

**APPENDIX C-2**  
**EXISTING FACILITY CONDITION ASSESSMENT**



**POINT PLEASANT  
WATER TREATMENT PLANT EXPANSION**

**TECHNICAL MEMORANDUM NO. 2  
EXISTING FACILITY CONDITION ASSESSMENT  
AND TREATMENT LIMITATIONS**

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Submitted by:



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## 1.0 INTRODUCTION

Utilities Kingston retained J.L. Richards & Associates Limited, in association with CH2MHill Canada Limited, to complete a Class Environmental Assessment (EA) to expand the treatment capacity at the Point Pleasant Water Treatment Plant (WTP) in order to implement the Master Plan for Water Supply for the City of Kingston Urban Area, dated June 2007. This Master Plan identified works that will be required to meet existing and future demand increases within the urban area of Kingston resulting from growth. The Master Plan EA determined that the expansion of the Point Pleasant WTP is of high priority. Therefore the purpose of this Class EA study is to identify the preferred strategy for meeting future water treatment needs at the Point Pleasant WTP.

The Point Pleasant WTP, located at 80 Sunny Acres Road, supplies water to the Kingston West water distribution system, and currently has a rated capacity of 45.5 megaliters per day (ML/d). This EA study will examine alternative strategies to increase the functional capacity of the WTP to 80 ML/d by the year 2012 in order to accommodate demand. With ever more stringent treated water quality requirements, and an expanding Kingston population, there may be a need to improve on both the capacity and treated water quality of the existing facility.

A number of important issues are being reviewed and addressed through five Technical Memoranda prepared as part the Class EA process, as summarized below:

Technical Memorandum No. 1: Source Water Quality and Drinking Water Treatment Objectives

Technical Memorandum No. 2: Existing Facility Condition Assessment and Treatment Limitations

Technical Memorandum No. 3: Low Lift Pump Station Upgrade/Expansion

Technical Memorandum No. 4: Treatment Process Expansion

Technical Memorandum No. 5: Treated Water Pumping and Storage Upgrade/Expansion

This Technical Memorandum provides a detailed condition assessment of the existing Point Pleasant WTP, including the evaluation of structural components, process and mechanical equipment and systems, electrical systems, and instrumentation and control.

## **2.0 LIMITATIONS AND ASSUMPTIONS**

### **2.1 Limitations**

The accuracy of discussions, conclusions, and costs presented in this Technical Memorandum are limited to the extent of the information available at the time the investigations were carried out. This information includes background information provided by Utilities Kingston and Operations Staff, regulatory codes currently in effect, and visual observations.

Site review was limited to visual observations at readily accessible locations of the exterior and interior of the WTP and plant site. No destructive testing or inspections were carried out. A Designated Substance Survey will be carried out by Utilities Kingston during the design phase of the project.

In the Structural, Architectural, and Electrical review sections, estimates of replacement costs have been included. These should be considered as order-of-magnitude approximations of what it might cost to replace existing infrastructure with comparable systems. Sizing and quality of the materials in the identified costs are similar to existing. Because the exact nature of site-wide upgrades, and therefore, modifications to the existing plant are unknown at this stage, these costs cannot be used to determine upgrade costs for the existing plant. Instead, these costs give an indication of what would be required to bring the structural, architectural, and electrical systems up to date using the same technologies. No consideration has been given for future expansion, constructability, phasing, and impact to the process during the implementation. Costs for process and mechanical systems have not been included because it is unlikely that the exact same processes will be employed in the upgraded plant. Costs for replacement and upgrade of existing infrastructure will be further discussed in Technical Memoranda 3, 4, and 5, where the low lift pumping station, water treatment processes, and high lift pumping station will be discussed. In the final Environmental Study Report, the costs from this Technical Memorandum as well as from Technical Memoranda 3, 4, and 5 will be compiled to provide an estimate of the Opinion of Probable Cost. The intent in this Technical Memorandum is to provide order of magnitude pricing to extend the life of the plant with the existing operating criteria.

#### **2.1.1 Assumptions**

Because of the complexity of the existing site and the number of systems and disciplines involved, some assumptions must be made when creating a condition assessment to extrapolate available information to attempt to understand the condition of the entire site. Some of the specific assumptions made are noted below:

- The assessment of the remaining life of a system is not exact. It is based on limited information and, in many instances, influenced by factors that may occur at some future date. Even the urgency of replacement may be determined by factors that cannot be predicted. For example, retroactive rulings by regulatory agencies may necessitate unanticipated replacement or updating of equipment within a short timeframe. By contrast, items such as paving, painting, or interior finishes might be delayed for an extended period of time, at the discretion of Utilities Kingston, subject to financial and other considerations. The actual year of replacement will be dictated by the physical condition of the system at the time of replacement. Also, certain replacements may be advanced or deferred by Utilities Kingston, subject to other considerations (e.g. financial, coordination with related work, incorporation into plant-wide upgrades, etc.).
- The assessment considers that the design life of the upgraded plant is taken as 18 years.
- The estimated replacement costs noted for the various items are order of magnitude only and are based on experience and current unit prices in the construction industry.
- All costs, including those for future years, are expressed in 2008 dollars. Hence, if these costs are to be used for long-range budgeting projection, the implications for potential future trends of inflation and interest must be applied accordingly.

It is recommended that a condition survey be undertaken approximately every five years in order to ensure that information presented in the report, including financial data, remains current and relevant.

### **3.0 STRUCTURAL AND ARCHITECTURAL REVIEW**

#### **3.1 General Methodology**

The following documents the findings of a visual assessment of structural/architectural systems, which was conducted on November 21, 2007. The findings have been supplemented by a review of the construction drawings and discussions with facility operators. The report outlines each observed component, corresponding deficiencies where noted, and provides an opinion of probable cost to repair or replace failing elements.

## 3.2 Results of Investigation

### 3.2.1 Roofing

The original roofs at the pump and process buildings (ca. 1976) were replaced around 1995. The roof construction comprises original precast concrete double tee slabs, vapour barrier (type unknown), insulation (type and thickness unknown), and conventional 2-ply modified bitumen membrane. The granulated cap sheet appears to be in good condition. At the parapets, curbs, and other roof penetrations, the pre-finished metal flashing also appears to be in fair to good condition. Mr. Jim Delahaye, Operator, Treatment Group, Utilities Kingston, reported that the roof slope at both buildings is not sufficient to prevent ponding water. This condition was observed at the time of inspection, as ponding water was noted at the northwest and southwest corners of the process building and at various locations on the pump building. While the roofs have been performing satisfactorily, the ponding conditions should be improved where possible to extend the service life of the roofs and reduce the risk of future leakage. A more thorough review is recommended during the preliminary design phase to determine the appropriate solution. With proper ongoing maintenance, these roofs should meet their expected service lives.

The inverted roof at the process building addition dates from original construction in 1989. The construction drawings indicate that it comprises precast concrete hollow core slabs, sloped concrete topping, membrane roofing, 100 mm rigid insulation (type unknown), and gravel ballast. The gravel ballast appears to be intact and there were no obvious signs of wind scour. The roof generally appears to be in good condition and, with proper ongoing maintenance, should also meet its expected 20–30-year service life.

#### Roofing

Description	Estimated Replacement Cost	Normal Service Life Expectancy	Estimated Remaining Service Life	Estimated Repair Cost
Pump Building	\$125 000	20 years	5 to 10 years	N/A
Original Process Building	\$150 000	20 years	5 to 10 years	N/A
Process Building Addition	\$75 000	25 years	5 to 10 years	N/A
Slope Improvement Allowance	N/A	N/A	N/A	\$25 000

### 3.2.2 Roof Framing

The buildings' roof framing typically comprises precast concrete double tee slabs or precast concrete hollow core slabs, which bear on the concrete frames. Where visible, the concrete slabs appear to be in good condition.

### 3.2.3 Exterior Wall Assembly

The exterior wall assembly throughout both the pump and process buildings typically comprises 125 or 150 mm precast concrete cladding with 25 mm insulation (internal), 25 mm air space, and 250 or 300 mm interior concrete block masonry infill. The insulated precast concrete panels have a rough exterior finish and were installed on the exterior face of the buildings' reinforced concrete frames. There are two bands of panels at the original process building and one band of full height panels at its addition and the pump building. The panels typically appear to be in good condition with the exception of staining and moss growth, which was observed throughout the exterior façades of both buildings. There did not appear to be any weep holes to vent/drain the wall construction. Some surface corrosion was noted on the angles, which support the upper band of precast panels on the original process building. These angles should be cleaned and repainted with a zinc-rich product to minimize the risk for potential corrosion.

The caulking at vertical joints between panels at the pump building and original process building has become brittle and cracked or separated from the concrete. A large hole in the caulking was observed at the south side of the pump building. At the addition to the process building, the caulking appears to be generally in good condition, with the exception of some minor cracking. The failed caulking should be removed and reinstated in conjunction with other exterior maintenance. At the top of cladding panels throughout both buildings, the pre-finished metal flashing appears to be in fair condition. However, the vertical face of flashing is not sufficient to prevent water infiltration and constant wetting of the cladding panels. Replacement with a better detail is recommended in conjunction with other exterior upgrades.

