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WILDERNESS MOUNTAIN WATER SERVICE COMMISSION
Notice of Meeting on **Tuesday, November 24, 2020** immediately following the AGM
Goldstream Conference Room, 479 Island Highway, Victoria, BC

For members of the public who wish to listen to the meeting via telephone please call **1-833-353-8610** and enter the **Participant Code 1911461 followed by #.** You will not be heard in the meeting room but will be able to listen to the proceedings.

Director Mike Hicks (Chair) Martin Lechowicz Doug Pepino Dale Tallyn

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AGENDA

1. **ELECTION OF CHAIR**

2. **APPROVAL OF AGENDA**
   Recommendation: *That the agenda be approved.*

3. **ADOPTION OF MINUTES OF THE MEETING OF JULY 30, 2020**
   Recommendation: *That the minutes of July 30, 2020 be adopted.*

4. **WM2020-06 WILDERNESS MOUNTAIN WATER SERVICE - SOURCE WATER VULNERABILITY STUDY**
   Recommendation: *The Wilderness Mountain Water Service Commission receives the report for information.*

5. **WM2020-07 WILDERNESS MOUNTAIN WATER SERVICE - WATER TREATMENT ASSESSMENT**
   Recommendation: *The Wilderness Mountain Water Service Commission receives the report for information.*

6. **WM2020-08 2021 OPERATING AND CAPITAL BUDGET**
   Recommendation: *That Wilderness Mountain Water Service Commission:*
   1. *Approve the 2021 Operating and Capital Budget as presented, and recommend that any deficit be brought forward as an expense in the 2021 budget, and a surplus be transferred to the Capital Reserve Fund;*
   2. *Recommend that the Electoral Areas Committee recommend that the CRD Board approve the 2021 Operating and Capital Budget and the five year Financial Plan for the Wilderness Mountain Water Service as presented.*

7. **CORRESPONDENCE**

8. **NEW BUSINESS**

9. **ADJOURNMENT**

Next Meeting: At the call of the Chair.

Inquires arising from this meeting may be sent to IWSAdmin@crd.bc.ca for direct response.

To ensure a quorum advise Sharon Orr 250.474.9622 if you are unable to attend.

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Agenda Item #3

MINUTES OF A MEETING OF THE WILDERNESS MOUNTAIN WATER SERVICE COMMISSION Held Thursday July 30, 2020 in the Goldstream Conference Room, 479 Island Highway, Victoria, BC

PRESENT: **Commissioners**: Director M. Hicks (Chair); D. Pepino; D. Tallyn; M. Lechowicz

Staff: I. Jesney, Senior Manager, Infrastructure Engineering; J. Marr, Acting Senior Manager, Water Infrastructure Operations; S. Orr (recorder)

The meeting was called to order at 2:00 pm.

1. APPROVAL OF RESOLUTION

1. That this resolution applies to the Wilderness Mountain Water Service Commission for the meetings being held between July 1, 2020 and December 31, 2020.
2. That the attendance of the public at the place of the meeting cannot be accommodated in accordance with the applicable requirements or recommendations under the *Public Health Act*, despite the best efforts of the Wilderness Mountain Water Service Commission because:
   a. The available meeting facilities cannot accommodate more than (8) people in person, including members of the Wilderness Mountain Water Service Commission and staff, and
   b. There are no other facilities presently available that will allow physical attendance of the Wilderness Mountain Water Service Commission and the public in sufficient numbers; and
3. That the Wilderness Mountain Water Service Commission is ensuring openness, transparency, accessibility and accountability in respect of the open meeting by the following means:
   a. By allowing the public to hear or participate via teleconference or electronic meeting software,
   b. By providing notice of the meeting in newspaper or local notice Board, including the methods for providing written or electronic submissions,
   c. By making the meeting agenda, as well as the other relevant documents, available on the CRD website, and directing interested persons to the website by means of the notices provided in respect of the meeting,
   d. By strongly encouraging the provision of, and subsequently receiving and distributing to members, written correspondence from the public in advance of the meeting, and
   e. By making the minutes of the meeting available on the CRD website following the meeting.

MOVED by Commissioner Pepino, and **SECONDED** by Commissioner Lechowicz,
That the Wilderness Mountain Water Service Commission adopt the resolution as presented.
CARRIED

2. APPROVAL OF AGENDA

The following items were added:
8. New Business
   - 8.1 - 2020 Annual General Meeting
   - 8.2 - Correspondence

- 8.3 - Debt Repayment

MOVED by Commissioner Tallyn, and **SECONDED** by Commissioner Pepino,
That the agenda be approved as amended.

CARRIED

3. ADOPTION OF MINUTES OF JUNE 15, 2020

MOVED by Commissioner Pepino, and **SECONDED** by Commissioner Tallyn,
That the Minutes of June 15, 2020 be adopted.

CARRIED

4. CHAIR'S REMARKS

The Chair did not have any remarks.

5. WM 20-03 PROPOSED PROJECTS UPDATE

I. Jesney provided a summary of the report and updated the Commission on some unplanned projects required for ongoing water system operation.

Discussion took place and staff answered questions from the Commission regarding:

- Hazardous tree removal
- Access road improvement
- Mold remediation at the treatment buildings
- Budget process and project funding

MOVED by Director Hicks, and **SECONDED** by Commissioner Tallyn,
That the Wilderness Mountain Water Service Commission approve projects #1, #3 and #4 to be funded in 2020 by the Community Works Fund.

CARRIED

6. WM 20-04 RURAL AND NORTHERN COMMUNITIES FUND GRANT OPPORTUNITY

I. Jesney provided a summary of the report as presented and stated that a provincial grant funding opportunity is available, *Investing in Canada Infrastructure Program – British Columbia - Rural and Northern Communities Infrastructure Grant*, and the closing date is October 22, 2020.

Discussion took place and staff answered questions from the Commission regarding:

- Island Health Filtration Deferral and water quality
- Source Water Vulnerability Study
- Project funding
- Consultant procurement

MOVED by Commissioner Tallyn, and **SECONDED** by Commissioner Pepino,
That the Wilderness Mountain Water Service Commission recommends to the Electoral Areas Committee and the Capital Regional District Board:

That staff be directed to prepare and submit an application for an Investing in Canada Infrastructure Program – British Columbia - Rural and Northern Communities Infrastructure.

CARRIED

7. WM 20-05 WILLIAM BROOK DAM- DISPOSITION OF IMPROVEMENTS TO LANDS

I. Jesney provided a summary of the report and stated the last direction from the Wilderness Mountain Water Service Commission was to dispose of the William Brook Dam reservoir and related improvements.

Discussion took place and staff answered questions from the Commission regarding:

- Property access and liability
- Water quality
- Emergency water supply
- Source Water Vulnerability Study

The Commission decided that more information was needed regarding source water vulnerability study and water quality.

MOVED by Commissioner Pepino**, and SECONDED** by Commissioner Lechowicz,
That this report be referred back to staff for additional information.

CARRIED

8. NEW BUSINESS

8.1 Annual General Meeting

Discussion took place and staff answered questions from the Commission about the upcoming nomination and voting process.

8.2 Correspondence

I. Jesney introduced copies of correspondence as circulated:

- Letter from Island Health, dated July 19, 2017, re: Wilderness Mountain Water System 706 Cains Way
-
- Letter from Island Health, dated November 15, 2017, re: Wilderness Mountain Water System, 706 Cains Way
- Letter from Island Health, dated December 6, 2017, re: Wilderness Mountain Water System, 706 Cains Way
- Permit to Operate, Island Health, dated January 11, 2018
- Wilderness Mountain Drinking Water System Inspection Report, Island Health, dated March 3, 2020
- Letter from Island Health, dated July 21, 2020, re: Wilderness Mountain Water System, 706 Cains Way
- Drinking Water Treatment Objectives, Version 1.1, dated November 2012

- Copy of Thurber Engineering Ltd. report to Doug Funk, dated June 30, 2020, re: William Brook Dam Geotechnical Assessment

MOVED by Commissioner Pepino**, and SECONDED** by Commissioner Lechowicz,

That the correspondence be received for information.

CARRIED

8.3 Debt Repayment

Commissioner Pepino stated he would like information regarding the debt repayment schedule and the time frame to start paying it back.

MOVED by Commissioner Pepino, and **SECONDED** by Commissioner Tallyn,

That the Wilderness Mountain Water Service Commission direct staff to report back to the Commission on the anniversary date of the debt.

CARRIED

9. ADJOURNMENT

MOVED by Commissioner Pepino, and **SECONDED** by Commissioner Tallyn,

That the meeting be adjourned at 3:50 pm.

CARRIED

________________________ ________________________

Chair Secretary

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Agenda Item #4
WM2020-06

**REPORT TO WILDERNESS MOUNTAIN WATER SERVICE COMMISSION
MEETING OF TUESDAY, NOVEMBER 24, 2020**

SUBJECT **Wilderness Mountain Water Service - Source Water Vulnerability Study**

ISSUE SUMMARY

To provide the Wilderness Mountain Water Service Commission (WMWSC) with a Source Water Vulnerability Study prepared by WSP Canada Inc. (WSP) in response to an Island Health Authority (IHA) requirement.

BACKGROUND

In July 2017, IHA issued a letter requiring the Capital Regional District (CRD) to submit a Source Water Vulnerability Study for the Wilderness Mountain Water Service. The project to deliver the study was deferred until 2020 awaiting the results of a grant application that would provide an alternate water source to the service. The grant application was unsuccessful and a consultant, WSP, was retained to deliver the study.

The study was completed in November 2020 with input from local residents and WMWSC members. The study is attached as Appendix A with recommendations and conclusions on page 28 of the document.

Next steps are to submit the study to IHA and await their response as well as consider the potential financial implications of the recommendations and report back to the WMWSC at a future date.

ALTERNATIVES

Alternative 1
The Wilderness Mountain Water Service Commission receives this report for information.

Alternative 2
That this report be referred back to staff for additional information with specific direction to scope and budget to provide the information.

IMPLICATIONS

There are no implications to receiving this report.

CONCLUSION

In 2017 Island Health required the CRD to provide a Source Water Vulnerability Study be carried out on the Wilderness Mountain Water System. The project was deferred until 2020 to consider a grant application, which was unsuccessful, and the study was completed in November 2020.

The next step is to submit the study to IHA for their consideration.

RECOMMENDATION

The Wilderness Mountain Water Service Commission receives this report for information.

Submitted by	Dale Puskas, P.Eng., Manager, Capital Projects
Concurrence	Ian Jesney, P.Eng., Senior Manager, Infrastructure Engineering
Concurrence	Ian Jesney, P.Eng., Acting General Manager, Integrated Water Services
Concurrence	Robert Lapham, MCIP, RPP, Chief Administrative Officer

ATTACHMENT

Appendix A: Wilderness Mountain Water Supply System – Source Water Vulnerability Study

Appendix A

CAPITAL REGIONAL DISTRICT

WILDERNESS MOUNTAIN WATER SUPPLY SYSTEM

SOURCE WATER VULNERABILITY STUDY

NOVEMBER 06, 2020

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WILDERNESS MOUNTAIN WATER SUPPLY SYSTEM

SOURCE WATER VULNERABILITY STUDY

CAPITAL REGIONAL DISTRICT

FINAL REPORT

PROJECT NO.: 201-08298-00

DATE: NOVEMBER 06, 2020

WSP

WSP.COM

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REVISION HISTORY

FIRST ISSUE

October, 9, 2020	Draft Report			
Prepared by	Reviewed by	Approved By		
Kaitlynn Livingstone, P.Eng	Elise Paré, P.Eng Thomas Munding, P.Eng	Simon Kras, P.Eng		
REVISION 1				
Prepared by	Reviewed by	Approved By		
Kaitlynn Livingstone, P.Eng	Simon Kras, P.Eng. Thomas Munding, P.Eng	Simon Kras, P.Eng		

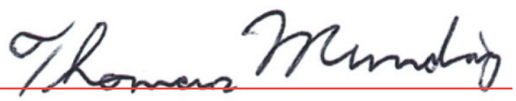
SIGNATURES

PREPARED BY

Kaitlynn Livingstone, P.Eng.
Climate Change Engineer

06-Nov-2020
Date

REVIEWED BY



Thomas Munding, P.Eng

06-Nov-2020
Date

Simon Kras, P.Eng.

06-Nov-2020
Date

APPROVED BY

Simon Kras, P.Eng.

