Design Report

WEFTEC 2009 Student Design Competition

Rosebank Sanitary Sewage Pumping Station and Forcemain Project

PROAQUA CONSULTING LTD.
UNIVERSITY OF TORONTO DESIGN TEAM
Toronto, Ontario, Canada

Team Members: Lyutfiye Gafarova
Rafiq Qutub
Sherif Kinawy
Tony Tsui

September 2009

Respected Members of the WEFTEC 2009 Student Design Competition Sub-Committee:

Thank you for considering the University of Toronto Design Team for the design of the Rosebank Sanitary Sewage Pumping Station and Forcemain. Enclosed is our final design report and associated appendices. We would like to express our utmost gratitude to the following individuals for their assistance throughout the duration of this project:

Edgardo Tovilla, M.Sc., P.Eng.
Student Design Competition Subcommittee Chair
Water Environment Association of Ontario

Hugh Tracy, P.Eng.
Delcan Consulting
Industrial Advisor

Dr. Barry Adams, P.Eng.
Professor of Civil Engineering, University of Toronto
Academic Advisor

Sam Al Saaty, Technical Sales Representative
ITT Water & Wastewater

Fabian Papa, M.A.Sc., MBA, P.Eng.
Adjunct Professor, University of Toronto

Marek Krynski, P.Eng.
Environmental Services Design,
Regional Municipality of Durham, Ontario

Chuck Hudsonroder
District Supervisor, Regional Municipality of Durham, Ontario

Kevin Waher, M.A.Sc. and **Stephen O'Brien, P.Eng.**
Wardrop Engineering

Please contact us if you require any further information on the project.

Sincerely,

Tony Tsui tony.tsui@utoronto.ca
Lyutfiye Gafarova luccia.gafarova@utoronto.ca
Sherif Kinawy sherif.kinawy@utoronto.ca
Rafiq Qutub rafiq.qutub@utoronto.ca

PROaqua Consulting Ltd., University of Toronto Student Design Team

Attribution Table

Section	Lyutfiye	Rafiq	Sherif	Tony
Abstract		✓		
Report Section				
1				✓
2		✓	✓	✓
3			✓	
4	✓			✓
5	✓			
6	✓	✓	✓	✓
7		✓		
8		✓		
9		✓		
Appendix				
A	✓			✓
B		✓		✓
C	✓		✓	
D			✓	✓
E	✓			
F	✓			
G	✓			
H	✓	✓		
I	✓			

Abstract

The Rosebank Sanitary Sewage Pumping Station (SSPS) is located in the City of Pickering east of Toronto on the northern shores of Lake Ontario. The current capacity of the Rosebank SSPS will not meet the projected flow demands for the year 2031. An Environmental Assessment report completed in 2008 recommended the construction of a new pumping station.

A site located west of the existing station on Rodd Avenue has been selected for the new SSPS. Part of the existing forcemain will be utilized to minimize impacts on the surrounding environment. A new 350 mm (14”) HDPE pipe will tie into the old forcemain and cross Petticoat Creek to discharge sewage into a new manhole east of the Creek.

The SSPS is designed with 2 duty and 1 standby submersible pumps. A control room will house an emergency diesel generator for backup power. The building exterior is designed to blend architecturally with the neighbourhood and the surrounding areas will be landscaped to improve the aesthetic appeal of the SSPS.

The estimated capital cost is $4.3 million. Upon approval of regulatory agencies, tendering and construction of the SSPS is expected to last for 18 months and will be commissioned by May 2012.

Table of Contents

LIST OF TABLES

LIST OF FIGURES

APPENDICES

1 Introduction

The Regional Municipality of Durham is located east of the City of Toronto in the Province of Ontario (**Figure 1**). The Region has identified the need to upgrade the existing Rosebank Sanitary Sewage Pumping Station (SSPS) located at 563 Rodd Avenue in the City of Pickering as well as the supporting sewage infrastructure to meet the need for increased capacity. This upgrade will help the Rosebank neighbourhood to expand in the City of Pickering by providing additional sanitary sewage pumping capacity to accommodate increased sewage flows. In addition, the upgrade will allow compliance with current engineering standards.

A Municipal Class Environmental Assessment (EA) for this upgrade was completed by R.V. Anderson Associates Limited (RVA) in February 2008. The purpose of the EA was to determine the environmental and social implications of upgrading the Rosebank SSPS and supporting forcemain. Based on the recommendations of the EA, this design report includes specifications for a new SSPS and forcemain upgrade.

The objectives of this design report are to:

1. Provide a preliminary design of the pumping station and forcemain in sufficient detail to allow for an accurate cost estimate;
2. Provide a basis for the following design stages and minimize major revisions; and
3. Identify major process equipment and components of this project.

1.1 Design Criteria

The following design criteria were obtained from the EA report based on flow projections for the year 2031 (**Appendix A**). The projections are in line with the approved City of Pickering and Regional Municipality of Durham Official Plans.

- Future drainage area: 121.3 ha
- Population: 4,760 people
- Estimated Peak flow: 138 L/s

Site elevations and other relevant data for design were provided by the Region of Durham. The design criteria and calculation approach is explained in detail in **Appendix B**.

1.2 Design Challenges

Certain aspects of the design, such as incorporating the existing forcemain, are dictated by existing conditions. The last major upgrade to the Rosebank SSPS was performed in 1998 which increased firm capacity to 87.4 L/s. The latest upgrade also included the partial twinning of a 250 mm (10”) diameter forcemain from the Rosebank SSPS to the west side of Petticoat Creek with a section of 250 mm (10”) PVC pipe. The existing SSPS is cumbersome to operate with limited capacity and outdated instrumentation and control. In addition, the existing forcemain does not have sufficient capacity to accommodate future flows at acceptable velocities. The EA recommended building a new SSPS on Rodd Avenue and installing a new 350 mm (14”) diameter extension of the forcemain that crosses Petticoat Creek.

The existing and proposed location of the SSPS is in close proximity to residential properties (**Figure 2**). Therefore, noise and odour control is necessary. Furthermore, setbacks from property lines are limited, which adds further constraints on building area and height. The design and construction of the SSPS building should therefore be designed with a small surface area and with minimal impact on the surrounding environment.

Figure 1: Location of the City of Pickering on the Northern Shores of Lake Ontario

Figure 2: Proposed Location of Proposed Rosebank SSPS (Generated by Google Earth)

2 Sewer System Solution Design

2.1 Pumping Station

The proposed site for the new Rosebank SSPS is a former residential lot on the north side of Rodd Avenue in the City of Pickering. The site is located approximately 100 meters west of the existing station and adjacent to the western limit of the seniors' retirement residence property.

The selected location provides adequate space for construction as well as future upgrades and expansion. The site of the new SSPS is located away from existing residential properties, thereby minimizing disruptions of vehicular and pedestrian movement during the construction period.

2.1.1 Ground Floor

The control and electrical room will be located at the ground floor level. This room will house a control panel, diesel generator area and washroom. The generator area will contain the diesel fuel storage tank and containment area. Entrance to the valve chamber will be available through an access hatch in the floor of the control room.

Access to the pumps in the wet well will be provided at the ground floor level through access hatches outside the building. An access hatch will be located over each pump for convenient removal using guide rails. Plan and section drawings of the SSPS are illustrated in **Appendix C**.

2.1.2 Wet Well

The wet well will be located below grade level and is sized to provide adequate storage of sanitary sewage between pump starts. The surface area of the wet well measures 35 m^2 with a length of 7.0 m and a width of 5.0 m. This area is adequate to accommodate three (3) submersible pumps (two (2) duty and one (1) standby).

According to the Ontario Ministry of the Environment (MOE) and pump manufacturers' criteria, the minimum cycle time for pumps is 10 minutes, or 6 starts per hour. This is the start time used to size the wet well. The depth of sewage in the wet well is 1.50 m, while the finished floor of the wet well is 6.10 m below the final grade of the pumping station (as shown in drawings in **Appendix C**). Calculations of the wet well volume and operating depths are presented in the design calculations section (**Appendix B)**.

The new Rosebank SSPS is designed to minimize the need for operator entry to confined spaces. Therefore, guide rails are provided inside the wet well to allow convenient removal of pumps should they require servicing. However, should there be a need to access the wet well, aluminum ladders located outside the station will provide access to the wet well from the ground level. Wet well access will be from the outside only such that the wet well will be completely isolated from the rest of the SSPS building.

In the unlikely event of a total station failure, an overflow pipe will direct excess sewage to a nearby creek to prevent flooding of the pumping station control room and surrounding residential dwellings. The overflow pipe inlet will be equipped with a check valve and insect screen and located below the critical basement elevation of surrounding properties. However, back-up and alarm systems are integrated into the SSPS design to minimize the chance of total failure.

2.1.3 Pumps

The Rosebank SSPS will house three (3) submersible wastewater pumps (two (2) duty and one (1) standby). Submersible pumps were selected because they require small installation footprint, no cooling requirement and reduced overall construction costs.

The two duty pumps have been sized to meet a peak flow of 138 L/s at a total dynamic head (TDH) of 32 m. An additional identical pump is available as standby in the event that one (1) pump fails or is taken out of service. During normal operating conditions, it is expected that only one (1) duty pump will be required. During peak flow conditions, two (2) pumps will run in parallel to meet peak flow.

Pump sizing calculations, technical specifications and pump performance curves are presented in **Appendix B**.

2.1.4 Station Piping

The station piping and forcemain header will use standard weight ANSI B36.10 steel pipe 250 mm (10”) in diameter. Gate valves will be provided to control the flow of sewage from the pumps and check valves will be used to prevent backflow in each pipe header. Air release valves will also be installed to remove entrapped air and a surge relief valve will provide adequate buffering against pressure surges by draining sewage back into the wet well if gauge pressure exceeds a threshold of 100 psi.

2.1.5 Inlet Screening

A manual bar screen will be installed at the inlet sewer entering the wet well. A portable trash receptacle at grade will be used remove accumulated solids. The equipment will be fabricated from stainless steel and the bar spacing will be approximately 75 mm dictated by the passage size of the duty pumps.

2.1.6 Electrical Supply

2.1.6.1 Main Power Supply

A 3-phase main power supply will be used. The main switchboard will direct the power to operate the pumps, pump controls and other electrical equipment. The electrical service will be configured in 600V grounded Wye. The motor control centre (MCC) will provide electric overload protection in the SSPS through the main circuit breaker.

2.1.6.2 Standby Power Supply

If the main power supply fails, emergency power will be provided by a standby diesel generator. The fuel tank is sized to store enough diesel fuel for operation at full load for at least 24 hours. An automatic transfer switch will constantly monitor the status of normal utility supply. In the event of a power failure, the diesel engine will start automatically and interlocks will cut off heating while ventilation and other vital functions will remain in operation (as recommended by Jones et al., 2006). An engine silencer will be installed to minimize noise levels while the generator is in operation.

2.1.6.3 Transformers

The main indoors step-down transformers will be 4160/600V, wye-delta solidly grounded, dry-type, 750/1000 kVA. The secondary transformers will be equipped with air circuit breakers. These transformers will be connected to the 600V switchboard.

2.1.6.4 Electrical load

Large loads such as motor and heating loads will be supplied with 3-phase power from the MCC. A 208Y/120V system will be used to supply the remaining loads. The 600V power will be switched through a main circuit breaker to an automatic transfer switch. The electric load will be automatically switched between the main supply and generator.

2.1.6.5 Lighting and Low Voltage Distribution

A 208Y/120V 3-phase, panel board will supply low voltage power. This panel board will be located in the electrical and control room. A secondary dry-type transformer will transform 600V power from the MCC to 208Y/120V which will be supplied to all lighting equipment by the panel board (Jones et al., 2006).

2.1.7 Architecture

Since the building is located in a residential area, the building exterior is designed to resemble other units in the neighbourhood. This design feature will not interfere with the security of the building. SSPS will be a steel frame and concrete block building with clay face brick to match the architectural design of the surrounding buildings. Steel roof shingles, resembling brown asphalt shingles are also proposed. In addition, back-painted Lexan windows will be used to enhance the appearance of the pumping station while maintaining security. Most windows will be located above ground level (near the roof). Entrance and exit doors on the exterior of the building will have appearance of traditional house doors.

2.2 Forcemain

The SSPS will lift incoming wastewater into the existing 250 mm (10”) diameter forcemain leaving the SSPS property parallel to the Petticoat Creek Pedestrian Bridge. The forcemain consists of twin barrel pipes: the old Asbestos-Cement, constructed in 1961, and the newer PVC pipe, constructed in 1998, with a total length of 1,030 m. The PVC pipe joins the Asbestos-Cement on the west side of Petticoat Creek. They are extended through a new High Density Polyethylene (HDPE) pipe, 285 m long and 350 mm (14") in diameter, which crosses Petticoat Creek. A schematic drawing of the proposed forcemain alignment is provided in **Figure 3**.

There are associated impacts with forcemain construction activities on the environment. First, there is a potential for minor disruption of the Waterfront Trail and valley area. There are also potential impacts on fish habitats as well as local vegetation. Therefore, in order to minimize these impacts around Petticoat Creek, the HDPE section will be installed using Horizontal Directional Drilling (HDD) technology. HDD technology avoids digging deep trenches and disturbing surrounding habitats.

2.3 Hydraulic Transients

The critical conditions governing the operation of the SSPS and forcemain are not steady state but transient pressure conditions that may follow a power failure to the pump motor. Power failure can be caused by a power outage or a voltage dip in electrical supply by a pump motor overload or by an emergency stop.

To take into account transient pressures, a surge relief valve is provided as shown on the Piping and Instrumentation Diagram (**Appendix D**). A 6" pressure relief valve is recommended to provide surge relief for the 250 mm (10") pipe header with a design flow rate of 138 L/s. In addition, a 2" air release valve is installed on each pipe header to remove entrapped air.

Figure 3: Proposed Forcemain Alignment

3 Instrumentation and Control

For unattended operation, a proper choice of instrumentation must be provided to allow automatic operation and remote monitoring of all equipment. Real-time monitoring and supervisory control of the SSPS will be carried out via a Supervisory Control and Data Acquisition (SCADA) system. A full SCADA system will provide communication, monitoring, control, recording, analysis and reporting functionalities. Control in a SCADA system can be automated through programming or alternatively set to alert an operator for action. A Remote Terminal Unit (RTU) will be installed at Rosebank SPS and will have the full capability of controlling the station as a stand-alone system and communicating with the Master Terminal Unit (MTU) at the central station.

3.1 Instrumentation and Equipment

Information received from various instruments will be stored in the RTU and communicated to the MTU. The controller provides 4-20 mA output signals to the RTU panel, which represent the wet well level and flow rate. Magnetic flow measurement will provide flow values in the 250 mm (10”) diameter forcemain header as a 4-20 mA output signal to the RTU panel. This flow meter will measure fluid velocity between a set of electrodes without restricting flow. The meter will be installed using a configuration that facilitates cleaning of the electrodes without having to remove the meter. Ultrasonic level indicators and backup float switches will be located in the wet well and will be used to control operation of the pumps. The RTU will automatically alternate duty operation between all three pumps to equalize wear and tear and achieve a balanced operation.

