to entering the pump. The benching design will be as recommended by the manufacturer of the pump.
The design of the pump station inlet chamber and sump is consistent with the principles of the American Hydraulic Institute.
The overall pump station sizes, and resulting sumps, shown on the drawings, reflect;

1. The requirement to avoid surcharging the incoming storm water sewer at the sewer invert elevations required by the drainage design and flow rates up to the 100 year peak flow.
2. The requirement to store sufficient water between the pump start level and stop level to result in a minimum cycle time of seven (7) minutes for pumps of this size (per manufacturers recommendations).
3. The requirement to maintain a water level when the lead pump stops (last to stop following a run cycle) such that the NPSH(available) to NPSH(required) ratio is a minimum of 1.15 to 1.65.

Pump Station 5 Inlet Elevation



3 Pump Selection

3.1 Pump Station Hydraulic Profile

Utilizing the Hydraulic Profile for PS 5 the system curves [Total Dynamic Head (TDH) vs Flow (L/s)] was generated for the pump stations. This reflects the TDH that the pump(s) need to overcome at a given flow condition for the particular system.
The TDH is comprised of static head (vertical lift) plus the dynamic head losses (due to piping friction, valves, fittings, entrance, exit, etc.). Dynamic head losses are determined using the Hazen-Williams equation.
The system curves reflect the TDH that the pump(s) need to overcome at any given flow point across the operating range of the system.

The curves for potential pumps are overlaid and the points of intersection with the system curve will indicate whether the selected pump will operate within the required range. Additionally, the NPSH (available) to NPSH (required) ratio has to be a minimum of 1.15 to 1.65 to ensure that the pump operation is satisfactory at the lowest TDH points.

The system curve and pump curve combination for PS 5 is shown below and on Drawing Sheet P5025.

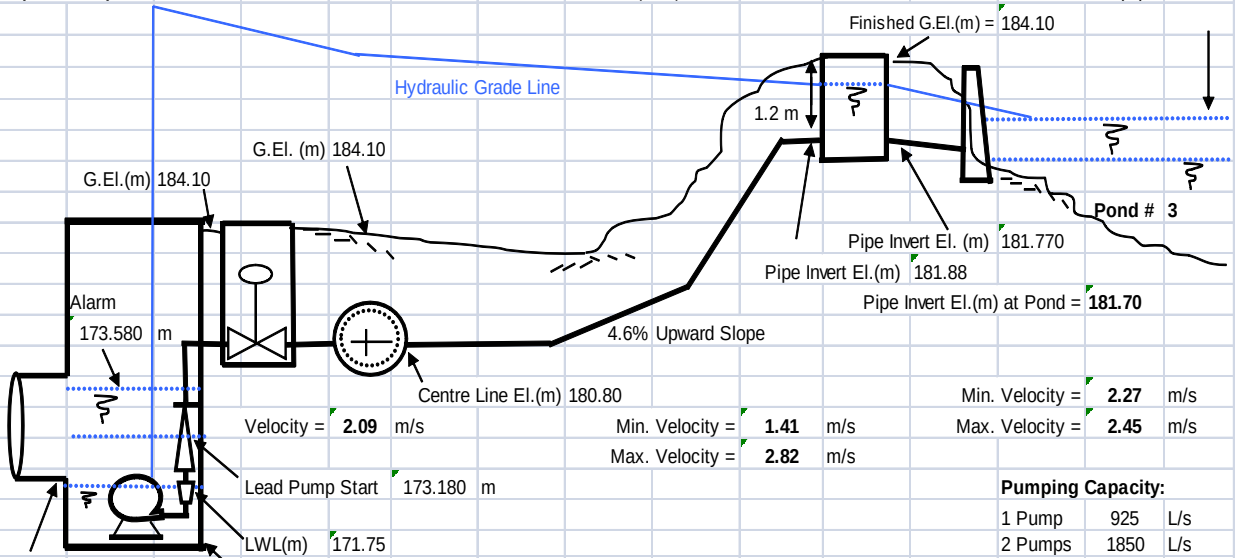
The Pump Station 5, Hydraulic Profile is shown below.

