APPENDIX A – MONTCALM PUMPING STATION PRELIMINARY DESIGN REPORT

SNC·LAVALIN

City of Winnipeg

Montcalm Wastewater Pumping Station

Preliminary Design Report

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1.0 INTRODUCTION

The City of Winnipeg (City) is planning to upgrade Montcalm Wastewater Pumping Station to improve station reliability and to bring the station into compliance with the latest codes and standards, particularly with respect to new requirements for electrical installations within hazardous rated sewage lift stations.

This report identifies the recommended work regarding ventilation, electrical distribution upgrades, motor starting, and instrumentation and control. In addition, cost estimates are provided to guide the City in budgeting for the work.

1.1 Work Requested by the City to be Included

The City originally requested that the following be included in the proposed work:

- Replacement of two existing wastewater sewage pumps in the dry well with two new 100 HP, 3ph, 600V pumping units.
- Repair or replace the incoming electrical feeder conduit from the CSTE to the station, due to significant water leaking into the station via this conduit.
- Replacement of the existing motor control centre, which serves the two new pumps, two existing wastewater pumps, as well as other loads in the facility.
- Replacement of the existing suction and discharge piping.
- Replacement of the existing ventilation and unit heaters.
- Provide 120 Volt power for the Rosemount flowmeter installation with two separate conduits to the SCADA panel. One conduit is to be utilized for 120 Volt power, and the other conduit for 4-20 mA flow indication and flow totalization via pulse output. Also, remote indication of flow is to be provided on the main floor of the pumping station.

Note: The flowmeter installation originally planned by the City has associated issues, as discussed in Section 3.1.

- Replacement of the existing level sensing bubbler system with a DP cell based system. Level sensing instrument to be relocated from motor room to pump room to allow for the installation of a flow meter.
- Miscellaneous structural, architectural, and civil improvements.

The scope of this report is limited to electrical, HVAC, and instrumentation preliminary design. In addition, a structural review was added to the scope of the preliminary design report after structural issues were identified.

2.0 BACKGROUND

The Montcalm Wastewater Pumping Station is powered from a Manitoba Hydro owned 500 kVA, 4160-600 V pad-mounted transformer which is located adjacent to the pumping station. The pad-mounted transformer feeds a CSTE which is located next to the transformer on the same pad. The CSTE contains utility metering equipment and the associated current and potential transformers.

Parallel runs of 500 MCM RW90 connect the CSTE to the building's 800 A main breaker, located in the MCC. The cables are installed in two 103mm (4") buried conduits. A third conduit exists between the CSTE and pumping station to serve as a spare duct.

The MCC contains four Benshaw soft starters for the four 100 HP lift pumps. Each soft starter is connected to a 20 kVAR capacitor bank to provide power factor correction (PFC). The PFC capacitors are installed on top of the MCC due to the limited space within the soft starter MCC buckets. A 60 Amp breaker in the MCC feeds a 45 kVA 600-120/208 Volt transformer and panelboard used for lighting and other miscellaneous 120/208 Volt loads. The MCC also contains 15 Amp circuit breakers for feeding two ½ HP blowers and one ½ HP hoist. Refer to drawing SK-001 for the existing electrical single line diagram.

The lift pumps are controlled based on level in the wetwell. A control panel in the motor room contains a process meter that provides wetwell level indication and is equipped with relay outputs that controls an alternator, which in turn signals the pump soft starters to run. A SCADA RTU panel, located in the electrical room, transmits status and alarm signals to the McPhillips Control Center where the wastewater collection system is monitored.

The electrical room is continuously ventilated by a 1/40 HP supply fan. A thermostat is installed in the electrical room which starts a second 1/20 HP supply fan upon a rise in temperature above the set point of 30℃. One ½ HP blower supplies outside air to the pump and motor rooms and a second ½ HP blower supplies outside air to the comminutor chamber and comminutor motor room. Four small, portable unit heaters are located in the pumping station to provide heating while the station is occupied in the winter.

3.0 PROCESS

While the process pumping is not within the scope of this report, analysis of the requirement for VFD driven pumps is included. The City has requested that VFDs be seriously considered, as the pumping station feeds two HDPE forcemains that flow beneath the Red River. It is desired by the City to reduce stress on the buried forcemains, which in turn minimizes the risk of a forcemain leak into the river.

3.1 Forcemain Flow Velocities

The forcemain discharge flow rates of the pumps were investigated, as it relates to the use of VFD driven pumps. The existing forcemain configuration dedicates two pumps per forcemain, although valves are present to isolate or tie the forcemains together. The original proposal to install a flowmeter on a common discharge header is subsequently evaluated. The City's standard for minimum velocity in a forcemain is 0.6 m/s (2 ft/s), which matches the guidelines for the minimum velocity from the Ontario MOE. The expected flow velocities for various pumping configurations are presented in Table 1.

Case	Total Discharge Rate (l/s)	Forcemain Velocity (l/s)	
		Single Forcemain (m/s)	Dual Forcemain (m/s)
1 Pump – 60% flow	170	**0.6**	**0.3**
1 Pump – Full Speed	284	1.0	**0.5**
2 Pumps – Full Speed	511	1.8	0.9
3 Pumps – Full Speed	795	2.8	1.4
4 Pumps – Full Speed	1022	**3.6**	1.8

Table 1 : Forcemain Flow Rates

Notes:

1. *The total discharge rates for multiple pumps are estimates only, as hydraulic system modelling is not within the scope of this report.*

As can be seen in Table 1, the forcemain velocities are below 0.6 m/s for one pump running into the dual forcemains, and when a VFD driven single pump discharges into a single forcemain, the flow must be limited only to 60% of the full capacity to ensure the velocity remains above the minimum velocity.

It should also be noted that if all four pumps operate and discharge into a single forcemain, the velocity in the forcemain would be approximately 3.6 m/s, which is above the maximum flow velocity of 3.0 m/s recommended by the Ontario MOE.

The four pump operating scenario needs further investigation and design planning. Under the current piping configuration, two of the pumps normally flow into one forcemain, and two of the pumps flow into the other forcemain. Thus, in any operating scenario, there are no issues with flow velocities in the existing piping configuration. However, under the proposed piping configuration to allow a flowmeter installation on a common discharge header, all pumps would flow into a single header to allow a flowmeter to be installed. Thus, to keep flow velocities up when using a single pump, one forcemain would need to be manually valved off. However, when four pumps would run during high flows, the flow velocities would exceed the recommended values, unless the valve configuration was manually changed. Both forcemains cannot be left in service continuously, as it is not recommended to operate one pump into both forcemains, as flow rates would be below the minimum recommended velocity. Thus, this configuration could potentially require a significant amount of valve opening and closing, if desired operating conditions are to be achieved. The second forcemain valve would need to be opened prior to a rainstorm and closed after. Manual operation of these valves is not deemed to be a viable option. It should also be noted, that use of a single forcemain with four pumps would somewhat limit the achievable throughput, compared to use of dual forcemains.

The available options are deemed to be the following:

- If it is established that four pump operating scenarios are infrequent, and the City is willing to accept high flow velocities and reduced pumping capacity, it may be acceptable to run continuously with only one forcemain in service.
- It would likely be possible to install an electric valve actuator on the existing forcemain valves, where the second forcemain would be opened during multiple pump operating scenarios, and closed when flows drop. The space requirements for an electric actuator have not been confirmed, and structural modifications may be required.
- Eliminate the installation of a flowmeter into the system.
- Install two flowmeters into the two forcemains, but in a new manhole to be installed over the forcemains. This would allow the existing piping configuration within the station to be retained.
- Reconfigure the station pumping such that some of the pumping is relocated into the existing comminutor chamber. This would allow the use of two flowmeters and avoid a common flowmeter header. This is discussed briefly in Section 9.2.6.

The City has indicated that it prefers to install the flowmeters, one per forcemain, in a new manhole exterior to the pumping station. This is presented as an option in Section 9.2.2.

3.2 Pump Speed Control

3.2.1 General Characteristics of VFD Pumping

Potential advantages of VFDs include:

- They potentially allow a pumping station to operate with a reduced wet well size.
- Energy savings by operating the pump at its most efficient design condition, even with variable conditions.
- Reduced energy demand costs by reducing the current surge at pump start-up.
- Operation of the pump at reduced speeds, which contributes to overall pump life.
- Provide the ultimate in pump speed and flow ramping during start-up and stopping, and can reduce the stress on forcemains under normal operation.
- In some cases, can run the pump at over 100% speed for certain operating conditions.
- Reduce downstream surges due to rapid flow changes.

Potential disadvantages of VFDs include:

- Operation at too low of a speed could result in clogging of pumps or overheating of motors.
- Additional capital cost.
- Heat removal from electrical equipment area must be assessed to ensure that the life of the VFDs is not degraded by excessive operating temperatures.
- Potential harmonics issues must be identified and addressed if they are a problem.
- Additional automation complexity.

3.2.2 Pump Cycle Time Analysis

A primary factor in determining the requirement for a VFD in this application is the pump cycle time. For a pump started across-the-line (no soft start), a typical guideline is to limit the number of pump starts for a 100 HP motor to 5.9 or less per hour, as per NEMA MG 10. This is primarily due to motor heating that occurs during start-up, and excessive starts can reduce the life of the motor. Motors fitted with soft starters will have different starting characteristics. In some cases motor heating during start-up may be reduced, and in other cases it may be increased. Detailed analysis, appropriate pump parameter setting, and potential soft starter over-sizing would be required to achieve a higher number of starts-per hour. The maximum starts-per-hour that could potentially be achievable with a soft start would be approximately 10, but a more realistic value of 6.5 starts per hour is recommended for this analysis. It is also recommended that starts-per-hour (SPH) calculation be performed with one pump out of service.

It should also be noted that VFDs have the potential to reduce energy consumption. However, in this facility, it is expected that the potential energy savings would be minor and would not alone provide motivation to select a VFD for pump control.

The following information provided by the City was utilized to assess the operational impact of a VFD pump installation:

- Pump start/stop historical data, December 2007 to May 2010.
- New pump datasheets with pump curves.
- An existing average Dry Weather Flow Rate (ADWF) of 152 L/s
- Pump start/stop setpoints, which are as shown in Table 2.
- The dimensions of the wet well / sump, which are as shown in drawing 261.

Pump	Start Setpoint		Stop Setpoint	
	m	ft	m	ft
Pump 1	1.22	4.0	0.46	1.5
Pump 2	1.37	4.5	0.88	2.9
Pump 3	1.68	5.5	1.01	3.3
Pump 4	1.83	6.0	1.13	3.7

Table 2 : Pump Start / Stop Setpoints

Assumptions made in the calculations include:

- The measured wet level is referenced with 0 being the bottom of the wet well.
- There is no delay in pump operation from the time the level setpoint is reached.
- Pump flow rate is 284 l/s for a single pump, and 511 l/s for two pumps into one forcemain.