Where exposed, the reinforced concrete appears to be in good condition. Some minor 'spider' cracking was noted above the hollow metal doors at the south façade of the process building. At the south side of the pump building, some exposed rebar was observed. This area should be patched to prevent further spalling. The exposed concrete may also benefit from the application of a breathable sealant to alleviate freeze-thaw deterioration.

The interior concrete block infill walls typically appear to be in good condition. Some minor diagonal joint cracking was observed at the south side of the pump building and at the top of block walls in the process building. These items should be addressed with ongoing maintenance.

Both buildings are prone to moisture related deterioration and significant thermal loss due to the absence of both a proper arrangement of vapour barrier and continuous thermal insulation. In addition, without a vented wall construction, moisture that infiltrates the assembly will not drain to the exterior. Replacement/retrofit of the exterior assemblies should be considered in conjunction with the life-cycle upgrade of these facilities, although the present assemblies can be maintained in a functional state.

**Exterior Wall Assembly**

Description	Estimated Replacement Cost	Normal Service Life Expectancy	Estimated Remaining Service Life	Estimated Repair Cost
Global Recaulking Program	\$20 000	10 years	0 years	N/A
Paint Steel Support Angles	N/A	N/A	N/A	\$2 000
Precast Panel Flashing	\$5 000	20 years	0 to 5 years	N/A
Patch Exposed Rebar	N/A	N/A	N/A	\$1 000
Concrete Sealant Application	\$1 000	N/A	N/A	N/A

**3.2.3 Doors**

The exterior doors throughout both buildings date from original construction. The double-door main entrance at the southwest side of the process building comprises double-glazed commercial anodized aluminum doors with side and transom lights. While the finish has worn in localized areas, the doors generally appear to be in good condition. Other exterior doors at the pump and process buildings typically comprise single or double hollow metal doors with metal frames. These doors appear to be in fair to good condition. Unless operational limitations necessitate replacement or reconfiguration, general maintenance is recommended and should include adjustment, installation of new weather stripping, recaulking, painting, and hardware replacement as necessary.

The various interior doors also typically date from original construction. They comprise hollow metal doors with metal frames. These doors generally appear to be serviceable and can be preserved with proper ongoing maintenance. At the bottom of the stairs in the process building, the metal doorframe has corroded and should be cleaned and repainted. The presence of Underwriters' Laboratories of Canada (ULC) labels for fire resistance rating was noted on the doorframes at the stairwell in the process building.

**Doors**

Description	Estimated Replacement Cost	Normal Service Life Expectancy	Estimated Remaining Service Life	Estimated Repair Cost
General Door Maintenance	N/A	N/A	N/A	\$5 000
Repaint Corroded Doorframe	N/A	N/A	N/A	\$1 000

**3.2.4 Windows**

The windows throughout the facility date from original construction. They comprise fixed, sealed, double-glazed units in extruded aluminum frames. At the second floor of the process building, failed glazing units were noted in the stairwell (1), office (2), laboratory (2), and lunchroom (2). At the exterior, the anodizing finish is wearing and caulking around the windows has cracked or separated from the frames or concrete at many locations.

Immediate replacement of the 7 failed glazing units is recommended. Further replacement of sealed glazings on an as-required basis should be anticipated in the near future. In addition, a global recaulking program is recommended in conjunction with other building envelope repairs to prevent further water and air infiltration. This work should also include the installation of new flashing as necessary.

While a simple maintenance program in conjunction with other envelope repairs will maintain the windows in a functional state, the units have exceeded their expected service lives. Significant improvement in thermal efficiency would only be possible with high quality, thermally broken modern windows. Complete replacement of the facility's windows should be considered in conjunction with upgrades to the exterior wall assembly to significantly improve the facility's thermal performance.

**Windows**

Description	Estimated Replacement Cost	Normal Service Life Expectancy	Estimated Remaining Service Life	Estimated Repair Cost
Replace Failed Glazing Units	\$3 500	N/A	N/A	N/A
Selective Glazing Replacement	\$500/unit	N/A	N/A	N/A
Window Replacement	\$40 000	20 years	0 years	N/A
Recaulking (See Exterior Walls)	N/A	N/A	N/A	N/A

### **3.2.5 Floor Slabs**

The buildings' floor structures typically comprise cast-in-place reinforced concrete slabs. Where visible, the concrete slabs appear to be in good condition. Above the process building pipe gallery, some minor flexural cracking was noted, which appears to correspond with cracking in the terrazzo floor finish at the second floor. The conditions did not appear to be significant.

### **3.2.6 Walls**

Where visible, the exterior concrete block infill walls throughout both buildings typically appear to be in good condition. Minor diagonal cracking in the mortar joints was noted at the south side of the pump building. In addition, some of the block walls in this area were not built in line with the reinforced concrete foundation wall and projected beyond its interior edge. This condition did not appear to be the result of building movement.

Where exposed, reinforced concrete walls appear to be in good condition.

At the top of block partition walls throughout the process building, there is typically a 25-100 mm between the top of walls and underside of concrete slabs. The walls did not appear to be restrained against out-of-plane movement. In many places, the block was built tight to the underside of the roof/floor slabs and horizontal joint cracking has occurred in conjunction with building movement. Significant cracking was observed at the second floor corridor.

Isolation of interior, non-structural block partition walls from the reinforced concrete frame is recommended to prevent further cracking. The installation of steel support angles at the top of walls is also recommended to brace the walls against out-of-plane movement. Without restraint, there is a significant risk that the walls could topple over in a design seismic event.

The process building expansion drawings (ca. 1989) indicate that the new foundation was placed against the original and that a space was provided between the existing and new concrete frames. The drawings do not indicate, however, the extent of movement anticipated in the design. At the second floor, a wrap-around steel frame was provided at openings to the addition. However at the first floor, the steel frames were not provided. Likely a result of differential movement between the 'two' structures, cracking was observed in the finishes at the joint between existing and new concrete frames at the first floor. Given that the cracking appears to be minor, the items should be addressed with proper ongoing maintenance. Appropriate finishes, which allow for movement, should be installed in these areas.

**Walls**

Description	Estimated Replacement Cost	Normal Service Life Expectancy	Estimated Remaining Service Life	Estimated Repair Cost
Isolate/Brace Block Partitions	N/A	N/A	N/A	\$25 000

**3.2.7 Foundation and Substructures**

Where visible at the filters in the process building, the reinforced concrete substructure appears to be in good condition. There was no obvious evidence of deterioration or distress. It is presumed that the substructures, including the filters, flocculation tanks, backwash tanks, clear well, and reservoirs, are inspected on a regular basis and maintained in good condition.

Mr. Delahaye reported that cracking and water infiltration are occurring at the joint between the tunnel and process building. Peeling paint was noted at this location at the time of inspection. A more thorough review of the tunnel and its joint to the building is recommended during the preliminary design phase to determine whether the joint can be improved. In addition, the application of an exterior membrane is suggested to prevent further water infiltration.

**Foundation and Substructure**

Description	Estimated Replacement Cost	Normal Service Life Expectancy	Estimated Remaining Service Life	Estimated Repair Cost
Tunnel Joint Repair Allowance	N/A	N/A	N/A	\$25 000

**3.2.8 Miscellaneous Metals**

Throughout the pump and process buildings, the miscellaneous metals appears to be generally in good condition. With continued maintenance, the items will provide a long service life.

**3.2.9 Interior Finishes**

The interior ceiling, wall, and floor finishes throughout both buildings appear to be generally in good condition. The ceilings typically comprise lay-in acoustic tile, painted gypsum wallboard, or exposed concrete (painted). Localized stains were noted on the ceiling tile at the second floor office in the process building. This staining is likely evidence of past roof leakage. The stained tiles should be replaced.

Partition walls throughout the facility typically comprise glazed concrete block, painted concrete block, painted gypsum wallboard, or exposed concrete (painted). These finishes are also generally in good condition. In addition to the cracking conditions addressed above, peeling paint was observed at locations where painted concrete has been exposed to moisture, including the pipe gallery, PAC storage area, and tunnel. These items should be addressed with ongoing maintenance. The use of a breathable paint product is recommended to prevent continued deterioration of this kind.

The floor finishes are typically comprised of painted concrete or terrazzo and appear to be generally in good condition. The concrete stairs at the pump building were recently painted, including the abrasive nosing, which has eliminated the abrasive safety finish. This practice would not meet current code requirements, as the colour of abrasive nosing no longer contrasts the stairs. In addition, the stairs will be slippery when wet.

The interior finishes should be renewed or restored in conjunction with ongoing maintenance.

**Interior Finishes**

Description	Estimated Replacement Cost	Normal Service Life Expectancy	Estimated Remaining Service Life	Estimated Repair Cost
Replace Stained Ceiling Tiles	N/A	N/A	N/A	\$150
Repair Cracks in Block Walls	N/A	NA	N/A	\$5 000
Renew Peeling Paint	N/A	N/A	N/A	\$5 000

**3.2.10 Miscellaneous Architectural Items**

The fixtures in the laboratory, washroom, and locker room at the process building appear to be generally in good condition.

The wood handrail in the process building stairwell would not meet current code requirements. The National Building Code of Canada (2005) limits the perimeter of a cross-section through a non-circular handrail to 125 mm, with the largest cross-sectional dimension not greater than 45 mm.