Windsor Essex Parkway - Storm Water Pump Station — **Pump Station # 5** — **Pond # 3**

Hydraulic Profile: Pump Station - Pond

Hydraulic Grade Line Elevations at PS:			Hydraulic Grade Line Elevations at Header:			Friction Factor C =	120
1 Pump Operation	183.78	m	1 Pump Operation	182.85	m	n =	0.013
2 Pumps Operation	184.91	m	2 Pumps Operation	183.99	m		

Pump Station #	5	Design TDH (m) =	12.6	Hydraulic Grade Line Elevations at MH:			Pond Water Elevations:	
Pump Static Head	11.30	m		1 Pump Operation	182.61	m	Pond NWL (m) =	181.70
Required Pump TDH	13.16	m		2 Pumps Operation	183.051	m	Pond HWL (m) =	182.70
							Pond Overflow (m) =	182.874



Velocity =	2.09	m/s	Min. Velocity =	1.41	m/s	Max. Velocity =	2.82	m/s	Min. Velocity =	2.27	Max. Velocity =	2.45	m/s
Dia. (mm)	750	(DL 30" Pipe)	Dia. (mm)	914	(CPP Pipe)	Dia. (mm)	1050	(RC Pipe)				
Length (m)	16.5		Length (m)	33.5		Length(m)	13		Slope	0.53846	%	

Pumping Capacity:		
1 Pump	925	L/s
2 Pumps	1850	L/s
3rd Pump	Spare	
4th Pump	Repair	

Head Losses:			Head Losses:			Head Losses:		
1 Pump Operation	0.93	m	1 Pump Operation	0.24	m	1 Pump Operation	0.34	m
2 Pumps Operation	0.93	m	2 Pumps Operation	0.93	m	2 Pumps Operation	0.429	m
Pumped			Pumped			Gravity Flow		

The following summarizes the maximum and minimum Static Head derived from the PS 5 hydraulic profile.

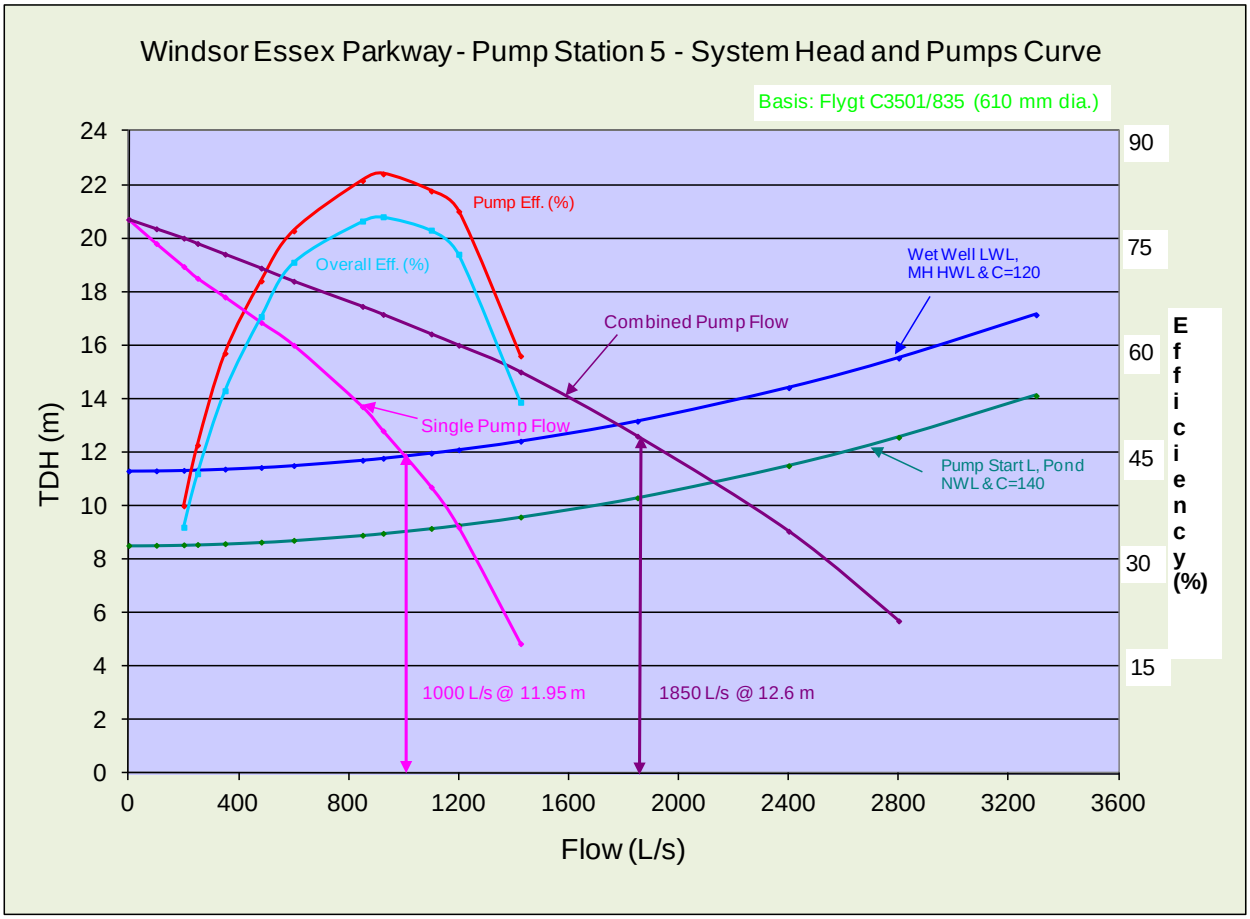
Design Flow	1,850 L/s
Minimum Static Head	181.700 – 173.180=8.520 m
Maximum Static Head	183.051 – 171.750 =11.301 m