06-Nov-2020
Date

WSP prepared this report solely for the use of the intended recipient, Capital Regional District, in accordance with the professional services agreement. The intended recipient is solely responsible for the disclosure of any information contained in this report. The content and opinions contained in the present report are based on the observations and/or information available to WSP at the time of preparation. If a third party makes use of, relies on, or makes decisions in accordance with this report, said third party is solely responsible for such use, reliance or decisions. WSP does not accept responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken by said third party based on this report. This limitations statement is considered an integral part of this report.

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CONTRIBUTORS

WSP

Simon Kras, P.Eng	Project Manager
Elise Paré, P.Eng	Climate Resilience Senior Review, QA/QC
Thomas Munding, P.Eng	Senior Advisor, QA/QC
Kaitlynn Livingstone, MASc, P.Eng.	Climate Resilience Engineer
Patricia Oka, MASc, P.Eng	Water Treatment Engineer

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EXECUTIVE SUMMARY

WSP was engaged by the Capital Regional District (CRD) to complete a Source Water Vulnerability Assessment to assess the long-term sustainability of the Wilderness Mountain community (Community) water sources. In order to provide an understanding of future vulnerability this assessment considered the potential impacts of climate change as well as future projected water demand. This assessment is intended to support the CRD in decision making related to the Wilderness Mountain Water Supply System. There are two reservoirs within the Community—both of which are man-made lakes fed by a surrounding catchment: The Wilfred Reservoir—the Community's current source, and the William Brook Reservoir—a smaller reservoir within the Community which was used in the 1980s and early 1990s.

This assessment has identified impacts to the Wilderness Mountain source water posed by climate change and development. Each identified impact has been classified based on sensitivity and adaptive capacity, which measures the ability to mitigate risk through adaptive measures. A vulnerability score was assigned for each impact based on a matrix which balances the sensitivity to each impact with the adaptive capacity.

Algal blooms were identified as a high-risk vulnerability due to increased water temperature, possible changes to stratification, and increased erosion and nutrient loading from rainfall. Improved reservoir management to mitigate algal growth, as well as improved monitoring and treatment of algae are recommended.

Two moderate-risk vulnerabilities were also identified:

- Bacterial growth in the treated water is expected to increase due to higher water temperatures. Additional chloramination or chloramine boosters may be required in the future.
- Increased intensity storm events could increase sediment loading resulting in elevated turbidity in the raw water. Treatment system upgrades should be designed for higher turbidity levels than currently observed.

It is likely possible to maintain the Wilfred Reservoir as a viable source for the next 30 years. However, in order to understand the cost and implications of building adaptive capacity, it is recommended that the CRD complete a feasibility study including a cost-benefit analysis. Measures to build adaptive capacity include source water management, treatment options, and water conservation efforts in the community.

If the Wilfred Reservoir is retained as a water source, we recommend the development of a Source Water Protection Plan to select the most appropriate management measures. The Plan should address any permitting considerations associated with reservoir management measures to satisfy the Ministry of Lands, Forests, Natural Resource Operations and Rural Development (MFLNRORD), the Habitat Acquisition Trust (HAT), the Department of Fisheries and Oceans (DFO), the Capital Regional District (CRD), and other agencies as required.

Because the Wilfred Reservoir is likely to have adequate capacity to serve the community, the benefits of retaining the William Brook Reservoir appear to be small compared to the costs. The William Brook Reservoir would be costly to connect to the system, and requires annual maintenance. If the CRD is interested in retaining William Brook as a future water source, we would recommend a more detailed feasibility study.

1 BACKGROUND & OBJECTIVES

1.1 PROJECT OBJECTIVES

This report details the findings of a source water vulnerability assessment completed for the Wilderness Mountain Water Supply System. Recent concerns related to water quality in the Wilderness Mountain Water Supply System have prompted the Capital Regional District (CRD) to assess the long-term sustainability of the Community's water sources. In order to provide an understanding of future vulnerability this assessment considered potential climate change impacts as well as future projected water demand. This assessment is intended to support the CRD in decision making related to the Wilderness Mountain Water Supply System.

1.2 WILDERNESS MOUNTAIN WATER SYSTEM

The Wilderness Mountain Water System (Figure 1) serves the Community of Wilderness Mountain, also known as Mount Matheson Estates, located in East Sooke. Of the 82 parcels located within the community, the Wilderness Mountain Water System currently includes 73 active service connections (CRD, 2019). There are two waterworks licenses on this source which permit the diversion of 29,000 m^3/year. (CRD, 2015).

The source water for the Wilderness Mountain water system is supplied from the Wilfred Reservoir (Figure 2). The reservoir is a man-made lake dammed at both ends. For purposes of this study, it is assumed that reservoir is primarily recharged by precipitation. There are a number of drilled wells near the reservoir, and further investigation would be required to study the groundwater interaction with the reservoir. The Wilfred watershed is protected by conservation covenant between the The Land Conservancy of British Columbia (TLC), and Habitat Acquisition Trust (HAT) (CRD, 2010), and the Wilderness Mountain Water Corporation, which was taken over by the CRD in 2008 (CRD Bylaw 3503).

In addition to the Wilfred Reservoir, the Wilderness Mountain System includes a treatment plant, two treated water storage tanks, and the distribution network. The William Brook Dam and reservoir were historically associated with this system, however as noted in the Wilderness Mountain Water System 2019 Annual Report, the William Reservoir is not used for water supply to this system at this time.

1.2.1 WILLIAM BROOK RESERVOIR

The William Brook Reservoir supplied the Community in the 1980s and early 1990s, before the Wilfred Reservoir was constructed and commissioned. The William Brook reservoir has been proposed by the Community as a supplementary water source to increase the available storage volume. The usable volume of the William Brook Reservoir is approximately 16,000 m^3 based on our preliminary estimates.

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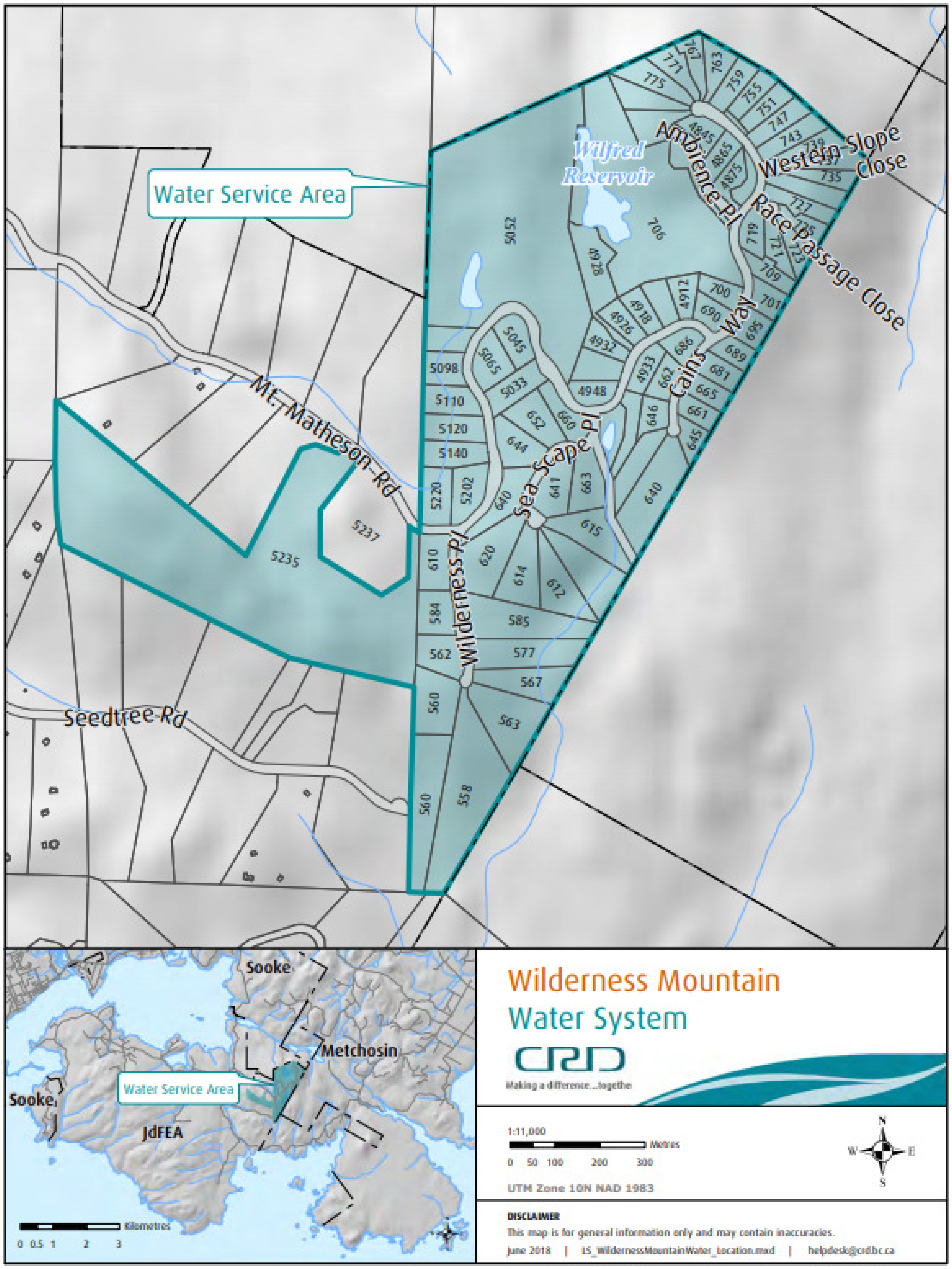

Figure 1 **Wilderness Mountain Water System (CRD, 2018)**

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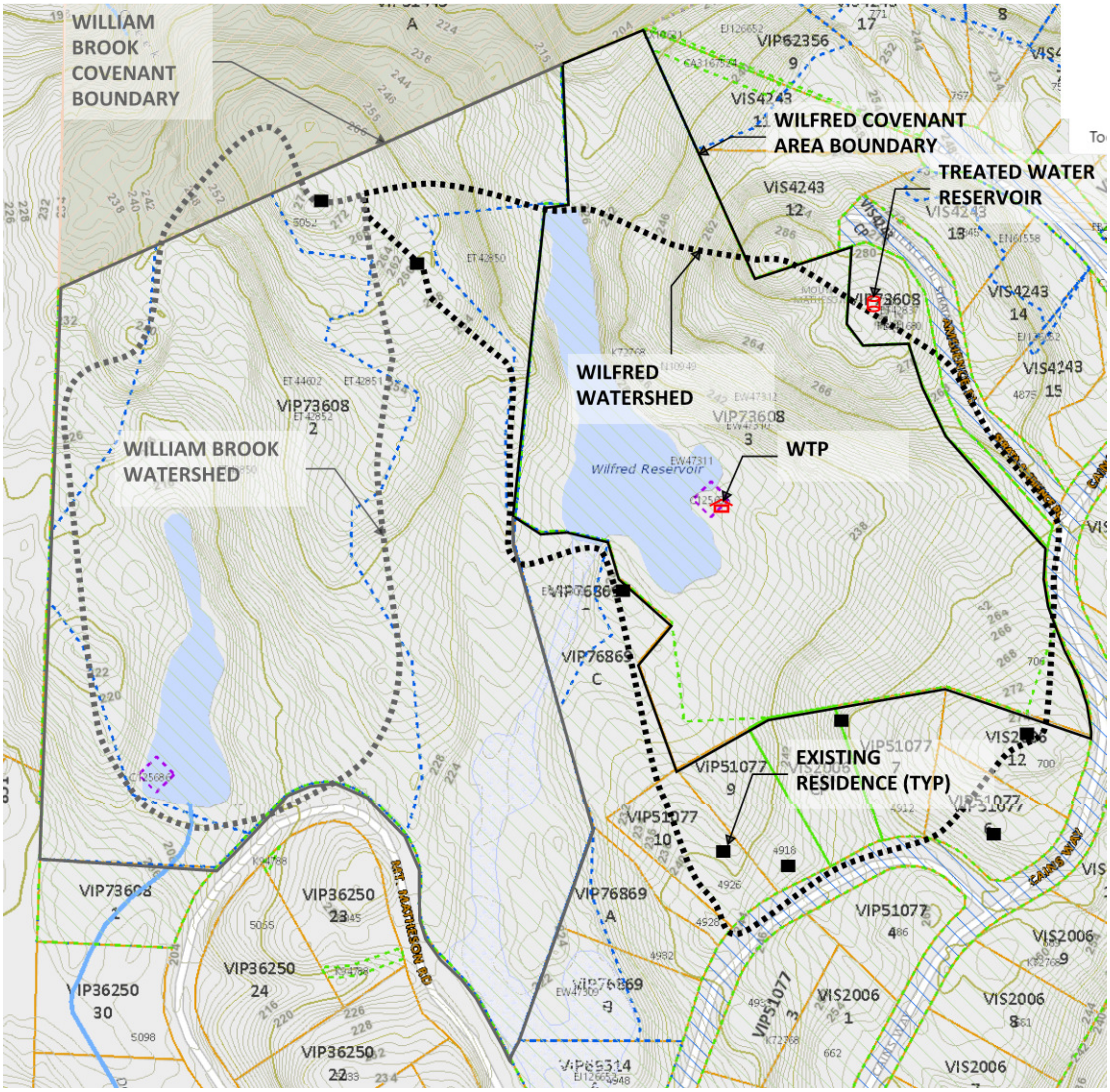

Figure 2 **Wilfred Watershed**

1.3 WILFRED RESERVOIR SOURCE WATER QUALITY

The raw water intake is located near the eastern shore of Wilfred Reservoir and subject to siltation from bank erosion and organic matter from the forested watershed. The intake is fixed at 4.27 m below the maximum water level (based on the 2002 Bathymetry Report by Coastal Geoscience research). The Wilfred Reservoir is prone to turbidity events with turbidity spikes between 1.0 NTU to 5.0 NTU. On average, these turbidity events last between 8 to 13 hours. Based on sampling carried out by WSP, the source water is relatively low in alkalinity and pH. The manganese levels in the reservoir are outside the Aesthetic Objectives, but below the Maximum Acceptable Concentrations in the current Guidelines for Canadian Drinking Water Quality (GCDWQ). Maximum Acceptable Concentrations are enforceable by the Vancouver Island Health Authority (VIHA), while Aesthetic Objectives are desirable to meet, but not typically enforced.