## 4.0 PROCESS AND MECHANICAL

### 4.1 Methodology and General Comments

The following section is based on a review of the available water quality data, a review of various background reports, and site visits.

### 4.2 Existing Treatment Capabilities

The Point Pleasant WTP is a direct filtration facility with coagulation, flocculation, and filtration as the primary treatment process, combined with chlorination for disinfection. This process is designed to remove organics, pathogens, and other water contaminants found in the raw water. To evaluate the effectiveness of this treatment process, the treated water quality was reviewed, as it is the primary indication of the level of source water contaminant removal or inactivation (in the case of pathogenic contaminants). Table 1 summarizes selected plant effluent and distribution system water quality parameters from 2004 – 2007. Detailed yearly summaries are present in Appendix 1 of Technical Memorandum No. 1.

**Table 1 – Selected Treated Water Quality Parameters For The Point Pleasant WTP.**

Parameter	2004			2005			2006			2007 <sup>1</sup>		
	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
Plant Effluent Turbidity (NTU)	0.07	0.23	0.11	0.08	0.29	0.12	0.03	0.29	0.10	0.02	0.21	0.10
Dissolved Organic Carbon (mg/L)	1.0	1.7	1.3	1.1	2.2	1.7	2.0	2.9	2.4	1.1	2.8	2.1
Colour (TCU)	< 2	8	3	< 2	9	3	< 2	< 2	< 2	< 2	< 2	< 2
Alkalinity (mg/L)	87	110	97	84	145	100	81	113	91	73	122	88
Hardness (mg/L)	115	139	125	104	138	120	104	147	117	106	124	117
pH	7.2	8.0	7.6	7.2	8.0	7.6	7.1	8.0	7.6	7.2	7.9	7.6
Aluminum Residual (mg/L)	0.01	0.57	0.07	0.00	0.26	0.10	0.01	0.29	0.09	0.01	0.27	0.09
Plant Effluent Chlorine (mg/L)	1.0	3.0	1.6	1.0	2.1	1.5	0.9	1.9	1.4	1.0	2.7	1.5
Total Trihalomethanes Plant Effluent(mg/L)	9.5	33.4	19.5	10.6	36.0	21.3	10.1	29.8	18.9	8.8	108	24.8
Total Trihalomethanes Distribution System <sup>2</sup> (mg/L)	24.2	44.2	35.7	23.5	42.6	34.4	28.6	38.5	32.6	21.7	36.0	28.8
E.coli	0	0	0	0	0	0	0	0	0	0	0	0
Total Coliforms	0	0	0	0	1 <sup>3</sup>	0	0	0	0	0	0	0

<sup>1</sup> This data only includes January – October 2007

<sup>2</sup> As measured at the Cataragui Arena sampling station

<sup>3</sup> Notifications were made to the local MOH. Re-sampling was initiated and the subsequent samples did not indicate adverse conditions

The Point Pleasant WTP effluent turbidity has not exceeded 0.29 NTU (monthly average) over the past 4 years. This is less than Ontario Ministry of the Environment’s (MOE) requirement of less than 0.3 NTU, 95% of the time, allowing the plant to claim the full 2.0-log, 2.0-log and 1.0-log removal credits for *Giardia*, *Cryptosporidium* and viruses, respectively, granted by the MOE for direct filtration plants. The overall average filter effluent turbidity for Filters #1 and #2 is 0.1 NTU, while Filter 3 has an average of 0.12 NTU. This results in a combined filter effluent turbidity of 0.11 NTU.

When examining the individual filter effluent turbidity summarized in Figures 1a, b, and c, there are differences seen both seasonally and between individual filters. Filters #1 and #2 follow similar trends regarding both average effluent turbidity and elevated turbidity during late summer – early autumn months. Filter #3, the most recently constructed of the filters, shows approximately 20% higher average turbidity compared to Filters #1 and #2, and shows higher turbidity during spring and early summer. This difference may be a result of differing loading rates between the filters, different flocculation conditions, differing filter media distribution or differing filter underdrain condition.

While the elevated turbidity events for the individual filters do not exceed the current 0.3 NTU regulation, they are consistently above the 0.1 NTU individual filter effluent (IFE) recommended as the design target outlined in Technical Memorandum No. 1. Jar testing in 2002 showed that a coagulant dose of 5 mg/L of PACl would result in a lower effluent turbidity and organics removal compared to the current dose of 0.8 – 1.2 mg/L. As such, modifications to the coagulation and flocculation process (coagulant dose, pH, flocculation mixing characteristics, etc.) could improve the individual filter effluent turbidity and should be examined as part of the Point Pleasant WTP expansion.

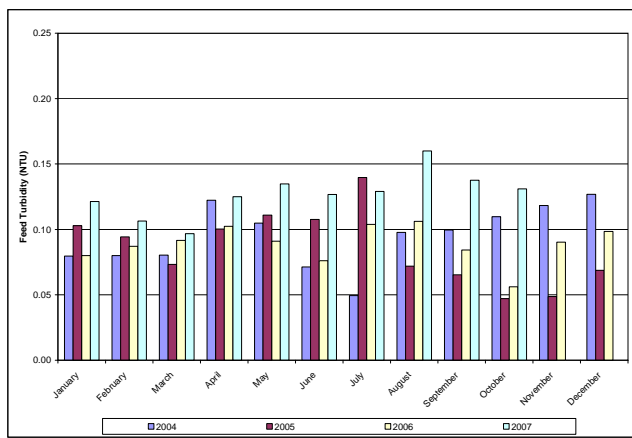


Figure 1a –Filter #1 Average Monthly Effluent Turbidity

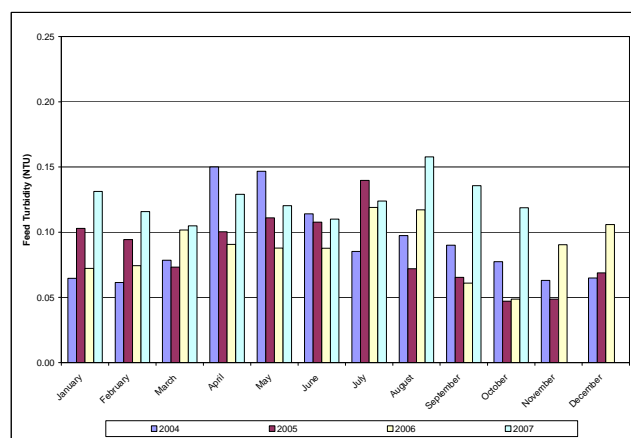


Figure 1b –Filter #2 average monthly effluent turbidity

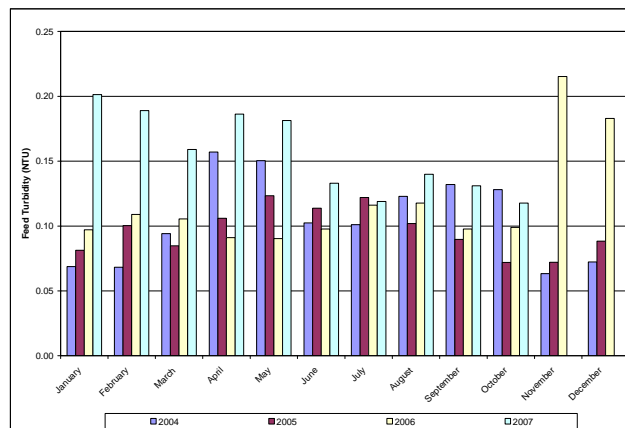


Figure 1c - Filter #3 Average Monthly Effluent Turbidity

Dissolved organic carbon and colour data show there is relatively low organics in the plant effluent. The low effluent organics are leading to plant effluent and distribution system total trihalomethanes that average 8.8 – 35.7 µg/L, well below the MOE regulation of 100 µg/L and United States Environmental Protection Agency (EPA) regulation of 80 µg/L. All microbial parameters are also consistently absent in the plant effluent. As such, it is evident that the existing direct filtration process is capable of producing water that meets all current applicable regulatory requirements for disinfection by-products.

Following the MOE's request to increase sampling and testing for lead as part of a corrosion identification and control program, Utilities Kingston undertook sampling in 25 locations (some of which were in the west distribution system) that were suspected of having lead services. The results of the testing showed that the lead concentrations were significantly below the regulatory limit of 10 µg/L. Historical testing has shown similar results.

The occasional qualitative taste and odour issues related to the raw water have improved since the GAC was installed in the filters. However, there are still occasional taste and odour issues for which the source is currently not fully known. These could be related to elevated levels of Geosmin and MIB in the source water, or high levels of chlorine in the distribution system. In any event, taste and odour from various sources is an issue that should be further investigated as part of the Point Pleasant WTP expansion.

The Ministry of the Environment's Inspection Report indicated that the concentration of aluminum in the treated water exceeds the operational guideline of 0.1 mg/L and that the residual aluminum is due to the presence of aluminum left over from the coagulant. The Inspection Report noted that "optimization of treatment should be applied to reduce this "residual" aluminum under the operational guideline of 0.1 mg/L". Aluminum above the operational guideline can cause coating of the pipes in the distribution system.

Utilities Kingston also conducts periodic, extensive analysis of the treated water for a wide variety of parameters in addition to those listed above (as outlined in Appendix B of Technical Memorandum No. 1). In all cases, the treated water quality meets the current MOE regulations.