The maximum and minimum Total Dynamic Head for PS 5 is summarized below.

Items	Head Losses (m) for Single Pump in Operation	Head Losses (m) for Two Pumps in Parallel Operation
Maximum Static Head		11.301
Minimum Static Head	8.520	
Total Head Losses	1.167	1.861
Total Dynamic Head (TDH)	9.687	13.162

3.2 System Head and Pump Curve

The following is the System Head and Pump Curve that was derived for Pump Station 5.



3.3 Pump Selection Summary - Pump Station 5

- Four (4) constant speed, submersible centrifugal pumps, two (2) duty and two (2) spare, Flygt Model C3501/835 (610 mm dia impeller) with 600VAC, 3ph, 60Hz, 385Hp. Motors. (This pump is the basis of design, but an approved equal from other manufacturers are acceptable.)
- Each pump has a rated capacity of 925 L/s @ 12.6m TDH.
- The combined capacity of the two (2) duty pumps is 1,850 L/s @ 12.6m TDH (100 year peak flow rate).

4 Pump Operation

The pumps will start and stop automatically based on the water level in the wet well. Operation of each pump is sequenced. An ultrasonic level transducer and a backup pressure level transmitter in the well will continuously monitor the well water level and send this data to the pump station programmable logic control (PLC) to direct the operating sequence of pumps. The pumps will be controlled by using the programmed duty pump sequence in the PLC. The first duty pump start will be cycled automatically, in an effort to balance the pump operating times.

Ultrasonic level transducers will be the primary level sensors and pressure level transmitters will be provided for redundancy. If there is a loss of echo and the ultrasonic level sensors fail, the standby pressure level transmitter will take over control. In addition to the ultrasonic level sensors and pressure level sensors, five (5) mechanical floats will provide backup in the event of PLC failure.

In the event of a pump failure, an alarm will be activated and the next pump in the duty sequence will be started. Check valve proximity switches are used to 'prove flow' for the pumps. In the event the pump is called to start, and there is 'no flow' indicated at the check valves, the pump will shut down, an alarm will be generated and the next pump in the duty sequence will be started.

5 Electrical

5.1 General

Diesel Generator Building DGB – 5 houses the electrical services for PS – 5.