Based on a review of source water quality data, the Wilfred Reservoir can be characterized as a moderately high organic water source based on True Colour. Nonetheless, the mean True Colour of 14.0 TCU is below the GCDWQ recommended maximum of 15.0 TCU. Both alkalinity and pH in the source water are relatively low, with the median pH of 6.67 being slightly lower than the recommended minimum of 7.0.

Total manganese in the water exceeds the aesthetic objective of 0.02 mg/L, but is generally below the Maximum Acceptable Concentration (MAC) of 0.10 mg/L. The provided data also indicates increases in algal concentrations in the months of June and July. It has been reported that algal bloom during summer typically contributes to elevated turbidity in the source water (CRD, 2019) resulting in frequent replacements of the WTP filter cartridges.

The source water is currently treated with a series of cartridge filters and disinfected with UV and chloramination. The existing treatment plant was commissioned in 2012. Pre-filtration was added to the treatment plant in 2017 to address turbidity issues. The existing plant does not provide treatment for the manganese or the low pH. While the existing treatment meets the required removal credits for total coliform, virus and pathogen removal and the required multi-barrier treatment, on occasions, the system fails to meet the 1.0 NTU treated water turbidity.

Following Boil Water Advisories in 2016 and 2018 respectively, VIHA issued a notice to the CRD removing the filtration exemption from the system, and requiring a system which would meet the 4-3-2-1-0 treatment targets required by the *Drinking Water Protection Act* (DWPA) and *Drinking Water Protection Regulation* (DWPR).

Based on the 2002 Bathymetry Report by Coastal Geoscience, the Wilfred Reservoir has a volume of approximately 42,000 m^3 above the current intake elevation. Although it is possible to lower the intake by approximately 1.0 m or use a floating intake, drawing the reservoir level below the current intake elevation may result in entrainment of sediments from the reservoir bottom. A relocated intake would, however, reduce the effects of near-shore runoff on source water quality.

During WSP's reconnaissance visit on August 20, 2020, a plume of high turbidity was observed following a rainfall event. An exposed slope of erodible material was also observed to the north of the Water Treatment Facility.

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2 METHODOLOGY

2.1 CLIMATE VULNERABILITY ASSESSMENT FRAMEWORK

This section describes the methodology and approach taken to assessing vulnerabilities to the Wilfred and William Brook Reservoirs in a changing climate.

Climate change vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change. Vulnerability is the factor of sensitivity and adaptive capacity of each infrastructure component and/or system.

Sensitivity is the degree to which a component is affected by climatic conditions or a specific climate change impact.

Adaptive capacity is the ability of a system to adjust to climate change (including climate variability and extremes) to avoid potential damages, to take advantage of opportunities, or to cope with the consequences. Adaptive capacity can reduce the vulnerability of infrastructure to a potential impact. This can be achieved by incorporating future climate projections into design criteria to enable infrastructure to adapt to a changing climate. Adaptive capacity can also be achieved by adjusting operations and maintenance procedures to adapt to a changing climate.

The ratings used to assess sensitivity and adaptive capacity have five distinct levels (very low, low, moderate, high, and very high), and correspond to the definitions detailed in the following table. As shown in the following table, adaptive capacity ratings are inversely proportional to the level of vulnerability.

Table 1 Definitions of levels for sensitivity and adaptive capacity

LEVEL	SENSITIVITY	ADAPTIVE CAPACITY
1	Very Low: The likelihood that the system is affected remains minimal.	Very High: Adaptation measures are very easily implemented and effective.
2	Low: The likelihood that the main components of the system will be affected by the hazard is minimal. There is a low chance that the secondary components will be affected by the hazard.	High: Adaptation measures are very easily implemented and effective.
3	Moderate: There is a low chance that the main components of the system will be affected by the hazard. There is a good chance that the secondary components will be affected by the hazard.	Moderate: Adaptation measures exist, but their cost, time of implementation or efficiency makes their implementation questionable.
4	High: There is a high likelihood that the system will be directly affected by the hazard.	Low: The implementation of adaptation measures is long and inefficient and/or the cost of implementing accommodation measures is similar to the value of the system.
5	Very high: There is a high likelihood that the system will be directly affected by the hazard.	Very Low: Adaptation measures are non-existent or the cost of implementing adaptation measures exceeds the value of the system.

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Once the levels of sensitivity and adaptive capacity have been defined, the vulnerability rating is developed using the following matrix:

Table 2 Vulnerability Matrix

Vulnerability		Sensitivity Rating				
		Very Low	**Low**	**Moderate**	**High**	**Very High**
Adaptive Capacity Rating	**Very Low**	Very Low	Low	Moderate	High	Very High
	Low	Very Low	Low	Moderate	High	High
	Moderate	Very Low	Low	Low	Moderate	High
	High	Very Low	Very Low	Low	Moderate	Moderate
	Very High	Very Low	Very Low	Low	Low	Moderate

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3 CLIMATE PROJECTIONS

3.1 CLIMATE SCENARIOS

Globally, climate change will result in a long-term rise in the Earth's average temperature. On a local scale, impacts will vary and include shifts in temperature, precipitation, wind, and other weather patterns, including extreme weather events. Broadly speaking, the local climate projections are divided into two different commonly used 'scenarios', or 'Representative Concentration Pathways (RCP)': the **active scenario (RCP 4.5)** and the **passive scenario (RCP 8.5)**. The active scenario is modelled assuming that there is a significant decrease in global greenhouse gas (GHG) emissions by the 2040s, while the passive scenario has been designed by assuming the worst case 'business-as-usual' approach without any mitigation measures implemented at global scale and a constant increase in GHG emission until the depletion of fossil fuel stocks (Figure 3). The passive scenario is the trajectory in which most changes are more significant.

The passive scenario (RCP8.5) was used for this study to represent future climate conditions for two reasons. First, amongst the readily available climate data, it is the scenario that best represents the ongoing trend in GHG emissions (Schwalm et al., 2020). Second, GHG emissions are one of the major sources of uncertainties regarding climate change projections. As it is necessary to make decisions on infrastructure design today despite this uncertain future, in terms of risk management, the best practice is to take a conservative approach.

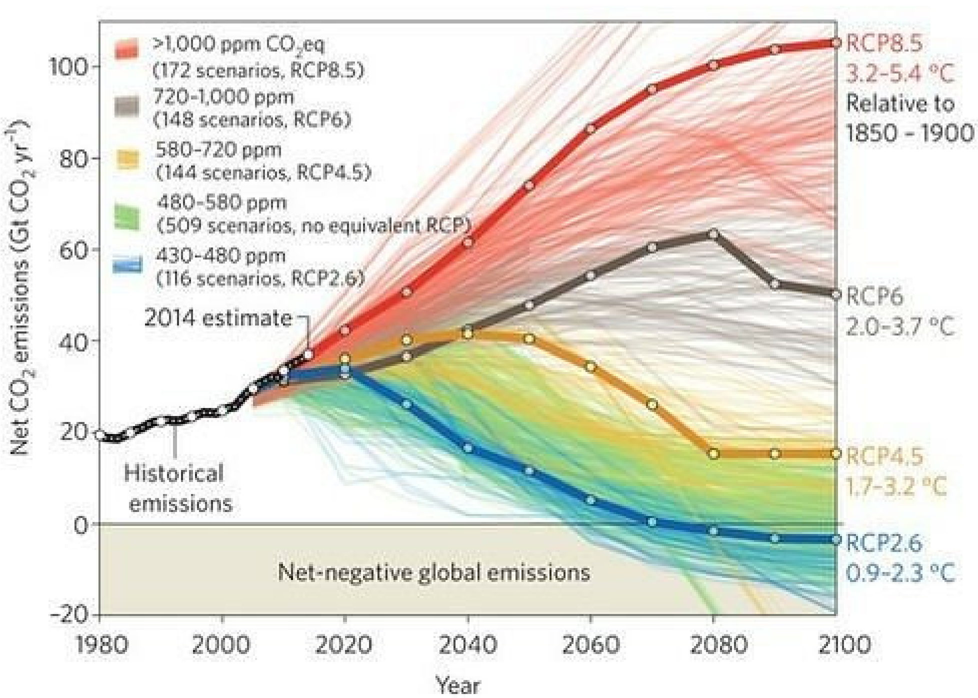

Figure 3 **Net CO_2 emissions for each RCP scenario until 2100 (from Fuss et al., 2014)**

3.2 CLIMATE PARAMETERS AND PROJECTIONS

Climate data for this assessment was obtained primarily from the Climate Projections for the Capital Region (CRD, 2017) report. The minimum and maximum values presented in the following tables are the 10th and 90th percentile values respectively as opposed to median values in order to understand vulnerabilities in the context of currently projected worst-case scenarios.

This study examines climate vulnerabilities using regional projections. Local effects can result in microclimates which do not follow the regional projections, and further assessment could be carried out to better understand the projections in light of the local microclimate. However, for purposes of identifying vulnerabilities, a regional approach is considered appropriate.

3.2.1 TEMPERATURE

As shown in Table 3 below, daytime high temperatures are projected to increase for all seasons, with the greatest temperature increases projected in the spring and summer months. Temperature is projected to continue to increase from the 2050s to the 2080s resulting in significantly higher temperatures expected by the end of the century. (CRD, 2017)

Table 3 Regional Average Daytime High Temperature

	Historic Average (℃)	2050s (℃)			2080s (℃)		
		Min	Median	Max	Min	Median	Max
Winter	6	7.3	8.4	9.3	8.6	10.4	12.4
Spring	12	13.6	14.7	16.5	14.7	16.3	19
Summer	20	22.1	23.3	24.2	23.7	25.2	27
Fall	13	14.4	15.6	16.8	15.8	17.3	18.9
Annual	13	14.5	15.8	16.9	15.9	17.5	19.2

Table 4 Regional Average Nightime Low Temperature

	Historic Average (℃)	2050s (℃)			2080s (℃)		
		Min	Median	Max	Min	Median	Max
Winter	1	2.6	3.6	4.3	4.2	5.4	6.4
Spring	3	4.7	5.5	6.6	5.8	7.1	8.8
Summer	10	11.8	12.8	14.0	13.3	14.7	16.5
Fall	6	7.6	8.6	9.8	8.8	10.3	11.6
Annual	5	6.7	7.6	8.7	8.0	9.3	10.8

In addition to average temperature projections, summer temperature parameters (Table 5) were also considered. As can be seen in the following table there is a significant increase projected in summer days where the temperature is projected to exceed 25 °C. The hottest daytime temperature is also projected to increase as is the 1-in-20 hottest daytime high.

