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Technical Memorandum

DATE: October 21, 2014

TO: Mr. Dave Newman, Director of Engineering, Town of Gibsons

FROM: Karl Mueller, P.Eng.

RE: **PROWSE ROAD PUMP STATION UPGRADE**
Upgrade Options for Prowse Road Pump Station
Our File 2132.015-300

1. Introduction

The Prowse Road Pump Station requires upgrades to accommodate additional loads from a proposed new development. Kerr Wood Leidal Associates Ltd. (KWL) was retained by the Town of Gibsons (Town) to review three upgrade options:

1. Retrofit the existing pump station;
2. Construct a new Prowse Road Pump Station; and
3. Construct a new, smaller station to supplement the existing station.

The purpose of this memorandum is to quantify the hydraulic loading of the current sanitary system, evaluate the three options above, and provide recommendations.

1.1 Background

The Prowse Road Pump Station is located along the foreshore in Gibsons. Constructed in 1972 and retrofitted in 1993, it pumps wastewater from Lower Gibsons to the Gibsons Wastewater Treatment Plant (WWTP). Additional sanitary loading from the proposed new development may cause flows to exceed the station's capacity.

The station comprises two 88 HP CP3300 HT Flygt pumps with 200 mm-diameter-steel piping, and a swing check valve and gate valve on each pump discharge line. The discharge lines are connected outside the station. The station piping shows signs of severe corrosion. Both Flygt pumps are operated as duty/standby on variable frequency drives (VFD). The station's electrical components were being upgraded at the time of KWL's site visit.

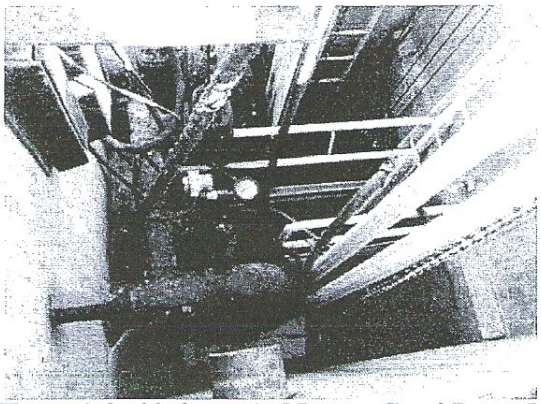

Figure 1: Inside Layout of Prowse Road Pump Station

A 250-mm-diameter, asbestos-concrete forcemain connects the station to the WWTP located at the top of the hill. The forcemain is approximately 560 m in length and was built with the original Prowse Road Pump Station. Upstream of the station, two concrete manholes collect flow from the shoreline trunk sewer located under the waterfront walkway and around the bluff.

1.2 Parameters of Assessment

The Town has provided the station record drawings and the Condition Assessment and Evaluation Study conducted by Paragon Engineering Ltd. (Paragon) in 2009. It has also provided SCADA information for the last year of operation to conduct the hydraulic loading analysis.

2. Hydraulic Loading Analysis

A flowmeter located adjacent to the wastewater treatment plant provides flow measurements of the Prowse Road Pump Station. Figure 2 on the following page shows the average station inflow following a rain event at approximately 30 L/s.