The building contains the main power disconnects, motor control centers, transfer switches, PLCs, emergency backup diesel generator, SCADA equipment, building ventilation and heating, etc. The pump motors utilize soft starters.

5.2 Emergency Generators

Refer to Appendix 1, containing Document 285380-06-109-0001 'Pump Stations – Electrical Power Supply Design Criteria'.

6. Structural

Refer to Appendix 2, containing Document 285380-03-109-0005 (rev 1) 'Structures Design Criteria for Pump Stations and Generator Buildings'.

7 Design Documentation

Refer to Appendix 3 for the list of drawings included in this submission.

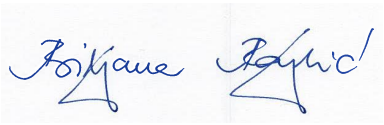
8 Checking and Review

8.1 Status of Design Check

As of the time of issue, the Phase 1, PS Pump Station 5, Mechanical, Electrical & Structural design has undergone internal quality control reviews, in accordance with the commitments in the Project Agreement, Schedule 15.2

8.2 Responsible Design Members

Originators:	Jahangir Chowdhury, P. Eng.
	John Del Degan, CET
	Nancy Guan, P. Eng
	Amin Mohammed, CET
	Michelle Walters, PE
Checkers:	Peter Rusch, P. Eng.
	Jeff Marsh, P. Eng.
	George Estephan, P. Eng.
Reviewer:	Lino Belgiorgio, P.Eng

Signed: 

Design Manager

Name: Biljana Rajlic

Engineering Qualifications: P.Eng.

Date: February 8, 2013

Professional Registration Number: 100041385

Affix Professional Seal

Signed: .....

Project Co Representative

Name: .....

Date: .....

Professional Registration Number: .....

Affix Professional Seal

APPENDIX 1 - Pump Stations – Emergency Electrical Power Supply Design Criteria

Document No. 285380-06-109-0001, R1

Document Type:	**PUMPING STATIONS DESIGN CRITERIA**
Submission Name:	Pumping Stations – Emergency Electrical Power Supply Design Criteria
Document Number:	285380-06-109-0001

HMM Design Consultant:		**HMM**
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05/02/2012	0	Issued for Use
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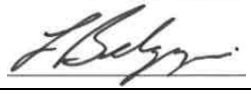
	Name, Title	Signature	Date
Prepared By	B.Wong, Proj. Engineer		12/06/02
Reviewed By	N. Guan, Elec. Engineer		12/06/02
Approved By	L. Belgiorgio, Mech. Lead		12/06/02

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Table 5. PumpStation 7 Emergency Generator Power Requirement List**.....6**

1 Emergency Electrical Power Supply-Overview

The purpose of this TAF is to summarize the emergency electrical power supply design criteria applicable to the Windsor Essex Parkway project, Pumping Stations PS 1, PS2, PS 5, PS 6 & PS 7.

The Project Agreement schedule 15-2, sub-section 7.3, Clause (xi), sentence 'E', requires provision of an emergency power supply for each pump station in the event of power failure.

2 Regulatory Standards

The Ontario Building Code stipulates that an emergency electrical power supply is to be in conformance with CSA standard C282-0, "Emergency Electrical Supply for Buildings", which covers the design and operation of standby power equipment and is applicable to Pumping Stations PS 1, PS 2, PS 5, PS 6 & PS 7.

3 Standby Power Generators

The standby power generators will provide standby power for the critical electrical loads at each pump station during a utility power outage period. A summary of the electrical loads for each pump station is listed in 4. Tables (Table 1, to Table 5).

Standby power diesel generator ratings are:

- For pump station 1, 900kW at rising temperature 125 degrees C, 600V, 3 phase, 60Hz, 0.8 PF.
- For pump station 5, 750kW at rising temperature 125 degree C, 600V, 3 phase, 60Hz, 0.8 PF.
- For pump stations 2, 6 and 7 each, 1500kW at rising temperature 80 degree C, 600V, 3 phase, 60Hz, 0.8 PF.

The generator will be able to be operated either automatically via the automatic transfer switch (ATS) or manually via the local generator control panel. The local generator control panel will be able to provide a hardwired interface capable of externally monitoring the generator status.