3.2 Instrument and Control Panel

The RTU control panel will be located in the electrical and control room. The parameters that will be monitored or controlled by the RTU are listed in Table 1. The following equipment will also be included with the RTU

- Uninterruptible Power Supply (UPS)
- Power supply for analog instruments
- Local Area Network (LAN)/Ethernet communication card and/or dialup modem
- Alarm annunciators
- Individual manual pump control
- Human Interface Unit

Table 1: Parameters Monitored and Controlled by the RTU

Digital Inputs
Pump P1: Auto Mode
Pump P1: Running
Pump P1: Fault
Pump P2: Auto Mode
Pump P2: Running
Pump P2: Fault
Pump P3: Auto Mode
Pump P3: Running
Pump P3: Fault
LAH: Wet Well High Level Alarm
LAL: Wet Well Low Level Alarm
Heat/Smoke Detector Alarm
Building Intrusion Alarm
UPS – Failure
Generator: Running
Generator: Default
Diesel Fuel: Low Level Alarm
Normal Power: Failure
Auto Transfer Switch: In Emergency Position
Auto Transfer Switch: Failure
Digital Outputs
Pump P1: Run Command
Pump P2: Run Command
Pump P3: Run Command
Analog Inputs
LIT: Wet Well Liquid Level
FIT: Forcemain Header Flow Rate
PIT: Pressure in Forcemain Header

3.3 Pump Control Standards

The pumps can be controlled manually by an operator or automatically by the RTU. Manual control is possible through a HAND (manual)/OFF/AUTO selector-switch for each pump. In OFF mode, the control functions are disabled and the pump will not operate unless forced to start by the high-level backup float. In HAND mode, the pump controller ignores automatic level controls and runs continuously until forced to stop by the low-level backup float. The motor would be stopped using an emergency push button.

In AUTO mode, the pump will operate according to the start and stop parameters as programmed into the SCADA system. The level in the wet well will be indicated by a 4-20 mA signal received from an ultrasonic level sensor. **Appendix B** displays the programmed elevations set for pump operation.

In addition to level indicators, high and low level backup floats will cause the pumps to start or stop if the ultrasonic level sensor fails. Lights indicating the status of each pump will be mounted on the control panel. In addition, level parameters can be monitored from the SCADA human interface through a graphical chart. The SCADA system will communicate with the Central Control Unit at the local Wastewater Treatment Plant.

3.4 Remote Terminal Unit

The RTU will handle data acquisition and control of devices. It will communicate with the MTU through the LAN line or the telephone modem. The RTU will be capable of independent operation in the event of a communication failure.

3.5 Communications

Inputs and outputs will be wired to the RTU in a plug-in arrangement. Two-way communication will be enabled between the MTU and RTU to enable remote control from the central station in addition to the reporting functions performed by the RTU.

3.6 Station Control

The MTU at the central station will provide a human interface as well as data logging, alarm processing, trending and security. In addition, the RTU will have control over each device separately. A remote alarm system will include the centralized standard system along with alarm inputs such as power failure, security, wet well levels and general alarms such as ventilation failure.

3.7 Safety

It is more difficult to shut down instrumentation and control systems since they are designed to operate continuously. In general, a low voltage of 24V DC is recommended for instrumentation and control systems. Plug-in connections should be used whenever possible for easy replacement of malfunctioning instruments. A special process (lock-out, tag-out) process must be implemented to safely disconnect equipment that utilizes higher voltages (Jones et al., 2006).

4 Building Services

This section discusses the design criteria for heating, ventilation, cooling, noise and odour control processes for the SSPS. Enhanced building services provide a safe working environment for operators. In addition, it provides community acceptance of the station and reduces maintenance and operation costs by minimizing deterioration of equipment and infrastructure.

4.1 Heating and Ventilation Services

Mechanical ventilation systems are designed to minimize roof and wall penetrations and ensure a safe working environment for operators. The wet well and the control room will have separate ventilation systems.

The west elevation incorporates the wet well ventilation system, which will be architecturally incorporated into the building. The east elevation is used as the diesel generator exhaust, whereas the north side of the building will incorporate a louvre exhaust equipped with a bird screen. This separation provides an ideal arrangement to prevent recirculation between exhaust and intake functions.

4.1.1 Wet Well Ventilation

To avoid septic conditions and generation of toxic gases in the wet well, a continuous ventilation system is designed at a minimum air change rate of 12 changes/hour (AC/hr), where air change is based on 100% fresh air. Ventilation will be provided through two 100 mm diameter aluminum vent pipes. The vent for fresh air intake will extend 900 mm above the top and will be equipped with a gooseneck and insect screen. The exhaust will terminate in an inverted “U” opening at least 600 mm above the finished ground level (Jones et al., 2006; MOE, 2008).

The intensity of the ventilation system is controlled automatically from a gas detection meter, which will be located 900 mm below the fresh air intake. A supply fan forces fresh air into the lower well and the exhaust fan removes diluted gases from the upper well area to provide dilution mix ventilation. Both fans operate in unison to provide a push/pull system to control the movement of potentially explosive gases entering the station from the connected sewer works. The fan wheels will be fabricated from non-sparking material in accordance with the Ontario Ministry of the Environment Regulations (MOE, 2008). As an option, it is proposed to utilize a thermostat-controlled heater fan to preheat fresh air pushed into the system. This will minimize freezing in the wet well during the winter months.

In accordance with NFPA 820 criteria and NFPA 70 classification of hazardous environment for electrical equipment, wet wells that are well–ventilated at all times could be reclassified as Class 1, Group D, Division 2 environmental spaces. However, it does not address the criteria regarding entry, exist and continuous occupancy. Therefore, prior to entering the wet well, operators and maintenance personnel must be trained and equipped with portable gas detectors and be supervised and observed by a competent person at the site as per the Confined Space Entry Guidelines set by the Region of Durham, Ontario Ministry of Labour and the Operational Health and Safety Act (OHSA, 2007). In addition, the gas detection unit will be calibrated on a regular basis to provide accurate readings.

4.1.2 Odour Control

Since the station is in a residential area, provision for odour control of the wet well ventilation exhaust was considered in design. Low hydrogen sulfide concentrations and low-to-moderate volatile organic compound (VOC) concentrations may be present at the SSPS. An activated carbon system is recommended to treat odours since it is relatively abundant and comparably inexpensive. The Activated Carbon filer will be part of the push-pull ventilation system exhaust.

4.1.3 Generator Area and Noise Control

The control room will house a diesel generator to provide backup power in the event of interruption of primary power supply. The generator will be equipped with a water-jacket heat exchanger to cool the generator engine. This system requires considerably less ventilation, thereby reducing the number of louvres in the exterior wall. As a result, risk of high sound levels outside of the building will be minimized. Fresh air will be provided to the room via a louvre and a damper combination (Silex Engine Silenser).

4.1.4 Control and Electrical Room

In order to provide optimum working conditions for electronic equipment and operators, the SSPS will have an HVAC system in the main control room. This system uses a room high wall fan coil with an exterior compressor and condenser and ceiling mounted single package cooling units. The ductless system is proposed for this room due to its low interior noise.

Room heating will be provided by a thermostat-controlled electric unit heater since hot water piping will not be connected in the electrical room. The ventilation system, rated at 50 m^3/hr, will draw fresh air from an exterior louvre/damper combination and discharge to the control room via a ceiling mounted fan.

4.2 Boiler

An electric water heater will be used in the SSPS to provide convenient hot water for operators during the winter months. Using electric heaters will avoid the installation of a natural gas supply line and this will reduce installation costs.

4.3 Potable Water

Water for sanitary facilities, diesel engine generator cooling, cleaning and flushing will be from a municipal potable water supply derived from the watermain on Rodd Avenue. Domestic hot water will be provided by an electric water heater.

4.4 Sanitary System

All plumbing and drainage will be according to the Ontario Plumbing Code. Sanitary wastewater from the SSPS (toilet, drains and wash sinks) will drain directly into the wet well. The drain into the wet well will be equipped with a check-valve to prevent sewage backup.

4.5 Telephone

Telephone with integral intercoms will be provided in the control room.

4.6 Physical Security

The SSPS building exterior will be designed to blend in with local buildings and architecture. Paved access to the site will be via the existing access roadway and a new driveway to the SSPS. The SSPS will be fenced off and parking will extend to the north side of the building to be hidden from Rodd Avenue. A 1.8 m high black chain link fence between brick piers will surround the site. A locked gate will be provided to permit vehicular access to the site. Also a video surveillance will be installed on the perimeter, which will be automatically activated in case of an intrusion.

5 Mitigation Measures

Potential impacts of construction activities on the environment (construction dust, odour, noise, sediment and any potential contaminated soil) must be mitigated throughout the implementation period. The construction Best Management Practices (BMP) must be followed to minimize the adverse affects on the surrounding environment. The following controls will be implemented to provide monitoring throughout the construction phase.

5.1 Traffic Control

To minimize the disruption of local pedestrian and vehicular traffic, traffic control signs and procedures must be in compliance with the Ontario Ministry of Transportation’s Manual of Uniform Traffic Devices, as well as the requirements of the Region of Durham and the City of Pickering. Since the trail route along the waterfront will be restricted, alternative detour routes for pedestrian traffic will be provided.

5.2 Silt Fencing

Silt fencing will be installed on the perimeter of the construction area in order to provide sediment and erosion control measures.

5.3 Grassed Swales

As part of the construction BMP measures, sediment traps and infiltration chambers must be installed to mitigate sediments and polluted water in addition to grassed swales for stormwater management.

5.4 Odour & Noise Control

Odour and noise will be controlled in accordance with construction BMP to minimize the disruption on local population and physical environment. Construction activities will be limited to normal working hours of Monday through Friday, 9 am to 5 pm. No construction activity will take place during weekends or statutory holiday in order to minimize impact on local residents.

5.5 Environmental Remediation

Construction of the new SPS provides an opportunity to enhance local habitat by planting native species on Rodd Ave and at Petticoat Creek. The new SSPS will be surrounded by native-species re-vegetation buffer planting zone. Native-species-trees will be planted to improve the aesthetic appeal of the new site. Landscaping within the SSPS area will include low maintenance ground cover, remedial soiling, seeding on 100 mm of topsoil and foundation planting around the building. Remediation plans are discussed in detail in **Appendix E**.

6 Approvals

The following approvals and permits are required before construction:

- MOE - Certificate of Approval (C of A) for sewage pumping station
- MOE - C of A for Air & Noise from diesel generator and exhaust stack
- City of Pickering (Site Plan Approval and Building Permit)
- City of Pickering (Electric Power (Hydro) Permit)
- Regional Municipality of Durham (as the Owner and eventual operator)
- Toronto and Region Conservation Authority (TRCA)
- Electrical Safety Authority inspection
- Technical Standards and Safety Authority (TSSA) for storage of oil and natural gas installation

7 Cost Estimate and Schedule

The total capital cost for the project is $4.3M with annual operating cost of approximately $ 51K. A detailed cost estimate is presented in **Appendix F**. Construction of the SSPS at the new location will last for one year followed by a warranty period of one year. The estimated design life for the sewage pumping station is 30 years. The City of Pickering and the Regional Municipality of Durham will assume full ownership of the SSPS Pumping Station in April 2013 once the Warranty Period expires. The implementation schedule is displayed in **Appendix G**.

8 Conclusion

The results of the Municipal Class Environmental Assessment (EA) completed by R.V. Anderson Associates Limited in 2008 recommended designing a new sanitary sewage pumping station for the Region of Durham since the existing Rosebank Pumping Station is inadequate to accommodate future growth in pumping demand.

PROaqua Consulting, the design team at the University of Toronto, performed the preliminary design of the pumping station including sizing of the pumps, instrumentation and control, emergency power supply, environmental rehabilitation and cost estimate. The area surrounding the new station site is designed to blend architecturally with the surrounding buildings, and local vegetation will be planted for aesthetic improvement. The new design will meet current engineering standards and local building codes, and more importantly, meet the sanitary sewage pumping needs for the Rosebank neighbourhood in the city of Pickering for the next two decades.

Sewage pumping capacity for the proposed station is based on the projected peak flow of 138 L/s for the year 2031, serving an estimated 4,670 people in the area. The existing forcemain totalling 1,030 m in length will be utilized. In addition, a new 350 mm (14”) HDPE pipe 285 m long will connect to the existing forcemain and discharge into a new manhole east of the Creek.

Upon approval of the design by the Region and obtaining the necessary approvals, construction will begin in the summer of 2011 and end in May 2012. The station will be commissioned and turned over to the Regional Municipality of Durham. The City of Pickering and the Regional Municipality of Durham will assume full ownership for the Sewage Pumping Station in April 2013, once the Warranty Period expires.

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Appendix A

Growth Potential and Flow Estimation

Appendix A: Growth Potential and Flow Estimation

Table A-1 Drainage Area, Population and Flow Projections
[Adapted from RV Anderson Environmental Assessment (RVA, 2007)]

Parameters	Unit	2000	2006	2011	2016	**Ultimate Future (2031)** Based on City of Pickering Official Plan	**Ultimate Future (2031)** Based on City of Durham Region Official Plan
Rosebank SPS Tributary Area	ha	121.3	121.3	121.3	121.3	121.3	121.3
Population Equivalent Within Rosebank SPS Service Area	PE	2490	2900	3200	3400	4760	4080
Average Per Capita Daily Flow	L/cap*d	364	364	364	364	364	364
Estimated Average Daily Flow	m3/day	906	1056	1165	1238	1733	1485
Harmon Peaking Factor (M=1+(14/(4+p^0.5)		3.51	3.45	3.42	3.4	3.26	3.33
Estimated Residential Peak Flow (normal)	m3/day	3181	3647	3982	4202	5657	4939
Extraneous Flows (Infiltration)							
Maximum Infiltration Rate	m3/ha/day	22.5	45	45	45	60 ha at 22.5	60 ha at 22.5
						61.3 ha at 45.0	61.3 ha at 45.0
Total Peak Extraneous Flow	m3/day	2729	5459	5459	5459	4109	4109
Pool Flow (Swimming pool drainage)	m3/day	2160	2160	2160	2160	2160	2160
	L/s	25	25	25	25	25	25
Estimated Peak Flow (including Peak Extraneous Flow)	m3/day	8070	11265	11600	11821	11925	11207
	L/s	93.4	130.4	134.3	136.8	138	129.7

1 - Based on 40% intensification of population of 3400 and infiltration rate of 22.50 m^3/ha/day, assuming sewer replacement and disconnecting of all foundation drains in half of the drainage area

2 - Based on 20% intensification of population of 3800 and infiltration rate of 22.50 m3/ha/day, assuming sewer replacement and disconnecting of all foundation drains in half of the drainage area

Table A-2: Rosebank Sewage Pumping Station Class EA: Forcemain Pipe Size Selection

Design Flow: 138 L/s					
10" (10.750 OD)	SDR17	100psi	8.78 lbs/ft	ID=9.486	V=3.03m/s
12" (12.750 OD)	SDR17	100psi	12.36 lbs/ft	ID=11.250	V=2.15m/s
14" (14.910 OD)	SDR17	100psi	14.91lbs/ft	ID=12.352	V=1.79m/s
Minimum velocity to prevent solids deposition	0.8 m/s				
Minimum velocity to re-suspend deposited solids	1.1 m/s				
Maximum velocity	2.5 m/s				

1000 Series 'Driscopipe' Polyethylene Pipe Standard Sizes and Dimensions (inch):

Appendix B

Process Design and Pump Selection

Appendix B: Process Design and Pump Selection

B.1 Wet Well Sizing

The wet well must be of enough size to provide adequate storage of sewage between pump starts. According to the Ontario Ministry of the Environment (MOE) and pump manufacturers' criteria, the minimum cycle time for pumps is 10 minutes (6 starts per hour). The equation used to determine the working volume is as follows:

$$V = \frac{TQ}{4}$$

Where,

$V =$ Working volume between pump starts, m^3

$T =$ Pump cycle time = 10 minutes = 600 s

$Q =$ Pump flow rate, m^3/s

Since there are two duty pumps in the pumping station, the peak flow is divided in half, which halves the required storage volume. Hence Q = 138 ÷ 2 = 69 L/s.