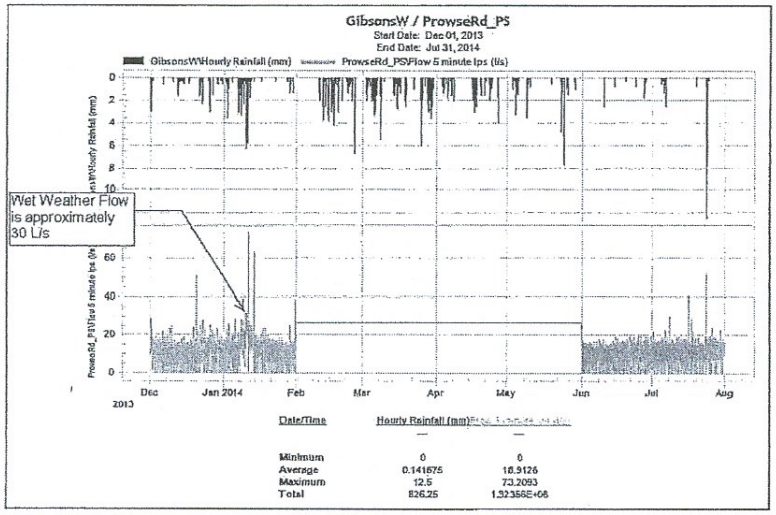

Figure 2: Wet Weather Pump Station Flow Graph

Figure 3 (below) shows the average base and peak dry weather flow to be approx. 10 L/s and 20 L/s respectively.

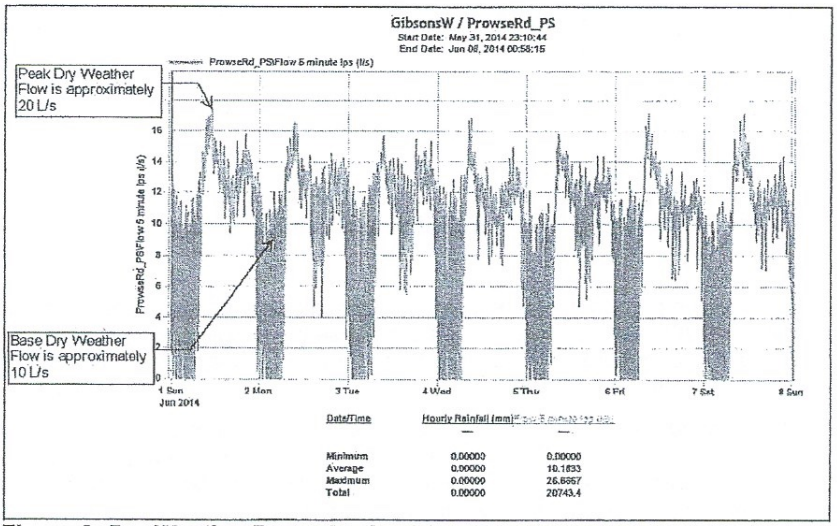

Figure 3: Dry Weather Pump Station Flow Graph

Based on this SCADA information, it can be anticipated that the typical daily flows pumped by the station is less than 30 L/s, which is within the station's capacity.

3. Pump Station Capacity Assessment

The pumps are generally in good conditions. The operators reportedly maintain the pumps and both pumps have been rebuilt in recent years. The operators also report that the pumps are operated at a maximum of 52 Hz to avoid overwhelming the WWTP headworks and bypassing the fine screen. The figure below shows the approximate system curve and the pump curves at full speed (60 Hz) and reduced speed (52 Hz).