4 Tables

Table 1. Pump Station 1 Emergency Generator Power Requirement List

Equipment Description	Start Type	Unit Load (KW)	Rated Current (A)	Duty Qty	Standby Qty	Connected Load (KW)	Demanded Loads (KW)
Pump	Soft starter	287	350	2	2	1148	574
Sump pump	FVNR	15	17	1		15	15
Lighting, HVAC, Control						40	40
Total						1203	629
Generator Size							900

Table 2. Pump Station 2 Emergency Generator Power Requirement List

Equipment Description	Start Type	Unit Load (KW)	Rated Current (A)	Duty Qty	Standby Qty	Connected Load (KW)	Demanded Loads (KW)
Pump	Soft starter	242	350	4	4	1936	968
Sump pump	FVNR	15	17	2		30	30
Lighting, HVAC, Control						40	40
Total						2006	1038
Generator Size							1500

Table 3. Pump Station 5 Emergency Generator Power Requirement List

Equipment Description	Start Type	Unit Load (KW)	Rated Current (A)	Duty Qty	Standby Qty	Connected Load (KW)	Demanded Loads (KW)
Pump	Soft starter	160	279	2	2	640	320
Sump pump	FVNR	15	17	1		15	15
Lighting, HVAC, Control						40	40
Total						695	375
Generator Size							750

Table 4. Pump Station 6 Emergency Generator Power Requirement List

Equipment Description	Start Type	Unit Load (KW)	Rated Current (A)	Duty Qty	Standby Qty	Connected Load (KW)	Demanded Loads (KW)
Pump	Soft starter	447	615	2	2	1788	894
Sump pump	FVNR	15	17	1		15	15
Lighting, HVAC, Control						40	40
Total						1843	949
Generator Size							1500

Table 5. Pump Station 7 Emergency Generator Power Requirement List

Equipment Description	Start Type	Unit Load(KW)	Rated Current (A)	Duty Qty	Standby Qty	Connected Load (KW)	Demanded Loads(KW)
Pump	Soft starter	447	615	2	2	1788	894
Sump pump	FVNR	15	17	1		15	15
Lighting, HVAC, Control						40	40
Total						1843	949
Generator Size							1500

APPENDIX 2 - Structures Design Criteria for Pump Stations & Generator Buildings

Document No. 285380-03-109-0005, R1

Document Type:	**STRUCTURAL DESIGN CRITERIA**
Submission Name:	Structures Design Criteria for Pump Stations & Generator Bldgs
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HMM Design Consultant:		**HMM**
Date	**Revision**	**Description**
July 3, 2012	0	Issued For Use
October 12, 2012	1	Re-Issued For Use

Issued by: Michelle Walters/Jeff Marsh/Biljana Rajlic — Name

October 12, 2012 — Date

Signature

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1 Scope

The purpose of this document is to collate the requirements of the Project Agreement (PA) and various design references, and to provide guidance to the designer.

In general, the following set of criteria shall be followed for design. In specific cases where the criteria does not fully address the concerns of the design at hand, the designer shall use his or her best engineering judgement, subject to the requirements of the Project Agreement.

2 Structures Design Criteria

2.1 General		
2.1.1 Principle References	• For all new structures in accordance with Project Agreement, Schedule 15-2 Part 2, Article 3; • In descending order of precedence: o Project Agreement, Schedule 15-2, Part 2, Article 3; o Ontario Building Code (OBC), 2006, Division B—Part 4; o National Building Code of Canada (NBCC), 2010; o Design of Concrete Structures (CSA A23.3-04); o Code Requirements for Environmental Engineering Structures, ACI 350M-06; o Design of Masonry Structures (CSA S304.1-04); o Canadian Foundation Engineering Manual (CFEM); o Canadian Highway Bridge Design Code, CSA S6-06; o Structural Manual; o OPS.	Sched. 15-2 Part 2 3.3 Sched. 15-2 Part 2 3.1 Sched. 15-3, Appendix B, 4.6.b Sched. 15-1 Part 2 Sched. 15-2 Part 2 3.1
2.1.2 Service Life	• 75 years: all main structural components; • Importance Category: Post-Disaster.	3.3 (a) (ii) OBC 2006, Division B—Part 4, Table 4.1.2.1
2.1.3 Seismic Design	• $S_a(0.2)$= 0.18; • $S_a(0.5)$= 0.086; • $S_a(1.0)$= 0.040; • $S_a(2.0)$= 0.011; • PGA= 0.120; • I_E = 1.25.	OBC 2006, SB-1, Table 1.2 for Windsor, ON
2.2 Loads		