Therefore, the minimum required working volume is:

$$V = \frac{TQ}{4} = \frac{(600\,s)\times(69\,L/s)\times 1m^3/1000L}{4} = 10.35\,m^3$$

The wet well has a surface area of 35 m^2 (L = 7.0 m, w = 5.0 m). Therefore, the operating depth (*H*), or the height between each pump start and stop is equal to:

$$H = \frac{V}{A} = \frac{10.35\,m^3}{35\,m^2} = 0.296\,m$$

For safety, an operating depth of 0.40 m will be used. Therefore, each pump will start and stop within 0.40 m. There will also be a buffer distance of 0.30 m between the starting elevations of each duty pump as explained in the following section.

B.2 Operating Levels

The maximum sewage elevation in the wet well is set at the invert elevation of the incoming sewer (77.9 m). The maximum depth of water in the wet well is at 76.4 m, which is 1.50 below the inlet sewer. This depth will be adequate to accommodate the operation of both duty pumps. Operating levels are set as shown in Table B - 1.

Table B - 1 Operating Levels in the Wet Well

Elevation (m)	Operation
77.90	High Water Level (HWL) in wet well.
77.60	Back-up Float- All pumps start and emergency alarm is annunciated
77.45	Duty Pump 2 Starts – Back-up Float
77.30	Duty Pump 1 Starts – Back-up Float
77.15	Duty Pump 2 Starts – Ultrasonic Level Transmitter
76.85	Duty Pump 1 Starts – Ultrasonic Level Transmitter
76.75	Duty Pump 2 Stops – Ultrasonic Level Transmitter
76.45	Duty Pump 1 Stops – Ultrasonic Level Transmitter
76.40	Back-up Float - All pumps stop and emergency alarm is annunciated
76.40	Low Water Level (LWL) in wet well
75.90	Finished Floor of the wet well
75.40	Bottom of concrete slab

B.3 Head Loss Calculations and Pump Design

In wastewater applications, centrifugal pumps are commonly used due to their design that minimizes clogging and ability to handle solid particles in sewage. The SSPS will feature three submersible centrifugal pumps (two duty and one standby). The two duty pumps are sized to handle peak flow while one duty pump is meant to handle flows during initial and normal operation conditions.

The advantage of using two pumps in parallel instead of one is to provide operational flexibility since the peak flowrate is rarely, if ever, encountered. Usually too much emphasis is given to meeting peak flow demands when normal operating flows are significantly less. The use of two pumps in parallel allows for one pump to operate during normal conditions and both pumps to run simultaneously during peak flow conditions. A third pump is supplied as standby in the event of failure or servicing of one of the duty pumps.

Design Parameters

The design flowrate is set at **138 L/s** based on peak flow projections for the year 2031 as explained in Appendix A.

In addition to flow rate, the total dynamic head (TDH) is required to size an appropriate pump. The TDH consists of static elevation and friction head losses. Static elevation is equal to the vertical distance between the wet well and the discharge point. Friction losses consist of velocity head and losses due to pipes, valves and fittings.

Head losses in pipes occur due to friction with internal wall surfaces. New pipes are considered smooth with low friction values. Older pipes, particularly steel or cast iron, become rough over time due to corrosion and result in larger friction. A common method for calculating head losses in pipe is using Hazen-Williams friction coefficients (*C* values).

Static Elevation

The following elevations were provided from the Region of Durham:

- Ground Elevation at the proposed site is 82.00 m.
- Highest point of the forcemain is 88.50 m.
- Elevation at the discharge manhole is 87.90 m.
- Invert elevation of the inlet sewer to wet well is 77.90 m.

In order to be conservative in hydraulic calculations, the elevation of the discharge point is assumed to be the highest point of the forcemain (88.50 m). Therefore, the vertical lift between the discharge point and inlet sewer to the wet well is 88.50 – 77.90 = 10.6 m. The inlet sewer is 1.5 m above the low water level (LWL). The LWL is the minimum wet well elevation level where the pump shuts off. Hence, the maximum static lift is **12.1 m**. It represents the difference between the discharge point of forcemain and the LWL in the wet well.

For design purposes, the maximum static lift will be utilized. In summary, the following are the design parameters:

Design Flow	**138 L/s**
Static Lift	**12.1 m**

Head Losses in Pipe

Piping is divided into three main sections:

1. Internal piping inside the station, designed to 10” (250 mm) nominal ANSI B36.10 Standard Steel pipe. Total length approximately 5.0 m.
2. Existing Forcemain:
    a. First section of the existing forcemain, 1,030 m long Asbestos-Cement (A-C) pipe, originally built in 1961 with a 10” internal diameter (250 mm). The current condition of the pipe is unknown (RVA et al., 2008).
    b. Second section of the existing forcemain, approximately 1,030 m long PVC pipe, 10" in diameter (250 mm). Originally installed during the last station upgrade in 1998 (RVA et al., 2008). This pipe runs parallel to the A-C pipe and flow is assumed to split equally between them. It is assumed to be identical in size to the A-C pipe.
3. New section of forcemain, 285 m High Density Polyethylene (HDPE) pipe 14" nominal (350 mm) in diameter which starts on the west side of Petticoat Creek by joining the A-C and PVC pipes together. The HDPE pipe crosses the Creek to the final discharge manhole on the east side of the Petticoat Creek (RVA et al., 2008). It is proposed to install the HDPE pipe using Horizontal Directional Drilling (HDD) technology to minimize impact on the sensitive environment in Petticoat Creek Conservation Area.

Each pipe section has its unique properties that affect system head loss calculations. The conditions of each pipe section are as follows:

Station Piping:

Standard Weight ANSI B36.10 Steel piping was selected for internal piping inside the station due to its high strength, ease of installation, shock resistance and ability to deflect without breaking (Jones et al., 2006). During initial flow conditions steel piping is smooth with a relatively high Hazen-William factor of C=145 (Jones et al., 2006). However, at peak flow conditions, which is the basis for pump selection, a conservative estimate of C=100 was used for head loss calculation. This value is consistent with the 2008 Ontario Ministry of the Environment Design Guidelines for Sewage Works (MOE, 2008).

Original A-C and PVC Parallel Forcemains

The Ontario Sewage Works Guidelines require fluid velocity in forcemain pipes to be between 0.6 m/s and 3.0 m/s to avoid solid deposition and prevent excessive head losses, respectively (MOE, 2008). Since peak flow is estimated at 138 L/s, fluid velocity in a 10” nominal pipe reaches 3.0 m/s, which exceeds the acceptable limit. Therefore, both existing A-C and PVC pipes will be utilized and flow will be split equally between them. Flow splitting reduces fluid velocity to 1.5 m/s during peak flow conditions, which is within the acceptable fluid velocity range. The A-C and PVC pipes run in parallel for 1,030 m from the pumping station and meet on the west side of Petticoat Creek where they join and connect to a new 12” HDPE pipe.

Both the A-C and PVC pipes are assumed to have identical lengths, internal diameters and friction coefficients. Because the PVC pipe is newer and smoother than the A-C pipe, friction in the PVC pipe is expected to be less than the A-C pipe. However, for simplicity it was decided to use a conservative estimate of C=100 for both pipes. This yields identical friction losses for both pipe sections and equal flow between the pipes. The assigned Hazen-William C-factor is also consistent with the Ontario Sewage Works Design Guidelines (MOE, 2008).

New HDPE Forcemain

The new 285 m HDPE pipe section of forcemain is considered smooth with a high C-value. A number of suppliers indicate that HDPE pipes and fittings have smooth internal surfaces with C=150 that remains relatively constant over time (Global Poly Systems Inc., 2007; KWH Pipe Canada, 2006; Royal Pipe Systems, 2004; IPEX, 2003). However, for design purposes the design team assigned C=120 as outlined in the Ontario sewage works design guidelines (MOE, 2008). This assumption has also been verified by our academic advisor (B. Adams, personal communication, January 19, 2009).

The preliminary design in the Environmental Assessment report recommended a 12” HDPE pipe. However, it is recommended to use a 14” pipe (350 mm) instead to minimize head losses. In our opinion the savings in pumping power over the lifetime of the system will significantly outweigh the initial capital cost of installing a pipe with a larger diameter.

Head loss for each pipe section was calculated in meters per meter of length according to the following modified Hazen-Williams formula expressed in SI units (Jones et al., 2006):

$$h_f = \left(\frac{151Q}{CD^{2.63}}\right)^{1.85} \div 1000 \qquad (1)$$

Where, h_f = Friction head loss in pipe per meter of piping, [m]
Q = Volumetric flow rate, [m^3/s]
C = Hazen-Williams "C" factor, [dimensionless]
D = Internal pipe diameter, [m]

Table B - 2 summarizes friction head loss values for each pipe section and total head loss for peak flow.

Table B - 2 Head Loss in Different Pipe Sections during Peak Flow Conditions

Pipe Section	Pipe Length (m)	C-factor	Friction Head loss, h_f (m/m pipe)	Section Head Loss (m)
Pipe inside SPS: Steel	5	100	0.043	0.22
Forcemain Pipe 1A: PVC Forcemain Pipe 1B: A-C	1,030	100	0.015	15.96
Forcemain Pipe 2: HDPE	285	120	0.006	1.71
			Total Head Loss (m)	**17.9**

Head Losses due to Valves and Fittings

Similar to pipes, valves and fittings result in friction head losses. The general equation used to calculate head loss is (Jones et al, 2006):

$$h_m = K\frac{v^2}{2g} \qquad (2)$$

Where, h_m = Friction head loss due to pipe or fitting, [m]
K = Constant factor that depends on shape of fitting, [dimensionless]
v = Fluid velocity, [m/s]
g = Gravitational acceleration constant, [9.81 m/s^2]

Although there are references that provide estimates for K-values, it is recommended to obtain them from manufacturers of fittings and valves whenever possible (Jones et al., 2006). In order to calculate head losses, an inventory of valves and fittings was prepared and the head loss for each item was multiplied by the number of items installed.

Table B - 3 summarizes friction losses for valves and fittings inside the pumping station in meters during peak flow conditions. K-values for fittings were obtained from manufacturers or reference textbooks. Air release valves are not included in calculations since their head loss is negligible (B. Adams, 2009, personal communication).

Table B - 3 Friction Head Loss Calculations for Valves and Fittings at Design Conditions

Item	K-Value	Unit Head Loss (m)	Qty	Total Head Loss (m)	Reference for K-Values
Velocity head	1.00	0.378	1	0.378	Jones et al., 2006
45° Wye Branch	0.50	0.189	2	0.378	Jones et al., 2006
45° Elbow	0.21	0.079	2	0.157	Karassik et al., 2001
90° Elbow	0.39	0.147	1	0.147	Karassik et al., 2001
Check Valve	2.00	0.756	1	0.756	Karassik et al., 2001
Gate Valve	0.08	0.030	1	0.030	M&H Valve, 2005
Knife Gate Valve	0.13	0.049	2	0.098	SPX Equipment, 2007
Increaser 10" to 14"	0.29	0.111	1	0.111	Jones et al., 2006
		Total friction head loss (m)		**2.06**	

Calculations Summary

Head losses due to pipes, valves and fittings, along with static lift are added to calculate the TDH. The following table summarizes head losses at the design point.

Table B - 4 Summary of Total Dynamic Head Calculations

	Head Loss (m)
Head loss, SPS piping	0.22
Head loss, PVC Pipe 1A Head loss, A-C Pipe 1B	15.96
Head loss, HDPE Pipe 2	1.71
Fittings and Valves	2.06
Static Head (at LWL)	12.10
Total Dynamic Head (m)	**32.0**

System Head-Flow Curve

Figure B - 1 displays the system (H-Q) curve developed using the calculations spreadsheet. Using above calculations and system curve, a suitable submersible pump was selected by matching the performance curve of two pumps in parallel against the system H-Q curve.

Head loss calculations were performed again using higher C-coefficients to represent the conditions likely to be encountered during initial operating conditions along with the minimum static lift (calculated at the HWL). This is represented by the discontinuous line. The additional curve is necessary to ensure that the pump will not approach run-out conditions and that there is enough pumping capacity to accommodate extreme hydraulic conditions.

It was noticed during the team's visit to several pumping stations in Durham region that *ITT Flygt* was the preferred brand of centrifugal pumps. The design team decided against recommending pump models that are unfamiliar to the operators and preferred to recommend *ITT Flygt* pumps since operators are familiar with their operation and maintenance.

A suitable pump for the Rosebank SSPS is ITT Flygt Model **NP3202.185 HT**. Appendix B.4 displays the pump performance curve and dimensional drawings for the submersible pumps. Table B - 5 summarizes pump specifications.

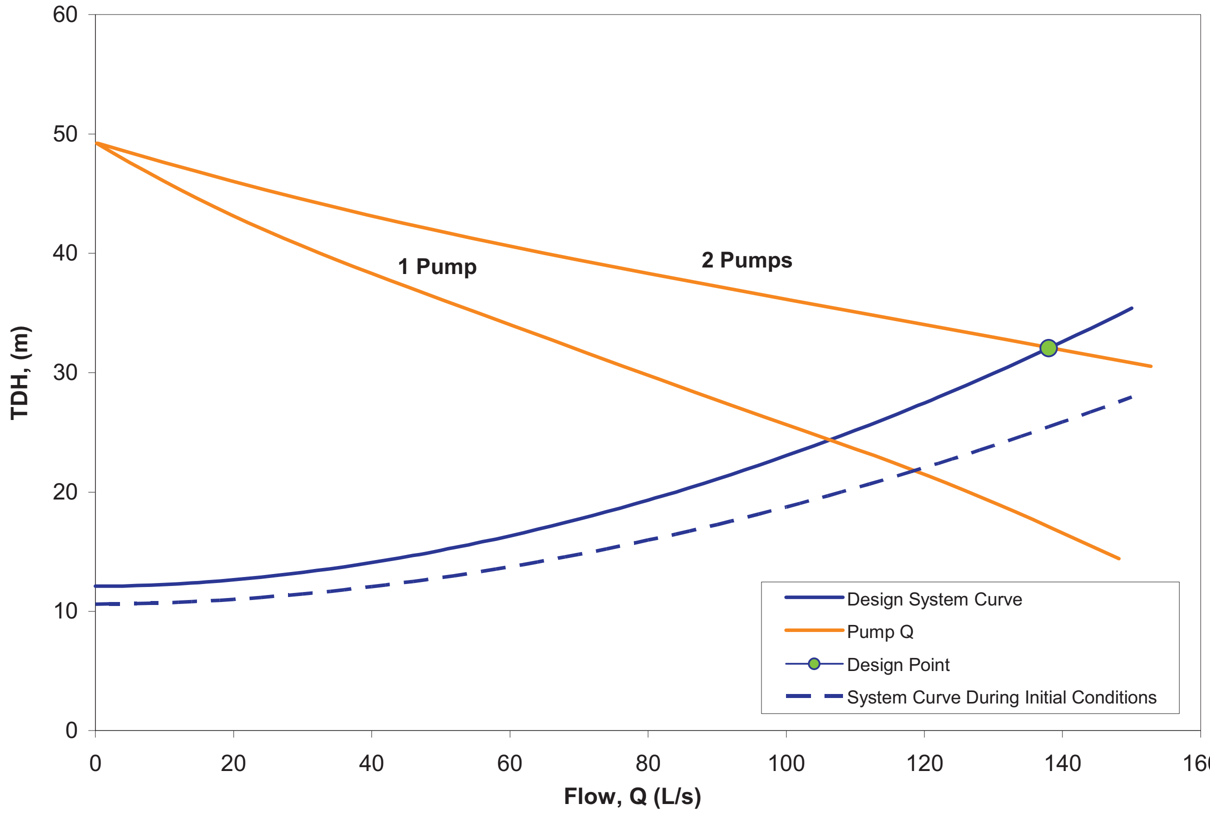


Figure B - 1 System H-Q and Pump Performance Curve

Table B - 5 Summary Centrifugal Pump Specifications

Model number	NP 3202.185 HT
Impeller diameter	294 mm
Motor shaft power	52 kW = 70 hp
Rated Speed	1175 rpm
Inlet/outlet size	150 mm
Number of blades	2
Voltage	600 V
Frequency	60 Hz

Checking for Cavitations

In order to ensure smooth pumping operation and avoid cavitations, the net positive suction head available (NPSHA) is calculated for the system and compared to the net positive suction head required (NPSHR) for the pump according to the formula:

$$NPSHA = H_{bar} + h_s - H_{vap} \qquad (3)$$

Where $NPSHA$ = Net positive suction head available [m]
H_{bar} = Barometric pressure of water column above sea level [m]
h_s = Static head of intake water above the eye of the impeller. Since the pump is submersible, h_s is always positive [m]
H_{vap} = Vapour pressure of fluid at maximum expected temperature [m]

H_{bar} value was obtained from the relevant tables and corrected for elevation of 74.9 m. The static head h_s is the height of water above the eye of the pump impeller, which is always positive in the case of submersible pumps. H_{vap} is based on maximum liquid temperature of 30°C. This has been verified by our industrial advisor (H. Tracy, personal communication, Feb. 17, 2009). Table B - 6 below summarizes the NPSH calculation for peak flow conditions.