The Certificate of Approval states that the plant "shall not be operated to exceed the rated capacity for the maximum flow rate into the treatment system of 32 m<sup>3</sup>/min", which is equivalent to 46.08 ML/d.

Key considerations for the plant expansion:

- i. Existing system is adequate to meet all existing physical and microbiological process removal regulations under the current flow rates.
- ii. Coagulation/flocculation process should be reviewed to optimize turbidity and organics removal for proposed design target.
- iii. Filter media depth and underdrain condition should be reviewed to minimize individual filter effluent turbidity for proposed design target.
- iv. Optimization of coagulation process to reduce the aluminum concentration below the operational guideline.

## **4.3 Condition Assessment**

### **4.3.1 Intake**

The existing intake consists of a 1200 mm diameter reinforced concrete pipe that extends approximately 460 m into Lake Ontario with a wooden crib inlet. The intake is approximately 15 m deep and was constructed in 1976. It has a coarse bar rack and was retrofitted to include chlorine piping for zebra mussel control. The chlorine diffuser is reportedly damaged, however, chlorine is still being fed into the intake pipe. The chlorine line is routed through an isolation sluice gate in the low lift pump station and would have to be removed to close the gate.

Based on the current rated plant capacity flow, the entry velocity into the intake is 0.06 m/s and the velocity in the intake pipe is 0.6 m/s. The MOE recommends entry velocities below 0.075 m/s and there is no recommendation for velocities in the intake pipe, however 1.2 m/s is considered to be at the higher end of the design velocity range. Therefore, the existing intake crib and pipe are considered to be adequately sized for the existing flows.

Based on the anticipated plant expansion to 90,000 m<sup>3</sup>/d (for a net output of 80,000 m<sup>3</sup>/d), the entry velocity would increase to 0.08 m/s and the velocity in the intake pipe would increase to 1.2 m/s. These are considered to be at the higher end of the design ranges, however, still acceptable. At a flow of 90,000 m<sup>3</sup>/d, the headloss through the intake would increase by over 1 m compared with the current rated capacity, which would result in a lowering of the water level in the low lift wet well. This will have to be taken into consideration during design of the upgrades to the low lift pumping.

A diving inspection of the intake was completed in 2004. In summary, findings of the inspection were:

1. Intake header was in good condition.
2. Zebra mussel growth was approximately 75 mm thick on inside and outside of wooden structure.
3. There was approximately 450 mm of debris in the bottom of the intake structure.
4. There were no obstructions at the intake bell.
5. A leak was observed in the chlorine line.

Key considerations for the plant expansion:

1. The intake appears to be adequate for the plant expansion.
2. The zebra mussel system needs to be upgraded (diffuser reinstated at intake and not routed through the sluice gate).
3. The additional headloss through the intake pipe will have to be considered in the low lift pumping upgrades.
4. The Permit to Take Water will have to be revised.

### 4.3.2 Low Lift Pumping Station and Raw Water Transmission Piping

The low lift pumping station consists of:

1. Wet well beneath the low lift pumps with a volume of 405 m<sup>3</sup>.
2. Removable, stationary screen rack.
3. Motorized traveling screen (downstream of stationary screen rack).
4. Low lift pumps (vertical turbine) – two with a pumping capacity of 27,244 m<sup>3</sup>/d (LLP #1 and #2) and two with a pumping capacity of 13,622 m<sup>3</sup>/d (LLP #3 and #4) (for a total pumping capacity of 81,723 m<sup>3</sup>/d and a firm pumping capacity of 54,488 m<sup>3</sup>/d). One of the 27,244 m<sup>3</sup>/d pumps (LLP #1) is equipped with an electric/diesel drive; the others are only electric.

There is a sluice gate at the opening of the intake pipe into the low lift pumping wet well to isolate the wet well. A second sluice gate allows the screen portion of the wet well to be isolated from the low lift pump suction wet well.

A chlorine feed line allows chlorine to be fed, if needed, into the low lift pump station wet well upstream of the screens. Chlorine can also be fed in the raw water transmission main.

The manual fixed screen consists of an angle iron frame and mesh screens with approximately 12 mm to 16 mm openings. This screen is only in place when needed. It appears to have seen limited service and is in good condition.

The automatic screen is a Rexnord traveling screen installed in 1977 and includes nominally 1050 mm wide panels made up of woven stainless steel mesh at approximately 12 mm centers. The mesh panels appear to be relatively new. Generally, the screen appears to be in good condition. Although there is only surface corrosion on the screen frames, failure of this type of screen is generally due to corrosion of fixed components below or at the water surface. It is, therefore, recommended that the submerged portions of the screen be inspected. A 40 year or greater life for this style of screen is not unusual. The capacity of the existing screen will be confirmed during the predesign phase when allowable headlosses upstream of the low lift pumps are assessed.

The low lift pumps are single-stage fixed speed pumps. Fairbanks Morse manufactured all the pumps and three are from the original 1977 construction. The fourth pump (LLP#2) was installed in 1989. The diesel drive for LLP#1 was manufactured in 2004 and has 76 operating hours.

None of the electric pumps appear to be equipped with premium efficiency motors. Although it is not unusual for a well-maintained pump of this type to achieve a service life in excess of 40 years, Technical Memorandum No. 3 will assess options for pump replacement based on the need for additional capacity, and life cycle costs. Potential options include:

- Maintain existing pumps for peak demand periods and provide new lead pumps.
- Replace some existing pumps to increase capacity.
- Install premium efficiency motors on existing pumps to remain in service.
- Replace all pumps.
- Evaluate Net Positive Suction Head characteristics for existing raw water pumps with a lower wet well level caused by increased flow and headloss through the raw water inlet and screen.

The original design included a 600 mm diameter motorized valve to control the rate of flow to the treatment process. This valve is no longer operational and flow control can only be achieved by turning low lift pumps off and on. The ability to modulate the pumping output from one or more pumps with variable frequency drives would improve the control of flow to the treatment process and should be compared with reinstatement of the raw water flow regulating valve and staging of pumps.

Raw water from the low lift pumps flows through a 750 mm diameter concrete pressure pipe to the rapid mixing tanks. The piping reduces from 750 mm diameter to 600 mm diameter for the flow meter and motorized butterfly valve. The coagulant (polyaluminum chloride, or PACl) is added between the flow meter and the motorized valve. The raw water transmission piping is stainless steel indoors and appears to be reinforced concrete pipe below grade. The piping appears to be in adequate condition.

At a flow rate of 90,000 m<sup>3</sup>/d, the velocity in the 750 mm diameter raw water transmission main would be slightly below 2.4 m/s, which is relatively high. The hydraulics of the raw water transmission, and the range of the existing flow meter, will have to be reviewed to determine whether the raw water transmission main will need to be upgraded as part of the plant expansion. It is likely that the flow element will not have sufficient range for current and future flows and will need to be replaced and that the raw water pipe will need to be twinned.

The floor drains in the Low Lift Pumping Station discharge to the lake, which could permit contaminants spilled on the floors to be discharged to the environment and come in contact with the source water. Although a plan to mitigate this risk has been formulated by Utilities Kingston to deal with this issue, a permanent solution should be implemented as part of the plant upgrades.

Key considerations for the plant expansion:

1. Low lift pumping firm capacity needs to increase to approximately 90,000 m<sup>3</sup>/d (from current 54,488 m<sup>3</sup>/d).
2. Pumping combinations need to be evaluated, with options potentially including new and existing pumps.
3. Variable frequency drive(s) or pump staging in combination with a raw water rate control valve would improve control of flow to the treatment process.
4. Capacities of existing screens and condition of underwater components need to be assessed.
5. Hydraulics and Net Positive Suction Head characteristics for existing and new pumps will need to consider additional headloss through the intake pipe, gates, and screens.
6. Raw water transmission piping and flow metering will likely need to be twinned or replaced.
7. Ensure floor drains do not discharge back to Lake Ontario.

#### **4.3.3 Coagulation**

Flow from the raw water transmission main (which has had the coagulant added) is discharged into the raw water chamber (inlet channel) that feeds the coagulation-flocculation-filtration trains. Treatment trains #1 and #2 were constructed in 1977, while treatment train #3 was added in 1989.

The coagulation step consists of rapid mixing of the coagulant with the water. This occurs in two mixing chambers (MC): MC #1 which feeds Flocculation Tanks #1 and #2 and MC #2 which feeds Flocculation Tank #3. MC #1 has a volume of 12.6 m<sup>3</sup> and MC #2 has a volume 10.9 m<sup>3</sup>. They are both equipped with 5.6 kW mechanical mixers.

It should be noted that since MC #1 feeds two of the three flocculation tanks, if it is out of service, the plant capacity is reduced by 2/3 of its rated capacity (i.e. approximately 30,000 m<sup>3</sup>/d).

The mixing chambers generally appear to be in good condition. The mechanical mixer for MC #1 appears to be 1977 vintage and has evidence of oil leakage. Ultimately it will need to be replaced before the end of the plant's next service life. The mixer for MC #2 is 1989 vintage and appears to be in good condition. Neither mixer is equipped with a premium efficiency motor, although the 1977 mixer appears to have had the motor replaced.