The flow rate into Montcalm Pumping Station was measured during dry weather flow between 2005-11-22 and 2006-02-24. The average flow rate was found to be in the range of 152 L/s (2409 USGPM), with a maximum dry weather flow of 340 L/s. Based upon a flow calculation document provided by the City, the design Average Dry Weather Flow (ADWF) for the station is 196 l/s (3100 USGPM) and the Peak Dry Weather Flow (PDWF) is 469 l/s (7440 USGPM). Note that this PDWF is 2.4 x ADWF, when a factor of 1.75 x ADWF has been utilized for some other cases. Regardless, the affect of pump cycling will be calculated for both flow rates.

Based upon approximated pump flow rates, the pumps would experience 2.2 starts-per-hour at ADWF, 2.4 starts-per-hour at 0.5 ADWF and 3.5 SPH at peak dry weather flow (1.75x).

Case	InFlow Rate (l/s)	# Pumps	Cycles / Hour Without Alternation	Cycles / Hour With Alternation
0.5 ADWF	98	1	7.1	2.4
0.6 ADWF	117	1	7.6	2.5
0.7 ADWF	137	1	7.8	2.6
0.8 ADWF	156	1	7.8	2.6
0.9 ADWF	176	1	7.4	2.5
1.0 ADWF	196	1	6.7	2.2
1.1 ADWF	215	1	5.8	1.9
PDWF (1.75x)	342	2	7.0	3.5
PDWF (2.4x)	469	2	5.5	2.7
PWWF (2.75x)	538	3	2.9	2.9
PWWF (4x)	728	3	1.5	1.5

Table 3 : Expected Pump Cycle Time

Notes:

1. *Cycles per Hour with Alternation assumes one pump is out of service.*

Historical pump cycle times are summarized in Table 4 below. Note that the pumping controls currently utilize alternation, and as there are typically four pumps in service, the historical starts per hour are below the calculated starts per hour, as would be expected due to the calculations assuming one pump is out of service. For all four pumps, less than 1% of all historical pump starts within the period analyzed occurred at a rate above 6 starts-per-hour (SPH).

	P1 No. Starts	P1 Avg. SPH	P1 SPH > 6	P2 No. Starts	P2 Avg. SPH	P2 SPH > 6	P3 No. Starts	P3 Avg. SPH	P3 SPH > 6	P4 No. Starts	P4 Avg. SPH	P4 SPH > 6
Dec 2007	392	1.46	0.00%	0	0.00	0.00%	393	1.45	0.00%	393	1.48	0.51%
Jan 2008	1081	1.47	0.00%	480	1.41	0.21%	716	1.48	0.00%	1079	1.47	0.00%
Feb 2008	977	1.44	0.20%	975	1.42	0.00%	0	0.00	0.00%	975	1.42	0.00%
Mar 2008	884	1.56	0.34%	881	1.26	0.00%	733	1.55	0.27%	887	1.41	0.34%
Apr 2008	851	1.44	0.00%	330	1.73	0.91%	851	1.45	0.00%	854	1.47	0.12%
May 2008	1174	1.68	0.17%	0	0.00	0.00%	1172	1.66	0.09%	1173	1.66	0.09%
Jun 2008	790	1.78	0.13%	277	3.42	0.72%	786	1.49	0.13%	786	1.47	0.00%
Jul 2008	1026	1.47	0.10%	805	1.62	0.25%	839	1.68	0.36%	1026	1.49	0.10%
Aug 2008	1087	2.17	0.92%	0	0.00	0.00%	1043	2.79	1.44%	1056	1.84	0.47%
Sep 2008	1069	1.67	0.28%	0	0.00	0.00%	1069	1.65	0.28%	1069	1.66	0.47%
Oct 2008	1051	1.65	0.10%	125	3.08	0.80%	1050	1.63	0.00%	1050	1.63	0.10%
Nov 2008	822	1.29	0.00%	823	1.30	0.12%	822	1.31	0.12%	822	1.30	0.12%
Dec 2008	1063	1.45	0.00%	1063	1.45	0.00%	1063	1.45	0.00%	1064	1.45	0.00%
Jan 2009	1091	1.48	0.00%	1092	1.48	0.00%	1092	1.48	0.00%	1092	1.48	0.00%
Feb 2009	950	1.46	0.00%	951	1.47	0.00%	950	1.47	0.00%	950	1.47	0.00%
Mar 2009	670	1.40	0.00%	925	1.50	0.00%	925	1.50	0.00%	926	1.50	0.00%
Apr 2009	745	2.25	1.74%	798	3.24	1.88%	800	4.20	2.13%	785	1.43	0.38%
May 2009	939	1.53	0.32%	941	1.56	0.32%	937	1.40	0.11%	939	1.63	0.32%
Jun 2009	944	1.45	0.11%	944	1.48	0.11%	941	1.44	0.11%	946	1.46	0.21%
Jul 2009	1076	2.10	1.12%	1064	1.69	0.56%	362	1.86	0.83%	1066	1.74	0.47%
Aug 2009	783	1.26	0.13%	784	1.58	0.13%	785	1.25	0.64%	786	1.61	0.64%
Sep 2009	848	1.21	0.00%	848	1.24	0.24%	846	1.21	0.00%	847	1.21	0.00%
Oct 2009	876	1.20	0.00%	877	1.20	0.00%	879	1.21	0.11%	875	1.20	0.00%
Nov 2009	845	1.21	0.00%	844	1.21	0.12%	845	1.22	0.24%	844	1.20	0.00%
Dec 2009	933	1.30	0.21%	932	1.29	0.11%	934	1.34	0.21%	931	1.33	0.32%
Jan 2010	902	1.25	0.11%	669	1.23	0.00%	900	1.24	0.00%	899	1.24	0.00%
Feb 2010	782	1.19	0.00%	783	1.20	0.13%	735	1.29	0.14%	784	1.21	0.13%
Mar 2010	319	1.13	0.31%	317	1.09	0.00%	274	1.98	0.36%	315	1.09	0.00%
Apr 2010	837	1.21	0.00%	837	1.22	0.12%	835	1.21	0.00%	835	1.21	0.00%
May 2010	215	1.00	0.00%	217	1.00	0.00%	215	1.00	0.00%	216	1.02	0.46%
Total	26022	1.50	0.22%	19582	1.51	0.21%	23792	1.59	0.25%	26270	1.45	0.16%

Table 4 : Historical Pump Cycle Times

Based upon an analysis of pump cycling frequency, there is not a basis for the installation of VFDs at the Montcalm Pumping Station, provided that pump alternation is provided.

3.2.3 Forcemain Velocity and Surge Control

A VFD driven pump would allow the pumping rate to more closely match the incoming flow rate. However, during periods of dry weather flow, when typically only one pump is required, it must be ensured that the VFD driven pump provides sufficient flow into the forcemain(s) to meet minimum flow requirements. As can be seen in Table 1, a single VFD driven pump can reduce the flowrate to 60% of full one-pump capacity, without having flowrates drop below the minimum flow velocity of 0.6 m/s. This reduced pumping rate is 102 l/s, which is 52% of the ADWF. Thus, a VFD driven pump would be expected to reduce pump start/stop cycles, and in many ADWF flow cases allow for more continuous pump operation. This could potentially reduce forcemain pipe stress.

However, the current level of forcemain pipe stress and pressure surges associated with pump startup has not been established. Montcalm Pumping Station is located adjacent to the Red River, and the forcemains cross the river and discharge into a structure on the west side of the river. The distance of the forcemains is estimated to be a little over 300m. The level of pressure surges in forcemains is related to the length of the forcemain, with longer forcemains typically exhibiting more issues unless appropriate methods of transient surge mitigation are provided. As these forcemains are relatively short, it is recommended to first determine the significance of the potential pressure surges.

While the pressure surges could be modelled, it is straightforward for this existing installation to install a pressure gauge on the forcemain and observe the pressure transients on the system while starting and stopping the pumps. If an issue is identified, then further investigation and potentially mitigation would be required.

If a forcemain pressure surge issue is identified, VFDs are one potential solution to the problem. However, another alternative worth considering is maximizing the effectiveness of soft starters to ramp pumps up and down. Allen Bradley has an option for their soft starters called “Pump Control”, which provides more effective ramping of the pump torque and speed up, compared to a traditional pump start, in a manner to reduce pump and hydraulic stress. Other vendor’s may have similar solutions, although this would require confirmation at design time.

3.2.4 Recommendation

While VFDs would provide the ultimate in pump speed ramping and control of hydraulic transients, they come at a significant additional expense and add complexity to the control system. Based upon the analysis performed, there is minimal motivation for installation of VFDs over soft starters for pump control.

However, the City has indicated that VFDs are preferred over soft starters at this time to reduce the stress on the forcemain. The City has indicated that two of the four pumps should be powered by VFDs and the other two pumps by soft starters. The VFD driven pumps would be the lead duty pumps and the soft start driven pumps would only start during high flows. Subsequently, VFDs are included in the proposed work.

3.3 Pump Bypass Starter

Soft starters and VFDs are based upon electronic power components, and can fail. While current equipment is very reliable, the failure rate of electronic power components is higher than electromechanical contactors. To provide additional reliability, bypass starters can be utilized to bypass the soft starter or VFD and allow for continued pump operation in the event of a soft starter or VFD failure.

The requirement for a bypass starter should be based upon the availability of the pumping system. It is recommended that the pumping station firm design flow capacity (PWWF) be provided with one pump out of service. In addition, it is recommended that for the PDWF case, that pumping capacity be provided with two pumps out of service. A summary of the analysis is shown in Table 5.

Case	Flow Rate (l/s)	# Pumps Required	# Pumps Out of Service	Bypass Starter Required
ADWF	196	1	2	No
PDWF (1.75x)	342	2	2	No
PDWF (2.4x)	469	2	2	No
PWWF (2.75x)	538	3	1	No
PWWF (4x)	782	3	1	No

Table 5 : Bypass Starter Requirements Electrical Analysis

Note that Table 5 is based upon the following assumed flowrates, and it is recommended that the City confirm that these flowrates are as expected.

- 1 Pump in operation: 284 l/s
- 2 pumps in operation: 511 l/s
- 3 pumps in operation: 795 l/s
- 4 pumps in operation: 1022 l/s

Thus, as can be seen in Table 5, there are a sufficient number of pumps installed in Montcalm Pumping Station to eliminate the requirement for pump bypass starters.

However, based upon our understanding of City practices, it is normal practice to provide bypass starters for soft starters and VFDs in lift stations, and thus bypass starters have been allowed for in the proposed design of any new starters.

4.0 VENTILATION ANALYSIS

4.1 Existing

The existing ventilation is provided by two small fans for the electrical room, and two blowers for the remainder of the station. Other than the electrical room, the blowers are not typically operated when unoccupied during the winter months. The following issues were also noted to exist with the current installation:

- There is a significant amount of moisture build-up in the pump room, and some in the motor room, due to the lack of ventilation.
- There are significant odour and corrosion issues in areas of the station, which are indicative of lack of sufficient ventilation.

The current ventilation is summarized in Table 6, however it should be noted that the ventilation rates shown are based upon old data and assumptions, and are not likely to be accurate.

