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Technical Memorandum

DATE: February 14, 2022

TO: Tom Csima, Manager, Operation and Projects
Village of Pemberton

FROM: Brandon Johnson, P.Eng.

RE: **Village of Pemberton**
Water Conservation Plan
Our File: 0743.018-300

Background

Kerr Wood Leidal Associates Ltd. (KWL) has been retained by the Village of Pemberton (the Village) to provide a Water Conservation Plan (the Plan). The Village has a higher per capita water use than the Canadian average, indicating potential for reducing consumption through water conservation and leak detection efforts.

The Village's water source derives from two active wells that withdraw from the Pemberton Creek Fan Aquifer which supply the Village population of approximately 3,100 as well residents of the Squamish-Lillooet Regional District who live in the Pemberton North Improvement District. Demands from the Pemberton North Water System (PNWS) comprise approximately 17% of the total demand.

The goal of the Plan is to identify both where conservation efforts should be made, and tools and work needed to reduce water use and leakage to achieve an overall reduction in per capita water use of 15% in the next 10 years.

Incentives to conserve water are both economic and environmental. Economically, the Village is significantly invested in its current source. Alleviating capacity constraints will defer infrastructure replacement costs, reduce operational costs, reduce water treatment costs, and maximize the time that the Pemberton Creek Fan Aquifer can be utilized before needing a new source. Environmentally, reducing the extraction of water from the aquifer will subsequently also reduce the volume of wastewater released, minimizing the impact to the environment.

Per-Capita Water Demands and Component Analysis

Average per capita water use is approximately 600 L/capita/day which included residential, industrial, and commercial use but excludes water demand from the Pemberton North Water System. In 2017, Canadian average per capita water use is 427 L/capita/day which also includes industrial, commercial, and other uses.

The village's current maximum day per capita demands are estimated at 1,190 L/cap/day which is high.

Per-capita water use is often used as a metric for assessing residential use and conservation efforts, however, it is affected by the type and quantity of industrial and commercial (ICI) use. High ICI water use

combined with a relatively low population can inflate the average per capita water use metric. Equally, higher than average system leakage can have the same effect.

Water conservation initiatives should put focus and effort where improvements can be made based on analysis of the components of water use. It is therefore necessary to understand where the greatest reductions are possible by measuring other metrics such as leakage levels, the leakage infrastructure index, residential base (indoor use), and seasonal water use.

The recommended process for determining the components of water use, including leakage, are as follows:

1. ICI Use: Quantified by customer water meter billing database and estimates for unmetered commercial and industrial use. It is noted that all businesses located in the Village's industrial park have water meters installed and it is estimated that metered ICI customers account for roughly half of the total ICI use[1] in the Village; however, these users are not serviced via the Village's water system. Average, base, and seasonal usage for industrial and commercial users may be estimated if all meters are read for billing at set times marking the normal transition from winter to summer usage.
2. Water System Leakage: Quantified by zone night flow analysis. It is noted that the Village is working towards providing SCADA monitoring for zone metering to allow leakage assessments to be completed.
3. Base Demand and Base Residential water use: Review of average winter demand data. Base demand is average winter demand. Base residential water use is calculated by deducting the estimated industrial and commercial use and estimated system leakage from average winter demand.
4. Seasonal water use: Review of yearly flow data. The yearly quantity of seasonal demand and period in which it occurs can be quantified by review of daily flow records.

Components of Water Demand

Water billing data from 2010 through to 2020 was reviewed along with source flow data from 2020 and 2021. In 2015, a major leak was identified and repaired. The leak was responsible for a daily loss upwards of 500 m^3 or 5.79 L/s, which accounted for roughly 20% of the water demand at the time.

A water balance was completed using billing data from 2016 to 2021 to categorize water use and applying the breakdown to 2020 source flow data. Water demands have decreased by approximately 10% since 2016. Seasonal water use in 2021 was significantly higher than 2020 (+32%); however, 2021 was an uncharacteristically hot year, leading to many municipalities observing record water usage and therefore was not considered in this analysis.