Table B - 6 Net Positive Suction Head Available

		Value (m)
H_{bar}	Barometric Pressure	10.24
h_s	Static Head	0.50
H_{vap}	Vapour Pressure	0.44
	NPSHA	**9.30**

The NPSHA calculated at the HWL would increase static head by 1.50 m. In all cases, the NPSHA is larger than the NPSHR as indicated on Table B - 4. Therefore cavitation conditions are unlikely to occur.

Design Parameter	Value	Units	Notes/Reference
Design Flow, *Q*	**138**	**L/s**	Appendix 2 of Municipal Action EA (Peak Flow = Design Flow)
	0.138	m^3/s	Converted from L/s
	1821.3	GPM	Converted from L/s
Forcemain and outlet piping			
Internal Piping inside SPS			
Material	Standard Weight (ANSI B36.10) Steel Pipe		
Nominal Size	10	inch	Assumed
Pipe 1 ID	10	inch	Pumping Station Design, 3rd Edition
	254	mm	Converted from inches
X-Sectional A	0.0507	m^2	
Velocity, *v*	2.72	m/s	Less than the MOE limit of 3 m/s. OK
C Factor	**100**		MOE Design Guidelines
Friction Headloss, h_f	0.0433	m/m pipe	Hazen-Williams Eqn, Pumping Station Design, 3rd Edition
Length	5	m	Estimated
Head loss in Pipe	**0.217**	**m**	
Forcemain Section 1A:			
Flow, 0.5 Q	69	L/s	Assumed equal flow to both sections of pipe (1A and 1B)
	0.069	m^3/s	Converted from L/s
	910.67	GPM	Converted from L/s
Material	PVC 10" Pipe		
Pipe 1 Length	1030	m	Double twin barrel. Assume one pipe flow.
Nominal Size	10	inch	Appendix 2 of EA
Internal Diameter	9.486	inch	Appendix 2 of EA
	240.94	mm	
X-Sectional A	0.0456	m^2	
Velocity, *v*	1.51	m/s	Less than the MOE limit of 3 m/s. OK
C Factor	**100**		Pumping Station Design, 3rd Edition + MOE Design Guidelines
Friction Headloss, h_f	0.015	m/m pipe	Hazen-Williams Eqn, Pumping Station Design, 3rd Edition
Head loss in Pipe	**15.962**	**m**	
Forcemain Section 1B:			
Material	Asbestos-Cement		
Pipe 1 Length	1030	m	Double twin barrel. Assume one pipe flow.
Nominal Size	250	mm	Given in EA
Internal Diameter	9.486	inch	Assumed similar to PVC pipe
	240.94	mm	Assumed similar to PVC pipe
X-Sectional A	0.0456	m^2	
Velocity, *v*	1.51	m/s	Less than the MOE limit of 3 m/s. OK
C Factor	**100**		Assumed as a conservative estimate based on MOE Guidelines
Friction Headloss, h_f	0.015	m/m pipe	Hazen-Williams Eqn, Pumping Station Design, 3rd Edition
Head loss in Pipe	**15.962**	**m**	
Forcemain Section 2:			
Material	1000 Series Driscopipe Polythylene Pipe 12" SDR17		
Pipe 2 Length	285	m	Appendix 2 of EA
Nominal Size	14	inch	Appendix 2 of EA
Internal Diameter	14	inch	Appendix 2 of EA
	355.6	mm	
X-Sectional A	0.0993	m^2	
Velocity, *v*	1.39	m/s	
C Factor	**120**		Pumping Station Design, 3rd Edition + MOE Design Guidelines
Friction Headloss, h_f	0.006	m/m pipe	Hazen-Williams Eqn, Pumping Station Design, 3rd Edition
Head loss in Pipe	**1.710**	**m**	

Head Loss due to Valves and Fittings

Item	K-Value	Head Loss (m)	Qty	Total Loss (m)	Reference
Velocity head	1	0.378	1	0.378	Pumping Station Design, 3rd Edition
45° Wye Branch	0.5	0.189	2	0.378	Pumping Station Design, 3rd Edition
45° Elbow	0.208	0.079	2	0.157	Pump Handbook (3rd Edition)
90° Elbow	0.39	0.147	1	0.147	Pump Handbook (3rd Edition)
Check Valve	2	0.756	1	0.756	Pump Handbook (3rd Edition)
Gate Valve	0.08	0.030	1	0.030	M&H Valve Company: Model C509 3-12
Knife Gate Valve	0.13	0.049	2	0.098	DeZURIK KGC CAST SS Knife Gate Valve
Increaser 10" to 14"	0.293	0.111	1	0.111	Pumping Station Design, 3rd Edition
				2.056	

Static Lift	
Invert elevation of inlet Sewer	77.9
Invert elevation at Discharge	88.5
Wet well depth	1.5
Low water level	76.4
Min. Static Lift	10.6
Max. Static Lift	12.1
Mid. Static Lift	11.35

Total Head Loss	(m)	
Head loss, SPS piping	**0.22**	
Pipe 1A: PVC Pipe 1B: A-C Old	**15.96**	
Pipe 2: HDPE	**1.71**	
Fittings and Valves	**2.06**	
Static Head	**12.10**	at LWL
TDH (m)	**32.0**	

NPSHA Calculations

H_{bar}	10.24	m	Measured at 74.9 m ASL
h_s	0.12	m	Static head above the eye of the pump impeller.
H_{vap}	-0.44	m	Vapour pressure of liquid at 30℃
NPSHA	9.92	m	Net positive suction head available

Assumptions

Pipe material inside SPS is assumed to be cast iron 10"
Inside SPS all pipes, fittings and valves are assumed to be 10" in size
Two identical pumps are installed to handle peak flow, one operating and other standby
Head losses from air release valve is negligible (B. Adams, personal communication, 2009)
First section of forcemain is divided equally into the old Asbestos-Cement pipe and the PVC pipe installed in 1998
The flow in one of the pipes is only considered for pump selection purposes

System Curve Data

	Design Conditions	Initial Conditions
Flow (l/s)	**TDH (m) at LWL**	**at HWL**
0	12.1	10.6
2	12.10752304	10.6055035
4	12.12729115	10.62001071
6	12.15801109	10.6425967
8	12.19906697	10.67282097
10	12.25005215	10.71039271
12	12.31066531	10.75509639
14	12.38066848	10.80676183
16	12.45986589	10.86524902
18	12.54809177	10.93043938
20	12.64520276	11.00223039
22	12.75107282	11.0805319
24	12.86558967	11.16526362
26	12.98865225	11.25635326
28	13.12016877	11.35373517
30	13.26005522	11.45734928
32	13.40823426	11.56714026
34	13.56463426	11.68305689
36	13.72918858	11.80505149
38	13.90183492	11.93307953
40	14.08251488	12.06709922
42	14.27117347	12.20707125
44	14.46775879	12.35295848
46	14.6722217	12.50472579
48	14.88451558	12.66233981
50	15.10459607	12.82576883
52	15.3324209	12.99498262
54	15.56794969	13.16995229
56	15.81114382	13.35065022
58	16.06196628	13.53704995
60	16.32038154	13.72912607
62	16.58635547	13.92685415
64	16.85985522	14.13021071
66	17.14084912	14.33917309
68	17.42930663	14.55371947
70	17.72519826	14.77382874
72	18.0284955	14.99948052
74	18.33917076	15.23065506
76	18.65719732	15.46733327
78	18.98254928	15.7094966
80	19.3152015	15.9571271
82	19.65512958	16.2102073
84	20.00230982	16.46872026
86	20.35671915	16.73264948
88	20.71833516	17.00197892
90	21.087136	17.27669296
92	21.4631004	17.5567764
94	21.84620763	17.84221438
96	22.23643745	18.13299246
98	22.63377013	18.42909652
100	23.0381864	18.73051277
102	23.44966744	19.03722775
104	23.86819486	19.34922831
106	24.29375067	19.66650159
108	24.72631729	19.989035
110	25.16587749	20.31681623
112	25.61241444	20.64983325
114	26.06591162	20.98807423
116	26.52635288	21.33152762
118	26.99372237	21.6801821
120	27.46800456	22.03402655
122	27.94918422	22.39305007
124	28.43724641	22.75724199
126	28.93217646	23.12659181
128	29.43395998	23.50108925
130	29.94258284	23.88072418
132	30.45803115	24.26548669
134	30.98029128	24.65536702
136	31.50934982	25.05035558
138	32.0451936	25.45044295
140	32.58780967	25.85561987
142	33.13718528	26.26587723
144	33.69330791	26.68120606
146	34.25616523	27.10159754
148	34.82574509	27.527043
150	35.40203556	27.9575339

NPSHR Calculations

Flow (L/s)	head (m)
16.779	5.182
21.078	5.09
25.377	5.028
29.674	4.993
33.969	4.974
38.262	4.96
42.554	4.942
46.844	4.926
51.133	4.917
55.42	4.924
59.706	4.957
63.991	5.023
68.274	5.127
72.556	5.273
76.836	5.449
81.115	5.643
85.394	5.844
89.672	6.045
93.948	6.276
98.218	6.611
102.475	7.128
106.715	7.803
110.95	8.522
115.183	9.242
119.415	9.958
123.643	10.703
127.856	11.545
132.043	12.559
136.179	13.834
140.236	15.435

Design Point

Flow (L/s)	Q (L/s)
138	32.04519

Pump Model NP3202.185 HT

Flow (L/s)	2Q (L/s)	head (m)
0.185	0.37	49.209
4.957	9.914	47.615
9.788	19.576	46.076
14.692	29.384	44.611
19.667	39.334	43.221
24.708	49.416	41.905
29.801	59.602	40.655
34.933	69.866	39.457
40.094	80.188	38.298
45.272	90.544	37.169
50.459	100.918	36.055
55.647	111.294	34.948
60.834	121.668	33.844
66.017	132.034	32.74
71.197	142.394	31.636
76.379	152.758	30.535
81.562		29.443
86.752		28.36
91.949		27.291
97.152		26.234
102.357		25.181
107.555		24.123
112.737		23.05
117.895		21.942
123.018		20.792
128.102		19.59
133.145		18.336
138.158		17.04
143.154		15.72
148.147		14.398

B.4 Pump Performance Curve and Dimensional Drawings

PERFORMANCE CURVE

PRODUCT	TYPE
NP3202.185	HT

DATE	PROJECT	CURVE NO	ISSUE
2009-08-14		63-460-00-4050	2

	1/1-LOAD	3/4-LOAD	1/2-LOAD
MOTOR COS PHI	0.89	0.86	0.78
MOTOR EFFICIENCY	93.0 %	93.5 %	93.5 %
GEAR EFFICIENCY	---	---	---

MOTOR SHAFT POWER	52	kW
STARTING CURRENT ...	---	
RATED CURRENT ...	61	A
RATED SPEED	1775	rpm
TOT.MOM.OF INERTIA ...	0.42	kgm2
NO. OF BLADES	2	

IMPELLER DIAMETER: 294 mm

MOTORTYPE	STATOR	REV
30-29-4AA	03D	11

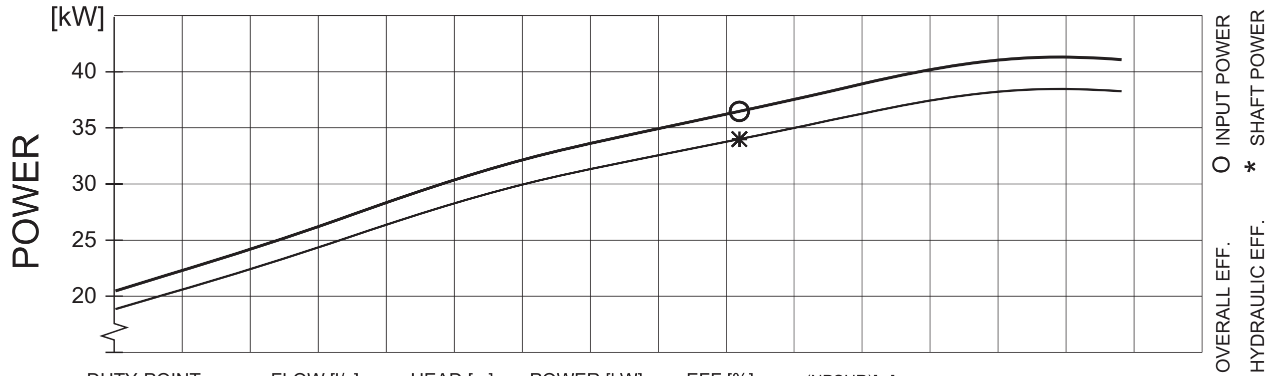
FREQ.	PHASES	VOLTAGE	POLES
60 Hz	3	600 V	4