Area	Occupied	Winter Unoccupied	Summer Unoccupied
Electrical Room	10.2 / 37.5 ACH	10.2 ACH	10.2 / 37.5 ACH
Main Floor Ventilation Room	Minimal to none	None	Minimal to none
Underground Level 1 (Comm. Motor Room)	0 - 12.6 ACH (See Note 2)	None	12.6
Comminutor Room			
Stairwell	0 – 15 ACH (See Note 2)	None	0 – 15 ACH
Motor Room			
Pump Room			
Valve Chambers			

Table 6 : Current Ventilation

Notes:

1. *Occupied ventilation rates are assumed to be worst case, winter rates. Some occupied ventilation is present during the summer, if personnel turn the fan on.*

2. *While a fan is present, no heating is installed for areas other than the electrical room. It is assumed that personnel do not continuously run the ventilation fan at full capacity during the winter, as it would likely freeze the station.*
3. *The ventilation rates are based upon original design drawings and assumptions and the accuracy of the existing ventilation rates is not likely to be accurate.*
4. *It is understood that ventilation is not typically turned on in the winter, as permanent heating is not installed.*

4.2 Ventilation Analysis – Electrical Room

The existing electrical room ventilation system was installed in 1996 and appears to provide sufficient ventilation. The small supply fan runs continuously to provide 10.2 ACH of positive pressure ventilation. On high temperature in the space (30°C), the large supply fan operates to provide 37.5 ACH of natural ventilation for cooling. A 4 kW unit heater provides heating for the space in winter. As the equipment was installed in 1996, it appears to be in reasonable condition, with significant service life left. No modifications are proposed for the ventilation system in the electrical room.

4.3 Ventilation Analysis - Comminutor Chamber

The comminutor chamber currently has exposed raw sewage flowing through it, and thus must be considered as a wet well space. To provide for safe entry into this space, significant ventilation and electrical classification is required. However, it is potentially feasible to pipe the raw sewage across the comminutor chamber, such that no raw sewage would be exposed. This would allow the comminutor chamber to be treated as a drywell space. The City has indicated that they believe that the installation is achievable.

Provided that the comminutor chamber is reconfigured as a drywell, there are three potential ventilation and electrical classification strategies that could be applied to the space:

- Option A: Provide 6 ACH of ventilation continuously and leave the space electrically unclassified. This meets NFPA 820, Ontario MOE, and Alberta Design Guide recommendations. For this option, the heater for the comminutor chamber, if electric, would need to be sized at approximately 20 kW to maintain a discharge temperature of 6℃ with an outdoor temperature of -40℃.

- Option B: Provide 30 ACH of ventilation only when occupied and electrically classify the space as a hazardous Class I, Zone 2 location. This meets NFPA 820, Ontario MOE, and Alberta Design Guide recommendations. For this option, the heater for the comminutor chamber, if electric, would need to be sized at approximately 125 kW to maintain a discharge temperature of 6℃ with an outdoor temperature of -40℃. Note that a further sub-option would be to reduce the ventilation rate to 6 ACH after the high-rate, 30 ACH ventilation has been active for ten minutes.
- Option C: Provide 6 ACH of ventilation when occupied and recirculate up to 75% of the air when unoccupied during the winter to conserve heat. Leave the space electrically unclassified. This meets NFPA 820 (provided gas detection is provided and integrated into the ventilation controls), but does not strictly meet the Ontario MOE or Alberta Design Guide recommendations.

The operating costs for each of the above scenarios were estimated, and are presented in Table 7.

Ventilation Option	Unoccupied Ventilation	Occupied Ventilation	Electric Heat		Natural Gas	
			Annual Operating Cost	Net Present Cost	Annual Operating Cost	Net Present Cost
Option A	6 ACH	6 ACH	$1,824	$48,300	$1,648	$43,700
Option B	None	30 ACH	$3,146	$83,400	$365	$9,700
Option C	6 ACH, 75% Recirc.	6 ACH	$1,051	$27,800	$576	$15,300

Table 7 : Comminutor Chamber Ventilation Operating Costs

Notes:

1. *The energy calculation for the Comminutor Chamber assumes that the space will be occupied for two (2) hours per week.*

2. *The net present value calculation assumes a 5% annual rate of increase of operating costs, 7% cost of capital and 40 years of operation. Capital cost has not been included in this value.*
3. *Electricity rates are assumed to be $0.0305 / kWh and $8.34 / KVA demand and natural gas rates are assumed to be $0.35 / cubic metre for the calculations.*
4. *A discharge temperature of 6℃ was assumed for options A through C. If the ventilation to the comminutor chamber were not to be heated, it is expected that condensation and freezing problems could develop, and that personnel would disable the ventilation prior to entry.*
5. *The large difference in electric vs. natural gas heating costs for options with non-continuous heating is due to the demand charges associated with electric heating.*

The lowest cost ventilation option for the comminutor chamber option is Option B using natural gas, where 30 ACH of ventilation is provided upon occupancy. However, this option is impractical as the associated air handling unit would be very large and difficult to locate on the site. Thus, it appears that Option C, which proposes 6 ACH of ventilation with 75% recirculation when unoccupied, is the most cost effective and practical solution.

4.4 Ventilation Analysis - Drywell Spaces

The drywell spaces within the facility are deemed to be the following:

- Basement Level 1 (shown on existing drawings as the Comminutor Motor Room)
- Stairwell
- Motor Room
- Pump Room
- Valve chambers
- Main Floor Mechanical Room

As the comminutor chamber is assessed separately in Section 4.3, it is not included in the calculations for this section.

It is recommended to ventilate the drywell spaces with 6 ACH of ventilation, with 75% recirculation when unoccupied. This generally meets the requirements of NFPA 820, although NFPA 820 does require that combustible gas detection be installed and that recirculation be disabled upon combustible gas detection. Note that the Ontario MOE and the Alberta Design Guide recommendations do not indicate an option for 75% recirculation.

The costs for drywell ventilation for both electric and natural gas heating were calculated, and are shown in Table 8. Note that the natural gas alternative is significantly less than the electric heat alternative, largely due to the demand charges associated with electric heating.

Ventilation Option	Unoccupied Ventilation	Occupied Ventilation	Electric Heat		Natural Gas	
			Annual Operating Cost	Net Present Cost	Annual Operating Cost	Net Present Cost
Proposed	6 ACH 75% Recirc.	6 ACH	$3,323	$88,000	$2,138	$56,600

Table 8 : Proposed Drywell Ventilation Operating Costs

Notes:

1. *The ventilation associated with the comminutor chamber is not included in the above costs.*
2. *The energy calculation for the Drywell assumes that the space will be occupied for eight (8) hours per week.*
3. *The net present value calculation assumes a 5% annual rate of increase of operating costs, 7% cost of capital and 40 years of operation.*
4. *Electricity rates are assumed to be $0.0305 / kWh and $8.34 / KVA demand and natural gas rates are assumed to be $0.35 / cubic metre for the calculations.*

4.5 Proposed Ventilation

It is recommended to supply 6 ACH of ventilation, with 75% recirculation when unoccupied for the comminutor chamber and all drywell spaces in the building. The comminutor chamber was discussed separately in Section 4.3, as it is currently a wet well space and after the proposed conversion, will be occupied only on occasion. As discussed in Section 4.3, natural gas heating is preferred due to lower operating costs. There are also benefits to combining the comminutor chamber air handler with the drywell air handler, as a single air hander is more cost effective, and takes up less space. The total ventilation costs, with a single air handler were calculated and are shown in Table 9. Note that with natural gas, the combined annual operating cost with the comminutor chamber included is only $130 more than the cost to ventilate the drywell spaces only, as shown in Table 8. Also note the significant cost benefit to utilizing natural gas over electric heating.

Ventilation Option	Unoccupied Ventilation	Occupied Ventilation	Electric Heat		Natural Gas	
			Annual Operating Cost	Net Present Cost	Annual Operating Cost	Net Present Cost
Proposed	6 ACH, 75% Recirc.	6 ACH	$4,209	$111,500	$2,268	$60,100

Table 9 : Proposed Single AHU Operating Costs

Notes:

1. *The energy calculation for the Drywell Spaces assumes that the space will be occupied for eight (8) hours per week.*
2. *The net present value calculation assumes a 5% annual rate of increase of operating costs, 7% cost of capital and 40 years of operation. Capital cost has not been included in this value.*
3. *Electricity rates are assumed to be $0.0305 / kWh and $8.34 / KVA demand and natural gas rates are assumed to be $0.35 / cubic metre for the calculation.*
4. *A discharge temperature of 6℃ was assumed for unoccupied conditions and 20℃ when occupied.*

It is recommended that a single indirect-fired natural gas unit be installed in the Main Floor Mechanical Room to ventilate the entire drywell space, including the comminutor chamber. The unit will normally provide 25% outdoor air during unoccupied periods and 100% outdoor air when occupied. With only one air handler, when any space within the building is occupied, the entire building would be ventilated at the full 6 ACH. However, the additional costs associated with this single occupancy group is deemed to be significantly less than the capital costs associated with a second air handler.

Note that if electric heating were to be utilized, it is recommended to separate the comminutor chamber heating system from the remainder of the drywell, to reduce demand charges when occupied. However, to reduce operating costs, natural gas based heating is recommended.

The ventilation recommendations, as summarized in Table 10, have been presented on the basis of currently accepted good engineering practice, and published codes and guidelines. Note however that local Manitoba Code regulations do not require conformance to the utilized codes and standards described, and while not recommended, do not preclude the use of a lower level of ventilation.

Area	Occupied	Winter Unoccupied	Summer Unoccupied
Above Grade/ Main Floor Electrical Room	A	A	A
Drywell Area Comminutor Chamber Basement Level 1 Stairwell Motor Room Pump Room Valve Chambers Mechanical Room	B1	B2	B3

Ventilation Legend:

Minimum 10.2 ACH continuous ventilation, unit heaters set to 20°C minimum, pressurized +25 Pa relative to adjacent spaces.
Increase to 37.5 ACH upon temperature exceeding 30°C

B1 6 ACH continuous, 18°C minimum, pressurized to +25 Pa

B2 6 ACH continuous, 6°C minimum, pressurized to +25 Pa, 75% recirculation

B3 6 ACH continuous, no heating, pressurized to +25 Pa

Table 10 : Proposed Ventilation

Notes:

1. *It is assumed that the Comminutor Chamber can be piped across, to avoid raw sewage being present in the drywell.*

4.6 Dehumidification

The Montcalm Pumping Station drywell has significant potential for moisture condensation onto the pipe work during the summer months when air humidity is high. Given that the proposed ventilation in the space will increase, it is expected that the condensation onto the pipe work could potentially be worse than the existing situation. However, it is expected that the moisture levels in the space will be lower during the winter, due to the heated ventilation being supplied. The solution to the condensation issue would be to install dehumidification. This is deemed to be an option, and it is planned, at minimum, to allocate a space for dehumidification during detailed design.

4.7 Detection of Combustible and Toxic Gases

The proposed ventilation rate of 6 ACH, with 75% recirculation when unoccupied is based upon NFPA 820. However, NFPA 820 requires that recirculation is turned off automatically upon combustible gas detection via a permanently installed gas detector. In discussion with the City, it is understood that City personnel utilize portable gas detectors when entering the pumping station and the City does not wish to install any permanent fixed gas detection, which would require regular calibration. Note that this does not meet NFPA 820 requirements.