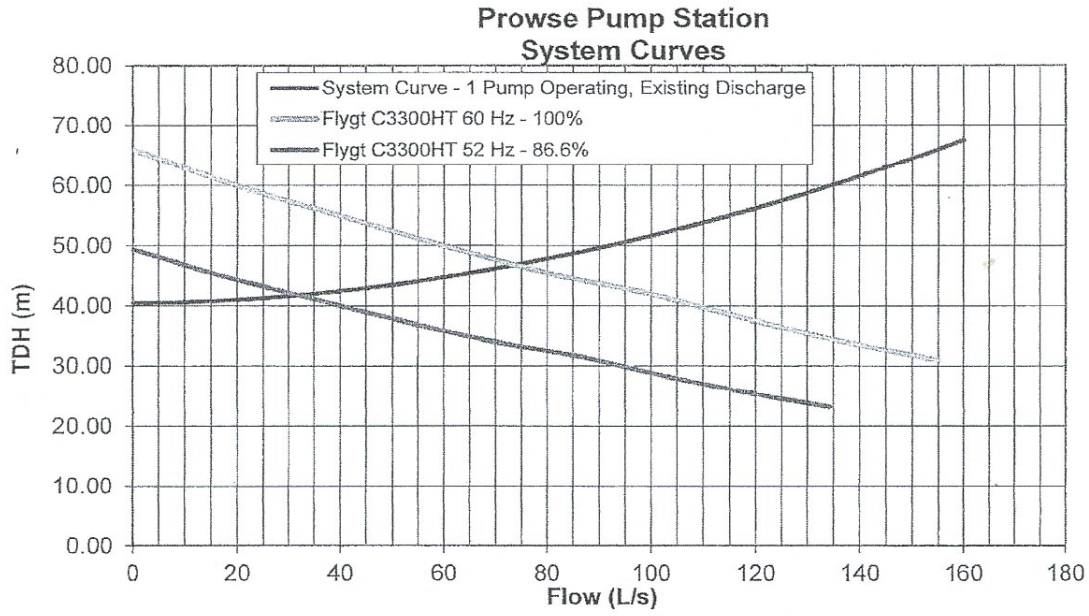

Figure 4: Prowse Pump Station System and Pump Curves

As indicated in Figure 4, the pump discharge is reduced by approximately half when operating at 52 Hz (33 L/s) compared to at 60 Hz (66 L/s). The station could increase its pumping capacity if the headwork at the WWTP is upgraded to accommodate the additional flow. We understand that the headworks upgrades are being looked at under a separate project.

The existing process piping is damaged, corroded, and generally in poor condition. Sections of abandoned piping from the original construction remained in the station following the 1993 upgrade. They are limiting the Town's crews' capabilities to access, operate, and maintain the station. The corroded pipe is also a risk to the Town as a sudden piping failure may trigger a full shutdown of the station.

4. Evaluation of Station Upgrade Options

The following three options were reviewed, and an advantage/disadvantage table was developed for each.

4.1 Option A – Construct New Prowse Road Pump Station

This option involves the construction of a new pump station and the decommissioning of the existing station. In 2012, KWL provided a cost estimate for this concept. The following is based on this concept.

The new station option would include replacing the wet well with a new, larger and deeper wet well that would provide sufficient storage volume for pump cycling under increased future flows. The new station would likely be located adjacent to the existing one, and the existing station would be used as a bypass during construction and then decommissioned.

The station would be located approximately 40 meters from the Gibsons Marina where the ground water table is high. Wet well excavation, complete with conventional shoring techniques, would require extensive dewatering given the high water table and shoring penetrations for existing pipes.

The components of a new station are as follows:

1. Civil Components: Site and structural work associated with building the new wet well, valve chamber, and flowmeter chamber;
2. Structural Components: Construction of a new electrical building that meets electrical and building codes;
3. Mechanical Components: All mechanical equipment, instrumentation, piping, pumps, valves, and appurtenances; and
4. Electrical Components: All electrical control components, power supply, and a new diesel-driven generator set.

Cost Opinion

The probable construction cost as estimated previously is approximately $2,063,000. This estimate is in 2012 dollars and will need to be adjusted for inflation. Since the estimate was completed a genset has been installed and this item can be removed from the estimate scope. Electrical upgrades have been completed at the existing station and depending on the design of the replacement station this scope item may also be reduced.

Advantage/Disadvantage Table

Table 1 on the next page presents the advantages and disadvantages for the new station option.

Table 1: Advantages and Disadvantages of Option A

Advantage	Disadvantage
▪ New station with new components and equipment provides the longest service life. ▪ Station design can be optimized to meet current and future demands. ▪ Site access to the station and equipment is improved. ▪ Decommissioning the existing station eliminates an aging risk asset for the Town. ▪ Refresh the waterfront area by blending in the new station with its surroundings. ▪ Remove old abandoned utilities in the area. ▪ Perform a condition assessment of the existing trunk sewer. ▪ Add odour control equipment.	▪ Most expensive option. May not be within budget. This option has the highest NPV cost of the options available.

4.2 Option B – Retrofit Existing Station

This option includes the removal of the station's internal components and replacement with stainless steel pipe, new valves and appurtenances, and a new above-ground valve vault.