Key considerations for the plant expansion:

1. Coagulation process and tanks appear to be in good condition.
2. Consideration should be given to replacing the drive and gear reducer for MC #1 and providing premium efficiency motors for both mixers.

#### 4.3.4 Flocculation

Following the coagulation step, the water flows into three dual-chamber flocculation tanks. The flocculation tanks have a volume of 172 m<sup>3</sup> and a retention time of approximately 15 minutes at the rated capacity. The flocculation tanks are equipped with variable speed mechanical mixers (between 0.74 and 1.0 kW). Mixers generally appear to be in good condition. Two flocculators in the 1977 plant have had motors replaced; none of the flocculators are equipped with premium efficiency motors.

There are a number of gates with hydraulic actuators on the inlets and outlets of Flocculation Tanks #1 and #2 that are in poor condition and should be replaced. These are summarized in Table 2:

**Table 2 - Summary of Gate Replacement Requirements**

Gate Location	Dimensions (W X H)	Actuator
Flocculation Tank #1 Inlet	500 mm X 500 mm	Existing: hydraulic Proposed: electric or manual
Flocculation Tank #2 Inlet	500 mm X 500 mm	Existing: hydraulic Proposed: electric or manual
Flocculation Tank #1 Outlet	500 mm X 500 mm	Existing: hydraulic Proposed: electric or manual
Flocculation Tank #2 Outlet	500 mm X 500 mm	Existing: hydraulic Proposed: electric or manual

The gates and motorized actuators on Flocculation Tank #3 are in better condition and do not appear to need replacing. It is noted that these gates are cast iron and equipped with manual actuators. Crank arms and nameplates have significant surface corrosion.

It is also noted that the mixing and flocculation tanks are installed directly over the clearwell and leakage through the concrete slab would present a possible source of contamination. Regular inspections of the slab should be completed.

Key considerations for the plant expansion:

1. Flocculation tank inlet and outlet gates and actuators need to be replaced.
2. Replacing the gates on Flocculation Tank #1 or #2 will reduce the plant water production capacity by approximately 30,000 m<sup>3</sup>/d while the gates are being installed since the two trains are interconnected. A leak test should be performed on the gates prior to replacement.
3. Flocculation tanks and flocculators appear to be in good condition, but consideration should be given to installing premium efficiency motors.
4. The concrete floor slab of the flocculation and mixing tanks should be inspected for potential leakage.
5. The mixing energy imparted by the mechanical mixers should be reviewed to verify that they are adequate for the flocculation tank volume and flows.

#### **4.3.5 Filtration**

Water flows from the Flocculation Tanks #1 and #2 into a common Filter Influent Channel that feeds Filters #1 and #2. Flocculation Tank #3 flows directly into Filter #3. The Filter Influent Channel is interconnected between Filter #2 and #3, but may be isolated by a slide plate.

The filters are dual-media and each have a surface area of 53.7 m<sup>2</sup> and side water depth of 2.9 m (from top of underdrain to top of filter box). At a design flow rate of 15,320 m<sup>3</sup>/d (per filter), the filtration rate is 12 m/h. The filter media consists of 900 mm of granulated activated carbon (GAC) and 150 mm of sand. A Leopold underdrain system supports the media. It consists of a series of plastic nozzles embedded in a false concrete floor. The existing underdrains could be replaced with a lower profile type underdrain that would allow more media and/or driving head through the filter. The cost of these modifications should be evaluated relative to their potential filter performance benefits during design.

The filter boxes, troughs, and underdrains are reportedly in good condition. Utilities Kingston has replaced backwash drain gates on Filter #1 and #2 with stainless steel gates and electric drives. New electric actuators have been purchased for the corresponding filter influent gates, but have yet to be installed. These are summarized in Table 3:

**Table 3 - Summary of Filter Inlet Gates**

Gate Location	Dimensions (WXH)	Actuator
Filter #1 Inlet	500 mm X 500 mm	Existing: hydraulic Proposed: electric to be installed by Utilities Kingston
Filter #2 Inlet	500 mm X 500 mm	Existing: hydraulic Proposed: electric to be installed by Utilities Kingston
Backwash #1 Outlet	500 mm X 500 mm	Existing: electric actuator and stainless steel gate
Backwash #2 Outlet	500 mm X 500 mm	Existing: electric actuator and stainless steel gate

The gates and motorized actuators on Filter #3 are in better condition and do not appear to need replacing. It is understood that the filter backwash drain gate and actuators may have been replaced in or about 2003.

Backwash water is supplied by two backwash pumps (duty/standby) that draw water from the clearwell and discharge into the filter underdrain. One pump is a 350 mm, 75 Hp vertical Fairbanks Morse end suction pump with an extended shaft and motor installed on the ground floor level. This pump was installed in 1977 and is nominally rated at 26.0 m<sup>3</sup>/min. The motor appears to have been rebuilt in 2003. The pump is equipped with a hydraulic valve that apparently does not provide for a modulating rate control. There is no separate isolation valve for the automatic discharge valve.

The second backwash pump is a Flygt 70 Hp submersible 450 x 350 pump in a dry pit application. The system is equipped with an electrically actuated discharge valve that apparently does not provide modulation capability. There is no isolation valve for this automatic valve.

Filtered water can be diverted to waste (during filter ripening or other times when the filtered water quality is “sub-standard”) or to the clearwell by operating motorized valves on the filter effluent piping. All piping is stainless steel and appears to be in good condition. Electric actuators appear to have been installed in the past several years and some valves have been replaced. Magnetic flow metres have been installed for Filters #1 and #2, however Filter #3 continues to use a venture-type metering device. Consideration should be given to changing the venturi on Filter #3 to a magnetic flow meter.

Filter-to-waste water can be sent to the backwash tanks or directly to the lake. The filter-to-waste line is direct connected and common to all filters. Filter-to-waste lines often have an indirect connection/air gap to reduce the risk of cross contamination between filters.

Air scour air is supplied by a single multistage centrifugal blower with a capacity of 59.5 m<sup>3</sup>/min. The air flow rate may be manually adjusted using an inlet butterfly valve. The 75 Hp Spencer blower was installed in 1977 and appears to be in good condition. There is no backup blower.

The Filter Gallery is installed directly over the clearwell and any significant flooding would drain into the clearwell through the access hatches in the area, and as a minimum should be sealed. Floor drainage piping from the area is cast into the slab over the clearwell; and although this is not common practice by today’s standard, should not pose a large risk provided the slab is inspected from the underside periodically.

The piping and valving in the filter pipe gallery appears to be in good condition. It is presumed that the backwash tanks and the associated equipment are also in good condition.

Key considerations for the plant expansion:

1. Filter boxes, troughs, underdrains, backwash pumps, air scour blower, piping and valving appear to be, or are presumed to be, in good condition.
2. Backwash pumps draw only from Clearwell A, which does not allow flexibility if Clearwell A is out of service. UK suggests that under normal conditions, Clearwell A could be out of service for up to 48 hours before a backwash is required. Options to draw from either Clearwell A or Clearwell B (below the Filter #3 train) for backwash purposes should be explored.
3. The risk of cross contamination due to direct connected filter-to-waste piping should be evaluated.

4. Risks of contamination due to floor drainage or flooding should be evaluated and mitigating measures implemented.
5. Options for providing back-up air scour should be reviewed in the event that the single blower is out of service.

#### **4.3.6 Chemical Addition**

##### **Coagulant Storage and Feed System**

The coagulant system was originally designed to operate with aluminum sulphate and sodium silicate (i.e. activated silica) and now operates with PACl only. The storage and feed system includes:

1. 9,085 L capacity FRP chemical storage tank installed in 1977.
2. Two Prominent solenoid-driven diaphragm metering pumps (duty/standby) with a capacity of 17.1 L/hr. Control is flow proportional to the flow measured by the raw water flow meter. These pumps were installed in 2003. A second set of pumps appears to be out of operation.
3. Chemical feed piping to the raw water transmission pipe.

In general, the coagulation chemical system appears to be operating satisfactorily. However, there are several issues that will need to be considered during design:

1. There is only one chemical storage tank, therefore a portable tank would have to be used if the tank is out of service.
2. The chemical storage tank capacity will likely be inadequate for the increased plant capacity.
3. Additional or larger metering pumps will likely be required for the increased plant capacity.
4. The existing storage and feed room is not very accessible and is fairly confined.
5. Single injection point does not allow backup or redundancy.
6. It should be verified that floor drains in the containment area are sealed.

## Chlorine Storage and Feed System

The chlorine feed system includes:

1. Tonne chlorine cylinders and two floor scales.
2. Four chlorinators.
3. Booster pump and plant water for eductors.
4. Chlorine solution feed lines.

The following injection locations are available:

1. Chlorinator #1 (44.5 kg/day):
  - a. Intake pipe
  - b. Low lift pump wet well upstream of screens (normally closed).
2. Chlorinator #2 (182 kg/day):
  - a. Raw water transmission main (normally closed).
  - b. Clearwell A.
  - c. This unit is used for spare parts only.
3. Chlorinator #3 (182 kg/day):
  - a. High lift pump discharge.
  - b. This unit is used as a manual standby unit only.
4. Chlorinator #4 (182 kg/day):
  - a. Backup to Chlorinator #1.
  - b. Inlet of chlorine contact chamber.
  - c. This is a newer unit.