2.2.1 Load Factors and Combinations	• see OBC, Division B—Part 4, Table 4.1.3.2; • Include Durability Factor, ACI 350M 9.2.6.	
2.2.2 Dead Loads	• Self Weight, Concrete; • Soil Loads and coefficients, per Geotechnical Recommendations 285380-04-119-0031.	
2.2.3 Live Load		
2.2.3.1 Live Load	• Live = 3.6kPa as specified in OBC 2006, Division B—Part 4, Table 4.1.5.3 for Pump Rooms;	
2.2.3.2 Truck Loading	• ULS, SLS: CL 625-ONT as specified in S6-06 Annex A3.4;	3.3 (a) (i) B MTO Tech Memo
2.2.3.3 Construction Loading	• Construction loading of 2.4 kPa of surface area; • Consult with Contractor if any heavy construction equipment beyond 2.4 kPa is to be used and include the actual load in the design.	Structural Manual SS109-40
2.2.3.4 Snow Load	• S_s = 0.8; • S_r = 0.4; • I_E = 1.25.	OBC 2006, SB-1, Table 1.2 for Windsor, ON
2.2.3.5 Hydrostatic Load	• Water table elevation at subdrains located 0.5m (active subdrain) and 0.7m (passive) above the High Water Level (HWL) in the Pump Stations. • Where no subdrains are provided, water table elevation as reported by AMEC report.	
2.2.3.6 Soil Load	• Soils unit weight and K value as reported by AMEC report.	
2.2.3.7 Application	• In-Service Condition I (Empty): Soils load + Hydrostatic load at passive subdrain elevation + Truck load • In-Service Condition II (Empty): Soils load	

	+ Hydrostatic load at passive subdrain elevation + Live Load • In-Service Condition III (With ACI350 Durability Load Factor, No OBC Code Safety Factors & Empty): Soils load + Hydrostatic load at water table elevation as reported by AMEC. • Construction Condition I (Empty): Soils load + Construction LL using dewatering	

2.2.3.8 Wind Load	• Hourly mean wind pressure o 1/10 = 0.36 kPa o 1/50 = 0.47 kPa	OBC 2006, SB-1, Table 1.2 for Windsor, ON
2.2.3.9 Stability Checks	• Uplift: o Safety Factor >=1.5 minimum for Seepage, Uplift heave o Uplift considered for water table as reported by AMEC.	CFEM Table 8.3
2.2.3.10 Deflection Checks	• Minimum member thickness per CSA A23.3-04, Clause 9.8.2.1, Table 9.2 • Maximum deflections per CSA A23.3-04, Clause 9.8.5.3, Table 9.3	
2.3 Materials		
2.3.1 Concrete Strength	• Minimum 28-day compressive strength: Pump Stations & Generator Bldgs: f'c (MPa) = 35 • Maximum aggregate size: 28mm • Normal Density Concrete, ρ=2400kg/m^3	ACI 350, Table 4.2.2, Concrete exposed to de-icing chemicals S-1 Concrete Mixture, CSA A23.1 Table 3 for very sever sulphate attack.
2.3.2 Reinforcing Steel Materials	• CAN/CSA-G30.180M92 Grade 400W, U.N.O. • Yield Strength, f_y=400MPa	MTO Memo dated Nov 22, 2010
2.3.3 Bolts	• Bolts: ASTM A325M	Structural Manual 8.1.1 (g) Structural Manual 8.8.2 (a) 4 and S6-06 10.4.7