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Table 5 Summer temperature parameters

	Historic Average (℃)	2050s			2080s		
		Min	Median	Max	Min	Median	Max
Summer days (number of days >25 ℃)	12	28	36	46	43	59	78
Tropical Nights (number of nights >20 ℃)	0	0	0.5	1	0	4	9
Hottest daytime high (℃)	29	31	32	33	33	35	36
1-in-20 hottest daytime high (℃)	32	34	36	37	36	38	39

As shown in the following table, increasing temperatures will also impact growing season length. As can be seen in the following table, the growing season in this region is projected to increase in length, extending to nearly the full year towards the end of the century. The length of growing season is considered in this assessment as this parameter may impact water demand related to irrigation. However, as Wilderness Mountain is a residential community, the impact of growing season length on water demand is not anticipated to be significant.

Table 6 Growing Season Length

	Historic Average (days)	2050s (days)			2080s (days)		
		Min	Median	Max	Min	Median	Max
Growing Season Length	268	310	326	338	342	350	356

3.2.2 PRECIPITATION

Precipitation is projected to increase in winter, fall, and spring. The greatest increase in precipitation is projected to occur in fall with a median projection of an 11% increase and the maximum (90th percentile) projection of 26% in the 2050s. Conversely summer precipitation is projected to decrease by as much as 41% in the 2050s and 50% in the 2080s.

Table 7 show precipitation projections for the region. (CRD, 2017)

Table 7 Total Precipitation Projections

	Historic Average (mm)	2050s (mm)			2080s (mm)		
		Min	Median	Max	Min	Median	Max
Winter	680	660	714	755	700	782	870
Spring	328	312	344	374	308	354	390
Summer	125	74	133	130	63	93	118
Fall	504	484	559	635	539	610	706
Annual	1660	1677	1743	1826	1726	1859	1942

Another set of parameters considered in this assessment are related to extreme rainfall projections. The following table outlines projections related to extreme precipitation. The projections for single-day and five-day maximum precipitation indicate the amount of precipitation that falls in a single day and five consecutive days respectively. The 95th and 99th-percentile wettest day parameters indicate how much precipitation falls on days which exceed the threshold set by the 95th or 99th percentile. The 1-in-20 wettest day precipitation represents a rainfall event which has a 5% chance of occurrence in any year. As can be seen in Table 8, all extreme precipitation parameters are expected to increase. (CRD, 2017)

Table 8 Extreme Rainfall Projections

	Historic Average (mm)	2050s (mm)			2080s (mm)		
		Min	Median	Max	Min	Median	Max
Single-day Maximum Precipitation	70	71	84	96	78	95	108
Five-day maximum precipitation	156	158	175	193	165	197	214
95th percentile wettest days precipitation	380	414	498	619	524	604	711
99th percentile wettest days precipitation	118	153	198	263	189	267	345
1-in-20 Wettest Day Precipitation	120	131	157	191	136	167	203

Dry spells are expected to occur in the summer and represent the number of consecutive days with less than 1 mm of precipitation. As shown in Table 9 the length of dry spells are projected to increase.

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Table 9 Projected Annual Dry Spells

	Historic Average (days)	2050s (days)			2080s (days)		
		Min	Median	Max	Min	Median	Max
Dry Spells	25	27	31	34	29	33	38

3.2.3 ADDITIONAL CLIMATE TRENDS AND HAZARDS

WIND

With the effect of climate change, wind speed will evolve as a function of location and season. Figure 4 shows the evolution of wind speed for the end of the 21st century compared to the most recent period, in winter (DJF) and in summer (JJA). The occurrence of black dots on the images indicate where trends are more robust.

On the upper panels, we can see that the BC coast will experience an increase in average wind speed during all seasons (non-robust trend).

On the lower panels, however, extreme winds are projected to decrease in all seasons. Summer extreme winds are projected to decrease in intensity by the end of the century (yellow shade). This decrease is considered robust (black-dotted region) and equals approximately to 5-10%.

Although extreme winds are projected to decrease, there is also the projection of increased storm activity in this region (CRD, 2017).

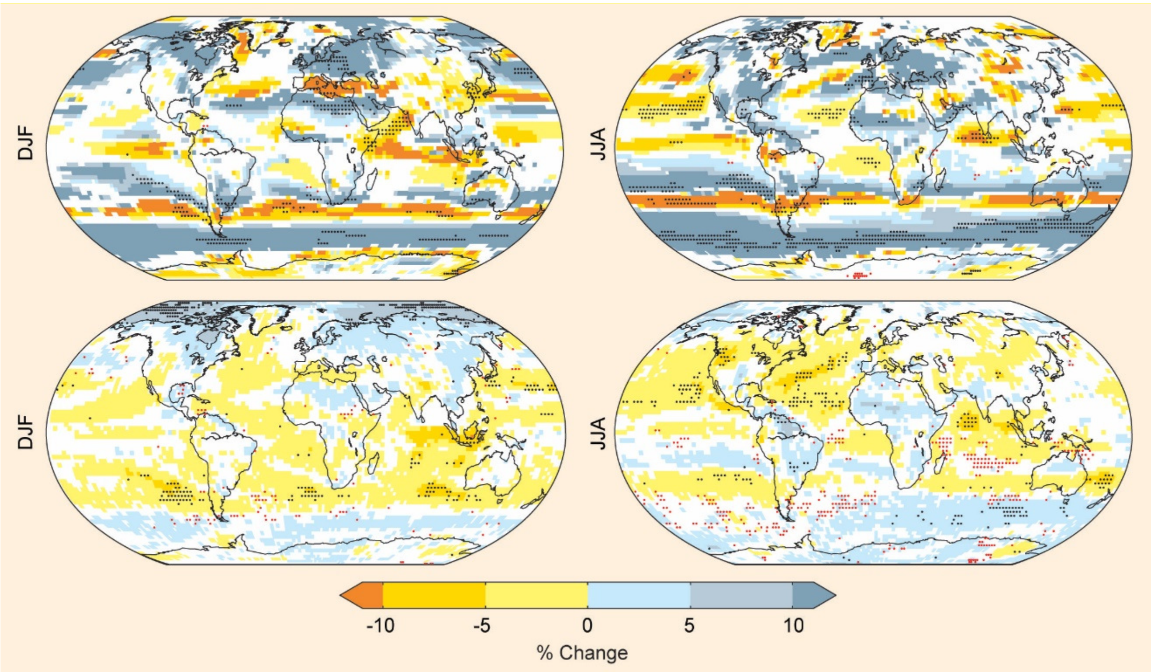

Figure 4 Averaged changes from a 19-member ensemble of CMIP3 GCMs in the mean of the daily averaged 10-m wind speeds (top) and 99th percentile of the daily averaged 10-m wind speeds (bottom) for the period 2081-2100 relative to 1981-2000 (% change) for December to February (left) and June to August (right) plotted only where more than 66% of the models agree on the sign of the change (IPCC, 2012)

WILDFIRE

Figure 5 and Table 10 show the forest fires which have occurred historically in this region since the beginning of the 20th century (location of Wilderness Mountain indicated by a star in Figure 5). There have been 14 historic forest fires which have ranged in size from 0.6 ha to 836.8 ha. The high fuel availability in this area combined with the historic occurrence of forest fires demonstrates that there is a risk of wildfire in this area.

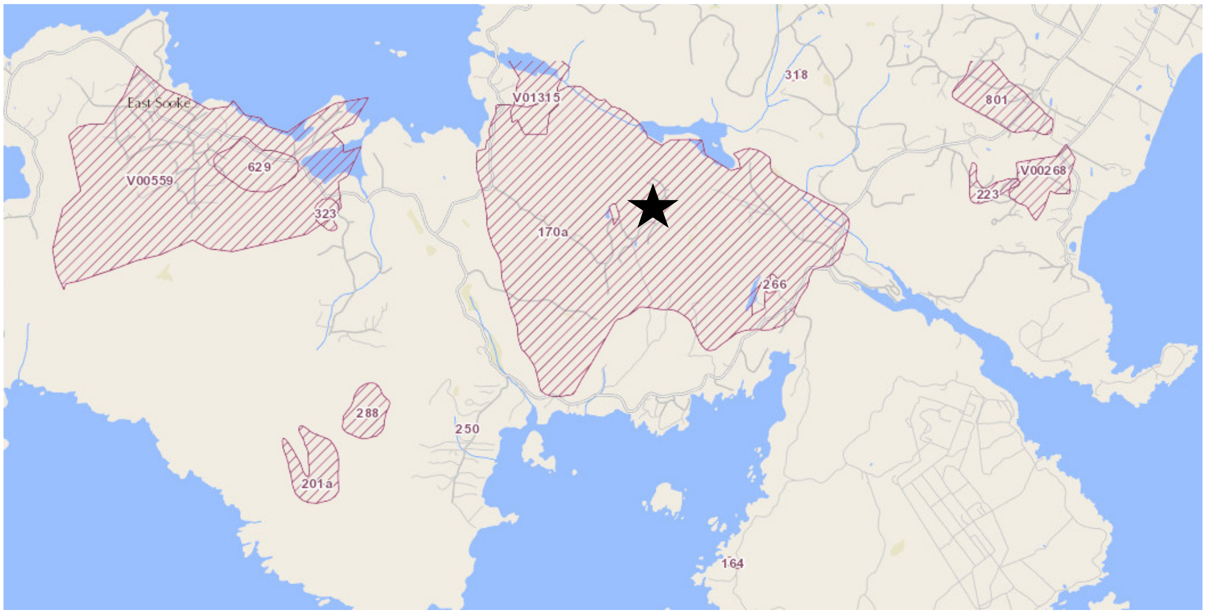

Figure 5 East Sooke historical forest fire perimeters 1900-2016 (iMapBC, 2020)

Most recent results on the future occurrence of fires in Canada show that western Canada will see a 50% increase in the number of dry, windy days that let fires start and spread (Wang et al., 2017). Moreover, fires could burn twice as much average area per year in Canada by the end of the century as has burned in the recent past (Flannigan, 2020). Confidence on the projections presented in scientific literature remains moderate due to the climate indicators selected to represent the occurrence of fires, and due to the level of uncertainty in climate projections.

Table 10 Historic forest fire areas (iMap BC, 2020)

Fire Code	Date	Hectares Burned
170a	1922	836.8
801	1922	49.5
629	1925	37
164	1932	1.5
318	1934	1.1
201a	1934	33.6
323	1935	7.1
288	1935	22.6
266	1936	1.7
250	1936	0.6
223	1937	10
V01315	1961	43.1
V00559	1951	496.7
V00268	1955	32.6

4 WATER SUPPLY VULNERABILITY ASSESSMENT

4.1 SENSITIVITY ANALYSIS

As noted in Section 2, sensitivity is the degree to which a component is affected by climatic conditions or a specific climate change impact. Sensitivities identified for Wilfred and William Brook Reservoirs are related to increasing annual temperatures, increased precipitation in the fall, winter, and spring, more intense extreme precipitation events, increased summer dry spells, increased wildfire risk, and increasing wind. These sensitivities are discussed further in this Section.

4.1.1 SENSITIVITIES RELATED TO WATER QUALITY

The sensitivity analysis completed for the reservoirs found that the highest rated sensitivities were related to increased organics and algal growth. Conditions for algal blooms in lakes are related to environmental conditions such as temperature, light, and nutrient content. The reservoirs are anticipated to become increasingly sensitive to algae growth during the summer months as summer daytime high/nighttime low temperatures are projected to increase by as much as 4.2 °C / 4.0 °C respectively by the 2050s and by 7 °C / 6.5 °C respectively by the 2080s. In addition to increases in average summer temperatures, extreme summer temperatures are also projected to increase. The reservoirs may also become increasingly sensitive to algal blooms year-round as temperatures are also projected to increase in fall, winter, and spring. Annual daytime high/nighttime low temperatures are projected to increase by as much as 3.9 °C / 3.7 °C respectively by the 2050s and by 6.2 °C / 5.8 °C respectively by the 2080s.

Surface water temperatures will tend to vary seasonally, while water temperatures at depth may remain relatively constant throughout the year. Although increased wind speeds may result in increased evaporative cooling, this may not be sufficient to offset the overall warming trend due to projected higher average annual temperatures. Changes to water temperature may impact stratification and turnover in the reservoirs, which could impact water quality. However, there are a number of factors which contribute to lake mixing and so it is difficult to assess this impact. (Woolway & Merchant, 2019; Havens & Jeppesen, 2018). Additional site-specific study would be required to better understand this vulnerability.

Evidence of turbidity in the reservoir from sediment runoff was already observed by WSP on August 20, 2020. Increases in the frequency and intensity of extreme precipitation events may also contribute to sensitivity to algal blooms as sediment and run-off may contribute to increased nutrients in the reservoir. (Jiménez Cisneros, 2014; AWWA, 2016; EPA, 2015).