GEARTYPE	RATIO
---	---

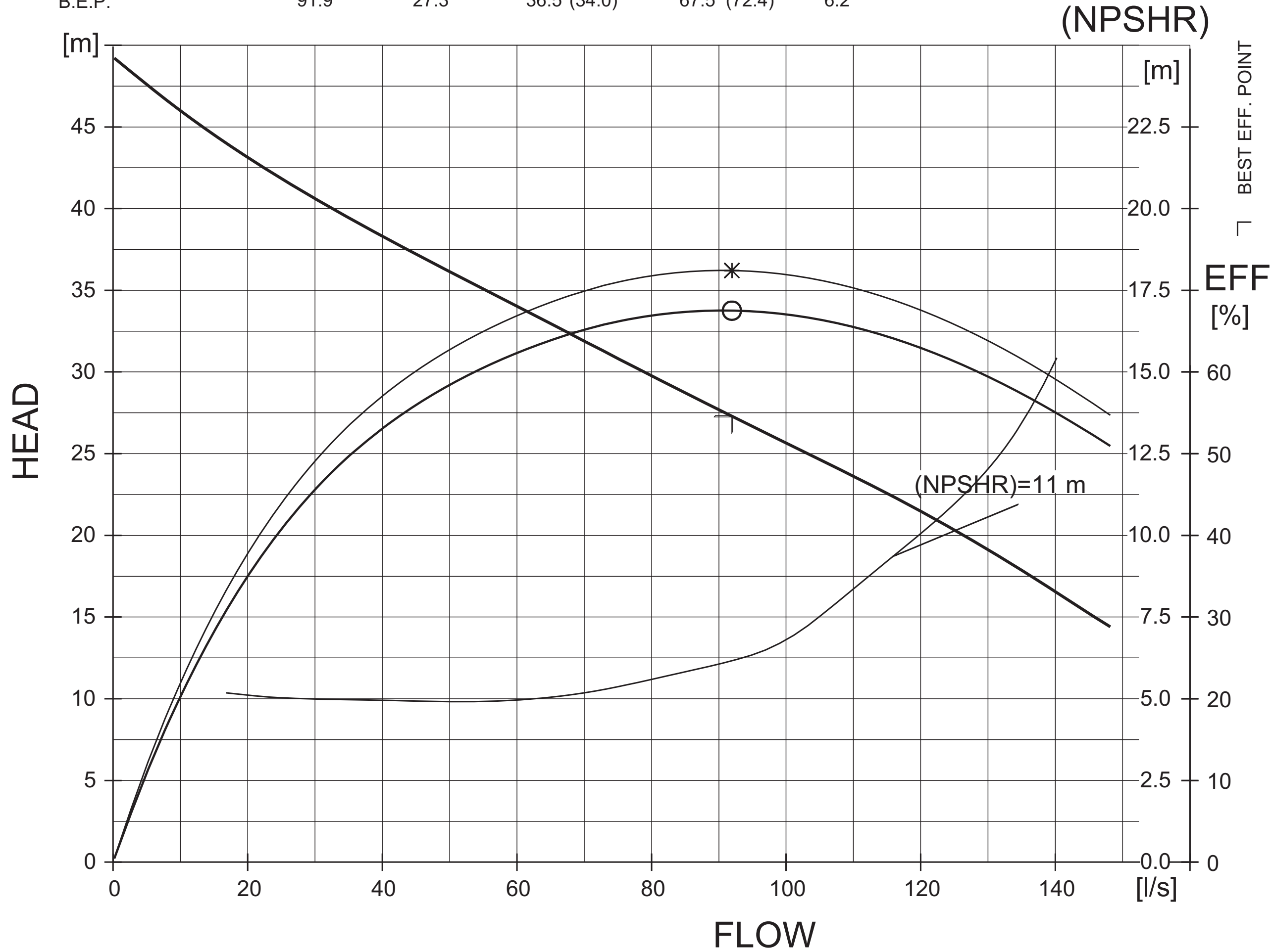
COMMENTS

INLET/OUTLET: -/150 mm

IMP. THROUGHLET: ---



DUTY-POINT	FLOW [l/s]	HEAD [m]	POWER [kW]	EFF [%]	(NPSHR)[m]
B.E.P.	91.9	27.3	36.5 (34.0)	67.5 (72.4)	6.2

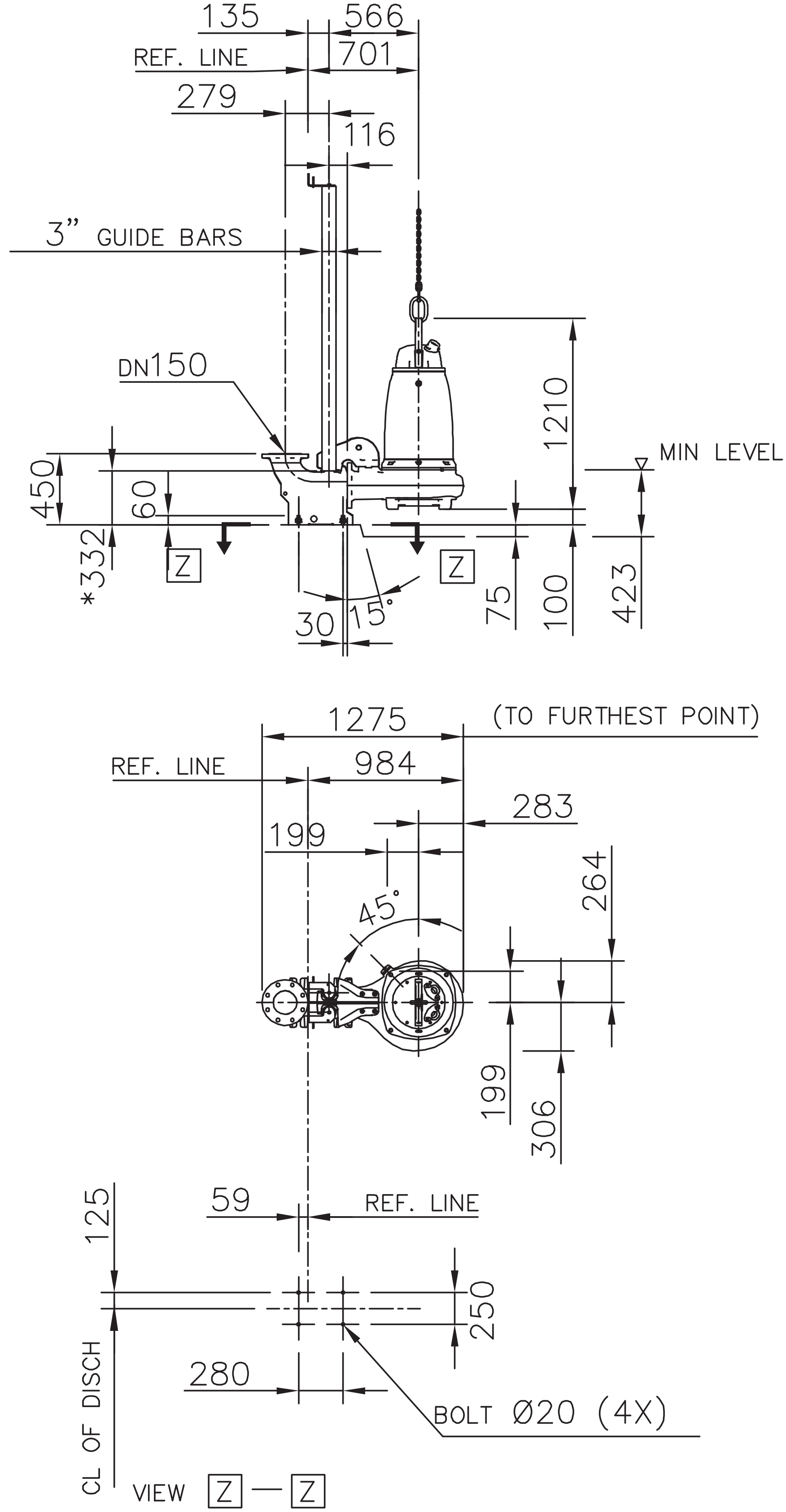


FLYPS3.1.6.2 (20060531)

(NPSHR) = (NPSH3) + margins

Performance with clear water and rating data at 40 °C

CURVE



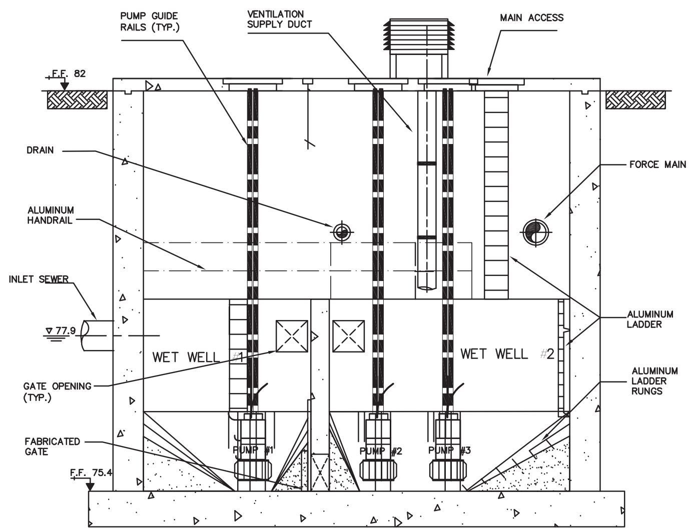
* DIMENSION TO ENDS OF GUIDE BARS

Weight (kg)	
Pump with cooling jacket	Disch
570	80
Pump without cooling jacket	
520	

FLYGT AUTOCAD DRAWING	Denomination: Dimensional drwg NP 3202 HT DN 150	Drawn by Sors	Checked by SB	Date 070305
		Scale 1:40		Reg no 5399
		6664300		3

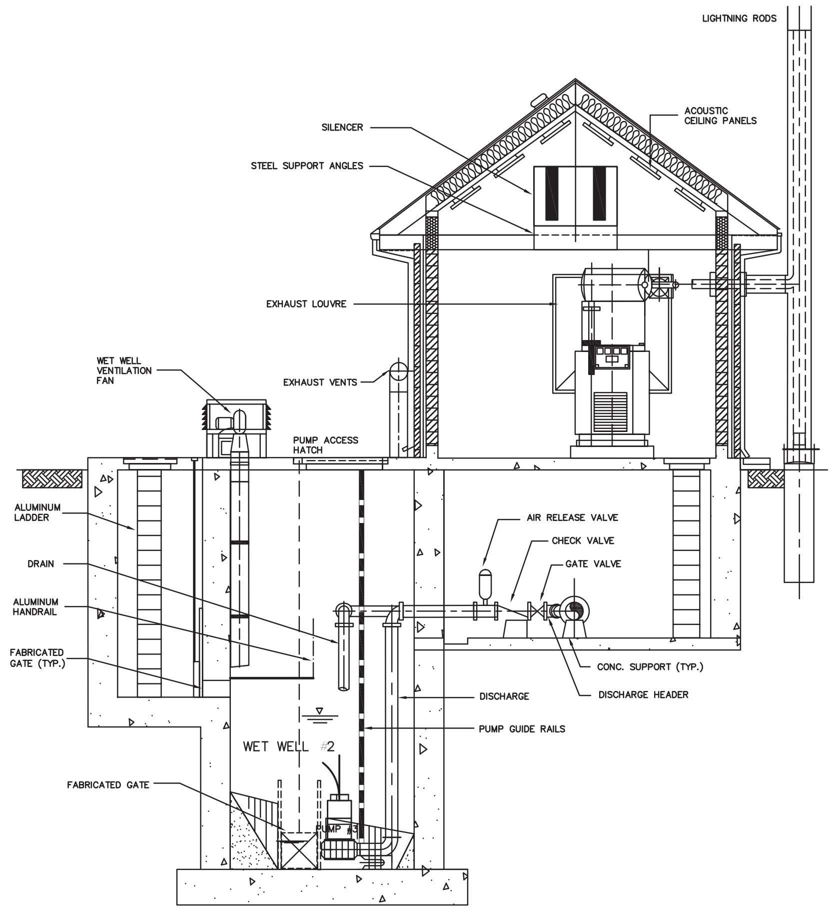
Appendix C

Design Drawings



Section A

0.5m 0 1m 2.0m



Section B

0.5m 0 1m 2.0m

General Notes

No.	Revision/Issue	Date
B	ISSUED FOR FINAL APPROVAL	09.08.22
A	MUNICIPAL CLASS EA	07.01.31

Firm Name and Address

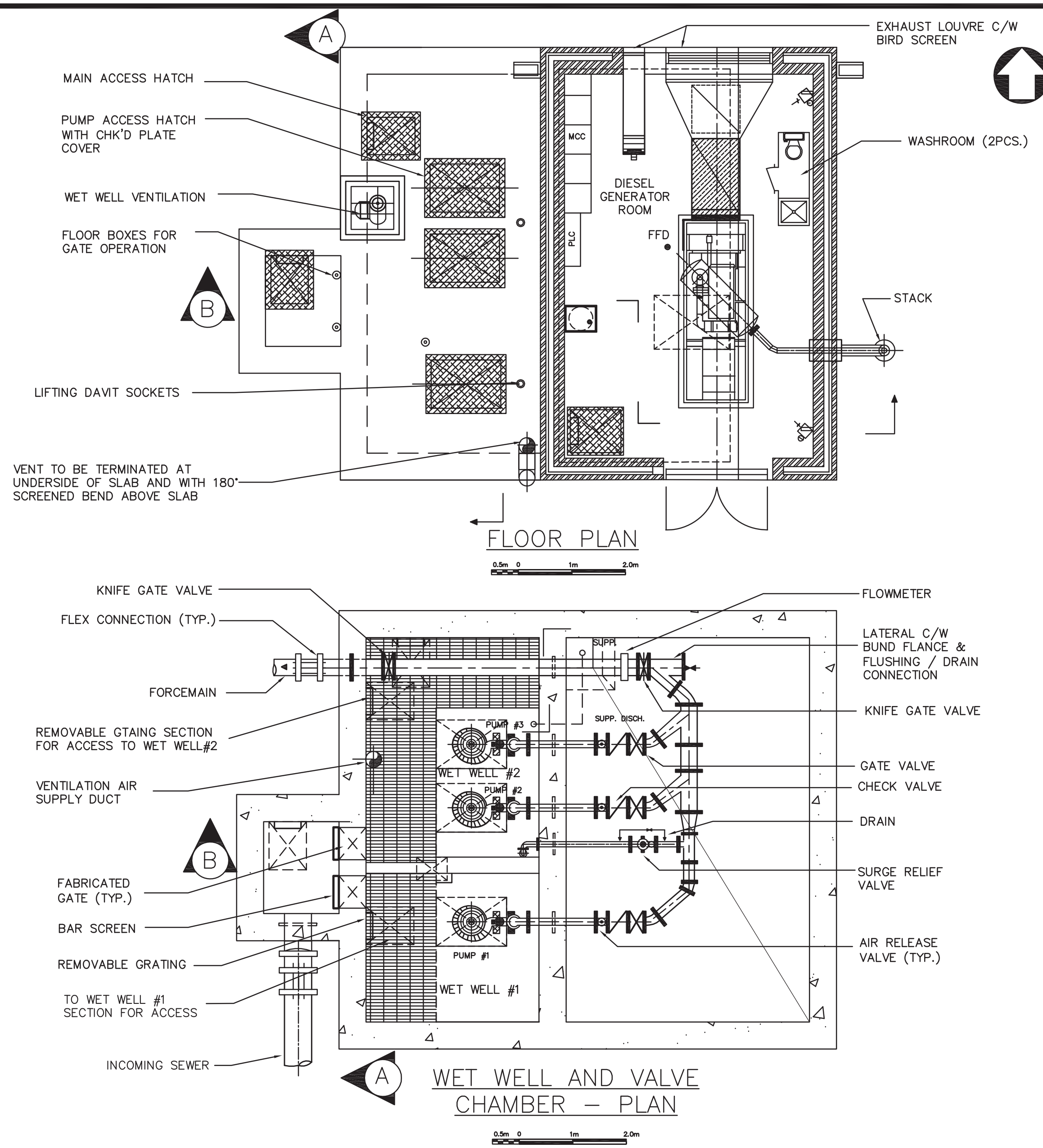
UNIVERSITY OF TORONTO
DESINGING TEAM

Project Name and Address

ROSEBANK SEWAGE
PUMPING STATION

CITY OF PICKERING

Project: SPS
Date: 2009.08.22
Scale: As Noted
Sheet: 1/2



General Notes

No.	Revision/Issue	Date
B	ISSUED FOR FINAL APPROVAL	09.08.22
A	MUNICIPAL CLASS EA	07.01.31