The following assumptions were made to complete the water balance:

1. Indoor residential water use is estimated to be 230 L/cap/day.
2. Unmetered ICI demands are assumed as approximately one-third of the total ICI demand. Approximately half of the total ICI customers are metered, and it is assumed that these include the larger water users. Note that metered ICI customers are serviced via the Mount Currie Water System under a water use agreement.
3. Total base usage is calculated from the average day winter demand multiplied by 365 days.

[1] Village of Pemberton Water System Performance Assessment

4. Seasonal usage is all water usage above the average winter base demand that occurs from May through September.

The components of water demand are presented in Table 1 below.

Table 1: Estimated Annual Water Use Breakdown

Period	Usage by Demand Type (m^3)					Total	% of Annual Total	Industrial Park Water Use[1]
	Res.	ICI	Bulk Water	PNWS	Water Losses			
Base Usage	220,000	25,000	7,000	32,000	135,000	419,000	69%	49,000
Seasonal Usage (% of Total for Demand Type)	143,000 (39%)	8,000 (24%)	4,000 (36%)	36,000 (53%)	NA	191,000	31%	16,000
Annual Total	363,000	33,000	11,000	68,000	135,000	610,000	100%	65,000
% of Annual Total	60%	5%	2%	11%	22%			
1. Industrial Park is supplied via the Mount Currie water system								

The following is noted with regards to the estimated annual water use breakdown:

1. Seasonal water use is high and accounts for 31% of total yearly demand and is estimated to account for 39% of the total non-metered residential demand. By comparison, in the lower mainland, seasonal demand accounts for 33% of total residential demand. The difference in seasonal use between the Village and the Lower Mainland is greater than these numbers signal since the assumed residential base use for the Village (230 L/cap/day) is approximately 30% greater than Lower Mainland base residential usage. On average each residential account uses 142 m^3 of seasonal (outdoor) water between May 1 and September 30 or 934 L/property/summer-day.
2. Water losses are moderate, estimate at 135,000 m^3/year which is roughly 22% of total annual water use or a leakage rate of 4.3 L/s. It is noted that actual loss levels may be higher than reported as loss levels are calculated based on a relatively conservative estimates of legitimate residential base demand. The accuracy of the audit would be improved by determining water loss through minimum night flow analysis once zone metering is completed and connected to SCADA.
3. The water loss total includes leakage within PNWS. The total annual water supplied to PNWS is approximately 120,000 m^3; comprised of an estimated 68,000 m^3 of legitimate usage and 52,000 m^3 of water loss. PNWS water losses are estimated to be 39% of the Village's total water loss of 135,000 m^3. The Village can liaise with Squamish-Lillooet Regional District on managing water use in PNWS to identify and reduce water losses.

Population and Growth

The village's current population serviced by the Village's water system is estimated at approximately 3,100. The following is noted with regards to serviced population, current development plans, and future growth.

1. On average between 1991 and 2016, the Village has grown at a rate of 80 people per year.
2. The Village population is estimated to increase by 686 people according to the several developments that are either under construction or have recently been completed.

3. Over the next 5 to 10 years, there are significant residential plans approved, housing approximately another 1,763 people.
4. Extrapolating the population best fit line into the year 2040, the population for the Village is estimated for the years 2020 to 2040[2] as shown in Table 2 below.

Table 2: Projected Water Service Population

Year	Population
1991 Water Study	550
2001 Census	1,637
2006 Census	2,192
2011 Census	2,369
2016 Census	2,574
2021 Census	3,407
2025 Estimate	3,510
2030 Estimated	3,925
2035 Estimate	4,335
2040 Estimated	4,750

Water Supply Capacity

The Pemberton Creek Fan Aquifer is unconfined and primarily recharged via Pemberton Creek at a rate of approximately 30 L/s. Production wells 1, 2, and 3 are located in the central portion of the aquifer.