2.4 Durability		
2.4.1 Structural Steel	• All structural steel, including contact surfaces of bolted joints, diaphragms and bracing but excluding surfaces in contact with concrete, shall be coated with an Approved coating system.	Structural Manual (MTO) 8.1.2
2.4.2 Concrete	• Per ACI 350-06, Chapter 4, Durability Requirements.	
2.4.3 Concrete Cover	Pump Stations • Per ACI 350-06, 7.7—Concrete protection of reinforcement	
2.4.4 Crack Control	• Per ACI 350-06, 10.6.4.2 for Severe Environmental Exposure	ACI 350-06, 10.6.4.5, for salt water, de-icing chemicals pH greater than 5.

APPENDIX 3 - 90% MTO Submission, List of Drawings

Parkway Infrastructure Engineers | Hatch Mott MacDonald

1-Feb-13

WINDSOR ESSEX PARKWAY

Pumping Station 5 & Diesel Generator Building 5

Phase 1

Project No. 285380

90% MTO Submission - Drawing List

Drawing No.	Revision	Drawing Name	Sheet No.	Date:
285380-03-060-SEG1-5000	A	New Construction Pump Station 5 - Cover Sheet, Site Plan and Key Plan		1-Feb-2013
285380-06-420-SEG1-5001	A	New Construction Pump Station 5 and Diesel Generator Building 5 - Site Plan	P5001	1-Feb-2013
285380-06-431-SEG1-5002	A	New Construction Pump Station 5 - Forcemain - Plan and Profile View - STA 0+000 to STA 0+033.5	P5002	1-Feb-2013
285380-06-432-SEG1-5003	A	New Construction Pump Station 5 - Forcemain - Typical Details - Mechanical	P5003	1-Feb-2013
285380-05-400-SEG1-5004	A	New Construction Diesel Generator Building 5 - Floor Plan - Architectural	B5004	1-Feb-2013
285380-05-401-SEG1-5005	A	New Construction Diesel Generator Building 5 - Roof Plans - Architechtural	B5005	1-Feb-2013
285380-05-402-SEG1-5006	A	New Construction Diesel Generator Building 5 - Building Sections - Architectural	B5006	1-Feb-2013
285380-05-403-SEG1-5007	A	New Construction Diesel Generator Building 5 - Building Elevations - Architectural	B5007	1-Feb-2013
285380-05-404-SEG1-5008	A	New Construction Diesel Generator Building 5 - Wall Sections - Architectural	B5008	1-Feb-2013
285380-05-405-SEG1-5009	A	New Construction Diesel Generator Building 5 - Building Details - Architectural	B5009	1-Feb-2013
285380-05-406-SEG1-5010	A	New Construction Diesel Generator Building 5 - Schedules - Architectural	B5010	1-Feb-2013
285380-03-075-SEG1-5011	A	New Construction Pumping Stations and Diesel Generator Buildings- Notes and Schedules - Sheet 1 - Structural	S5011	1-Feb-2013
285380-03-075-SEG1-5012	A	New Construction Pumping Stations and Diesel Generator Buildings - Notes and Schedules - Sheet 2 - Structural	S5012	1-Feb-2013
285380-03-068-SEG1-5013	A	New Construction Pump Station 5 - Foundation and Mid-Level Plans - Structural	S5013	1-Feb-2013
285380-03-070-SEG1-5014	A	New Construction Pump Station 5 - Roof Plan and Section - Structural	S5014	1-Feb-2013
285380-03-069-SEG1-5015	A	New Construction Pump Station 5 - Sections - Structural	S5015	1-Feb-2013
285380-03-073-SEG1-5016	A	New Construction Diesel Generator Building 5 - Foundation Plan - Structural	S5016	1-Feb-2013
285380-03-073-SEG1-5017	A	New Construction Diesel Generator Building 5 - Cross Section - Structural	S5017	1-Feb-2013
285380-03-076-SEG1-5018	A	New Construction Pumping Stations and Diesel Generator Buildings - Typical Details - Sheet 1 - Structural	S5018	1-Feb-2013
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