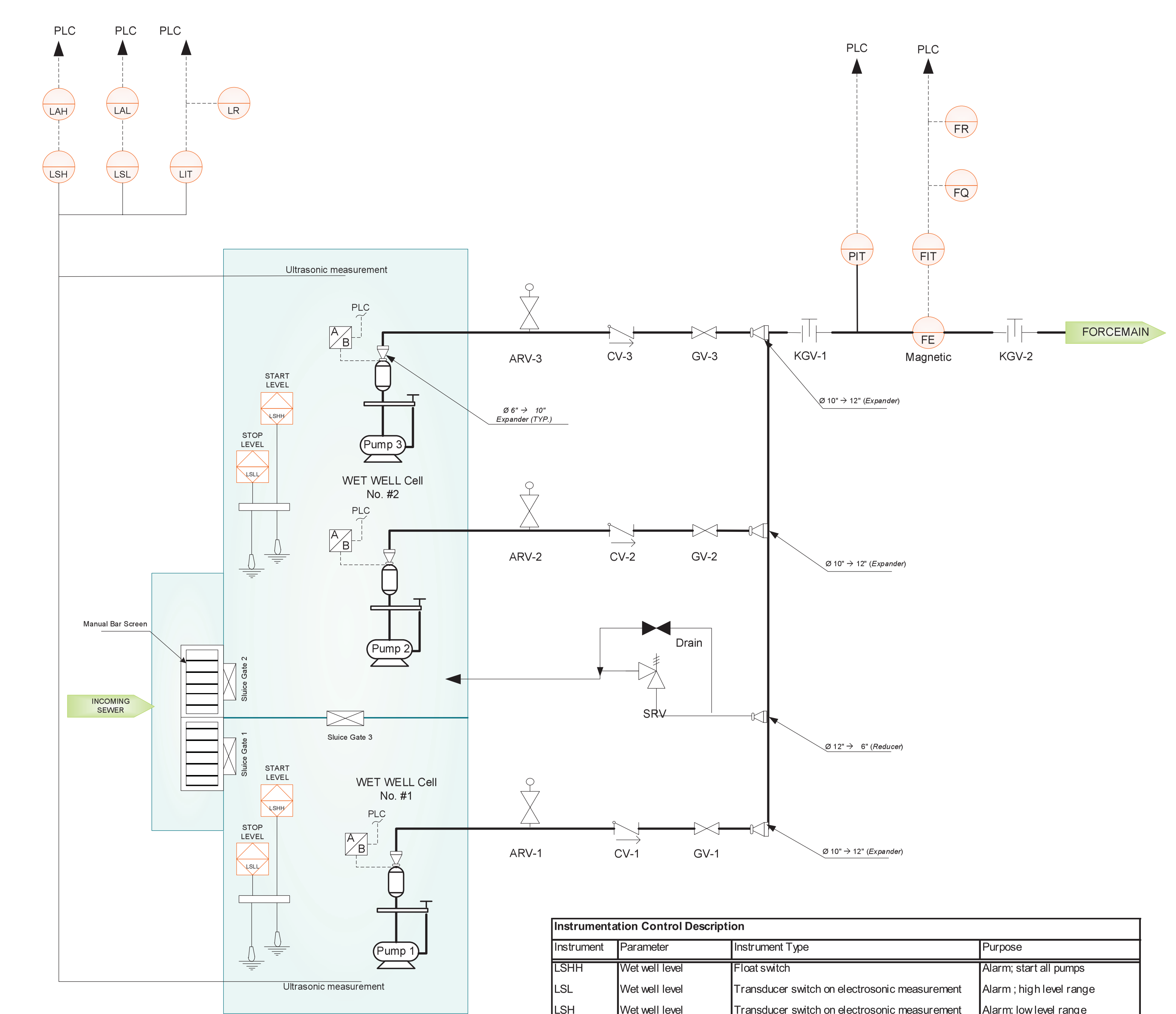
Firm Name and Address
UNIVERSITY OF TORONTO DESINGING TEAM

Project Name and Address
ROSEBANK SEWAGE PUMPING STATION
CITY OF PICKERING

Project: SPS
Date: 2009.08.22
Scale: As Noted
Sheet: 2/2

Appendix D

Instrumentation and Control Diagram



Instrumentation Control Description

Instrument	Parameter	Instrument Type	Purpose
LSHH	Wet well level	Float switch	Alarm; start all pumps
LSL	Wet well level	Transducer switch on electrosonic measurement	Alarm ; high level range
LSH	Wet well level	Transducer switch on electrosonic measurement	Alarm; low level range
LSLL	Wet well level	Float switch	Alarm; stop all pumps
LIT	Wet well level	Discrete signal	Pump sequence; monitoring
PIT	Forcemain pressure	Capacitance transmitter	Monitoring
FIT	Forcemain flow	Magnetic	Monitoring

ABBREVIATIONS:

- A/B Pump controller drive
- ARV Air release valve
- ASD Adjustable-speed drive
- CV Check valve
- FE Flow element
- FIT Flow indicator transmitter
- FQ Flow integrator
- FR Flow recorder
- GV Gate valve
- LAH Level alarm high
- LAHH Level alarm high-high
- LAL Level alarm low
- LALL Level alarm low-low
- LIT Level indicator
- LIA Level indicator alarm
- LR Level recorder
- LSH Level switch high
- LSHH Level switch high-high
- LSL Level switch low
- LSLL Level switch low-low
- KGV Knife gate valve
- PIT Pressure indicator transmitter
- SRV Surge relief valve

PROJECT:

ROSEBANK SEWAGE PUMPING STATION

THE REGIONAL MUNICIPALITY OF DURHAM

PROCESS AND INSTRUMENTATION DIAGRAM

VERSION: 1.6

DATE MODIFIED: 2009/08/19

SCALE: NOT TO SCALE

PREPARED BY:

UNIVERSITY OF TORONTO DESIGNING TEAM

PROaqua Consulting Ltd

Appendix E

Remediation Plans

Appendix E: Remediation Plans

Figure E - 1illustrates the affected areas due to construction activities of the new Rosebank Sewage Pumping Station. As part of the remediation plan, the vegetation on the affected sites will be restored to appropriate conditions.

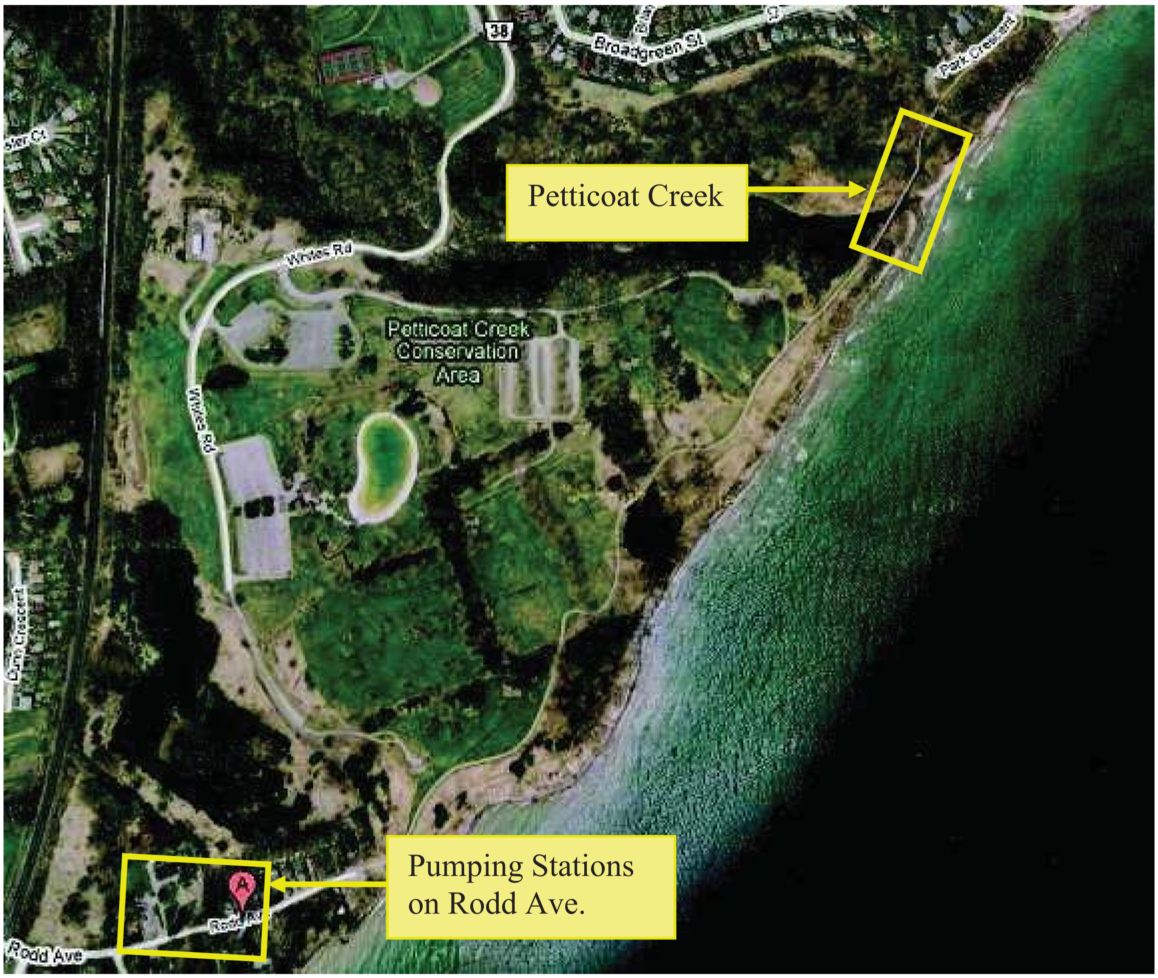


Figure E - 1 Satellite Image of the Affected Area

E.1 Rodd Ave. Remediation Plans

The vegetation on the existing pumping station has similar upland field species as in the proposed location for the new sewage pumping station. Hence, similar remediation plan will be applied for both sites. It is also known that the existing Rosebank SSPS land will be sold off to the Toronto and Region Conservation Authority (TRCA) after its demolition. Therefore, remediation plans for both sites must meet the minimum requirements acceptable to the TRCA. The new SSPS will be surrounded by native-species re-vegetation buffer planting zone. Native species trees will also be planted to make the site aesthetically appropriate for the area. Proposed native species are listed in Table E - 1.

Figure E - 2 displays the location of native species re-vegetation and Figure E - 4 shows the planting concept around the proposed new site (obtained from RVA et al., 2008).

Figure E - 2 Remediation Planting Concept - Existing Sewage Pumping Station

Adapted from Municipal Class Environmental Assessment for Rosebank Sanitary Sewage Pumping Station Upgrade and Forcemain crossing of petticoat creek in the City of Pickering

Figure E - 3 Proposed Site for new Sanitary Sewage Pumping Station on Rodd Ave.

Figure E - 4 Remediation Planting Concept – Proposed Location for New Sewage Pumping Station

Adapted from Municipal Class Environmental Assessment for Rosebank Sanitary Sewage Pumping Station Upgrade and Forcemain crossing of petticoat creek in the City of Pickering

Table E - 1Species Illustration for the New and Existing Vegetation Sites

Acer Rubrum

Other Names: Also known as Red Maple

Plant Type: Deciduous Tree

Cornus Racemosa / Sericea

Other Names: Gray/ red osier dogwood

Plant Type: shrub

Adapted from: http://www.mobot.org

Fraxinus Pennsylvanica

Other Names: Green / Red Ash

Plant Type: Deciduous Tree

Rosa Palustris

Other Names: Swamp Rose

Plant Type: shrub 2-7 feet

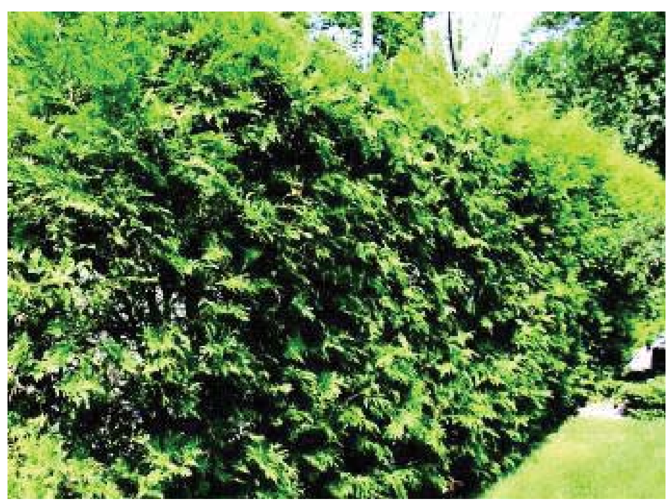
Adapted from:
http://www.rosesloubert.com/carolinadefinition.htm

Salix Discolor

Other Names: Pussy Willow

Plant Type: shrub or tree

Thuja occidentalis



Other Names: Arborvitae

Plant Type: evergreen coniferous tree

Viburnum Dentatum

Other Names: Arrowwood

Plant Type: Shrub

Adapted from:
http://www.missouriplants.com/Whiteopp/Viburnum_dentatum_plant.jpg

E.2 Forcemain Remediation Plans

Figure E - 5 illustrates the remediation planting concept for the Forcemain and Table E - 2 lists the species that are common to the region and will used in the Forcemain remediation plan. For more details, please refer to the Environmental Assessment by RVA.

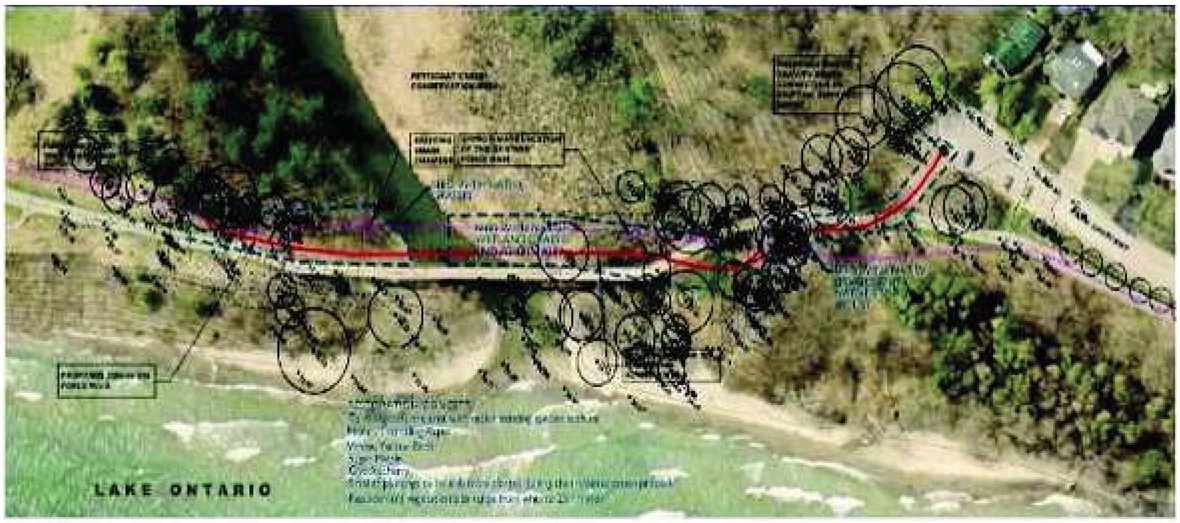


Figure E - 5 Remediation Planting Concept – Forcemain

Adapted from Municipal Class Environmental Assessment for Rosebank Sanitary Sewage Pumping Station Upgrade and Forcemain crossing of petticoat creek in the City of Pickering