Warmer water will hold less oxygen. If the lake water warms as a result of climate change, then water within the reservoirs may experience decreased dissolved oxygen levels. Decreased oxygen level may in turn impact metals and nutrient concentration in the source water as lower oxygen levels may increase nutrient and metals concentrations. Increased nutrient concentrations may contribute to the risk of algal blooms and increased metals concentrations may exceed drinking water guidelines in the future which could impact the treatment process. Reduced dissolved oxygen could also impact the effectiveness of biofiltration process as this is an aerobic process. However, the sensitivity to the biofiltration impacts was assessed as low since only a minor decrease in effectiveness in likely as a result of decreased oxygen levels.

The final sensitivity related to temperature is related to bacterial growth in the distribution system. The current water temperature in this system is already relatively high, with a median temperature of 12 °C. As temperature increases in the future, warmer water temperatures may promote bacterial growth in the distribution system.

Sensitivities related to more intense precipitation events are related to increased runoff washing sediment into the reservoir during heavy rainfall. As extreme precipitation events are projected to increase in both intensity and

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frequency, the sensitivity to this risk is high, although the forested area surrounding the reservoir will provide some resilience against erosion. Runoff can impact turbidity as it can increase sediment suspended in the water immediately after an extreme precipitation event. Sediment entering the reservoirs can also have long term quality impacts. Sediment can release metals or nutrients into the reservoirs which may lead to exceedances in drinking water parameters or contribute to algal growth. Extreme precipitation events and storm activity may also result in increased organics being washed into the reservoirs. This could result in increased organics loading which would impact the treatment process. Although there is limited development in the watershed, aerial images of the watershed indicate the presence of residential homes within the catchment area. This leads to an increased sensitivity to the risk of nutrients entering the reservoirs and could contribute to algal blooms.

Increased length of dry spells may also influence water quality. The Wilfred reservoir was assessed to have a moderate sensitivity to longer dry spells as these dry spells are likely to occur during summer months when reservoir levels are the lowest. In the event of a dry spell, water quality is likely to degrade due to increased concentration of metals, organics, turbidity, and algae. (Miller & Yates, 2006)

Two other climate parameters which may affect water quality are wildfire and wind. Since the catchment area is relatively small, the sensitivity to wildfire risk was assessed as low since the main risks to water quality would be related to a wildfire within in the watershed. In the event of a wildfire in the watershed, the reservoirs may be exposed to ash, fire debris, or fire retardant entering the water all of which would decrease water quality. (HealthLink BC, 2018; Murphy et al, 2015).

Finally, wind may impact mixing in the reservoirs due to turbulence created by increased average wind speed, wind during extreme storm events, or changing wind patterns. Since only a moderate increase in average wind speed is projected, and the projections for wind are not considered robust, sensitivity to this vulnerability was assessed as low.

Table 11 Sensitivities Related to Source Water Quality

Climate Projection	Impact description	Sensitivity Rating
Increasing annual temperatures	Increasing temperatures can increase the risk of algal blooms. Warmer water provides improved growing conditions for blue-green algae.	Very High
	Bacterial growth in distribution system.	High
	Increasing temperatures could impact thermal structure and lake stratification. Climate change may impact stratification and turnover in the future which could impact nutrient distribution in the reservoirs.	Moderate
	Reduced dissolved oxygen in source water impacting metals concentrations.	Moderate
	Reduced dissolved oxygen in source water impacting biofiltration.	Low
More intense extreme precipitation events	Sediment run-off into reservoirs as a result of extreme storm events can impact water quality.	High
	Increased precipitation may lead to run-off leading to water quality issues, including risk of increased algal growth due to nutrient run off into the water.	Low
Dry spells (typically occur in summer)	Water quality is likely to degrade due to increased concentration of metals/organics/turbidity/algae during a drought.	Moderate
Increased wildfire risk	Wildfire can impact water quality due to run off with ash or fire debris and/or fire retardant.	Low
Increased wind/increased extreme precipitation events	Increased organics in reservoirs due to debris blown by wind or washed into the reservoirs during extreme storm events	Moderate
Increased wind	Increased wind may influence mixing in reservoirs increasing turbidity	Low

4.1.2 SENSITIVITIES RELATED TO SOURCE WATER AVAILABILITY

Climate projections for this region indicate higher precipitation in the winter, fall, and spring, and decreased precipitation in the summer. In terms of source water availability, this indicates that water supply will not be an issue in the fall, winter, and spring, however, there are vulnerabilities related to water supply in the summer. Source water availability in the summer will also be impacted by increasing summer temperatures and increased length of dry spells.

One factor influencing source water availability is the rate of evaporation of water from the surface of the reservoirs. Atmospheric evaporative demand is a function of a number of climate parameters including air and surface temperature, solar radiation, humidity, and wind speed (Compendium of Forest Hydrology and Geomorphology in British Columbia. BC Land Management Handbook 66). As temperature and average wind speed are projected to increase, the reservoirs were assessed as being highly sensitivity to this impact. However, as there are a number of parameters influencing evaporative demand, and some uncertainly around how climate parameters may change and interact, more detailed modelling would be required to better understand this risk.

The water source was also assessed to have a high sensitivity to decreased precipitation and longer dry spells which would both reduce reservoir recharge in the summer.

Wilfred Reservoir levels from 2012 - 2020 were reviewed to identify historic trends in reservoir levels (data was received from the CRD). Based on the data reviewed, the reservoir typically reaches its full capacity in the winter months. As precipitation is projected to increase during fall, winter, and spring, reservoir levels are likely to be higher in the fall and spring and it is likely that more water will overflow from the reservoir during this time. Flood risk was evaluated at a high level and it was determined that as there is adequate area for water to overflow, the flood risk surrounding the reservoir is very low.

Historically, Wilfred Reservoir levels typically begin to decrease in May or June and reaches the lowest level in late summer or early fall. Climate change is likely to impact summer reservoir levels and as summer temperatures increase along with decreased precipitation, there is a risk of water levels decreasing below previous summer low levels.

One additional sensitivity considered was decreased reservoir capacity due to increased sediment entering the reservoirs during extreme precipitation events. The sensitivity to this impact was assessed as low since this would occur over a long period of time and significant amounts of sediment would need to enter the reservoirs before water supply was impacted. The risk of excessive sedimentation could be mitigated by improvements in reservoir management.

Table 12 Sensitivities Related to Source Water Availability

Climate Projection	Impact description	Sensitivity Rating
Increasing summer temperatures	Increasing temperatures lead to higher evaporation rates in the reservoirs leading to lower levels and reduced water supply. Evapotranspiration rates in the watershed are also projected to increase which could lead to reduced recharge into the reservoirs.	High
Decreased precipitation in summer	Decreased precipitation in the summer may lead to reduced reservoir levels and a risk of water shortages in the summer.	High
Longer summer dry spells	Increased length of dry spells may result in lower water levels.	High
More intense extreme precipitation events	Run-off into reservoirs as a result of extreme storm events can increase sediment in reservoirs reducing reservoir capacity over time.	Low

4.2 ADAPTIVE CAPACITY

Adaptive capacity is the ability of a system to adjust to climate change (including climate variability and extremes) to avoid potential damages, to take advantage of opportunities, or to cope with the consequences. Adaptive capacity can reduce the vulnerability of infrastructure to a potential impact. This can be achieved by incorporating future climate projections into design criteria to enable infrastructure to adapt to a changing climate. Adaptive capacity can also be achieved by adjusting operations and maintenance procedures to adapt to a changing climate.

Table 13 outlines measures that can be considered to build adaptive capacity for each impact identified. As can be seen in the following table, adaptive capacity can be built through a variety of initiatives including (1) planning measures such as emergency response plans or source water protection plans, (2) operations and maintenance measures such as source water monitoring procedures or modification to treatment plant operations, (3) water conservation measures, (4) reservoir management, or (5) treatment infrastructure.

This assessment did not include any cost-benefit analysis or feasibility assessment of different options to build adaptive capacity. Additional studies will need to be undertaken to provide additional details on costs, benefits, and feasibility of the various high-level measures outlined below.

Table 13 Assessment of Adaptive Capacity

Climate Projection	Impact description	Adaptive Capacity Rating	Adaptive Capacity Description
Increasing annual temperatures	Increasing temperatures can increase the risk of algal blooms. Warmer water provides improved growing conditions for blue-green algae.	Moderate	Adaptive capacity has been assessed as moderate since there are measures that the CRD can take to provide safeguards against algal blooms, as well as monitoring and response if these blooms do occur. If not already in place, frequent monitoring, especially during the summer, and detailed response plans for algal blooms are recommended. Safeguards against algal growth would consist of improvements to the operation of the reservoirs. These improvements may include incorporating a bottom drain, sediment removal and aeration. Capacity to address algal blooms may be incorporated into water treatment system design. The addition of a roughing filter in the treatment process provides improved capacity for removing algae. If the occurrence of algal blooms increase in the future, allowing for treatment process modifications, such as coagulation during an algal bloom, may increase treatment capacity during an algal bloom. During operations, adaptive capacity may be built through operations and maintenance procedures such as increased filter backwashing.

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Climate Projection	Impact description	Adaptive Capacity Rating	Adaptive Capacity Description
Increasing annual temperatures	Bacterial growth in distribution system.	High	Chloramine dosing can be increased to ensure adequate residual, although this will need to be balanced with aesthetic objectives for customers near the point of chlorination, and the increased risk of disinfection by-products. Additional chlorine or chloramine booster stations could be constructed elsewhere in the distribution system in the future as well if deemed appropriate.
Increasing annual temperatures	Increasing temperatures can impact thermal structure and lake stratification. Climate change may impact stratification and turnover in the future which could impact nutrient distribution in the reservoirs.	Moderate	Ongoing monitoring, including sampling at various depths, is recommended to track how source water quality is changing. Incorporating a floating intake with appropriate level of weighting will result in water being drawn from the seasonal elevation where water quality is highest. Aeration in reservoirs could be considered to promote mixing.
Increasing annual temperatures	Reduced dissolved oxygen in source water impacting metals concentrations.	Moderate	Oxidation could be used to remove metals. If nanofiltration is included in treatment process, this would allow for removal of dissolved manganese.
Increasing annual temperatures	Reduced dissolved oxygen in source water impacting biofiltration.	High	Aeration could be introduced if oxygen levels impact biofiltration effectiveness.
More intense extreme precipitation events	Sediment run-off into reservoirs as a result of extreme storm events can impact water quality.	Moderate	There is moderate adaptive capacity to turbidity issues as there can be some adjustments made to treatment processes (such as increased backwash) to deal with increased turbidity.
More intense extreme precipitation events	Increased precipitation may lead to run-off leading to water quality issues, including risk of increased algal growth due to nutrient run off into the water.	Moderate	Ongoing monitoring of nitrates in water quality. Some adaptive capacity can be built through regulations and watershed protection measures.
Dry spells (typically occur in summer)	Water quality is likely to degrade due to increased concentration of metals/organics/turbidity/algae during a drought.	Moderate	Based on ongoing water quality monitoring, it may be possible to adapt some treatment processes to account for lower water quality during drought. However, adaptive capacity is primarily dependent on treatment system design. Adaptive capacity could be built through the inclusion of nanofiltration in the treatment process to improve treatment capability. However, although nanofiltration would improve treated water quality, nanofiltration may not be able to maintain high flow capacity if source water quality is low.

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Climate Projection	Impact description	Adaptive Capacity Rating	Adaptive Capacity Description
Increased wildfire risk	Wildfire can impact water quality due to run off with ash or fire debris and/or fire retardant.	Moderate	Adaptive capacity can be built by ongoing monitoring for fires and ensuring the district has robust wildfire response plans. In the event of the use of fire retardant in the area, additional testing for emerging contaminants (PFCs/ PBDEs), nitrates, nitrites, and turbidity is recommended.
Increased wind/increased extreme precipitation events	Increased organics in reservoirs due to debris blown by wind or washed into the reservoirs during extreme storm events	Moderate	Managing vegetation surrounding the reservoirs (i.e. cutting overhanging branches) will help to build adaptive capacity. Incorporation of nanofiltration could help to build adaptive capacity as this will enable filtration of organics.
Increased wind	Increased wind may influence mixing in reservoirs increasing turbidity	Moderate	Additional backwashing in the event of higher turbidity.
Increasing summer temperatures	Increasing temperatures lead to higher evaporation rates in the reservoirs leading to lower levels and reduced water supply. Evapotranspiration rates in the watershed are also projected to increase which could lead to reduced recharge into the reservoirs.	Moderate	Proactive water conservation measures in summer months can help to protect against reduced water availability.
Decreased precipitation in summer	Decreased precipitation in the summer may lead to reduced reservoir levels and a risk of water shortages in the summer.	Moderate	Proactive water conservation measures in summer months can help to protect against reduced water availability.
Longer summer dry spells	Increased length of dry spells may result in lower water levels.	Moderate	Proactive water conservation measures in summer months can help to protect against reduced water availability.
More intense extreme precipitation events	Run-off into reservoirs as a result of extreme storm events can increase sediment in reservoirs reducing reservoir capacity over time.	Moderate	A reservoir bottom drain can be provided, which would tend to discharge sediment downstream instead of capturing it in the reservoir. Sediment levels can be monitored over time and reservoirs can be dredged if capacity becomes an issue.