1. Well 1 is inactive due to excessive iron and manganese concentrations.
2. Well 2 is the backup well constructed in 1997 at a depth of 41.8 m. It has a diameter of 300 mm and a rated flow of 76 L/s.
3. Well 3 is the current duty well constructed in 2007 at a depth of 46 m. It has a diameter of 200 mm and a rated flow of 50 L/s.

During the summer months water is consumed quicker than the aquifer's recharge rate. The aquifer water levels typically recover each winter as the Village's water usage drops. The sustainable use of the Pemberton Creek Fan Aquifer requires the Average Daily Demand (ADD) to remain below 30 L/s (2,600 m^3/day). Currently, ADD is approximately 21 L/s.

Climate Change Adaptation and Mitigation

The following is noted with regards to climate change adaptation and mitigation:

1. In general, weather is likely to become wetter in the winter and drier in the summer in the future in the Squamish-Lillooet region. According to the Pacific Climate Impacts Consortium (PCIC; plan2adapt.ca), by the 2050s, precipitation in the region is expected to change from current normal as follows (median of forecasts, and range of 10^{th} to 90^{th} percentiles):

[2] Village of Pemberton Water System Performance Assessment

   a. Annual +2.4% (-1.7% to +7%)
   b. Summer -5.9% (-30% to 5.3%)
   c. Winter +2.9% (-1.9% to +8%)

2. As well, the Pacific Climate Impacts Consortium (PCIC; plan2adapt.ca), estimates that by the 2050s annual average temperatures in the region will increase by +3.1˚C (+2.1˚C to +4.2˚C).
3. Extreme weather events (temperature and precipitation, drought, and flooding) are expected to increase in frequency. The impact on water service may include increased storage requirements for balancing peak flows.
4. The physical capacity of the Pemberton Creek Aquifer is considered a constraint into the future with climate change worsening the effects of a growing population on demand.
5. Benefits of water conservation (mitigation and adaptation):
   a. Reducing the extraction of water from the aquifer will reduce the volume of wastewater released, minimizing the impact to the environment.
   b. Reducing costs and carbon emissions of expanding the infrastructure to accommodate growth (e.g., manufacturing, transporting, and installing larger watermains).
   c. Reducing carbon emissions associated with trucking water to overcome capacity constraints.
   d. Maintaining more water storage in reserve for emergencies such as wildfires or extreme drought, which may increase due to climate change.

Water Demand Targets

The following water conservation targets are recommended:

1. Overall water supply flow (annual total or average) at WTP: Maintain below 25 L/s through year 2040.
2. Maximum day demand at WTP: Maintain below 50 L/s through year 2040.
3. End user demand (L/cap/day): Reduce to 900 L/cap/day Maximum Daily Demand (MDD) and 450 L/cap/day ADD at WTP by year 2040.

Achieving a per-capita reduction in water demands of approximately 25% over the next 20 years will rely on a combination of educational and regulatory measures to reduce water demands in existing buildings, water-efficient new construction, and implementation of a water distribution loss management program. If these measures are implemented, the targets are achievable with a water service area population of 4,750 in year 2040.

Current and Planned Water Conservation Measures

A planned adaptive strategy enables conservation measures to be tailored to meet the changing needs of the community over time. The following conservation measures are currently undertaken or are planned for implementation as required.

1. **Regulation** (current): In 2015 the Village established an Outdoor Water Use Regulation Bylaw (Bylaw No. 792), which includes four water conservation levels as shown on Figure 1 below.