Chlorinators #1 through #3 may be original from 1977, however, various control upgrades and repairs have been made over the years. Chlorinator #4 is newer. All chlorinators are made by US Filter Wallace & Tiernan. With the exception of Chlorinator #2, the chlorinators appear to be in reasonable condition. A water booster pump in the chlorine room appears to be out of service.

The capacity of the chlorinators, booster pumps and feed lines will have to be reviewed as part of the capacity expansion.

A Capital Controls gas detection system installed for the chlorine room(s) appears to be relatively new.

The chlorine cylinder storage room has previously been reviewed for compliance with the latest design standards and good practices. Highlights of the report prepared by JLR include:

- Relocate the exhaust fans' intake and discharge locations.
- Upgrade lighting and controls.
- Improve chlorine gas storage room and chlorination room containment.
- Install pipe supports and identification labelling.
- Modify the chlorine gas tonner handling equipment and docking bay to ensure safe handling of the containers.
- Assess the need for a scrubbing system.
- Upgrade heating, lighting, and ventilation in the entrance vestibule (i.e. pressurization).
- Provide chlorine gas leak detection in the chlorinator room.
- Remove and replace emergency eye wash station, including provisions for tempered water supply and an alarmed flow switch.
- Supply repair kit, SCBA equipment, and PPE (to be stored in appropriate location).
- Supply additional warning signs at the chlorination facilities' entrance points.
- Review chlorine alarm system and identify monitoring points that may improve the system reliability.

Key considerations for the plant expansion (note some of these items are repeated from above):

1. Existing coagulant storage and feed system is confined and not very accessible.
2. Single coagulation chemical storage tank does not offer redundancy.
3. Coagulant system is likely not adequate for the increased flows. A new chemical storage and feed room with new equipment may be warranted.
4. Single point of chemical injection does not offer redundancy

5. Chlorination system capacity and injection points will have to be reviewed as part of the design.
6. Chlorine cylinder storage room will have to be reviewed for compliance with current design standards and good practices.

#### **4.3.7 Disinfection**

Disinfection is provided by post-filter chlorination. Chlorine is added to the water as it flows from the clearwells to the chlorine contact tank.

Currently, the governing disinfection requirement is to provide 1-log Giardia inactivation, which requires a minimum CT of 97 mg/L-min. For the purpose of this Condition Assessment, we have assumed that all primary disinfection is occurring in the chlorine contact tank (i.e. we have not included the CT from the clearwells or reservoir). With a chlorine residual of 1 mg/L in the effluent from the chlorine contact tank, the maximum flow through the chlorine contact tank to achieve the required CT is 58,000 m<sup>3</sup>/d (under worse case temperature and pH conditions). At a flow rate of 80,000 m<sup>3</sup>/d through the chlorine contact tank, the minimum chlorine residual in the effluent would be 1.4 mg/L. Alternatively, an additional 2035 m<sup>3</sup> of baffled chlorine contact tank volume would be required to achieve the disinfection requirements and maintaining a minimum chlorine residual of 1 mg/L in the effluent.

A number of hydraulic pinch-points were created when the old reservoir was converted to a chlorine contact tank. Before the reservoirs were converted to a chlorine contact tank and reservoir, the flow entered the reservoirs through any or all of four valved 750 mm diameter inlets. As part of the modifications, the flow now enters the chlorine contact tank through a single valved 750 mm diameter inlet. Additionally, a new 750 mm diameter valved opening was created to convey the flow from one chlorine contact tank cell to the other. The water exits the chlorine contact tanks by flowing over a 2100 mm wide weir and then into the reservoir through two 750 mm diameter valved inlets. Water exits the reservoir through two 750 mm diameter valved outlets.

The modifications made to the chlorine contact tank (i.e. single inlet and transfer pipe) have reportedly resulted in hydraulic constraints that limit the flow of water that can flow by gravity from the clearwells through the chlorine contact tanks and reservoirs.

There is an overflow weir in both cells of the chlorine contact tank as well as drain pipes and valves. The valves are reported to be in poor condition. The overflow and drain pipes direct the flow to the lake. It is noted that the high lake level is elevation 76 m, with maximum wave level project to be 78.27 m. The top of concrete for the Reservoir and Contact Tank base slabs is 76.05 m, which is just above the static maximum lake level. The high water level could potentially be above the bottom of the Reservoir. This should be reviewed in greater detail during the predesign phase. A pumping arrangement may be necessary to reduce the risk of lake water flowing into the reservoir.

Chlorine residual is measured at the inlet and outlet of the chlorine contact tank.

The condition of the chlorine contact tank, baffles, and other submerged equipment was not assessed and are presumed to be in good condition. An inspection of the valves and concrete should be undertaken during design to confirm that no upgrades are required.

It is not clear from the “as-constructed” drawings if a waterproof membrane was installed between the backfill over the below-grade Reservoir and chlorine contact tank. Test holes should be excavated to verify the presence of a membrane. Additionally, as access hatches appear to be only 150 mm above grade, hatches should be well sealed.

Key considerations for the plant expansion:

1. To provide the required disinfection at a flow rate of 80,000 m<sup>3</sup>/d, a minimum chlorine residual concentration of 1.4 mg/L would have to be maintained at the outlet of the chlorine contact tank (under worse case temperature and pH conditions).
2. Consider modifying the clearwells to discharge filtered water to the opposite end from the water influent to the chlorine contact tanks, change the chlorine feed point and take advantage of additional volume in the clearwells to achieve some disinfection in the clearwells.
3. Hydraulic pinch-points should be addressed to allow higher flows through the chlorine contact tanks.
- 7.3. An inspection of the valves and concrete should be undertaken during design to confirm that no upgrades are required.
- 8.4. The condition of the chlorine contact tank, baffles, and other submerged equipment was not assessed and are presumed to be in good condition.

#### **4.3.8 Clearwells**

Filtered water flows directly from the filters into two clearwells constructed under the flocculation tanks and filters. Clearwell A (under Flocculation Tanks-Filters #1 and #2) has a volume of 1,000 m<sup>3</sup> and Clearwell B (under Flocculation Tank-Filter #3) has a volume of 550 m<sup>3</sup>. The clearwell serves as a source of supply water for the two backwash pumps.

Access to the clearwells is through 600 mm X 600 mm hatches.

The condition of the clearwells was not assessed, but it is presumed that the concrete is in good condition.

Key considerations for the plant expansion:

1. Clearwells are presumed to be in good condition.
2. Clearwell volume may need to increase depending on the treatment technology.
3. As noted in Section 4.3.7, flooding of the Filter Galley floor is a potential source of contamination as is leakage from flocculation or mixing tanks above.
4. Consideration should be given to piping one backwash pump to Clearwell B in order that filters can be backwashed when Clearwell A is taken out of service.

#### **4.3.9 Reservoir**

The reservoir, which was constructed as part of the 1989 expansion, currently consists of two cells, each with a volume of 3280 m<sup>3</sup>. Each cell can be isolated separately. Flow exiting the chlorine contact tank enters the reservoir through one or two 750 mm diameter valved inlets. Water exits from the reservoirs through two 750 mm diameter valved outlets and flows through a 750 mm diameter concrete pipe from the reservoirs to the high lift pump station wet well.

There is an overflow weir in both cells of the chlorine contact tank as well as drain pipes and valves. The overflow and drain pipes direct the flow to the lake.

Access into the reservoirs is through 900 mm diameter openings or 1800 mm X 1800 mm openings.

The condition of the reservoir cells was not assessed and is presumed to be good. An inspection of the valves and concrete should be undertaken during design to confirm that no upgrades are required.

Key considerations for the plant expansion:

1. Reservoir cells are presumed to be in good condition.
2. Reservoir volume will likely need to increase to accommodate the increased high lift pumping rate and to provide treated water storage at the plant.
3. The significance of high lake levels above the top of base slab elevations for the clearwell should be evaluated.

#### **4.3.10 High Lift Pumping and Discharge Piping**

The high lift pumping station consists of:

1. High lift pump wet well beneath the high lift pumps with a volume of 920 m<sup>3</sup>
2. High lift pumps (vertical turbine) – two electric pumps rated at 13,622 m<sup>3</sup>/d each (HLP #1 and #2), one electric/diesel driven pump rated at 13,622 m<sup>3</sup>/d (HLP #3), one electric pump rated at 13,622 m<sup>3</sup>/d (HLP #4), and one diesel-driven horizontal split-case pump (HLP #5) rated at 27,244 m<sup>3</sup>/d (for a total pumping capacity of 81,732 m<sup>3</sup>/d and a firm pumping capacity of 54,488 m<sup>3</sup>/d with the fire pump and 40,866 m<sup>3</sup>/d without the fire pump). The rated Total Dynamic Head for all the pumps is 70.4 m (100 psi).
3. HLP #5 has been equipped with a 420 Hp Caterpillar diesel drive manufactured in 2003. The engine is water cooled. HLP #3 is driven by a 212 kW Volvo diesel engine that was manufactured after 2001. This engine is cooled by a fin tube radiator and heat is rejected to the room. HLP #2 appears to have an electric motor rebuilt in 2001. It is believed that all HLPs were installed in 1977 with the exception of HLP #4, which was installed in 1989.
4. None of the electric-driven pumps are equipped with premium efficiency electric motors. These motors likely represent the greatest energy demand in the plant.