4.3 VULNERABILITY RATINGS

The vulnerability assessment completed for the Wilderness Mountain water source identified a number of vulnerabilities related to source water quality as outlined in Table 14 and vulnerabilities related to water quantity as outlined in Table 15. The vulnerabilities were assessed based on the sensitivity and adaptive capacity ratings for each impact identified. It is important to note that if no measures are taken to improve adaptive capacity, the vulnerability ratings will be higher than the levels presented below.

As shown in Table 14, the highest rated vulnerability is increased algal blooms due to increasing temperatures. Moderate level vulnerabilities are related to bacterial growth in the distribution system due to increasing

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temperatures and degraded water quality due to increased sediment entering the reservoir during extreme precipitation events. Six low vulnerabilities were identified related to additional water quality concerns as a result of increasing temperatures, more frequent and intense extreme precipitation and storm events, longer summer dry spells, increased wildfire risk, and increased wind. The lowest ranked vulnerability was related to reduced dissolved oxygen impacting the biofiltration process.

Of the four vulnerabilities assessed related to source water availability (Table 15), three were rated as moderate and one was assessed as a low vulnerability. The three moderate vulnerabilities are all related to summer climate projections which may impact reservoir levels. The low vulnerability is related to the longer-term vulnerability of reduced reservoir capacity due to sediment accumulating in the reservoirs over time.

Table 14 Summary of vulnerabilities related to water quality

Climate Projection	Impact description	Vulnerability Rating
Increasing annual temperatures	Increasing temperatures can increase the risk of algal blooms. Warmer water provides improved growing conditions for blue-green algae.	High
	Bacterial growth in distribution system.	Moderate
	Increasing temperatures can impact thermal structure and lake stratification. Climate change may impact stratification and turnover in the future which could impact nutrient distribution in the reservoirs.	Low
	Reduced dissolved oxygen in source water impacting metals concentrations.	Low
	Reduced dissolved oxygen in source water impacting biofiltration.	Very Low
Increased extreme precipitation events	Sediment run-off into reservoirs as a result of extreme storm events can impact water quality.	Moderate
	Increased precipitation may lead to run-off leading to water quality issues, including risk of increased algal growth due to nutrient run off into the water.	Low
Increased wind/increased extreme precipitation events	Increased organics in reservoirs due to debris blown by wind or washed into the reservoirs during extreme storm events	Low
Dry spells (typically occur in summer)	Water quality is likely to degrade due to increased concentration of metals/organics/turbidity/algae during a drought.	Low
Increased wildfire risk	Wildfire can impact water quality due to run off with ash or fire debris and/or fire retardant.	Low
Increased wind	Increased wind may influence mixing in reservoirs increasing turbidity	Low

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Table 15 Summary of vulnerabilities related to source water availability

Climate Projection	Impact description	Vulnerability Rating
Increasing summer temperatures	Increasing temperatures lead to higher evaporation rates in the reservoirs leading to lower levels and reduced water supply. Evapotranspiration rates in the watershed are also projected to increase which could lead to reduced recharge into the reservoirs.	Moderate
Decreased precipitation in summer	Decreased precipitation in the summer may lead to reduced reservoir levels and a risk of water shortages in the summer.	Moderate
Longer summer dry spells	Increased length of dry spells may result in lower water levels.	Moderate
More intense extreme precipitation events	Run-off into reservoirs as a result of extreme storm events can increase sediment in reservoirs reducing reservoir capacity over time.	Low

5 IMPACTS TO WATER DEMAND

5.1 WATER DEMAND PROJECTION

Four years of demand data between April 27, 2016 and August 24, 2020 were provided by CRD to WSP to determine the current water consumption by the community. The data consist of the instantaneous reading of the existing treatment plant's feed water flowmeter, as recorded by the Supervisory Control And Data Acquisition (SCADA) system. From the 25,139 received data points, 197 indicated erroneous instantaneous flows of greater than 27 L/s and were therefore removed from the analysis. Daily flow values were calculated from the data based on the instantaneous flow values and timestamps for each data point. For each data point, the flow volume was assumed to be equal to the instantaneous flowrate multiplied by the time elapsed between readings.

Table 16 and Figure 6 present the annual water consumptions of the Community between 2016 and 2020. From the provided data, Figure 7 shows the current maximum daily demand (MDD) is 260 m^3/day, determined by the highest daily consumption within the assessed period. The current average daily demand (ADD) is 70 m^3/day, determined by taking the linear average of the daily consumptions over the assessed dates. The average winter flow is 45 m^3/day and summer is 90 m^3/day.

Table 16 Wilderness Mountain Annual Water Consumption

ANNUAL WATER CONSUMPTION (M^3)

2016	2017	2018	2019	2020*
16,901	22,780	25,432	22,793	17,232

*As per record water consumption data up to August 24th, 2020.

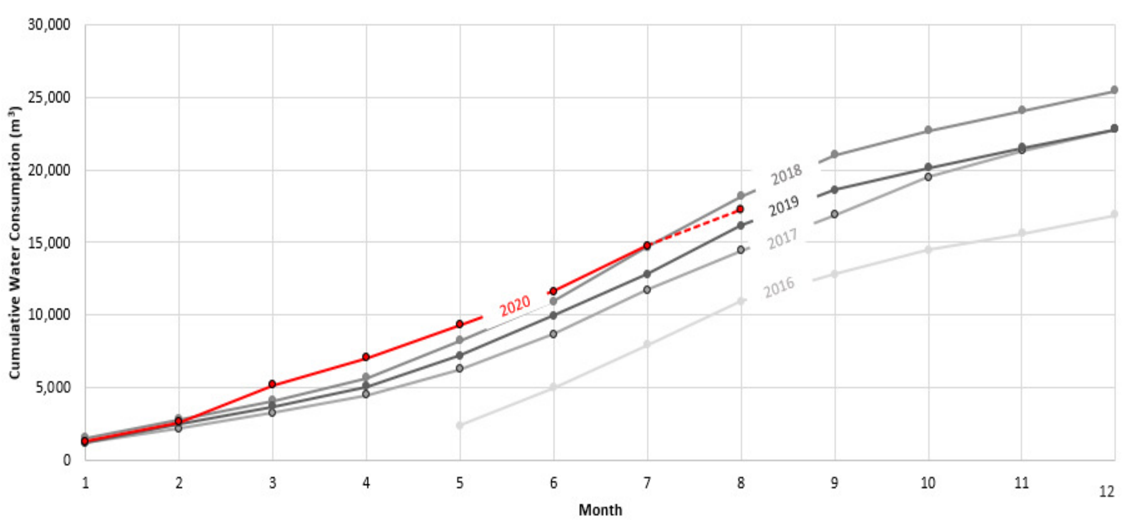

Figure 6 Wilderness Mountain Annual Water Consumption 2016-2020

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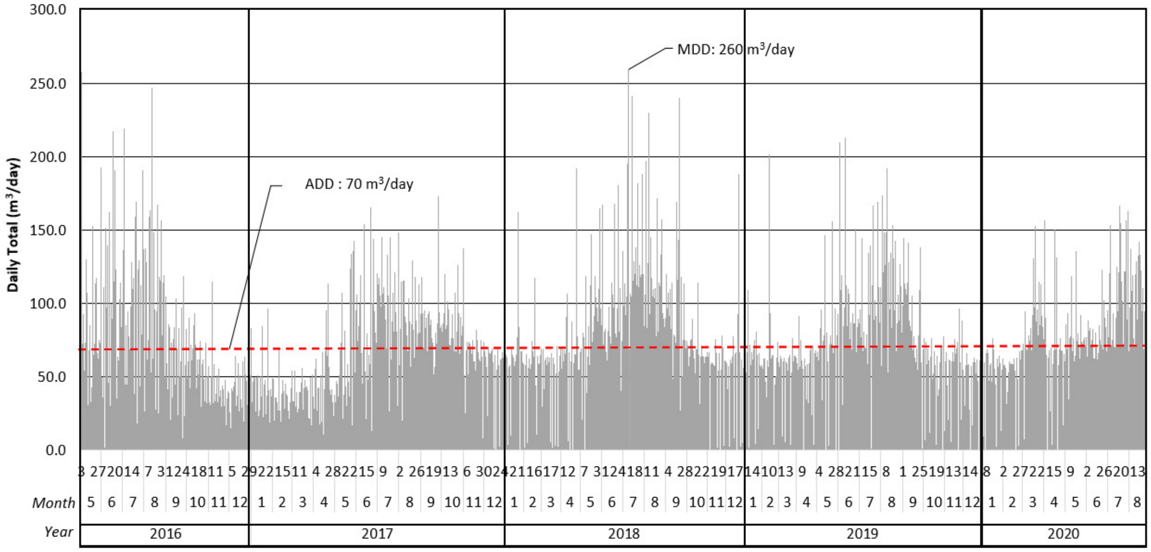

Figure 7 Wilderness Mountain Daily Water Consumption 2016 – 2020

Water demand of the Community showed a marked increase between 2016 and 2017. Demands from 2017 to 2020 show some fluctuation, but no clear upward trend. The increase between 2016 and 2017 may be partially caused by the new auto-flush system that was installed at the end of Wilderness Place in 2017. This auto flush system uses approximately 2,000 m^3 of water per year. The current maximum daily demand of 3.0 L/s (260 m^3/day) has now reached the treatment system design capacity, and there are 11 additional service connections which could potentially be connected in the future.

WSP has completed a study under a separate cover recommending upgrades to the treatment system. The MDD proposed for the treatment system upgrades is 360 m^3/day. This value is based on the CRD's design guidelines, which stipulate an average consumption of 545 litres/capita/day (lcd). For the Wilderness Mountain Water System's 82 lots, using an average of 3.2 persons per lot, the ADD is calculated at 143 m^3/day. A peaking factor of 2.5 (as per the CRD Design Standard) was applied to yield an MDD of 360 m^3/day.

5.2 CLIMATE IMPACTS ON DEMAND

Community water demand is projected to be increase in summer months due to projected temperature increases, decreased summer precipitation, and extended summer dry spells. Additionally, the growing season is projected to increase in length in this region which may have an impact on water demand leading to increased water demand throughout the year. However, as previously noted, since Wilderness Mountain is a residential community, increased growing season length is anticipated to have a relatively minor impact on the overall water demand as irrigation would be limited to residential landscaping and gardening. Furthermore, increased precipitation in the fall, winter, and spring may reduce irrigation demand in non-summer months. Increased temperatures are projected to increase evapotranspiration which may lead to increased watering requirements.

Previous studies have found that water use is correlated with temperature increases, and that these increases are greater in summer months (Chang, Praskievicz, and Parandvash, 2014). Although residential water use would depend on local factors such as size and type of landscaping, it can be assumed that summer temperature increases would lead to increased water demand in the summer. Based on information provided by the CRD, there are already water restrictions put in place in the community during summer months, it likely that these efforts will need to continue and possibly intensify to reduce summer water demand. This will be important for this community as it is

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projected that climate change will impact reservoir levels in the summer due to increased evaporation and reduced recharge.

5.3 TREATMENT PROCESS WATER DEMAND

As outlined in Section 4, this assessment identified a number of vulnerabilities related to source water quality. These vulnerabilities indicate that there are water quality risks for this water source and water quality may degrade over time. In the event of decreased water quality, the treatment process may require additional filter backwash. Because backwash water is expected to be returned to the reservoir through a soakaway pit, there would be no net effect on raw reservoir levels.

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6 ADDITIONAL CONSIDERATIONS

6.1 RESERVOIR MANAGEMENT

The current reservoir design is susceptible to sedimentation, which results in a limited design life. The reservoir is fed by sediment-laden surface water. The reservoir acts as a settling basin, building up a sediment layer on the bottom while cleaner water is discharged downstream over the spillway. The intake is located at the edge of the reservoir near the bottom, resulting in relatively high levels of metals and turbidity in the raw water.