This option will allow the Town to reuse the existing wet well and pumps, while completely replacing the internal components of the station. The existing piping and accessories are severely corroded and in poor condition, which prevents the Town's crews from efficiently operating and maintaining the station. Replacing the piping will improve the station's flow characteristics, reduce the system head loss, and improve the infrastructure's reliability. Retrofitting the station combined with the treatment plant upgrades, discussed separately, will maximize the station capacity.

The wet well is shaped like a rectangle with rounded ends and the pumps and inlet pipe are located in the middle of the rectangle with open space in the rounded ends of the wet well. The rounded ends of the wet well are minimally benched and are essentially dead space allowing for the accumulation of solids. In this option the station invert should be benched with reinforced concrete as per the Hydraulic Institute's recommendations for providing optimal pump intake and solids handling characteristics in the station. This will improve the life expectancy of the pumps, operating performance, and reduce maintenance. From the visual inspection the existing concrete appeared in good condition and showed minimal signs of corrosion. A more thorough inspection will need to be completed during mechanical replacement and concrete repairs completed at that time. The original structure design is not to current BCBC design standards and will require upgrades to meet current code. Structural upgrades (wet well and electrical building) are not being considered as a part of this option.

The recommended piping is stainless steel (SS) schedule 10, which performs well in corrosive environments such as wastewater facilities. Pipe ends will be either flanged or plain ends connected with either grooved or mechanical couplings.

In this option we would recommend installing the valves in an aboveground vault located at the edge of the existing concrete station lid. An example of the above ground valve chamber is shown in the figures below. With the aboveground valve chamber all valves can be accessed for maintenance without completing a confined space entry and the maintenance requirements can be reduced.

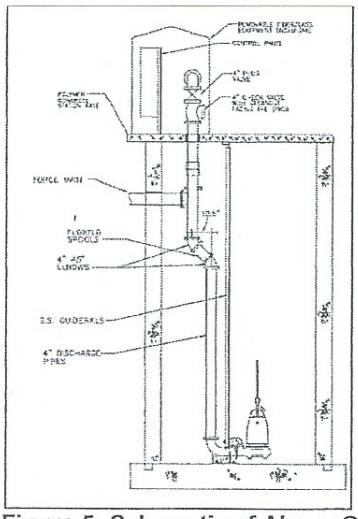

Figure 5: Schematic of Above Ground Valve Vault (From Flygt)

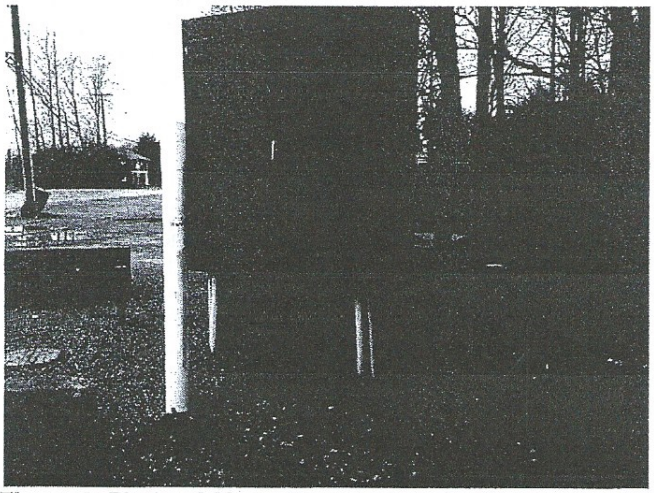

Figure 6: Photo of Above Ground Valve Vault Over a Lift Station

The existing check valve is a traditional swing check model, which does not have a high hydraulic flow coefficient compared to other valve designs and the valve has relatively poor transient properties. We would recommend replacing the swing check style valve with a swing-flex style valve, which is better suited to the wastewater environment, and has better hydraulic and transient performance.

The gate valve should be replaced with a new resilient seated gate valve suitable for wastewater or a full port plug valve.

Modifications would be required to the hatches to suit the pumps and piping and the hatches should be replaced with new hatches complete with fall arrest systems. It may prove more economical to construct a new cast in place structure over the existing station to accommodate the new hatches and should be investigated further.