5.0 ELECTRICAL

5.1 Electrical Load Analysis

The capacity of the electrical service was investigated to determine if it is sufficient to power the new ventilation equipment loads. An electrical load estimate was performed for both electric and natural gas heating alternatives, and is summarized in Table 11 and Table 12.

As can be seen from the load analysis, the existing supply transformer should be able to support either the electric or natural gas heating alternatives.

Load	Connected (A)	Demand Factor	Load Estimate (A)
Pump 1 – 100 HP	95	1	95
Pump 2 – 100 HP	95	1	95
Pump 3 – 100 HP	95	1	95
Pump 4 – 100 HP	95	1	95
45 KVA Transformer (120/208V loads)	43.3	0.5	22
Hoist – ½ HP	1	0.5	0.5
AHU-L1	1.5	1	1.5
Total Load (without PFC)			**404**
Proposed Spare Capacity			**~77**

Table 11 : Load Estimate @ 600V – Natural Gas Heating

Notes:

1. *Loads shown are preliminary and will be reviewed at detailed design.*

Load	Connected (A)	Demand Factor	Load Estimate (A)
Pump 1 – 100 HP	95	1	95
Pump 2 – 100 HP	95	1	95
Pump 3 – 100 HP	95	1	95
Pump 4 – 100 HP	95	1	95
45 KVA Transformer (120/208V loads)	43.3	0.5	21.7
Hoist – ½ HP	1	0.5	0.5
Supply Fan SF-L1	1.5	1	1.5
Supply Fan SF-L2	1.0	1	1.0
Heating – Drywell, 65 kW assumed	62.5	0.75	46.9
Heating – Comm. Chamber, 20 kW assumed	19.2	0.75	14.4
Total Load (without PFC)			**466**
Proposed Spare Capacity			**~15**

Table 12 : Load Estimate @ 600V – Electric Heating

Notes:

1. Loads shown are preliminary and will be reviewed at detailed design.

5.2 Motor Starters

The City has indicated that the existing Benshaw motor starters are starting to age and spare parts are becoming more difficult to obtain. Note that the existing Benshaw starters were installed in 1996. The City has requested that two new Variable Frequency Drives (VFDs) be installed to power two of the wastewater lift pumps. The VFDs would also include a bypass starter with a motor overload to allow for starting of the motor in the event of a VFD failure. Isolation contactors will be utilized to isolate the VFD when in bypass mode of operation. The base design would allow for continued use of two soft starters for two pumps, and the other two soft starters, replaced by VFDs, would be utilized as spares. However, replacement of the soft starters is a potential option, as identified in Section 9.2.1.

The starters will utilize either NEMA or IEC style contactors, however if IEC contactors are utilized, they will be sized a minimum of one size larger than the minimum required.

5.3 Required Electrical Distribution

The existing MCC contains four sections. The first section, starting from the right, contains the main 800A breaker. The second section contains small starters and feeder breakers. The third and fourth sections are 30” wide, rather than the standard 20”, and each contain two 100HP soft starters. The existing Benshaw soft starters are installed in an extremely compact manner, and it is expected to be a challenge to fit a soft starter from another manufacturer, with the same number of auxiliary contactors, within the same space. A VFD with a bypass starter is also not expected to fit within the existing space.

In addition, the potential sequencing of the upgrade implementation was investigated. Any significant modifications to the MCC structure would require a complete power outage of significant duration, which in turn would require bypass pumping. Given the flow rates at the station, it is expected that a minimum of two 100 HP pumps would be required to meet PDWF requirements. It would be advantageous to configure the new electrical distribution in a manner that minimizes shutdown requirements.

Thus, it is proposed to install a 600V distribution panel in the station. This distribution panel would be installed in the area identified as the “Mechanical Room” of the station. The new distribution panel, PNL-L1, would be set up to power two pumps, while the existing MCC would power the two remaining pumps. The new PNL-L1 would feed the existing MCC, MCC-L1.

There are many advantages to this proposed configuration, including:

- Allows the new distribution panel and VFDs to be installed without a shutdown of the existing pumps.
- Would allow for a reduced shutdown window associated with the replacement of the buried cables from the CSTE.
- Provides more space for the ventilation equipment feeder(s).
- Makes future maintenance events simpler, as the existing MCC can be shut down, without affecting all four pumps. Note that shutdown of PNL-L1 may require the supply of temporary power to MCC-L1 in the future.
- The building where the existing MCC is located is believed to have been constructed in the 1930's, and is constructed of clay brick. The space where the mechanical room is located was constructed around 1950, and is constructed with concrete walls. While there are some issues with the 1950's building due to attack of corrosive gases, it is expected that the building is easily repairable. However, it is assumed that at some point in the future, the 1930's building superstructure will require replacement. With the electrical distribution split into two MCCs, future replacement of the 1930's building superstructure would be simplified.

5.4 Design Basis

5.4.1 General and Environmental Requirements

Electrical equipment in conditioned spaces will be rated 0°C to 35°C, 0 – 95% RH.

All electrical equipment will be CSA approved, or equivalent. Where existing electrical equipment is modified, an appropriate Department of Labour inspection will be performed.

Enclosures will be either Type 1 or Type 12 on the main floor of the pumping station. On lower levels, enclosures will either be NEMA 12 or NEMA 4.

5.4.2 Power Factor Correction

The existing system utilizes power factor correction capacitors connected via a dedicated contactor to the individual motor starters. This configuration is appropriate for soft starters but is not required for VFD.

The existing motor capacitor banks are sized at 20 kVAR. This is slightly undersized for a 100 HP motor, where the capacitor is switched via a dedicated contactor. At the detailed design stage, replacement of some or all of the capacitors with larger units will be investigated.

5.4.3 Grounding

According to City drawing 1542, a three-rod electrode was installed with 3/0 AWG bare copper wire in 1996. This grounding is deemed to be adequate for this facility. If possible, this electrode will be reutilized, although any modifications to the electrical service will require at minimum, reconnection of the ground electrode.

5.4.4 Electrical Classification

Provided that the ventilation is upgraded as proposed, the interior drywell spaces and comminutor chamber would be electrically unclassified. However, the wet well would be a Class I, Zone 1 location, as well as a Category 2 Wet location as per CEC Section 22.

5.4.5 600V Distribution Panel

The proposed new PNL-L1 will be fed from the existing utility transformer via the existing outdoor CSTE. Specific requirements for the 600V distribution panel are as follows:

- Rating – 800 A, 600 V, 3 ph, 3 wire.
- Enclosure – Indoor drip proof.
- A power meter to allow for power monitoring. The power meter will include a form-C dry contact for power alarming to the SCADA system. The power meters will have the capability for future Ethernet connections.
- TVSS.

5.4.6 Variable Frequency Drives

The proposed new VFDs would be located in the existing Mechanical Room, adjacent to the 600V distribution panel, PNL-L1. Each VFD will be in an independent floor-standing enclosure. Specific requirements for the VFDs are as follows:

- Rating – 74.6 kW (100 HP), 600 V, 3 ph.
- Enclosure – Indoor drip proof.
- Manual-Off-Auto and VFD-Bypass selector switches.
- Door-mounted VFD keypad.
- Bypass and isolation contactors.
- Line and load reactors or other harmonic mitigation as required.

5.4.7 Transformers – 600-120/208 V

It is proposed to reutilize the existing 45 kVA transformer, and thus no new 600-120/208V transformers are required. It should be noted that the existing transformer does not meet code in that 150mm of clearance is not provided between the walls and the transformer. In addition, the transformer is mounted below the panelboard and impedes on the 1 metre of clear space required around the panelboard. However, these issues are not deemed to major issues, and it is expected that they are grandfathered as being accepted at the time of installed.

5.4.8 Panelboards – 120/208 V

It is believed that the existing panelboard was installed in 1996, and is in good condition. No new 120/208V panelboards are required as the existing panelboard will be reutilized.

5.4.9 Uninterruptible Power Supply

It is proposed to install a UPS for control power to critical controls.

5.4.10 Motor Starters and Feeders (600 V)

600 V motor starters will be located in the existing Motor Control Center (MCC). Each motor starter will be lockable, providing an isolation lock-off point for maintenance purposes. New local motor disconnect switches will not be installed.

Motor starters will typically contain motor circuit protectors, NEMA contactors, electronic overloads, dedicated control power transformers, an HOA (Hand-Off-Auto) switch, and a red pilot light to indicate running status.

5.4.11 Lighting

There is insufficient lighting in a significant number of areas within the pumping station. It is proposed that the lighting be upgraded as follows:

- Replace the incandescent lighting in the existing electrical room with fluorescent lighting. Provide an average lighting level of at least 300 lux.
- Replace the incandescent lighting in the remaining main floor space (Mechanical Room) with fluorescent lighting. Increase the average lighting level to at least 250 lux.
- Replace the incandescent lighting in the lower levels with fluorescent lighting. Provide an average lighting level of at least 250 lux.
- Install fluorescent lighting in the modified Comminutor Chamber. Provide an average lighting level of at least 150 lux.
- Install battery based emergency lighting throughout all commonly occupied areas of the pumping station.

5.4.12 Receptacles

There are a limited number of 120V convenience electrical receptacles throughout the station. It is proposed to install additional 120V receptacles. In addition, 240V receptacles will be installed at key locations where a portable hoist could be utilized. This will be coordinated with the City at the detailed design stage. All receptacles located below grade will be of the weatherproof type with covers.

5.4.13 Cables and Wiring

The underground conduits from the CSTE to the pumping station have been noted to allow excessive water into the pumping station. It is proposed to replace the conduits and associated wiring with Teck90 cables. The cables would be routed underground, and up the exterior of the pumping station, entering the pumping station through the wall. The cables would be protected with checker plate above grade.

The existing conduits from the MCC to the pump motors is believed to be rigid galvanized steel. The conduits appear to be aged, and it is assumed that some corrosion exists on the interior of the conduits. It is proposed to replace the existing conduits to the pumps with new rigid aluminum conduit and RW90 wiring. Rigid conduit is proposed to provide mechanical protection, as pumps and motors could be moved in the vicinity of the wiring route.

As the existing electrical distribution is aged, it is proposed to replace most conduit and wiring. New wiring would generally be RW90 in conduit. In any area with the potential for mechanical abuse, rigid aluminum conduit would be utilized. In areas where mechanical abuse is not an issue, PVC conduit would be utilized.

All wiring for 600 V systems will be rated 1000 V. All 120/208 V wiring will be rated 600 V.

5.4.14 Engineering Studies Required

The following electrical engineering studies will be required as part of the design and performed by the Engineer.

1. A short circuit study is required to ensure that the electrical equipment is adequately rated.
2. A coordination study is required to ensure that selective tripping, in the event of a fault, occurs to the greatest extent possible.
3. An arc flash study is required to evaluate the potential arc energy and potential hazards, and provide labels for installation on the electrical equipment.
4. A harmonics study to evaluate potential harmonic issues due to the use of variable frequency drives.

5.4.15 Implementation Requirements

The Montcalm Pumping Station is critical to the wastewater collection system in Winnipeg. All work must be staged and shutdowns must be planned with limited durations to prevent sewer overflows or backing up into basements. This must be investigated and planned further during detailed design.

6.0 AUTOMATION ANALYSIS

The automation system is composed of the instrumentation and control system responsible for monitoring and controlling the pumping station.