Figure E - 6 View from Lake Ontario to Petticoat Creek

Table E - 2 Species Illustration for the Forcemain Vegetation

Poplar

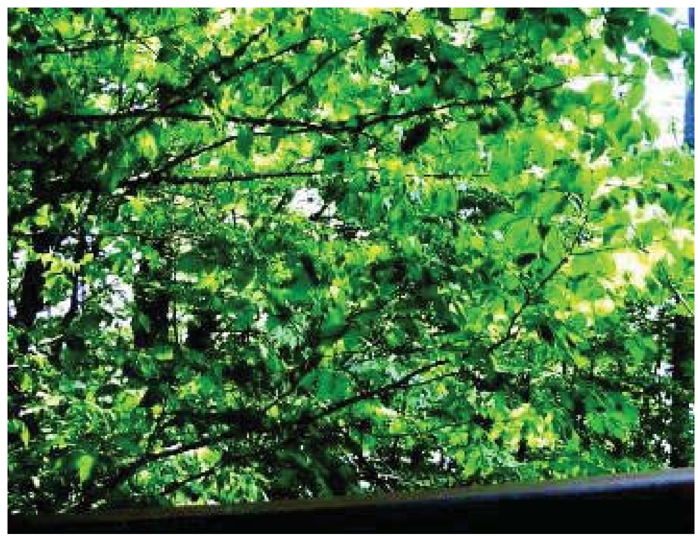
Other Names: Populus

Plant Type: deciduous flowering tree

Trembling Aspen

Other Names: Populus Tremuloides

Plant Type: deciduous tree

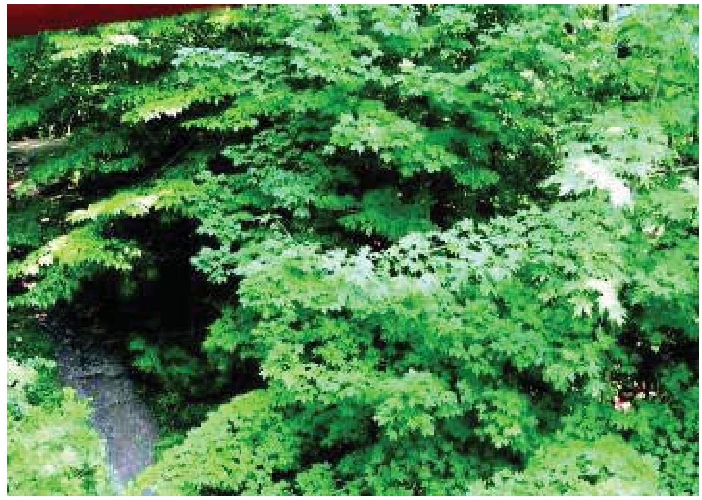


Yellow Birch / White Birch

Other Names: Betula Alleghniensis / Betula Papyrifera

Plant Type: deciduous tree

Sugar Maple



Other Names: Acer Saccharum

Plant Type: : deciduous tree

Chokecherry

Other Names: Prunus Virginiana

Plant Type: shrub or small tree

Appendix F

Capital Cost, Maintenance and Operating Costs

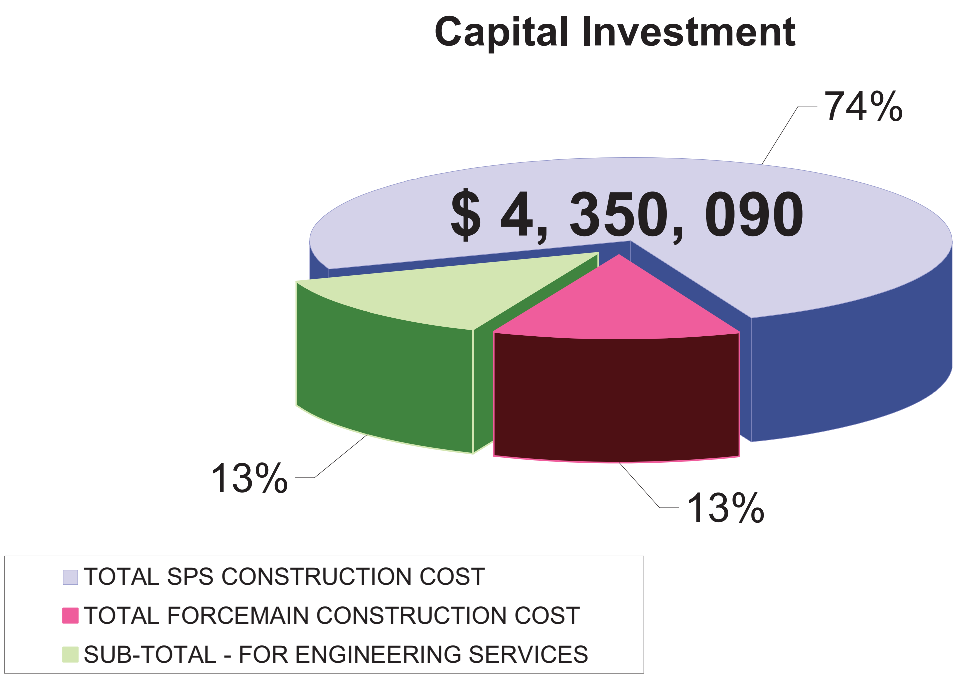
Appendix F: Capital Cost, Maintenance and Operating Costs

The Sewage Pumping Station is a unique type of project in the Ontario's public sector. The sections below provide analysis for capital cost, and annual maintenance and operating cost associated with the project.

F.1 Capital Investment

The Capital Investment cost was provided in EA report, which incorporates capital expenditures and expenses. The total Capital Investment for the project was estimated $4,350,090 where:

- 74 % of the capital investment is for construction of Sanitary Sewage Pumping Station and forcemain at Rodd Avenue
- 13% of the capital investment is for construction of the forcemain across Petticoat Creek
- 13 % of the cost were budgeted for engineering services



Detailed capital investment break down is provided in Table F - 1.

Table F - 1 Capital Cost [Adapted from Rosebank SSPS and Forcemain Crossing of Petticoat Creek Class EA RVA # 056626]

Item description	Unit	Unit Cost	Quantity	Total Cost
SPS CONSTRUCTION				
Pumping Station				
mobilization/Demobilization	LS			$ 90,000
Site Work				
Concrete	m^3	$1,500	250	$ 375,000
Masonry	LS			$ 30,000
Metals	LS			$ 15,000
Woods and Plastics	LS			$ 4,500
Thermal & Moisture Protection	LS			$ 8,000
Doors and Windows	LS			$ 6,000
Finishes	LS			$ 6,000
Specialties	LS			$ 4,000
Process Equipment				
- Pumps	EA	$35,000	3	$ 105,000
- Installation at 25%	LS			$ 30,000
- Other Miscellaneous Equipment	LS			$ 75,000
Instrumentation and Control	LS			$ 75,000
Conveying Systems	EA	$11,000	1	$ 11,000
Mechanical	LS			$ 23,000
Electrical	LS			$ 200,000
Diesel Generator	LS	$250,000	1	$ 250,000
Demolition & Site Restoration (Old Pumping Station)	LS			$ 40,000
Shutdown for Commissioning of New Pumping Station				
- Portable Pumping Station	$/day	$600	5	$ 3,000
Lump Sum for other Requirements	LS			$ 75,000
Rodd Avenue Sewer - Including all restoration				
Removals of Existing Piping (AC Pipe)	LS			$ 60,000
Sewer Piping				
200ø	M			$ 48,000
250ø	m			$ 15,000
Manhole	EA			$ 22,500
Valve Chamber at PS	EA			$ 7,500
By-pass pumping for Connection of new sewers to existing manhole	LS			$ 8,000
Portable Pumping Station	$/day	$600	10	$ 6,000
Rodd Avenue Forcemain				
Removals of Existing Piping (AC Pipe)	LS			$ 21,000
Forcemain Piping				
- 2 - 250f HDPE DR17 Forcemain	m	$1,000	160	$ 160,000
Forcemain Connections including tanker trucks	EA	$16,000	2	$ 32,000
Geotechnical investigation	LS			$ 28,000
Topographical Survey	LS			$ 20,000
Sub-Total For Pumping Station, Rodd Avenue Sewer and Forcemain				**$ 2,140,900**
Contractor's mark up, bonds, insurance, etc. @20%				**$ 428,180**
TOTAL SPS CONSTRUCTION COST				**$ 2,569,080**

Item description	Unit	Unit Cost	Quantity		Total Cost
Forcemain Crossing at Petticoat Creek					
Forcemain 350 Piping					
350ø - west end of bridge by open-cut	m	$850	80	$	68,000
350ø - HDD under Creek	m	$1,000	150	$	150,000
350ø - east end of bridge by open-cut	m	$850	20	$	17,000
Shutdown of Forcemain for connections including tankers - (could be coordinated with P.S. shutdown and tanker cost could be reduced)	LS			$	30,000
Underground Utilities Survey, including shutdowns	LS			$	11,000
Drain Chamber	EA	$21,000	1	$	21,000
Air Release Chamber / Vacuum Relief Chamber	EA	$21,000	1	$	21,000
Restoration and/or Transplanting of Valley Crossing	LS			$	16,000
Testing During Construction - For Sewer and FM	LS			$	7,000
Sediment and Erosion Controls	LS			$	5,000
Geotechnical Investigation	LS			$	7,500
Topographical Survey	LS			$	10,000
Sub-total for Forcemain Crossing				**$**	**363,500**
Contractor's mark up, bonds, insurance, etc. @20%				**$**	**72,700**
TOTAL FORCEMAIN CONSTRUCTION COST				**$**	**436,200**
CONSTRUCTION TOTAL				**$**	**3,005,280**
ENGINEERING SERVICES FOR DESIGN AND CONSTRUCTION ADMINISTRATION					
Pumping Station, Rodd Avenue Sewer and Forcemain				$	385,362
Forcemain Crossing at Petticoat Creek				$	65,430
SUB-TOTAL - FOR ENGINEERING SERVICES				**$**	**450,792**
TOTAL FOR CONSTRUCTION AND ENGINEERING SERVICES				**$**	**3,456,072**
CONTINGENCY @ 25%				$	864,018
TOTAL PROJECT COST				**$**	**4,320,090**

F.1.1 Annual Maintenance and Operating Cost

Maintenance and Operating costs of the SSPS constitutes of two parts:

- Annual energy cost (electricity from mainline and diesel generator)
- Annual maintenance cost

It is hard to determine or estimate any indirect costs associated with operating consumption; hence the calculations of the operating cost do not account any indirect cost that is associated as the result of the consumption.

F.1.1.1 Energy Cost

Assumptions

Pump Capacity at Full (57.8 HP (E))	43.12	kW	Q_{pump}	113.1	L/s
Miscellaneous (heating, lighting and loads)	10	kW	$Q_{avrg.}$	87.4	L/s
200kW diesel generator consumption at 100%	55.9	gph			
Cost of electricity	0.1	$/kWh	Electricity	363	days/year
Cost of diesel	0.8	$/L	Diesel	2	days/year

Note: the annual diesel consumption includes 1 hour / month of partial load tests and 12 hours of full load test. As part of the Emergency Preparedness Plan, the diesel generator tank was sized for 48 hours emergency period.

Table F - 2 Annual Energy Consumption

Type of Energy	Consumption Category	Annual Energy	
		Use, kW•h	Cost, $
Electricity	Pump	290,299	29,030
	Miscellaneous	87,120	8,712
Diesel	Pump	1,599	1,354
	Miscellaneous	480	406
Total		**379,498**	**39,502**

F.1.1.2 Maintenance and Services

The maintenance and services cost of a Sewage Pumping Station is taken at 5% of the capital cost of pumps, accessories, and controls. However, as per literature review objective figures are difficult to obtain, since the pumps with similar specifications will have different repair costs for no discernible reason. For annual maintenance and services costs see Table F - 3.

Table F - 3 Annual Maintenance and Services Cost, $

Item description	Quantity	Total Cost
Process Equipment		$135,000
- *Pumps*	3	$105,000
- *Installation at 25%*		$ 30,000
Instrumentation and Control		$ 75,000
Conveying Systems	1	$ 11,000
Total capital cost of pumps, accessories and control		$221,000
Maintenance and Services at 5%		**$ 11,050**

F.1.1.3 Annual Operation Cost

Table F - 4 Annual Operation cost, $

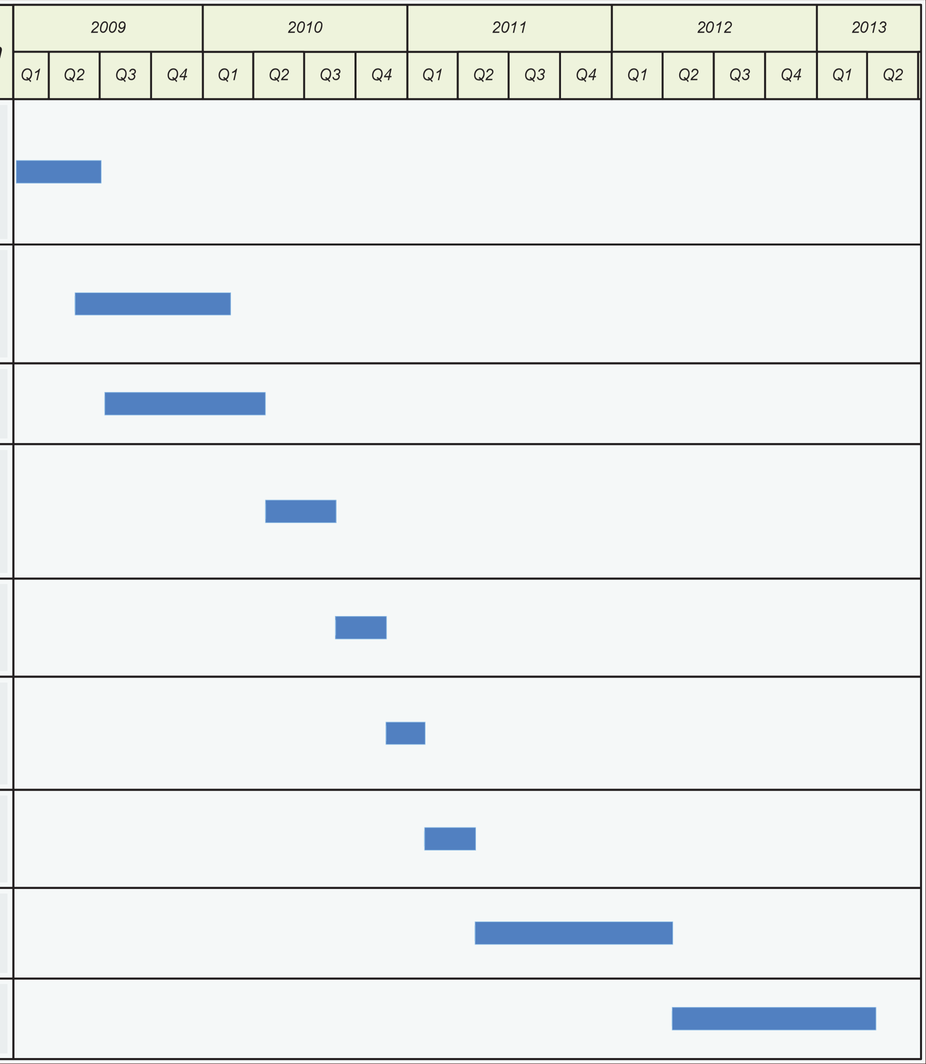
Annual Energy Cost	$ 39, 502
Maintenance and Services Cost	$ 11, 050
Total Annual Operation Cost	**$ 50, 652**

Appendix G

Implementation Schedule

Rosebank Sanitary Sewage Pumping Station and Forcemain Construction Schedule

ID	Task Name	Start	Finish	Duration
1	Complete Preliminary Report for approval to the Regional Review Committee	02/02/2009	03/07/2009	22w
2	MOE Review and Sign-off [Conceptual Design]	5/18/2009	2/19/2010	40w
3	Detailed Design	10/07/2009	22/04/2010	41w
4	MOE and Stakeholders Approvals and Sign-off [Detailed Design]	23/04/2010	26/08/2010	18w
5	Tender Period for Contractors	26/08/2010	24/11/2010	13w
6	Tender Evaluation Contract Awards	24/11/2010	01/02/2011	10w
7	Review Shop Drawings	01/02/2011	02/05/2011	13w
8	Construction Period	02/05/2011	18/04/2012	50w 3d
9	Commissioning (Construction and Technical Warranty)	18/04/2012	16/04/2013	52w