General improvements would be made to the instrument and piping supports, and electrical cabling layout inside the station.

Existing Station Life Expectancy

The existing pumps were purchased during the 1993 station retrofit and have been rebuilt in recent years. Pumps can generally operate for 30 to 35 years if maintained as per the manufacturer's recommendations before full replacement is required. As such, the pumps can likely operate for an additional 10 to 15 years until pump replacement is necessary.

The existing process piping will also be replaced with new stainless steel piping that will significantly reduce the Town's piping failure risk.

Electrical upgrades were being completed at the station. New electrical installations can last up to 40 years on average.

The station retrofit is expected to increase the remaining life expectancy of the station by 10 to 15 years provided that the additional flow from the new development does not exceed the existing pump station's capacity. The station is currently operating at approx. 33 L/s and is reportedly keeping up with incoming flows. These upgrades combined with the treatment plant upgrades will increase the station firm capacity to approx. 75 L/s. Constructing the North Road diversion/bypass will allow Upper Gibsons and Gospel Rock catchments to drain by gravity to the treatment plant which will divert approx. 18 L/s and 10 L/s (see 2008 KWL report) away from the Prowse Road pump station and freeing up station capacity.

Further Investigations

In the near future the station structure should be inspected by a qualified structural engineer to asses for damage and structural upgrades required. The existing forcemain is near the end of its service life and a pipe sample is required to review the condition of the existing pipe and estimate the remaining life. For the station upgrades bypass infrastructure will be required on the existing forcemain and the installation is scheduled for 2015. It would be a good opportunity to install a temporary station bypass (three-day duration) to allow the existing station to be drained, cleaned, and inspected and obtain a sample of the existing forcemain pipe near the station.

Cost Opinion

The probable construction cost of this option is approximately $493,000.

Advantage/Disadvantage Table

Table 2 presents the advantages and disadvantages for the station retrofit option.

Table 2: Advantages and Disadvantages of Option B

Advantage	Disadvantage
▪ Improved flow characteristics with new piping and valve. ▪ Reduced capital costs through reuse of existing pumps. ▪ Improved maintenance frequency with easily accessible equipment. ▪ Minimized construction costs because of no significant civil and site work. ▪ Improved pump hydraulics with new station benching. ▪ Improved system reliability. ▪ Retrofit electrical control system for the pumps to allow remote station control.	▪ Above ground valve vault may be an eye sore along the waterfront. ▪ No increase in the pump station's control volume. ▪ Investing capital into a 40-year-old structure that may require replacement in the near future. ▪ Further wet well investigation may reveal significant structural damage that may require full replacement. ▪ Existing electrical building may not meet electrical code.

4.3 Option C – Construct New, Supplementary Station

This option involves constructing a new pump station to supplement the existing Prowse Road Pump Station.

Description

The developer proposed financing construction of a new station to supplement the existing station and handle the additional sanitary loads anticipated by the new development. The new station would be located adjacent to the new development and would pump directly to the WWTP.

Cost Opinion

The developer provided a cost estimate of $600,000 for the construction of this station.

Existing Station Life Expectancy

Similarly to Option B, the pumps at the existing station can likely operate for an additional 10 to 15 years until replacement is necessary. The newly installed electrical equipment can last up to 40 years on average.

However, the corroded process piping inside the existing station will likely fail before the pumps or the electrical installation. The existing piping poses a significant risk as any pipe failure would disrupt the Town's wastewater conveyance capacity.

The new supplemental station will not increase the remaining life expectancy of the Prowse Road Pump Station.

Advantage/Disadvantage Table

The following table presents the advantages and disadvantages for a new smaller station to supplement the existing Prowse Road pump station option.