6.1 Level Sensor

Montcalm Pumping Station currently has a single wet well level sensor. One disadvantage of the existing system is that the level sensor is a bubbler based system, and relies upon compressed air. The compressed air is currently supplied via a portable commercial-grade compressor, and is monitored by a pressure switch connected to the SCADA system for alarming. A means to manually purge the line is provided. While this configuration has proven effective operation, the City has expressed interest in converting the level sensor to a differential pressure sensor, directly off the wet well level. The City has utilized differential pressure cells at many other lift stations with success, and the advantage of this system is that it is simple. The disadvantage of a simple differential pressure system is that it is more susceptible to dirt and grease build-up, which could affect measurements, although the City has noted reliable operation from the differential pressure installations at other pumping stations.

The Design Guidelines for Sewage Works 2008, published by the Ontario Ministry of the Environment recommends that bubbler type level monitoring systems should include dual air compressors. This is not currently provided at Montcalm Pumping Station.

It should also be noted that the operation of the station is currently dependent upon a single level sensor. Should the level sensor fail, the station would be inoperable until an operations crew arrives at site, establishes an alternate means of level measurement, and manually control the pumps. To increase reliability, a second level sensor is recommended. In addition to providing backup control, the second level sensor allows for comparison between the two level sensors, and an alarm can be set when the level difference exceeds a specified tolerance level.

An option for the backup level sensor is a submersible pressure sensor. This type of sensor would typically be installed in the wet well, and serviced via a manhole. At the

Montcalm Pumping Station, the wet well manhole is near to a pump suction intake, which would affect the reading on the submersible pressure sensor. Thus, installation of a submersible pressure sensor in the wet well would require the installation of a new manhole or shaft into the wet well, which is not deemed to be cost effective for this project. Installation of a submersible level sensor into the pipe-work proposed across the existing comminutor chamber was also investigated; however the invert of the existing connection between the comminutor chamber and the wet well is 0.89m (2.92') above the bottom of the wet well. Thus, a submersible level sensor installed in the comminutor chamber would not be able to sense levels below 0.89 m in the wet well. In addition, a stilling chamber would need to be installed to ensure that flow velocities at the submersible level sensor remain low. While it would be possible to modify the comminutor chamber as required, it is deemed that the cost to install the submersible level sensor is not warranted.

Thus, it is recommended to install a simple differential pressure level sensor in addition to the existing bubbler system. The two level sensors can be configured in a redundant configuration to ensure a high level of reliability. The location for installation of a differential pressure level sensor is not necessarily straightforward, and it is proposed to investigate utilizing the wall in the stairwell that is adjacent to the wet well for this purpose.

6.2 Pump Control

The existing control system utilizes the wet well level to control the operation of the four lift pumps. A wet well level sensor sends a 4-20 mA signal to a Precision Digital meter, which has output relays that turn on at setpoint levels. These level setpoint signals pass through an alternator, which in turn controls pump operation. This system is similar to many other pumping stations and is well proven within City pumping stations.

One disadvantage with this system is that it is not easy for operators to change the wet well level setpoint. The Precision Digital meter is not intuitive in its setup, and it is anticipated that an instrument technician would typically be required to change the level setpoint.

It may be desirable during certain operating events to change the desired wet well operating level. This could be accomplished by utilizing the SCADA system.

As discussed in Section 6.1, it is also recommended to provide level sensor redundancy. This is not feasible with the existing Precision Digital meter installation. This functionality could be accomplished via either a PLC or utilization of the SCADA RTU.

If control functionality is installed into the SCADA RTU, the security of the system must be investigated. The RTU is accessed via a PSTN modem, and has no security username or password implemented. As the existing RTU is only acting as an alarm and information system, it would not be a large issue if the existing system were compromised. However, if pump control were to be implemented in the RTU, the potential consequences of unauthorized access would be unacceptable. This will be investigated further as part of the Wastewater SCADA Study, which is in progress.

In addition, as it is proposed to install automated control, including potential future remote control capability via SCADA, it is recommended to install a PLC for station control. In addition to providing pump control, the PLC allows for installation of a local HMI to provide full alarm display, and pump control capability local at the station. Finally, it is proposed that the PLC would also provide control for the ventilation at the station. This PLC control approach is currently installed at Marion Wastewater Pumping Station.

It is proposed to install a local colour touchscreen HMI on the main floor of the pumping station. This would provide operators with alarm indication, a process mimic graphic indicating the status of the pumps and ventilation in the station, as well as manual control capability for the station. Wet well levels and discharge flows would be displayed on the HMI.

6.3 SCADA System

The SCADA communication could occur via one of two potential methods:

- The PLC could communicate with a RTU via Modbus or Modbus TCP for communication with the SCADA system. The RTU would not require any dedicated I/O.
- The PLC could utilize a DNP3 RTU module to allow for direct communication to the SCADA system.

It is proposed that the method of SCADA communication to be implemented be reviewed at the detailed design stage.

Note: SNC Lavalin is working on another project with the City that will potentially set the direction for the future SCADA system. The decisions made as a result of the SCADA report could potentially affect the proposed SCADA interface.

6.4 Flowmeter

The City's original proposal was to install a single discharge flowmeter in a common pump discharge header mounted in the pump motor room. However, as discussed in Section 3.1, this configuration will not be acceptable for the various forcemain operating scenarios.

If flowmeters (flowtubes) are installed exterior to the station, as discussed in Section 9.2.2, t is desired that the flowmeter transmitters be installed within the station building, if possible. This will allow for simplified maintenance of the flowmeter transmitters, without entering the flowmeter manhole. In addition, the flowrates would also be available on the proposed HMI on the main floor, as well as via the SCADA system.

As requested by the City, the power will be supplied to the flowmeter transmitters in a separate conduit from the instrumentation conduit or cable, which will contain wiring for 4-20 mA flow indication and flow totalization via a pulse output.

6.5 Ventilation Controls

The following additional controls will be required to achieve the proposed ventilation strategy for the station:

- New ventilation air handler control and monitoring.
- Drywell exhaust damper control, based upon occupancy.
- Main Floor Room Temperature Sensor, with PLC input connection for alarming.
- Motor Room Temperature Sensor, with PLC input connection for alarming.
- Occupied switch and ventilation controls, mounted on the control panel.

6.6 Other Instrumentation

Other instrumentation to be installed includes the following:

- Power Fail Contact from the Power Meter
- Comminutor Chamber Flood Alarm – Flygt Ball
- Pump Room Flood Alarm – Flygt Ball
- Station High and Low Temperature Alarming (via temperature sensors)

6.7 Control Panel

The proposed control panel modifications are fairly extensive, and it is therefore recommended to replace the control panel. It is proposed that the PLC panel will be designed by the Engineer and supplied by the Contractor. Based upon previous projects, it is assumed that the RTU panel (if required) will be supplied and installed by City E&I forces.

7.0 BUILDING ANALYSIS

Through site investigations and preliminary analyses, it is determined that the proposed upgrades to the electrical, instrumentation, and heating and ventilation equipment require a reconfiguration of some of the existing space. The existing electrical room, which is approximately 3m by 3m, is quite small, and no spare space is available. However, the existing main floor space adjacent to the electrical room, which currently houses only a single ventilation fan, is unutilized and could be repurposed. This room is designated as the Mechanical Room in this report.

The main floor Mechanical Room is shown in Figure 1 and Figure 2. See Section 8.0 for a structural review of the space.

Figure 1 : Mechanical Room - South-East View

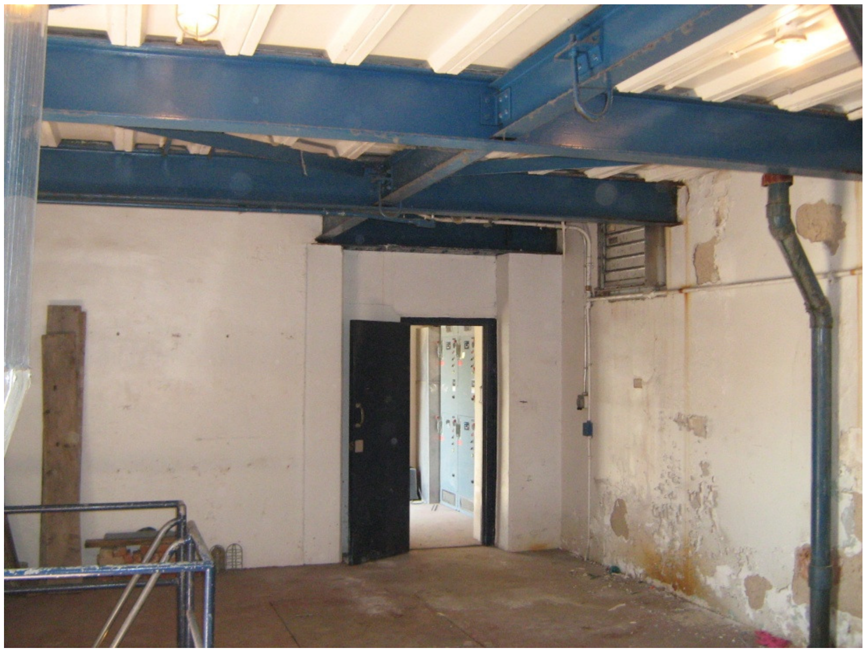

Figure 2 : Mechanical Room - North-West View

The Mechanical Room will be repurposed for HVAC, electrical, and automation equipment. To accomplish this, it is recommended that the space be refurbished by repairing and painting the surfaces. Some access hatches to the lower level may need to be reconfigured or removed to accommodate ducting for the lower levels. This will require further review during detailed design.

8.0 STRUCTURAL REVIEW

A visual examination of the Montcalm Waste Water Pumping Station was performed on March 31, 2011 for the purpose of structural assessment. The observations of the visual inspection are identified below.

8.1 Main Floor Mechanical Room

The main floor mechanical room is in the east portion of the building and was constructed in approximately 1950. It currently houses a supply fan, and has stairwell access to the lower levels. The room is of brickwork construction, with steel beams supporting the roof. The following issues were identified:

- The roof steel beams appear to be adequate to carry the imposed structural loads. However, they require cleaning and painting. See Figure 3.