The pumps discharge into a 900 mm diameter concrete discharge header. A surge relief valve on the header discharges to the raw water intake well. The piping reduces from 900 mm diameter to 600 mm diameter for the flow meter. There is an isolation valve on the 900 mm diameter treated water line to the distribution system in a valve chamber at the entrance to the water treatment plant site.

The high lift pump wet well has a partition wall with a sluice gate, however, the flow currently can only enter the wet well through a single inlet. A valve that permits water from the clearwell to bypass both the chlorine contact tank and the Reservoir cells is not used but appears to still exist. Potentially, this valve should be removed and replaced by a blind flange.

At a flow rate of 80,000 m<sup>3</sup>/d, the velocity in the 900 mm diameter treated water discharge pipe would be 1.4 m/s.

The main concern regarding the high lift pump discharge is that there is only one pipe leaving the plant. This does not allow any flexibility in the event that the pipe is out of service. The existing flow meter will likely not have a sufficient operating range for the higher flows. A second discharge pipe should be provided with the plant expansion. The capacity of the high lift pumping will need to be increased as part of the plant expansion. The need to increase the reservoir/wet well storage (currently 7,480 m<sup>3</sup>) will also have to be reviewed in conjunction with the increased pumping.

The floor drains in the High Lift Pumping Station discharge to the lake, which could permit contaminants spilled on the floors to discharge to the environment and come in contact with the source water. Although a plan to mitigate this risk has been formulated by Utilities Kingston, a permanent solution should be implemented as part of the plant upgrades.

Key considerations for the plant expansion:

1. High lift pumping firm capacity needs to increase to 80,000 m<sup>3</sup>/d or slightly more (from current 54,488 m<sup>3</sup>/d).
2. Should add a second high lift discharge header to convey treated water from the plant into the distribution system.
3. Ensure floor drains do not discharge back to Lake Ontario.
4. Technical Memorandum No. 5 will evaluate High Lift pump combinations and capacities and take into consideration the age and capacity of the pumps. Potential options should include:
  - Replace all pumps.
  - Maintain existing pumps for peak flows and standby.
  - Replace only some pumps to increase station capacity and maintain other pumps.
  - Supplement existing pumps with new pumps.

#### **4.3.11 Process Waste Management**

Backwash wastewater is directed to two backwash tanks, each with a volume of 292 m<sup>3</sup>. Supernatant from the backwash tanks is decanted by gravity directly to the lake, and the sludge is pumped to the sanitary collection system. Water is decanted through floating decanters on swivel joints. The decanting piping and motorized valves were upgraded in 2003. Sludge is pumped to the sanitary collection system by two submersible pumps (one in each backwash tank). The capacity of the submersible sludge pumps is 7.6 L/s. A valved interconnect between the two backwash tanks was added in 2003.

The existing waste management system will have to be assessed with respect to treatment technologies being evaluated for the plant expansion. Additional tanks or other modifications will likely be required.

Key considerations for the plant expansion:

1. The capacity of the existing process waste management facility will have to be reviewed in conjunction with the evaluation of treatment technologies and will likely need to be expanded and/or modified.

#### **4.3.12 Building Mechanical**

##### **4.3.12.1 Plumbing**

Plant water is connected to the upstream side of the treated water venturi flow meter and is, therefore, not accounted for in the flow measured at this location, nor is plant water usage metered. From this tie point, a 75 mm line is routed through a backflow preventor to supply the plant water system, and connect to a 100 mm line that serves the on-site fire hydrants. The line to the fire hydrants is isolated due to the poor condition of this system and to control associated leakage. It is recommended that the fire protection for the site be reviewed during the preliminary design phase. It also appears that the plant water supply to the chemical rooms may not be isolated from water serving washrooms, sinks, and showers. The Process Building is equipped with a men's and a women's washroom on the second floor level, in addition to a shower/locker room on the main level. These facilities appear to meet current needs, however, they may be dated by the end of the expanded plant's service life. Neither facility is equipped for handicapped use.

A single washroom is also found in the Pump Building and is of a similar vintage as the Process Building washrooms. Hot water in both buildings is provided by electric hot water heaters.

Floor drainage piping for the Filter Gallery is cast into the slab over the clearwell. This is a practice that is generally avoided by today's standards; however, periodic inspections to confirm the integrity of the piping will reduce the risk of any contamination. It should also be confirmed that two floor drains in the PACI chemical containment area are isolated or sealed. In some plants, drains in containment areas are sealed with cleanout covers of "plumber's plugs" to permit periodic floor washdown and drainage.

It is understood that sanitary drainage from both the Process and Pump Buildings is disposed of to an existing septic tank and tile system at the southwest corner of the site. This system is in need of replacement, and UK would like to connect to the municipal sewer system. This connection may require a small sanitary pump well and a force main to Sunny Acres Road.

Roof drainage in the Process Building is conveyed to a sump at the lower level. This sump is drained to a storm sewer outside the building and then to the Lake. It is understood that drainage for the Pump Building is conveyed in a similar manner. Roof drainage piping in the buildings is corroded on the surface but appears to be intact.

Key considerations for a plant expansion:

1. Complete periodic inspections to confirm floor drainage and drainage piping over the clearwells does not present a risk of leakage.
2. Seal floor drains in chemical containment areas.
3. Evaluate the need for handicapped washrooms. If significant retrofits of the administration areas are required, provisions for handicapped access may be necessary.
4. Remove the existing septic system at the southwest corner of the site and provide a small sanitary pump well as necessary to dispose of sanitary drainage to the municipal sewer.

#### **4.3.12.2 Heating**

Generally process areas are heated by a combination of 3 or 5 kW electric unit heaters. Administration areas and smaller process areas, such as the tunnels, are heated by surface mount electric fin-tube convectors. Some recessed electric cabinet heaters are installed in various locations such as stairwells. Generally, the electric heating equipment appears to be in reasonable condition. Some electric unit heaters have been removed and not replaced, such as in the Filter/Flocculator Area.

At the time of the site visit, the outdoor air temperature was in the order of  $-10^{\circ}\text{C}$ . Administration areas were comfortable. Process areas were cool, however, this is believed to be due to setpoints and not equipment capacity. There was some evidence of condensation on concrete surfaces and outside walls, however, this is generally a greater problem during spring and early summer when warmer humid air comes into contact with cold concrete surfaces.

Key considerations for a plant expansion:

1. Investigate the installation of a gas-fired hot water heating system for the Process Building and gas fired unit heaters in the Pump Building, including automatic controls for night setback, etc.
2. Investigate radiant heating in high bay areas. Radiant heating can be effective in areas where there are cold surfaces and space temperatures are lower.

#### **4.3.12.3 Air Conditioning/Dehumidification**

Only the Administration Area is air-conditioned. It is understood the roof top air conditioning unit may be original from the 1977 construction project. It is likely the unit provides less ventilation air than may be required by current standards and uses a R-22 CFC refrigerant for cooling. Operators indicated that cooling performance of the unit is marginal.

Small residential type dehumidifiers are installed in the tunnel to limit condensation on cold surfaces during periods in the summer. It is also noted that in other areas of the plant there is evidence of condensation on cold surfaces as demonstrated by areas of surface corrosion on stainless steel pipes, peeling paint, and condensation on windows. Dehumidification in areas that may be isolated from open tankage can be effective to limit condensation and reduced life of equipment such as controls and electrical.

Key considerations for a plant expansion:

1. Replace the air conditioning and ventilation system for the Administration Area. The new system will likely need to supply additional ventilation air and will use a HCFC type refrigerant.
2. Investigate dehumidification in enclosed process areas such as MCC rooms, tunnels, the Filter Gallery, and other process areas where open water is not present.

#### 4.3.12.4 Ventilation

Generally the plant is equipped with very basic ventilation systems. The Filter/Flocculation Area is provided with two goosenecks on the WTP roof, which are ducted down to near the surface of Filter #1 and 3. There does not appear to be any mechanical exhaust in the area, however. It is suggested that mechanical ventilation be added, potentially using make-up air taken from other areas of the building that require ventilation. Outdoor air would then be made up to the other areas.

The Administration Area is ventilated by the roof top unit. Available information for this unit is limited, however, it is expected that it provides minimal ventilation. Generally this is not an issue from a code perspective due to the low occupancy; additional ventilation may be required for humidity control and higher occupant loads. Considering the location of the WTP, operable windows may also be an option for ventilation. Regardless, the rooftop mechanical unit should be replaced.

The Laboratory has no dedicated exhaust system. Operators indicate that very limited testing is completed in this area and exhaust may not be necessary. If necessary, an extractor arm type exhaust could be added for specific exhaust requirements.

Ventilation systems in the Filter Gallery and Equipment Rooms appear to be limited. It is suggested this be reviewed during the preliminary design phase to determine the most efficient means of heat removal, if necessary, and dehumidification control. It is likely that existing MCCs will be replaced in an expanded plant and dedicated MCC Rooms with climate control should be provided.

The Chemical Room appears to have limited ventilation and although the chemical is generally enclosed by tanks or piping, chemical rooms typically require a higher rate of ventilation.