Table 3: Advantages and Disadvantages of Option C

Advantage	Disadvantage
▪ Station design can be designed to meet future demands from the development. ▪ Lowest cost option for the Town. ▪ Will reduce existing loading of Prowse Road Pump Station.	▪ Additional infrastructure for the Town to operate and maintain. ▪ Station provided by a developer may be designed for low capital cost, but high lifecycle cost. ▪ Does not address the current issues at the existing station. The Town would have to invest separately in retrofitting the station. ▪ Requires additional discharge location at the WWTP. ▪ No upgrades to the aging station (pump control volume, pump cycling, piping in poor condition). ▪ No upgrades to meet WorkSafeBC requirements for maintenance access.

5. Full Station Replacement Trigger Events

Options B and C will extend the life of the existing station by varying degrees. However, if any of the following events occurs, the existing Prowse Road Pump Station will require a full replacement similar to Option A:

1. **Seismic Event**

   The electrical building and wet well are likely not designed to withstand current BCBC seismic loadings. A large seismic event is likely to cause severe damage and require replacement.

2. **Mechanical and Pump Failure**

   The pumps have an estimated remaining life of 10 to 15 years. At the end of the 10 year period the station should be reviewed to determine if it is still adequately servicing the community, and mechanical components (piping, pumps, HVAC) should be reviewed for replacement. If the station structure is still in adequate condition then a pump replacement rather than a full replacement may still be warranted. Will require further investigation at that time.

3. **Wet Well Concrete Damage and Failure**

   If an assessment of the wet well shows concrete significant deterioration and/or failure and structural damage, it is likely more cost effective to construct a new station wet well rather than repairing the existing.

4. **Electrical Installation Failure**

   New electrical installations typically have a 40 year life. At the end of this period it will be prudent to build a new station including a replacement electrical building.

6. Financial Analysis

The following table compares the present value for both Options A and B. Option C was not assessed as the existing Prowse Road pump station requires immediate retrofit, and there is no expected remaining life based on the piping condition. The analysis estimated the yearly interest rate at 6%.

Table 4: Present Value Analysis

Scenario	Estimated Cost	Life Expectancy	Present Value
Option A: New Station	$2,063,000.00	40 years	$776,100
Option B: Station Retrofit	$493,000.00	15 years	$319,200

The present value for Option B is lower representing lower expenditures and greater present value for the Town.

7. Treatment Plant Headworks Upgrades

Pump station discharged is currently limited by the capacity of the inlet fine screen and headworks manhole at the treatment plant. The operators have determined from experimentation that flows in excess of 33 L/s seem to backwater the headworks (WWTP inlet manhole) and overflow the fine screen.

To allow the station to pump at full installed capacity additional capacity is required at the treatment plant inlet and generally includes increasing the capacity of the inlet fine screen as well as increasing the available storage in the inlet headworks manhole. These improvements are being discussed under a separate project.

8. Conclusions and Recommendations

Based on the findings of this assessment, the following conclusions were reached:

- The existing pumps are in good condition;
- Based on the SCADA information provided by the City, the pumps are capable of pumping the existing flows;
- The existing mechanical piping is in poor condition and is a failure risk to the Town;
- Option A would provide the Town with the greatest flexibility, but at the largest initial capital investment;
- Option B would allow the Town to retrofit the existing station and extend the pump station's remaining life by 10-15 years until a new pump station is required;
- Provided upgrades to the WWTP headwork are completed, option B will also allow the Town to increase the loading from future developments up to the pump station's full capacity; and

- Option C is not recommended because it relies on the existing pump station, and does not reduce the risks posed by the existing corroded mechanical piping.

Therefore, KWL recommends the following:

- Proceed with Option B;
- Investigate on required WWTP headwork upgrades to increase pumping capacity; and
- Resume work on infrastructure assessments to obtain a full understanding of the wastewater system's conditions.

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Revision History

Revision #	Date	Status	Revision Description	Author
C	2014/10/21	Final	Incorporate review comments	KM
B	2014/10/14	DRAFT	Added the following sections: financial analysis, station trigger events, life expectancy, hydraulic loading, and recommendations	PC
A	2014/08	Original		PC

OQM | Organizational Quality Management Program

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From: Emanuel Machado
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To: Andre Boel
Subject: Accepted: George, results KWL