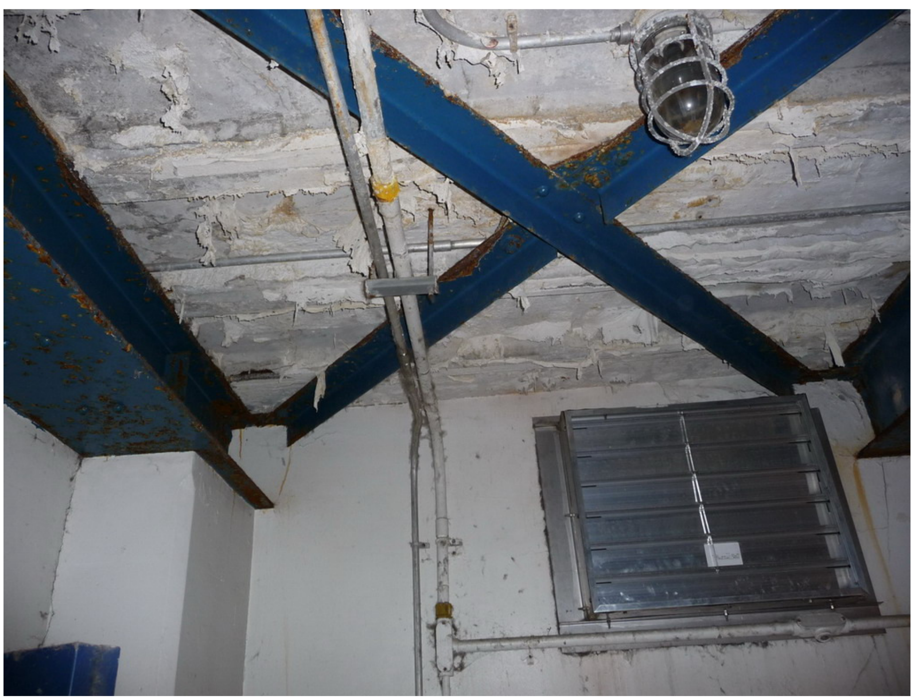

Figure 3 : Mechanical Room Ceiling

- The plaster surface and the underneath hollow tiles of the walls show damage at several locations. The damaged portions require repairs. The level of insulation in the building is unknown. The original 1950's drawing number 263 shows 50mm (2") of foam glass in the walls sandwiched between 200mm (8") bricks and 100mm (4") hollow tiles. However, the accuracy of this drawing is not known. Insulation adequacy of the walls was not assessed, as the scope of this work was the building repairs only. See Figure 4.

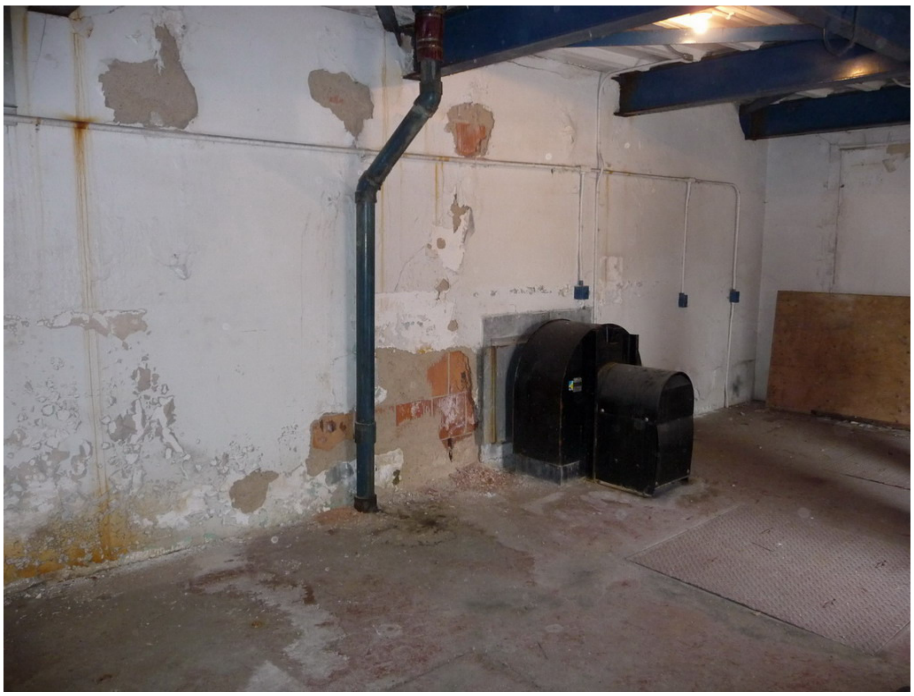

Figure 4 : Mechanical Room

- The floor of the room requires surface repairs.
- A crack above the door between the electrical room and mechanical room requires repair.

8.2 Comminutor Motor Room

The comminutor motor room is beneath the mechanical room and above the comminutor chamber. It is of concrete construction, with reinforced concrete beams supporting the floor above. At one time this space housed motors for the comminutors, but these have been removed. The following issues were identified with the space:

- The reinforced concrete ceiling beams and slab appear to be in a satisfactory condition.
- The hatch opening in the ceiling of the room and the area around it needs structural repairs. See Figure 5.

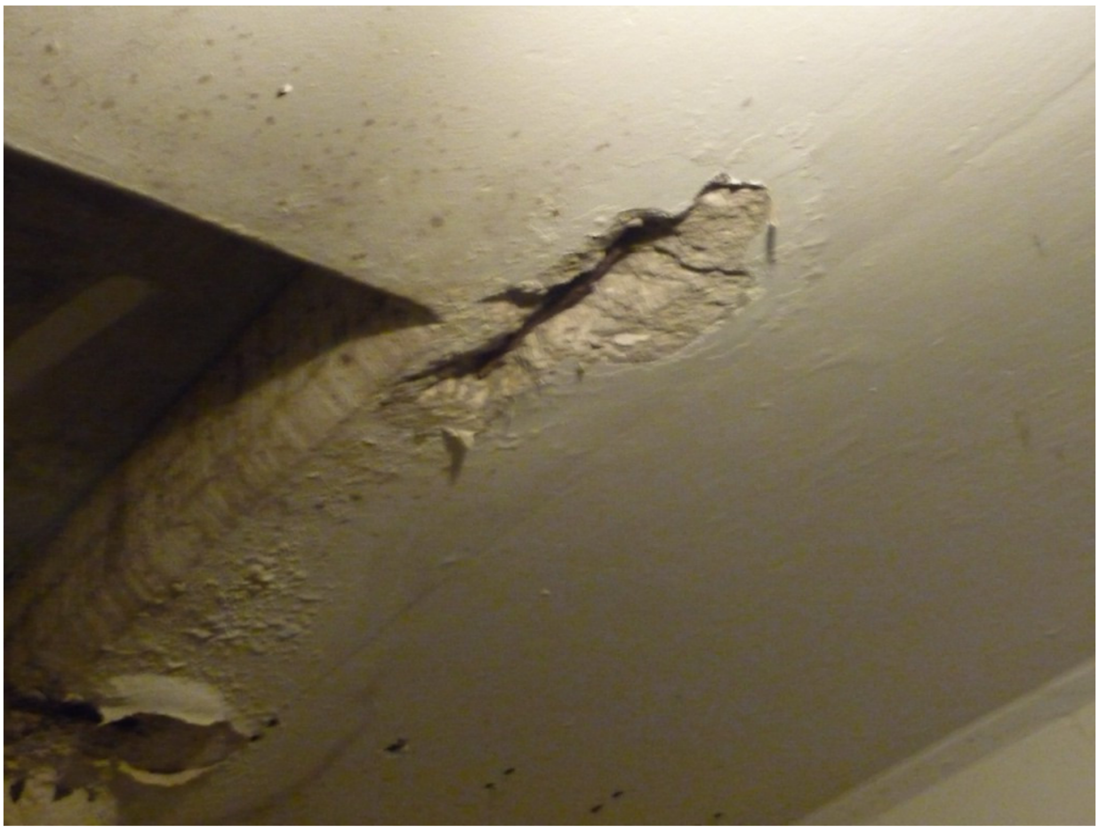

Figure 5 : Comminutor Motor Room Ceiling Hatch

- The reinforced concrete ceiling, roof beams, walls and floor of the Comminutor motor room requires surface repairs and painting.

8.3 Comminutor Chamber

The comminutor chamber is beneath the comminutor motor room, and allows wastewater to flow from the sewer to the wet well. Currently the comminutor room has exposed wastewater, however it is planned to pipe the wastewater across the room. The access to the room is via a stairwell that is normally covered to reduce the odours in the remaining parts of the station. The comminutor chamber is of concrete construction and was built in the early 1950s. The following issues were identified with the space:

- The reinforced concrete roof beams and slab seem to be in a satisfactory condition. A detailed structural assessment will have to be carried out if heavy live loads or equipment loads are expected on the floor of the Comminutor Motor room.
- A roof beam around the opening for the stairs shows extensive concrete degradation, and structural repairs need to be carried out. See Figure 6.
- A steel roof beam in this chamber appears to be damaged extensively. The purpose of the beam needs to be identified and the beam replaced if required. See Figure 7.

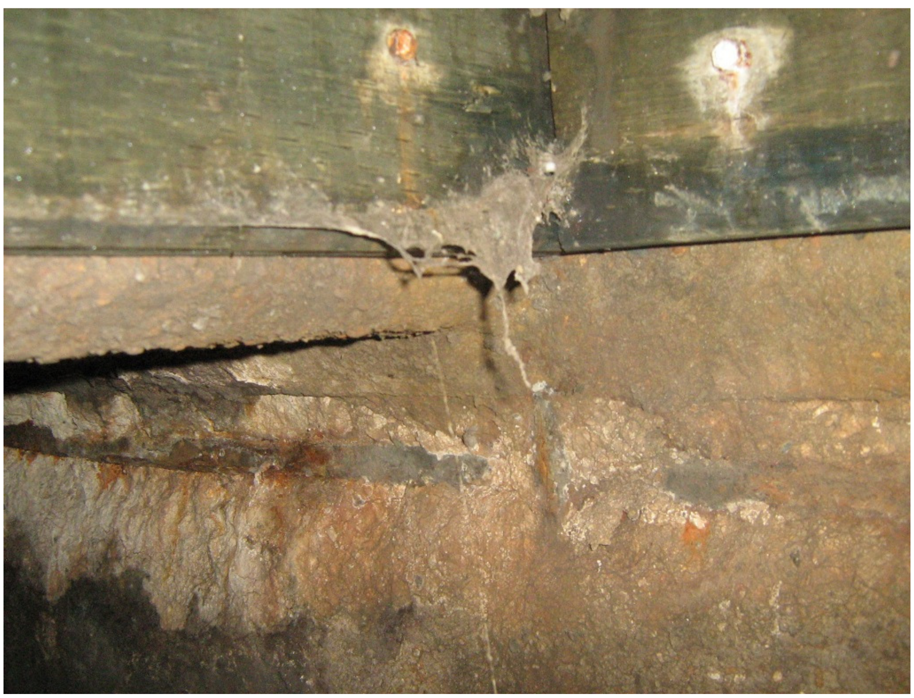

Figure 6 : Comminutor Chamber Stairway Opening

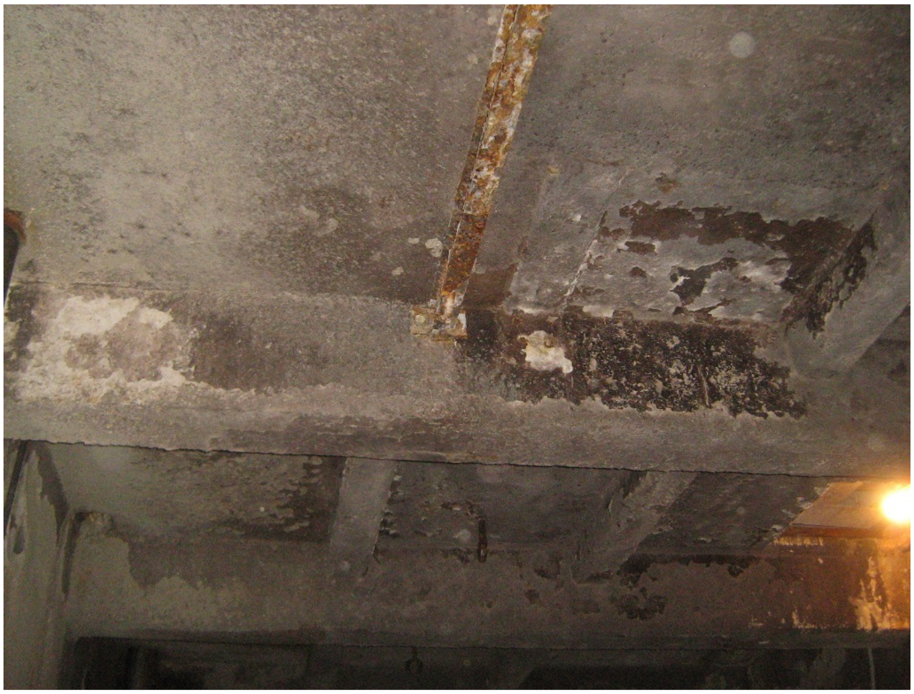

Figure 7 : Comminutor Chamber Steel Beam

8.4 Motor Room

The motor room is part of the original station construction in the 1930s, and houses four motors for the wastewater pumps in the pump room below. There are also two smaller rooms off the motor room that provide access to the valve chambers below. The following issues were identified with the space:

- The monorail beam in the Motor room shows some corrosion damage. It needs to be cleaned and painted.
- The walls of the Motor room are defaced by some dripping fluid. The leaks need to be plugged and the walls painted. See Figure 8.