A thermocline is visible in both reservoirs—occurring near 4.0 m depth for the Wilfred Reservoir and near 3.0 m depth for the William Brook Reservoir. Below the thermocline, the water becomes more acidic (lower pH), and the dissolved oxygen drops substantially.

Table 17 Water Quality Parameters Variation With Depth

WATER QUALITY PARAMETERS – WILFRED RESERVOIR*

Depth (m)	Temperature (ºC)	Dissolved Oxygen (mg/L)	pH	Oxidation Reduction Potential
1.0	19.19	7.92	6.98	92.2
2.0	19.04	7.91	6.97	94.2
3.0	18.91	7.77	6.94	97.0
4.0	15.48	3.12	5.63	143.0
5.0	11.47	0.49	5.50	145.0
6.0	9.13	0.18	5.82	57.0

* Taken near deep point in south basin of reservoir.

WATER QUALITY PARAMETERS – WILLIAM BROOK RESERVOIR*

Depth (m)	Temperature (ºC)	Dissolved Oxygen (mg/L)	pH	Oxidation Reduction Potential
1.0	18.8	7.11	8.00	63.5
2.0	18.8	7.12	7.10	73.8
3.0	18.0	4.43	6.85	36.4
4.0	15.4	0.36	6.43	50.1

* Taken near abandoned intake.

In the absence of improved reservoir management, sediment and organics will continue to build up in the bottom of the reservoir. Organic matter and nutrients in the sediment will result in further depletion of dissolved oxygen (DO) near the sediment layer.

Possible reservoir management measures which could be considered in a future Source Water Protection Plan are:

- Installing aerators to oxidize metals and nutrients in the sediments and reduce stratification through improved mixing.

- Installing a bottom drain at the deepest points, to discharge sediments downstream instead of storing them in the reservoir.
- Replacing the existing fixed intake with a floating intake to draw water from the reservoir surface instead of from the bottom.
- Vegetation control, including trimming of vegetation near the edge of the reservoir to limit the amount of organic leaf matter entering the source water.
- Erosion control to limit sediment flushed into the reservoir during rainfall events.

6.2 WILLIAM BROOK RESERVOIR

The William Brook Reservoir has been proposed as an additional source to complement the storage volume of the Wilfred Reservoir. WSP provides the following considerations to inform the CRD's decision-making regarding retaining the William Brook Reservoir:

- The reservoir has approximately 50% the usable storage volume of the Wilfred Reservoir, and is subject to the same vulnerabilities.
- Based on the sampling activities completed, the William Brook reservoir currently has higher levels of iron and manganese and higher colour than the Wilfred Reservoir. Additional treatment may be required for removal of metals to meet Aesthetic Objectives.
- If the William Brook reservoir is retained by the CRD, there would be annual maintenance costs for reservoir and dam management above existing costs.
- Seismic design requirements have become progressively more stringent since the William Brook Reservoir Dam was designed. An assessment of the dam will likely be required by the Province. The assessment would include a structural analysis to confirm that it is designed to withstand a 1 in 2,475-year seismic event based on current codes.

Based on our preliminary review, the benefits of retaining the William Brook Reservoir appear to be small compared to the costs. If the CRD is interested in retaining William Brook as a future water source, we would recommend a more detailed feasibility study. The reservoir is currently not connected to the Treatment Plant. Connecting the William Brook Reservoir to the system in the future would require replacement of the existing raw water pump station and a new raw watermain approximately 1,300 m long. The rough order-of-magnitude cost for the connection based on present-day dollars is $1.3M.

Our preliminary analysis indicates that the Wilfred Reservoir has the capacity to provide some level of resilience against climate change and increased demands. Additional measures may be feasible in the future to increase the effective capacity of the reservoir, including evaporation reduction measures, and possibly even raising the dams at the north and south ends.

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7 RECOMMENDATIONS AND CONCLUSIONS

Based on the vulnerability assessment completed, there are key vulnerabilities identified in this assessment which could impact the sustainability of the Wilfred and William Brook Reservoirs as a water source for the Wilderness Mountain Water System. Although there were vulnerabilities identified related to both water quality and water availability, the water source was found to be more sensitive to degradation of water quality in a changing climate. The Wilfred reservoir is currently facing water quality issues, and climate change is projected to exacerbate current quality issues.

It is recommended that measures are taken to improve adaptive capacity to impacts which were identified as having a moderate to very-high sensitivity in order to reduce the vulnerability of the Wilfred Reservoir. In particular, the reservoir is vulnerable to algal blooms and so implementing measures to manage algae within the reservoir was identified as a high priority to ensure water quality in a changing climate. Additionally, the reservoir was identified as being highly sensitive to issues related to run-off into the reservoir during extreme precipitation events.

It is likely possible to maintain the reservoirs as a viable source for the next 30 years. However, in order to understand the cost and implications of building adaptive capacity, it is recommended that the CRD complete a feasibility study including a cost-benefit analysis. Measures to build adaptive capacity include source water management, treatment options, and water conservation efforts in the community.

Development of a Source Water Protection Plan is recommended to select the most appropriate management measures. The Plan will need to address any permitting considerations associated with reservoir management measures to satisfy the Ministry of Lands, Forests, Natural Resource Operations and Rural Development (MFLNRORD), the Habitat Acquisition Trust (HAT), the Department of Fisheries and Oceans (DFO), the Capital Regional District (CRD), and other agencies as required.

Based on our preliminary review, the benefits of retaining the William Brook Reservoir appear to be small compared to the costs. If the CRD is interested in retaining William Brook as a future water source, we would recommend a more detailed feasibility study.

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APPENDIX

A VULNERABILITY ASSESSMENT

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Climate Impact				Vulnerability				
				Sensitivity		Adaptive Capacity		
ID	Impact category	Climate Projection	Impact description	Sensitivity Rating	Sensitivity Rationale	Adaptive Capacity Rating	Adaptive Capacity Description	Vulnerability Rating
1	Water quality	Increasing annual temperatures	Increasing temperatures can increase the risk of algal blooms. Warmer water provides improved growing conditions for blue-green algae.	Very High	Sensitivity has been assessed as very high as there is a high level of confidence of temperature increases in the region and these temperatures increases will create conditions in which algal blooms are more likely.	Moderate	Adaptive capacity has been assessed as moderate since there are measures that the CRD can take to provide safeguards against algal blooms, as well as monitoring and response if these blooms do occur. If not already in place, frequent monitoring, especially during the summer, and detailed response plans for algal blooms are recommended. Safeguards against algal growth would consist of improvements to the operation of the reservoirs. These improvements may include incorporating a bottom drain, sediment removal and aeration. Capacity to address algal blooms may be incorporated into water treatment system design. The addition of a roughing filter in the treatment process provides improved capacity for removing algae. If the occurrence of algal blooms increase in the future, allowing for treatment process modifications, such as coagulation during an algal bloom, may increase treatment capacity during an algal bloom. During operations, adaptive capacity may be built through operations and maintenance procedures such as increased filter backwashing.	High
2	Water quality	Increasing annual temperatures	Bacterial growth in distribution system.	High	Existing water temperature is already quite high (median temp is 12 °C, ranging from 4-21 °C). Aesthetic objective is 15. Higher temperature makes treated water more sensitive to bacteria outbreaks in the distribution system.	High	Chloramine dosing can be increased to ensure adequate residual, although this will need to be balanced with aesthetic objectives for customers near the point of chlorination, and the increased risk of disinfection by-products. Additional chlorine or chloramine booster stations could be constructed elsewhere in the distribution system in the future as well if deemed appropriate.	Moderate

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3	Water quality	Increasing annual temperatures	Increasing temperatures can impact thermal structure and lake stratification. Climate change may impact stratification and turnover in the future which could impact nutrient distribution in the reservoir.	Moderate	Wilfred reservoir is assumed to follow stratification patterns of a warm monomictic lake. Wilfred Reservoir was assessed to have a moderate sensitivity to this impact due to the historic temperatures and location of the lake.	Moderate	Ongoing monitoring, including sampling at various depths, is recommended to track how source water quality is changing. Incorporating a floating intake with appropriate level of weighting will result in water being drawn from the seasonal elevation where water quality is highest. Aeration in reservoirs could be considered to promote mixing.	Low
4	Water quality	Increasing annual temperatures	Reduced dissolved oxygen in source water impacting metals concentrations.	Moderate	Warmer water holds less dissolved oxygen Changing temperatures are likely to change the water chemistry, in particular leading to decreased levels of dissolved oxygen. This in turn can result in increased dissolved metals. Reduced oxygen may make it more difficult to treat metals.	Moderate	Oxidation could be used to remove metals. If nanofiltration is included in treatment process, this would allow for removal of dissolved manganese.	Low
5	Water quality	Increasing annual temperatures	Reduced dissolved oxygen in source water impacting biofiltration.	Low	Sand filtration relies on bacterial growth, decreased dissolved oxygen may impact effectiveness of biofiltration process.	High	Aeration could be introduced if oxygen levels impact biofiltration effectiveness.	Very Low
6	Water quality	More intense extreme precipitation events	Sediment run-off into reservoir as a result of extreme storm events can impact water quality.	High	There is a high likelihood of increased extreme storm events. The reservoir is highly sensitive to run off from storm events due to the topography and slopes surrounding the reservoir. Increased sediment in the reservoir is likely to impact turbidity, and may also have long term water quality impacts due to metals or nutrients released from sediment.	Moderate	There is moderate adaptive capacity to turbidity issues as there can be some adjustments made to treatment processes (such as increased backwash) to deal with increased turbidity.	Moderate

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7	Water quality	More intense extreme precipitation events	Increased precipitation may lead to run-off leading to water quality issues, including risk of increased algal growth due to nutrient run off into the water.	Low	There is currently limited development in this watershed and so the sensitivity was assessed as low, however the presence of residential homes in the catchment area still poses a risk of nutrient run-off.	Moderate	Ongoing monitoring of nitrates in water quality. Some adaptive capacity can be built through regulations and watershed protection measures.	Low
8	Water quality	Dry spells (typically occur in summer)	Water quality is likely to degrade due to increased concentration of metals/organics/turbidity/algae during a drought.	Moderate	There is a moderate sensitivity to this issue. Future water quality may be impacted by climate change and so drought has the potential to exacerbate water quality issues in summer months. Biofiltration will not be able to address increased metals, and will only have a limited capacity to treat organics. There is also a risk of disinfection by-products as a result of increased organics in the source water.	Moderate	Based on ongoing water quality monitoring, it may be possible to adapt some treatment processes to account for lower water quality during drought. However, adaptive capacity is primarily dependent on treatment system design. Adaptive capacity could be built through the inclusion of nanofiltration in the treatment process to improve treatment capability. However, although nanofiltration would improve treated water quality, these filters may not be able to maintain high flow capacity if source water quality is low.	Low
9	Water quality	Increased wildfire risk	Wildfire can impact water quality due to run off with ash or fire debris and/or fire retardant.	Low	Sensitivity is moderate as wildfire risk will increase over time and the area surrounding the reservoir is forested leading to the possibility of a future wildfire in the area which could impact water quality. If fire retardant enters water system there could be an increase in phosphate, nitrate, or nitrite.	Moderate	Adaptive capacity can be built by ongoing monitoring for fires and ensuring the district has robust wildfire response plans. In the event of the use of fire retardant in the area, additional testing for emerging contaminants (PFCs/ PBDEs), nitrates, nitrites, and turbidity is recommended.	Low
10	Water quality	Increased wind/increased extreme precipitation events	Increased organics in reservoir due to debris blown by wind or washed into the reservoir during extreme storm events	Moderate	As the reservoir is surrounded by trees, there is a moderate sensitivity to increased organics in the reservoir as a result of leaves or other organic matter entering the reservoir as a result of run off or wind during extreme storm events.	Moderate	Managing vegetation surrounding the reservoirs (i.e. cutting overhanging branches) will help to build adaptive capacity. Incorporation of nanofiltration could help to build adaptive capacity as this will enable filtration of organics.	Low