The Pump Building is equipped with roof top exhaust fans and outdoor air make-up dampers in the walls. The dampers are uninsulated, do not seal well and are corroded, and should be replaced. Currently, staff operate the exhaust fans and open outside doors during summer months. “Man cooler” type fans are also used periodically to cool pump motors. The installed type of system can be effective and should be upgraded to suit new pumping requirements. New dampers should be insulated and be equipped with blade seals. Given the proximity of the WTP to residential development, it is also possible that sound attenuation will be required on ventilation openings.

Two of the diesel drives in the Pump Rooms are water-cooled and only radiant heat is rejected to the space. The third drive (Volvo) is equipped with a fin-tube type radiator that should perhaps be ducted to outdoors.

A previous report regarding the chlorine room systems was completed by JLR in 2005. Recommendations made with respect to ventilation in this area included:

- Relocate the exhaust fans' intake and discharge locations.
- Assess the need for a scrubbing system.
- Upgrade heating, lighting, and ventilation in the entrance vestibule (i.e. pressurization).
- Provide chlorine gas leak detection in chlorinator room.

Key considerations for a plant expansion:

1. Replace the rooftop air conditioning unit for administration areas and investigate operable windows.
2. Investigate ventilation and dehumidification requirements for the Process Building Filter Gallery and other equipment rooms.
3. Provide dedicated climate control for new MCC Rooms.
4. Upgrade existing Pump Building ventilation systems.
5. Implement Chlorine Room ventilation upgrades as noted.

#### **4.3.12.5 Oil System**

The diesel fuel system supplies oil to the diesel engines and a small 25 kVA standby generator set. The system consists of an indoor day tank in a dedicated and contained room, and an outdoor above-grade double wall tank. The system appears to be less than 10 years old and appears to be in good condition. An evaluation of risks associated with an oil line leak or breakage at one of the engines should be completed. UK has advised that the original underground oil storage tank has been removed.

Key considerations for an expanded plant include completing an assessment of risks associated with an oil line failure to the engines.

## **5.0 ELECTRICAL**

### **5.1 Methodology and General Comments**

A visual “walkthrough” assessment of the electrical system was completed on November 21, 2007. Most of the electrical, instrumentation, and control equipment on the site is part of the original installations. Technological advances in the field of intelligent controllers can now provide the operator and remote support staff with a more detailed understanding of equipment operations.

We note that the previous construction was during a time period where PCBs were present in lighting ballasts and capacitor banks. The removal of such materials is costly. Therefore, an investigation should be carried out early in the project, and proper contingencies should be included in the cost analysis.

### **5.2 Condition Assessment**

#### **5.2.1 High Voltage Substation**

The existing substation is a 1.5 MVA, 44 kV to 600 V, 3 phase substation with an overhead feed to an oil-filled transformer complete with high voltage bushings and a tap box for an underground secondary. The substation was designed to accommodate expansion to a second transformer. All equipment is from the original construction.

The substation is filled with vegetation and is unlikely to meet new Code requirements for touch and step potential. The substation will, at the very least, need to be cleared of vegetation and be provided with new aggregate material.

If the station is to remain in service, the ground grid will need to be tested, and a fault study should be undertaken to evaluate the transformer. Replacement costs of the ground grid are difficult to assess and could range from \$50 000 to \$500 000 depending on soil conditions and available fault currents.

Due to the age of the equipment, the provision of a new substation with a tamperproof transformer sized to suit should be considered. This will also facilitate the construction process.

It is also recommended that the new substation be located in close proximity to the high lift pumps, which represent the largest electrical load.

The replacement cost of the existing substation would be in the order of \$350 000 plus any additional costs to extend or modify the incoming 44 kV line.

### **5.2.2 600 V Distribution**

The existing switchgear and MCCs are, for the most part, over 35 years old and hence, replacement and additional components are no longer readily available. A few years ago, a major fault occurred in the main gear and significant damage was incurred. This equipment was reinstated because it is critical to the operation of the plant.

For the reasons stated above, the existing switchgear and MCCs should be replaced.

The 600 V cabling will need to be replaced if the existing distribution equipment is replaced. If some or all of the existing distribution equipment remains, it is still recommended that the major feeder cables be replaced because they are approaching the end of their useful life. Unplanned cable failure can be costly and difficult to repair.

The replacement cost of the existing 600 V MCCs including equipment, labour, and accessories would be in the order of \$835 000. The cost to replace the existing major 600 V cabling would be in the order of \$105 000 and excludes motor feeders.

### **5.2.3 120/208 V Distribution**

Most of the panels and feeders were installed as part of the original construction and should be replaced as they have reached the end of their useful life and replacement components are no longer available.

The replacement cost of the existing 120/208 V distribution would be in the order of \$50 000.

### **5.2.4 Emergency Power**

The existing generator is a 120/208 V, 35 kW unit that serves only lighting and control systems. Pumping is via diesel/electric pumps.

This unit should be replaced due to its age.

The replacement cost for the existing emergency generator would be in the order of \$47 000, but it is doubtful that the size would be adequate.

### **5.2.5 Lighting and Related Services**

For the most part, the existing lighting is T12 fluorescent from the original installation. These units should be replaced with more efficient fixtures appropriate for the application. The replacement cost for the existing lighting would be in the order of \$50 000, assuming no PCBs are present.

## **6.0 CONTROLS AND INSTRUMENTATION**

### **6.1.1 Controls**

The existing control system consists of a series of Bristol Babcock 3300 DCS controllers with RS485 communications.

This equipment is no longer supported and components are no longer manufactured. For this reason, replacement of this equipment with current technology is recommended.

Costs to replace the existing controls with comparable new control equipment and software would likely be in the order of \$710 000.

### **6.1.2 SCADA**

The existing SCADA is Wonderware and is functioning well. Wonderware is Utilities Kingston's standard, but updates and upgrades will be required to suit the new control hardware and process modifications.

The SCADA hardware consists of desktop PCs. The life expectancy for computer hardware running this type of 24-hour application is five years or less.

The equipment should be replaced with server-grade equipment in racks housed in a separate, climate-controlled room.

Replacement of the existing SCADA system with a new one, including hardware, software, setup, and programming would likely be in the order of \$440 000.

### **6.2.3 Instrumentation**

Instrumentation will be reviewed on a case-by-case basis because new water quality instruments have been installed in the last five years. For this equipment, consideration will be given mostly to the constructability issues related to relocating equipment.

Pressure, flow, and level instruments will be replaced for the most part with newer technology.

Replacement of existing instrumentation would likely be in the order of \$975 000.

## 7.0 SUMMARY AND RECOMMENDATIONS

The purpose of this Technical Memorandum was to determine the state of existing infrastructure at the Point Pleasant WTP. Until the exact nature of the anticipated upgrades are understood, it is unclear what changes to the existing plant will be required. The only recommendation at this stage is to proceed with Technical Memoranda 3, 4, and 5, and with the environmental assessment process, where the nature of the site upgrades will be determined.

Table 4 provides a summary of costing information.

**Table 4 - Summary of Preliminary Cost Estimates**

Item	Cost
<b>Structural and Architectural</b>	
Pump Building Roof	\$125 000
Original Process Building Roof	\$150 000
Process Building Addition Roof	\$75 000
Allowance to improve Roof Slope	\$25 000
Global Recaulking Program	\$20 000
Painting Steel Support Angles	\$2 000
Precast Panel Flashing	\$5 000
Patch Exposed Rebar	\$1 000
Concrete Sealant Application	\$1 000
General Door Maintenance	\$5 000
Repaint Corroded Door Frames	\$1 000
Window Replacement <sup>(1)</sup>	\$40 000
Isolate/Brace Block Partitions	\$25 000
Tunnel Joint Repair Allowance	\$25 000
Replace Stained Ceiling Tiles	\$150
Repair Cracks in Block Walls	\$5 000
Renew Peeling Paint	\$5 000
<b>Electrical and Instrumentation</b>	
Grounding Grid <sup>(2)</sup>	\$500 000
Replace Existing Substation	\$350 000
Replace Existing 600 V MCCs	\$835 000
Replace Existing 600 V Cabling	\$105 000
Replace Existing 120/208 V Cabling	\$50 000
Replace Existing Emergency Generator	\$47 000
Replace Existing Lighting <sup>(3)</sup>	\$53 000
Replace Existing Controls with a Comparable System	\$710 000
New SCADA system	\$440 000
New Instrumentation	\$975 000
<b>Total<sup>(4)</sup></b>	<b>\$4 550 000</b>
Notes:	
(1) Cost for window replacement assumes that all windows are replaced at once. See section 3.2.4 for further details	
(2) Highest cost for grounding grid replacement assumed	
(3) Assumes that no PCBs are found	
(4) As these are approximate, the total does not include other associated costs such as mobilization, contractor mark-up, contingency, etc.	

As mentioned previously, the costs shown in this Technical Memorandum and summarized in Table 4 are only estimates of the cost to replace aging infrastructure with exactly the same type. Therefore, the costs cannot be used directly to obtain an Opinion of Probable Cost for the site upgrades. As the nature of the site-wide upgrades is determined through the environmental assessment process, the costs for the upgrades will be included in Technical Memoranda 3, 4, and 5. All costs will be summarized and an Opinion of Probable Cost for the entire project will be developed in the Environmental Study Report.