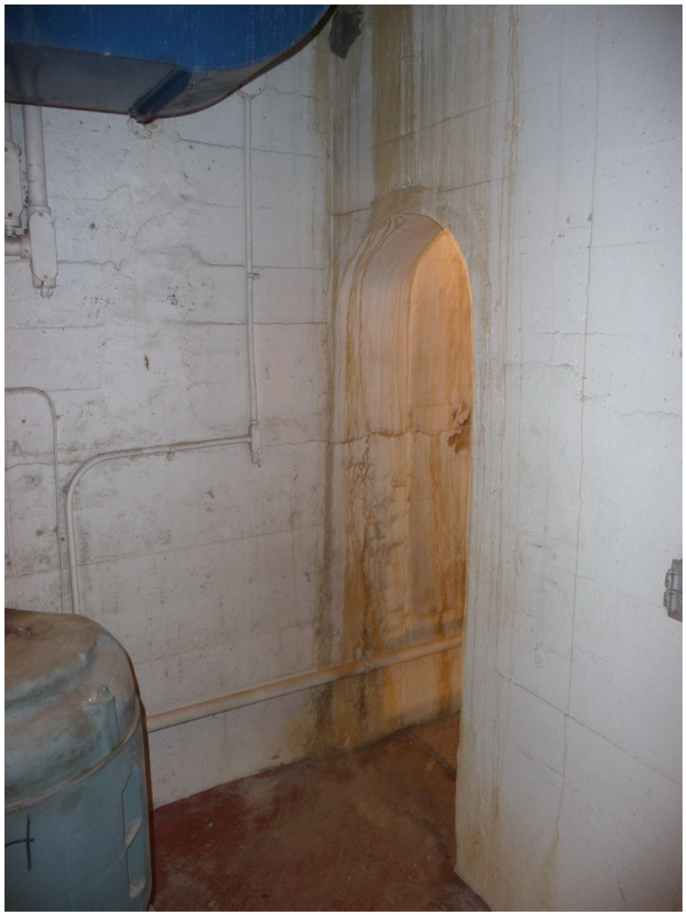

Figure 8 : Motor Room Walls

8.5 Pump Room

The pump room is located at the lowest level within the pumping station. It houses the four wastewater pumps and a sump pump. A valve chamber is also located off the end of the pump room. The following issues were identified with the pump room:

- The hatch opening in the roof of the Pump room and the area around it requires structural repairs. See Figure 9

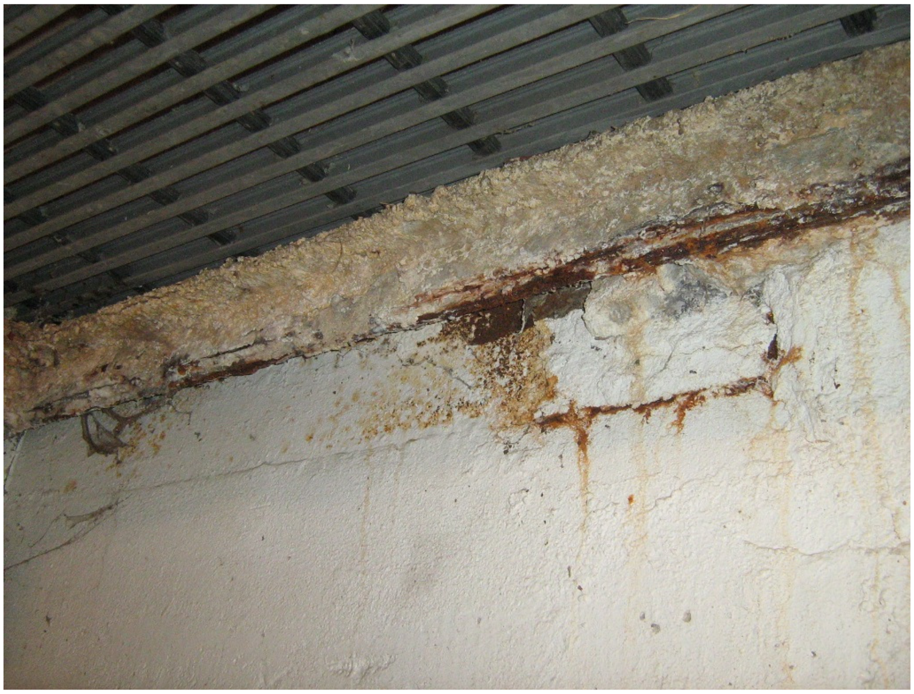

Figure 9 : Pump Room Ceiling Hatch

- The concrete floor and the walls of the Pump room show extensive degradation at some locations. These areas need to be repaired.

Figure 10 : Pump Room Floor

8.6 Stairwell (to Pump Room)

The stairwell is part of the original 1930s pumping station construction, and originally housed the comminutor chamber until it was replaced by the larger comminutor chamber constructed in the 1950s. The stairwell provides access to the motor and pump rooms. The following issues were identified with the stairwell:

- Extensive plaster damage observed near the lower end of the stairwell needs to be repaired. See Figure 11.
- The walls of the Stairwell are defaced by some dripping fluid. The leaks need to be plugged and the walls painted. See Figure 12.
-

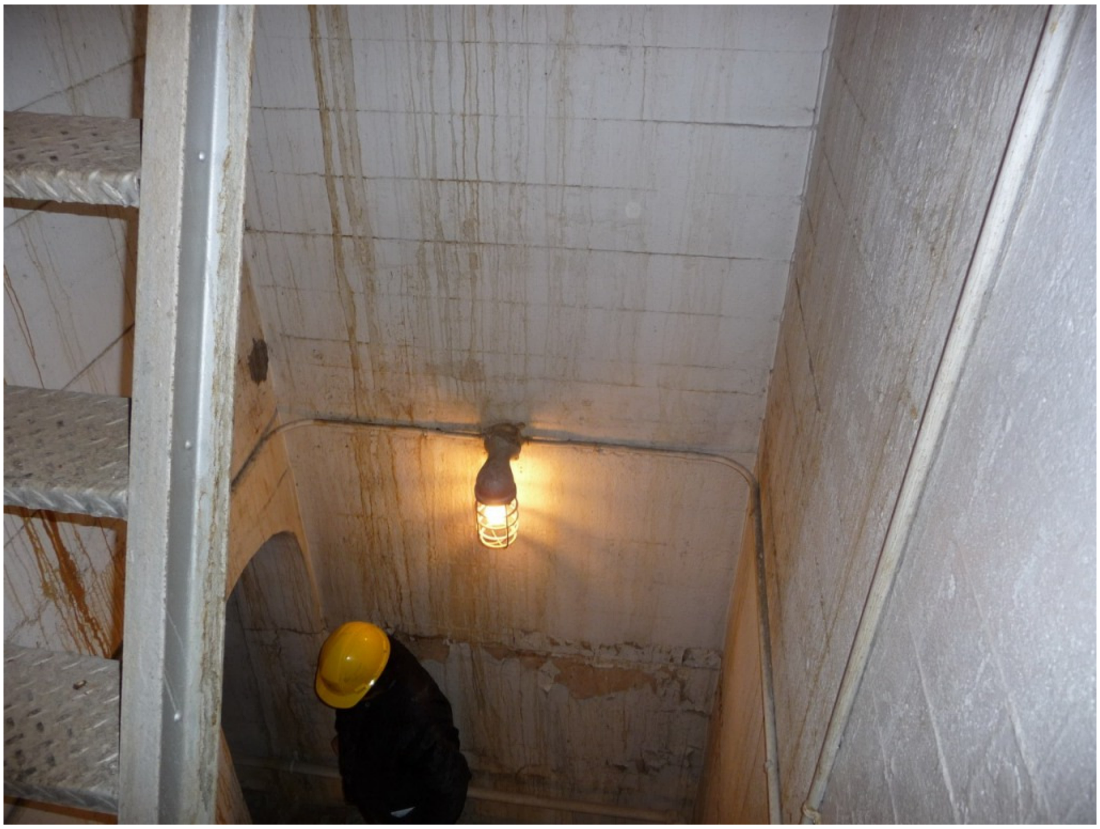

Figure 11 : Stairwell

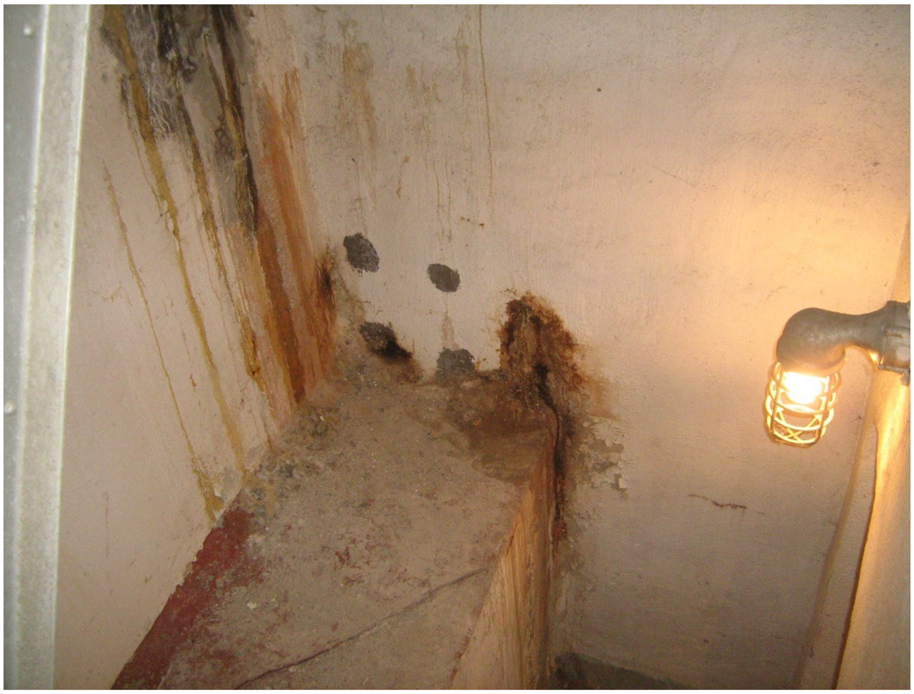

Figure 12 : Stairwell Leaks

8.7 Roof

The roof of the building consists of 70mm (2-3/4”) concrete Haydite panels and 32 mm (1-1/4”) of fibreboard (refer to original 1950s number drawing 263). The following issues were identified:

- The concrete Haydite panels in the roof of the Mechanical room are cracked and the reinforcement has undergone extensive corrosion at several locations. A new roof with proper insulation, grade and flashing needs to be installed. See Figure 13.