Appendix H

Vendor Information

Appendix H: Vendor Information

Equipment ID	Equipment Information		Manufacture	Contact Info/ Supplier
Submersible Wastewater Pump	Model No. Impeller Diameter Rated Speed Motor Shaft Power Rated Capacity Electrical	NP 3202.185 HT 294 mm 1175 rpm 70 hp 113.1 L/S 600 volt, 3 phase, 60 Hz	ITT Water & Wastewater	93 Claireville Drive Toronto, ON M9W 6K9 Tel: 416-679-1199 Fax: 416-679-0406 www.ittwww.ca
Swing Flex Check Valve	Valve Model No. Valve Size Service	Swing Flex Check Valve 510 A 250 mm (10”) Pump Discharge	Val-matic Valve and Manufacturing Corp	Syntec Process Equipment Ltd. 68 Healey Road, Unit 1 Bolton, Ontario Canada L7E 5A4 Tel.: (905) 951-8000 Fax: (905) 951-8002 Website: www.syntecpe.com
Knife Gate Valve	Valve Model No. Valve Size Service	250 mm Knife Gate Valve F8112 250 mm Recirculation/Drain Header	Trueline Valve Corporation 20201 Clark Graham Baie d’Urfe (Quebec) H9X 3T5 Toll free: 1-800-667-4819 Tel.: 514.457.5777 Fax: 514.457.6163 www.trueline.ca	Syntec Process Equipment Ltd. 68 Healey Road, Unit 1 Bolton, Ontario L7E 5A4 Canada Phone: (905) 951-8000 Fax: (905) 951-8002 E-Mail: info@syntecpe.com
Wastewater Combination Air Valve	Valve Model No. Inlet/Outlet Size Service	Wastewater Combination Air Valve 49A/308 8” Flange Air and Vacuum Relief	Valmatic Valve and Manufacturing Corporation 905 Riverside Drive, Elmhurst, IL 60126 Tel: 630-941-7600 www.valmatic.com Email: valves@valmatic.com	Syntec Process Equipment Ltd. 68 Healey Road, Unit 1 Bolton, Ontario, L7E 5A4 Canada Phone: (905) 951-8000 Fax: (905) 951-8002 E-Mail: info@syntecpe.com

Equipment ID	Equipment Information		Manufacture	Contact Info/ Supplier
Resilient Wedge Gate Valve	Valve Model No. Valve Size Service	Resilient Wedge Gate Valve A-2360 250 mm (10") Flange Recirculation/Drain Header	Mueller Canada	Mueller Canada 82 Hooper Rd. Barrie, Ontario, Canada L4N 8Z9 Tel: 705-719-9965 www.muellercanada.com
	Valve Model No. Valve Size Service	Resilient Wedge Gate Valve A-2360 300 mm Flange Pump Discharge		
	Valve Model No. Valve Size Service	Resilient Wedge Gate Valve A-2361-6 400 mm Flange Pump Suction		
Electric Actuator	Operator Model No. Output Speed HP	Electric Actuator onto 6" Mueller Gate Valve IQ18 - 3 Phase 29 RPM at 60 Hz 0.24 HP	Rototork Controls	Rotork Controls (Canada) Ltd. 838 Upper Canada Drive - Unit #3 Sarnia, Ontario Canada N7W 1A4 Phone: 519 337 9190 Fax: 519 337 0017 www.rotork.com
Diesel Standby Generator	Model Number Voltage Power Rating Engine Engine Model Engine Alternator Controller Model	200REOZJB 190-600 V 200 kW John Deere 6081AF001 4-Cycle, Turbocharged, Aftercooled Kohler Decision-Maker™ 3+, 16-Light Controller Matrix 16 Engine Controller	Kohler Power Systems	CF Industrial Products 263 Talbot Street West Leamington Ontario N8H 4H3 Phone: 519-322-2311 Fax: 519-322-2916

Equipment ID	Equipment Information		Manufacture	Contact Info/ Supplier
Battery Charger	Model Number	SCA Series Battery Charger	Vulcan Electric Inc.	40 Telson Road, Markham, Ontario, Canada L3R 1E5 Toll Free: 1-800-268-6949 Phone: 905-513-1550 Fax: 905-513-1557 Email: info@vulcanelectric.ca
Engine Silencer	Model Number Insertion Loss (dBA) Grade	JDDPR-6 35-50 Hospital Plus	Silex Innovations Inc. - Head Office 6659 Ordan Drive Mississauga, Ontario Canada, L5T 1K6 Phone: 1-800-387-7818 905-612-4000 Fax: 905-612-8999 www.silex.com	Laura Palmer Territory Manager 905-612-4000 ext 224 laurap@silex.com
Fuel Tank	Material Comment	Steel Sheet ASTM A569 or equal Manufactured to Underwriters Laboratories of Canada Standard CAN4/ULC-S602-M latest edition with ULC label	DTE Industries Limited	69 Comstock Road Toronto, Ontario M1L 2G9, CANADA Tel.: (416) 757-6278 Fax: (416) 757-5579 Toll-Free: 1-800-387-1400 e-mail : sales@dteindustries.com
Programmable Logic Controller	CPU CPU Baseplate Power Supply Digital Input Module Digital Output Module Analogue Input Module PLC Operator Interface Model LCD Display Network Interface Cable	SLC 5/04, 16K Word Processor Cat. No. 1747-L541 Cat. No. 1746-A10 30 Watts Cat. No. 1746-P2 Cat. No. 1746-1B16 Cat. No. 1746-0B16 Cat. No. 1746- NI8 N14 Allen-Bradley DTAM Plus 8K Memory – Cat. No. 2707-L8P1 DH-485-Cat No. 2707-NC1	Rockwell Automation Allen-Bradley	135 Dundas Street Cambridge Ontario N1R 5X1 Canada Tel: 1-519-623-1810 Fax: 1-519-623-8930 www.rockwellautomation.com

Equipment ID	Equipment Information		Manufacture	Contact Info/ Supplier
Clamp-on Flowmeter	Model	SITRANS FU1010 (Standard)	Siemens	ACI Instrumentation Ltd 120 Woodstream Blvd. Unit #6 Woodbridge, Ontario LL7Z1 Telephone: 9052650063 www.aciltd.ca
Ultrasonic Level Monitor	Model	Siemens HydroRanger 200 Wastewater Monitoring and Control System	Siemens Milltronics	Siemens Milltronics Process Instruments Inc. 1954 Technology Drive, P.O. Box 4225 K9J 7B1 Peterbourough, ON Telephone:+1 705 745 2431 Fax:+1 705 745 0414
	Range	0.3 m to 10 m		
	Accuracy	0.25% of range or 0.24”, which ever is greater		
	Resolution	Greater of 0.1% program range or 0.08”		
	Transducer	EchomaxR series and ST-H series		
Alarm Annunciator	Model	AN-3100D Annunciator	AMETEK Power Instruments Panalarm	255 North Union Street Rochester, NY 14605 USA Tel: 1-585-263-7700 Fax: 1-585-262-4777 E-mail: power.sales@ametek.com
Hollow Metal Doors and Frames	Hinges	Stanley Works	Specialty Precision Metal Tech	9 Nixon Rd Unit 11 Bolton, ON, L7E 1G5 Phone: 905-857-2449 Fax: 905-857-7412
	Locksets	Schlage Lock Company		
	Passage Sets	Schlage Lock Company		
	Exit Devices	Von Duprin		
	Cylinders	Best Lock		
	Door Closers	LCN		
	Thresholds, Seals, Grilles	K.N. Crowder Mfg. Inc.		
Electrical Enclosures	Model	NEMA Type 12 (Conforms to IP62)	Eaton Electrical Group Cutler-Hammer Manufacturing	2-1333 Thornton Rd S. Oshawa, ON L1J 8M8 Phone (905) 443-0981 Fax (905) 443-0986 www.eatoncanada.ca

Equipment ID	Equipment Information		Manufacture	Contact Info/ Supplier
Air Conditioning	Model Capacity	Mr. Slim Split-ductless: Late Models (R22): P-Series Cooling-only (R22) 18,500 BTU Cooling Capacity	Mitsubishi Electric	Mitsubishi Electric Sales Canada Inc. 4299 14th Avenue Markham, Ontario L3R 0J2, Canada Phone: (905) 475-7728 Fax: (905) 475-6897 www.mitsubishielectric.ca
Emergency Lighting	Model Exit Light Remote Fixture	UNI 13140-22520 LPEX300 EF18DM-12V12W	Thomas & Betts Limited 700 Thomas Avenue St-Jean-sur-Richelieu, Quebec J2X 2M9 Tel.: (450) 347-5318 Fax: (450) 347-1976 E-mail: emergi-lite-info@tnb.com	Thomas & Betts Limited 2233 Argentia Road, Suite 116 Mississauga, Ontario L5N 2X7 Telephone: (905) 567-8480 Toll Free: 1-800-263-2301 Fax: (905) 567-9438
Rolling Steel Service Doors	Supplier Model Hinges Locksets Passage Sets Exit Devices Cylinders Door Closers Thresholds, Seals, Grilles	Kinnear – Canada Thermotite Door –SDF0PSC Stanley Works Schlage Lock Company Schlage Lock Company Von Duprin Best Lock LCN K.N. Crowder Mfg. Inc.	Wayne Dalton	Wayne Dalton PO Box 305 Alliston, ON L9R1V6 Phone: 7054350466
Electric Chain Hoist	Model Capacity Lift Lifting Speed Hoist Motor HP Hoist Classification Motor Type Performance Standard	ER Series – ER030L 3 tonnes (3000 kg) 10 feet 16 fpm 4.6 HP ASME H4 TEFC Squirrel Cage ASME HST-1	Kito Corporation	R.W.S. Hoists and Cranes Inc. 110 Ironside Crescent, Unit 19 Scarborough, ON M1X1M2 Telephone: 4162912005

Appendix I

Examples of Existing Architecture on Rodd Avenue

Appendix I: Examples of Existing Architecture on Rodd Avenue

Figure I- 1: 550 Rodd Ave.

Figure I- 2: 546 (to the left) and 548 (to the right) Rodd Ave

Figure I- 3: 547 Rodd Ave.

Figure I- 4: 544 Rodd Ave.

Figure I- 5: 542 Rodd Ave

Figure I- 6: 540 Rodd Ave.

Figure I- 7: 538 Rodd Ave.

Figure I- 8: 537 A Rodd Ave.

Figure I- 9: 513 Rodd Ave.

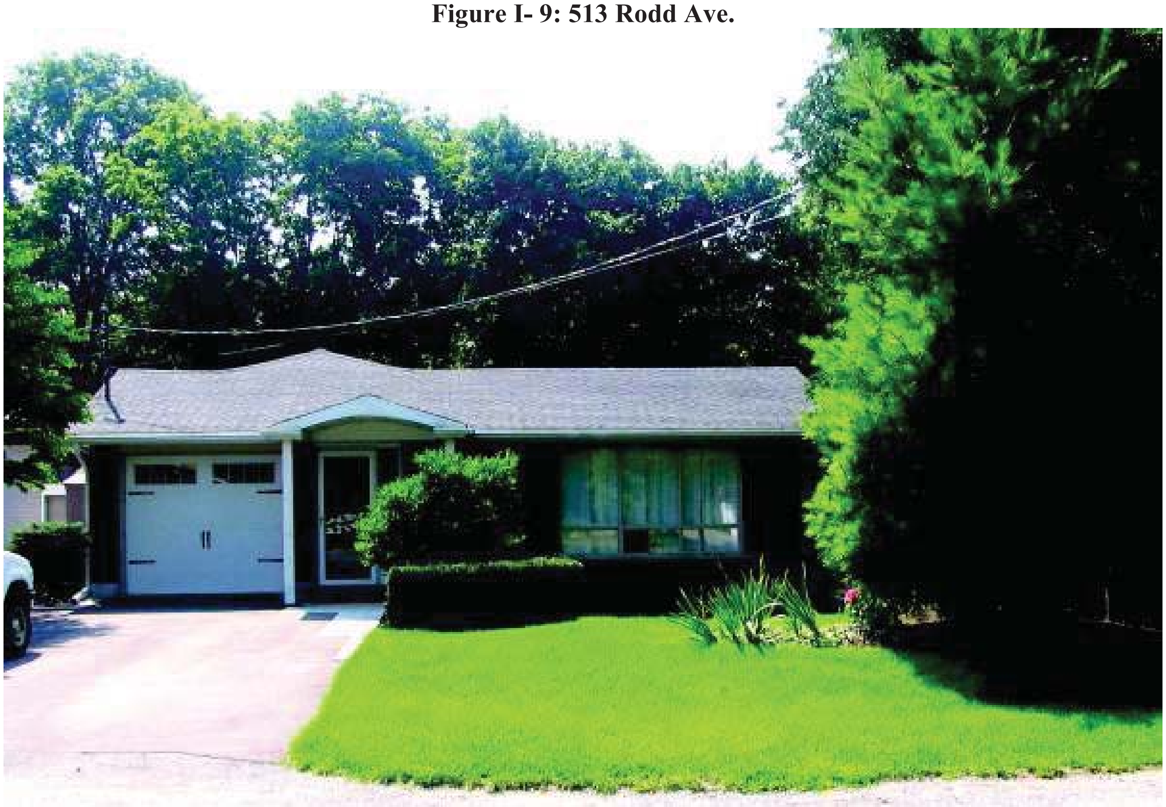


Figure I- 10: 511 Rodd Ave

Figure I- 11: Rosebank Villa (Front View)

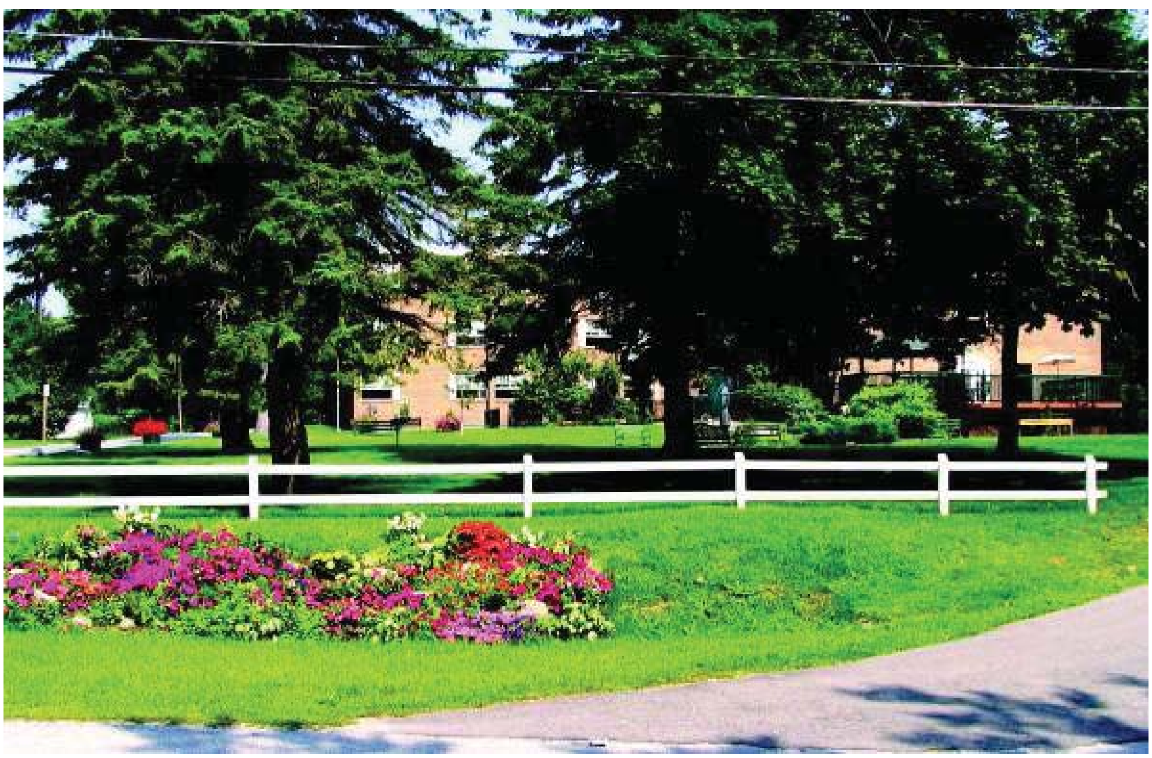


Figure I- 12: Rosebank Villa (Side View)