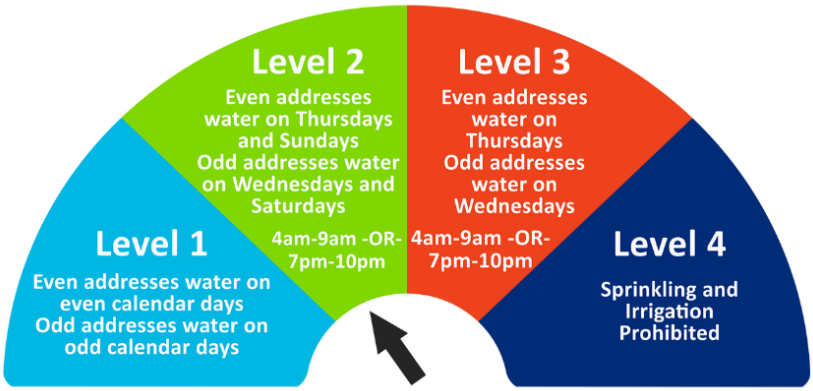

Figure 1: Village of Pemberton Outdoor Water Use Levels

The Village advertises the current level of watering restrictions in social media and on its website. The Village also provides details about best practices for reducing indoor water use on its website to educate the public.

2. **Retail metering program** (feasibility study completed 2007, prioritized implementation in progress: The Village's zoning and building code bylaws require all new developments to install water meters and low-flow toilets and urinals (residential and ICI). Approximately half of all ICI connections are currently metered.
3. **Consumption based billing** (current): Metered customers are billed for water based on water consumption and a two-tiered inclining block rate structure where consumption over 65 m^3 per quarter is penalized with a higher water rate (2.25 times). The Village has developed appropriate non-metered and metered rate structures that achieve stable revenues and appropriate incentives to reduce base and peak demands.
4. **Water Loss Management** (current and planned): The Village has implemented zone metering and is in the process of connecting zone meters to SCADA for the purpose of monitoring nighttime flows and leakage levels. Distribution losses are estimated to average 2.2 L/s, which is approximately 11% of annual demand. Ongoing recommended measures include minimum overnight flow monitoring, keeping records of leaks found and repaired, and sounding for leaks at line valves and curb stops when they are exercised or located. Losses are the greatest in the Pemberton North Water System, comprising approximately three quarters the total loss value.
5. **Demand Management Program** (Current): Providing information to customers through print and electronic media has been a major component of the Village's conservation program since its inception. Print media has included bill stuffers, flyers and brochures that address indoor and outdoor water conservation practices. This information has also been posted on the Village's website and published in its bi-monthly e-newsletter. The Village also ensures responsible 'water wise' irrigation for all civic properties in accordance with their bylaw. The Village will continue to implement a program to reduce peak and annual water use as needed to defer capacity upgrades and meet the planned conservation targets, including a community awareness campaign aimed at water efficient lawn and landscape maintenance.
6. **Reporting usage and water budgets on water bills** (current and future): Displaying information about water use on water bills is completed to raise customer awareness about their water use. Comparing each customer's water use to a system average, or to a water use budget based on

system constraints will enable customers to make informed and timely decisions about how they use water.

7. **Water Conservation Plan Renewal** (planned for 2026, and every five years thereafter): A review of this plan will be conducted every five years to update forecasts and targets, consider new information, and adjust program activities as required to meet targets.

Program Implementation Responsibility, Cost and Schedule

The Manager of Operations and Projects will have overall responsibility for the water conservation program. Aspects of the program may be delivered by public works (e.g., water-loss management), finance (rates), and development services, corporate, and legislation (bylaw administration, forecasting and public engagement). The program can be considered in the municipal water budget. Planned measures will proceed within the next five years (subject to budget approvals), or as necessary to achieve targets and avoid premature infrastructure capacity upgrades where it is cost-effective.

Linkages to Other Plans and Policies

This Plan supports the Official Community Plan; outdoor water use bylaw; Water Rates Bylaw; PNWS water rates study; Water and Sewer Asset Management Plan; and Corporate Asset Management Policy.

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Revision History

Revision #	Date	Status	Revision Description	Author
A	January 10, 2022	DRAFT	Initial Draft	BLJ/RYL
B	January 17, 2022	DRAFT	Updated based on received data	BLJ/RYL
1	January 31, 2022	FINAL	Minor updates based on feedback from client	RLJ/RYL
2	February 14, 2022	FINAL	Minor updates based on feedback from client	RLJ/RYL

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