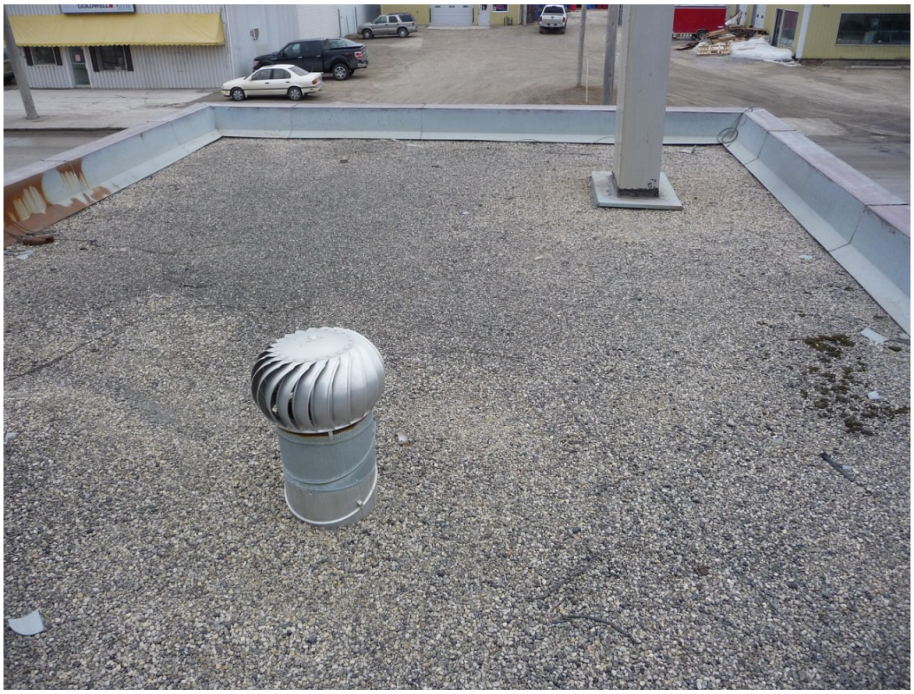

Figure 13 : Montcalm Pumping Station Roof

9.0 PROPOSED WORK

9.1.1 Summary of Base Work

It is proposed to perform the following work:

- Building / Structural
    - Replace the building roof including the concrete Haydite panels.
    - Mechanical Room:
        - Clean and paint the roof steel beams.
        - Repair and paint the inside surface of the building walls.
        - Repair the surface of the floor.
        - Repair the crack in the wall above the door to the Electrical Room.
    - Comminutor Motor Room:
        - Repair the hatch opening(s).
        - Repair and paint the surface of the ceiling, beams, walls, and floors.
    - Comminutor Chamber
        - Repair the beam around the stairway.
        - Replace the steel beam on the ceiling.
    - Motor Room
        - Clean and paint the monorail beam.
        - Repair the leaks in the walls, clean and paint.
    - Pump Room
        - Repair the hatch opening in the ceiling of the pump room.
        - Repair and restore the concrete floor and the walls.
    - Stairwell
        - Repair the plaster damage at the bottom of the stairwell.
        - Repair the leaks in the walls, clean and paint.
    - Reconfigure access hatches and floor penetrations as required to allow for ducting penetrations.

- Process Pumping
    - All wastewater pumping design modifications are the responsibility of the City of Winnipeg, and not within the scope of this report.
- HVAC
    - Install a new indirect fired natural gas air handling unit in the main floor Mechanical Room to service all drywell spaces, including the Mechanical Room. Note that an alternative to install electrical heating is presented, but not recommended.
    - Allocate space in the air handler for a potential future dehumidification unit.
    - Install ducting and relief dampers as required.
    - Provide a natural gas service to the pumping station.
- Electrical
    - Install two new Variable Frequency Drives, complete with bypass and isolation contactors, for powering two of the wastewater lift pumps.
    - Install a new 600V distribution panel, PNL-L1, in the Mechanical Room. The distribution panel would power the Variable Frequency Drives and new HVAC loads.
    - Install new buried Teck90 feeder cables from the CSTE to the new PNL-L1. Feed the existing MCC-L1 from the new PNL-L1.
    - Abandon two of the existing soft starter buckets in MCC-L1 and retain for spare parts.
    - Replace the existing lighting in the station. Install lighting in the comminutor chamber
    - Install new battery based emergency lighting for regularly occupied areas of the station.
    - Install new convenience receptacles throughout the station. Convenience receptacles below grade would be GFI protected.
    - Replace the receptacle for the sump pump.
- Instrumentation
    - Install a simple differential pressure level sensor for the wet well. This will require the installation of new lines from the dry well into the wet well. This would be installed in addition to the existing bubbler system.
    - Install a new PLC based control panel in the Mechanical Room on the main floor of the pumping station. The control panel would include a

touchscreen HMI and a dedicated level indicator, for use in the event of an HMI failure.

- Install a mushroom stop pushbutton near each pump and motor to provide local emergency stop capability.
- Provide UPS capability to power critical controls in the event of a power failure.
- Provide a ventilation control panel for the ventilation systems.
- Provide Ethernet networking as required.
- Provide for two flowmeter connections. The discharge flowmeters would be connected to the PLC via both analog input (flowrate) and pulse input (totalized flow).
- Provide ventilation instrumentation as shown on the P&ID drawings.

9.1.2 Cost Estimate

A cost estimate for the base proposed work is shown in Table 13 below.

Description	Item Cost	Cost
Temporary Bypass Pumping		$ Not Incl.
Wastewater Pumping and Piping Modifications		$ Not Incl.
Structural		
Roof Replacement	$ 88,000	
Main Floor Mechanical Room Repairs	$ 39,000	
Lower Level Repairs	$ 60,000	
Floor Modifications - Penetrations	$ 14,000	
Total Structural		$ 201,000
Heating and Ventilation		$ 36,000
Electrical		$ 194,000
Automation		$ 140,000
Total Direct Costs – Contractor		$ 571,000
Indirect Costs – Contractor		$ 76,000
Contingency (20%)		$ 114,000
Taxes (PST)		$ 53,000
Indirect Costs – Owner (Finance & Admin Charge)		$ 24,000
Total		**$ 838,000**

Table 13: Base Work - Cost Estimate Summary

Notes:

1. *The cost estimate is a Class 4 cost estimate and is in 2011 dollars.*
2. *Engineering is not included in the cost estimate.*

9.2 Options

9.2.1 MCC-L1 Replacement

The existing MCC, under the proposed design, has been identified as MCC-L1. To save costs, it is proposed in the base proposed work to re-utilize the existing MCC and two of the existing soft starters. Replacement of this existing MCC and associated soft starters is presented here as an option.

The additional capital cost of this option is expected to be in the range of $60,000.

9.2.2 Flowmeter Installation

As discussed in Sections 3.1 and 6.4, installation of a flowmeter within the station is not practical, and thus it will require installation of a new manhole exterior to the station, to allow flowmeters to be installed in each of the two forcemains. This will have a significant additional expense.

The required work would include:

- Install a new manhole over the forcemains.
- Install a new magnetic flowmeter in each of the forcemains.
- Install a sump pump in the manhole.
- Install the required power and control conductors between the manhole and pumping station via direct burial.
- Install the flow transmitters within the main floor of the pumping station to allow for easier maintenance.

The additional capital cost of this option is expected to include:

- Manhole installation: Not in scope of report.
- Mechanical installation: Not in scope of report.
- Flowmeters: $30,000
- Electrical and Controls: $25,000

9.2.3 Dehumidification

As discussed in Section 4.6, there is significant potential for moisture condensation onto pipe work during moist summer weather. The solution would be install dehumidification into the air handling system.

The additional capital cost of this option is expected to be in the range of $30,000.

9.2.4 Portable Generator Connection

It is good design practice to provide a connection point for a portable generator in the event of an extended utility failure. This would involve installation of a second main breaker in the MCC, interlocked with the utility breaker. A special receptacle would be provided to allow for connection of a portable generator. Locking receptacles that are tamper proof are available, and would work well for this application. This provides a safe and simple means to power the station from a portable generator. The minimum size of generator that should be capable of powering the station and starting the pumps would be calculated for future reference by City operations and electrical personnel.

The additional capital cost of this option is expected to be in the range of $15,000.

9.2.5 Hoist

The hoist in the station is aged. The City has indicated that it will review a previous report (by the MMM Group) to determine its adequacy.

9.2.6 Pumping Reconfiguration

The City has indicated that the design responsibility for mechanical pumping upgrade of Montcalm Pumping Station lies with the City, and thus this report does not address the mechanical pumping installation. It was noted by SLI during the site visits that the pump room at Montcalm Pumping Station is extremely tight, with very limited working space. This limited space adds significant challenges to pump replacement and maintenance events. See Figure 14 for the existing Pump Room configuration.

Figure 14 : Montcalm Pumping Station Pump Room

As part of this project, it is planned to convert the Comminutor Chamber into a dry space by piping across the chamber from the sewer into the wet well. While the space is not ideally set up for pumping, there are options available to install pumping within this space. This would require significant additional investigation and design. It should be noted that installation of pumping in the Comminutor Chamber is not within the scope of this report, and is only included as a potential concept. This project would be the ideal time to implement this concept, should it be desired by the City and proven to be feasible.

APPENDIX A

Drawings

Drawing Number	Rev	Description
SK-001	00	Electrical Single Line Diagram, Existing
SK-002	01	Electrical Single Line Diagram, Proposed 600V Distribution, Preliminary Design
SK-010	01	Equipment Layout Plan, Main Floor, Preliminary Design
SK-011	00	Equipment Layout Plan, Lower Level, Preliminary Design
SK-012	00	Equipment Layout Plan, Motor Room and Comminuter Room, Preliminary Design
SK-013	00	Equipment Layout Plan, Pump Room, Preliminary Design
SK-020	00	Process & Instrumentation Diagram, Ventilation – Electrical Room
SK-021	00	Process & Instrumentation Diagram, Ventilation - SF-L1 & SF-L2, Electric Heat Alternative
SK-022	00	Process & Instrumentation Diagram, Ventilation AHU-L1, Natural Gas Heat Alternative