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11	Water quality	Increased wind	Increased wind may influence mixing in reservoir increasing turbidity	Low	Wind may increase water turbidity.	Moderate	Additional backwashing in the event of higher turbidity.	Low
12	Source water availability	Increasing summer temperatures	Increasing temperatures lead to higher evaporation rates in the reservoirs leading to lower levels and reduced water supply. Evapotranspiration rates in the watershed are also projected to increase which could lead to reduced recharge into the reservoirs.	High	There is a high sensitivity to reduced water levels due to increased evaporation rates as a result of increased temperatures. Temperature increases are highly likely to occur and this issue will become worse with time.	Moderate	Proactive water conservation measures in summer months can help to protect against reduced water availability.	Moderate
13	Source water availability	Decreased precipitation in summer	Decreased precipitation in the summer may lead to reduced reservoir levels and a risk of water shortages in the summer.	High	Reduced summer precipitation may lead to water shortages in the summer due to limited reservoir recharge from rain.	Moderate	Proactive water conservation measures in summer months can help to protect against reduced water availability.	Moderate
14	Source water availability	Longer summer dry spells	Increased length of dry spells may result in lower water levels.	High	Reduced summer precipitation may lead to water shortages in the summer due to limited reservoir recharge from rain.	Moderate	Proactive water conservation measures in summer months can help to protect against reduced water availability.	Moderate

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15	Source water availability	More intense extreme precipitation events	Run-off into reservoir as a result of extreme storm events can increase sediment in reservoir reducing reservoir capacity over time.	Low	Although this may become an issue, sensitivity is low as this would occur slowly over time and it is not anticipated that sedimentation would drastically reduce capacity in the short term.	Moderate	A reservoir bottom drain can be provided, which would tend to discharge sediment downstream instead of capturing it in the reservoir. Sediment levels can be monitored over time and reservoirs can be dredged if capacity becomes an issue.	Low
16	Water demand	Increasing summer temperatures	Increasing temperatures are correlated to higher water demand.	Moderate	Sensitivity to this impact has been assessed as low since water use is residential and so even though there is likely to be increased water use, the impact overall is likely to still be within the capacity of the water system.	Moderate	Proactive water conservation measures in summer months can help to protect against reduced water availability.	Low
17	Water demand	Increased length of growing season	Increased length of growing season may increase water demand for landscaping/gardening for water users.	Low	Sensitivity to this impact has been assessed as low since there is no large scale agricultural uses in the community. Lengthened growing season for residential gardens/landscaping was assessed to be relatively low.	High	Water conservation efforts and homeowner efforts to plant drought resistant plants can reduce residential water use.	Very Low
18	Water demand	Temperature and precipitation trends leading to degraded water quality	Increased backwash	High	Based on projected impacts to water quality, it is likely that additional water will be required to meet filter backwash requirements.	Moderate	Consider this is treatment system design and operations.	Moderate

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APPENDIX

Making a difference...together

Agenda Item #5
WM2020-07

REPORT TO WILDERNESS MOUNTAIN WATER SERVICE COMMISSION
MEETING OF TUESDAY, NOVEMBER 24, 2020

SUBJECT **Wilderness Mountain Water Service - Water Treatment Assessment**

ISSUE SUMMARY

To provide the Wilderness Mountain Water Service Commission (WMWSC) with a Water Treatment Assessment report prepared by WSP Canada Inc. (WSP) as part of the Water Vulnerability Study for the Wilderness Mountain Water System to support a grant application.

BACKGROUND

At their meeting held July 30, 2020 the WMWSC directed staff to prepare a grant application for the "Investing in Canada Infrastructure Program - British Columbia – Rural and Northern Communities Infrastructure" (ICIP) program.

In order to provide a complete picture for the grant application, a water treatment assessment was required that included conceptual design and cost estimating. A consultant, WSP, had already been retained to produce a Water Vulnerability Study for the WMWSC so the scope of work was expanded to include a Water Treatment Assessment. The resultant report is attached as Appendix A.

The report presents two alternatives, one with nanofiltration and one without, with estimated capital costs of $3.9 million and $2.9 million respectively. In addition, the increase in annual operating costs per property was estimated at approximately $1,200 annually, with replacement costs estimated at an additional $900 annually at the current number of serviced lots. While the grant program, if successful, would cover the capital costs with the exception of $50,000 of non-grantable costs, the increase in annual operating cost was determined to be untenable for the community.

On November 8, 2020, in a conference call with the WMWSC, staff recommended and the WMWSC agreed not to move forward with the ICIP grant application for treatment improvements. The WMWSC also declined to move forward with any other grant applications for the next year.

ALTERNATIVES

Alternative 1
The Wilderness Mountain Water Service Commission receives this report for information.

Alternative 2
That this report be referred back to staff for additional information with specific direction to scope and budget to provide the information.

IMPLICATIONS

There are no implications to receiving this report.

CONCLUSION

The WMWSC directed staff to prepare a grant application to the ICIP program which required conceptual design and cost estimating to be carried out to support the grant application. The consultant, WSP, provided the information and given the increased costs of operating the system it was decided not to move forward with the grant application.

RECOMMENDATION

The Wilderness Mountain Water Service Commission receives this report for information.

Submitted by	Dale Puskas, P.Eng., Manager, Capital Projects
Concurrence	Ian Jesney, P.Eng., Senior Manager, Infrastructure Engineering
Concurrence	Ian Jesney, P.Eng., Acting General Manager, Integrated Water Services
Concurrence	Robert Lapham, MCIP, RPP, Chief Administrative Officer

ATTACHMENT

Appendix A: Water Vulnerability Study on the Wilderness Mountain Water System – Treatment Assessment & Recommendation

CAPITAL REGIONAL DISTRICT
REPORT NUMBER: 201-08298-00

WATER VULNERABILITY STUDY ON THE WILDERNESS MOUNTAIN WATER SYSTEM

REPORT 1 - TREATMENT ASSESSMENT & RECOMMENDATION

OCTOBER 30, 2020 FINAL

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WATER VULNERABILITY STUDY ON THE WILDERNESS MOUNTAIN WATER SUPPLY SYSTEM

REPORT 1 - TREATMENT ASSESSMENT & RECOMMENDATION

CAPITAL REGIONAL DISTRICT

FINAL

PROJECT NO.: 201-08298-00
CLIENT REF:
DATE: OCTOBER 30, 2020

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October 30, 2020

Confidential

Capital Regional District
625 Fisgard Street
Victoria, B.C. V8W 1R7

Attention: Dale Puskas, P.Eng., Manager Capital Projects

Subject: Water Vulnerability Study on Wilderness Mountain Water Supply System Report #1: Treatment Assessment and Recommendation

Client ref.: 2020-618

Dear Mr. Puskas:

We are pleased to submit our Report No. 1 - Treatment Assessment and Recommendation. The report is the first report of two to be delivered under the Water Vulnerability Study on Wilderness Mountain Water Supply System project.

Yours sincerely,

Simon Kras, P.Eng.
Project Management,
Infrastructure

WSP ref.: 201-08298-00

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REVISION HISTORY

FIRST ISSUE

September 24, 2020	DRAFT			
Prepared by	Reviewed by	Approved By		
Patricia Oka, P.Eng.	Thomas Munding, P.Eng.	Simon Kras, P.Eng.		
October 5, 2020	DRAFT			
Prepared by	Reviewed by	Approved By		
Patricia Oka, P.Eng.	Thomas Munding, P.Eng.	Simon Kras, P.Eng.		
REVISION 2				
October 7, 2020	DRAFT			
Prepared by	Reviewed by	Approved By		
Patricia Oka, P.Eng.	Thomas Munding, P.Eng.	Simon Kras, P.Eng.		
REVISION 3				
October 29, 2020	FINAL			
Prepared by	Reviewed by	Approved By		
Patricia Oka, P.Eng.	Thomas Munding, P.Eng.	Simon Kras, P.Eng.		

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SIGNATURES

PREPARED BY

30-Oct-2020

Patricia Oka, P.Eng.
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Date

REVIEWED BY

30-Oct-2020

Thomas Munding, P.Eng.
Senior Water Treatment Engineer

Date

APPROVED[1] BY

30-Oct-2020

Simon Kras, P.Eng.
Project Manager

Date

WSP prepared this report solely for the use of the intended recipient, WSP, in accordance with the professional services agreement. The intended recipient is solely responsible for the disclosure of any information contained in this report. The content and opinions contained in the present report are based on the observations and/or information available to WSP at the time of preparation. If a third party makes use of, relies on, or makes decisions in accordance with this report, said third party is solely responsible for such use, reliance or decisions. WSP does not accept responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken by said third party based on this report. This limitations statement is considered an integral part of this report.

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1 INTRODUCTION

1.1 PROJECT OVERVIEW

The community of Wilderness Mountain, also known as Mount Matheson Estates is a rural residential development located in East Sooke. The estates are made up of 82 total parcels over a total area of 124 hectares. The 2019 Annual Water Report indicates 71 active service connections. The Wilderness Mountain water system is supplied from the Wilfred Reservoir. The Wilfred Reservoir is prone to turbidity events with turbidity spikes between 1.0 NTU to 5.0 NTU. On average, these turbidity events last between 8 to 13 hours. The source water is also understood to be low in alkalinity and pH and contain manganese at levels that do not meet the current aesthetic objective of the Guidelines for Canadian Drinking Water Quality (GCDWQ).

The source water is currently treated with a series of cartridge filters and disinfected with UV and chloramination in an existing treatment plant. Treated water is distributed to the consumers and stored in two (2) existing reservoirs. The existing plant does not provide treatment for the manganese or the low pH. Although Vancouver Island Health Authority (VIHA) had previously provided a filtration exemption for the system, the system periodically fails to meet the 1.0 NTU maximum treated water turbidity. The system also does not provide adequate chlorine contact time for disinfection prior to reaching the first customer.

Following Boil Water Advisories in 2016 and 2018 respectively, VIHA issued a notice to the CRD removing the filtration exemption from the system, and requiring a system which would meet the 4-3-2-1-0 treatment targets required by the *Drinking Water Protection Act* (DWPA) and *Drinking Water Protection Regulation* (DWPR). This includes providing adequate surface water treatment to meet the *Giardia* and *Cryptosporidium* removal, chlorine contact time (CT) to meet the 4-log virus removal as well as turbidity reduction to below 1 NTU.

Water demand in the Wilderness Mountain community has fluctuated between 2017 and 2020 without a clear increasing trend after a sharp increase between 2016 and 2017. The increase can be partially explained by the addition of a seasonally operated autoflush valve at a dead-end on Wilderness Place. The current system is now operating at its design capacity, with an estimated maximum daily demand of 3.0 L/s (260 m^3/day). There are 11 possible additional service connections which may be considered in the future. A design flow of 360 m^3/day is proposed to provide resilience against the possibility of worsening source water quality, which could reduce the effective capacity of a treatment system.

In 2018, the CRD retained Colquitz Engineering to review options for improving the water quality at Wilderness Mountain. Colquitz conducted a feasibility study comparing three options for improvements to the system to address the water quality concerns. One of these options was a new dissolved air flotation (DAF) system with a capacity of 3.5 L/s (300 m^3/day). The estimated capital cost for this option was $4,230,000 with an annual operational cost of $160,000.

DAF systems are relatively complex from an operational perspective. These systems have multiple stages of treatment and required careful monitoring for coagulant dosing. Furthermore, these systems generate backwash containing treatment chemicals, which is challenging to dispose of at this site, given the lack of a sanitary sewer system in the Community. The estimated capital cost is also quite high for a community of this size to finance.

1.2 OBJECTIVES

Given VIHA's directive to the CRD to address the water quality concerns at Wilderness Mountain, the CRD retained WSP to assess treatment options for the Wilfred Reservoir treatment system and provide recommendations for a system in line with the Guidelines for Canadian Drinking Water Quality (GCDWQ), which complies Provincial regulations and with VIHA directives. If the CRD chooses to use the William Brook reservoir to provide additional capacity, then additional treatment may be required for removal of metals. For this reason, this report

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applies only to the Wilfred Reservoir. Further discussion is provided under a separate cover in WSP's Source Water Vulnerability Assessment Report.

This report describes WSP's treatment recommendations, based on the demand and water quality data provided by the CRD. Detailed descriptions of the recommended technologies are also discussed within. The report will also include estimated footprint, a Class 'C' capital cost estimate, as well as operations and maintenance costs.

2 EXISTING SYSTEM

The Wilderness Mountain water system is supplied by the Wilfred Reservoir. The intake is located near the eastern shore and subject to siltation from bank erosion and ingress of organic matter from the forested watershed. The intake is fixed at 3m below the maximum water level, and the piping is largely exposed and unprotected from vandalism. Raw water from the open reservoir is pumped to a treatment plant located on the eastern shore of the reservoir, and treated water is distributed to the 71 consumers of the Mount Matheson Estates as it fills up two (2) existing treated water tanks.

2.1 WILFRED RESERVOIR SOURCE WATER QUALITY

Table 2-1 summarizes of the source water quality between January 1st, 2015 and July 9th, 2020 as provided by the CRD. The red coloured numbers indicate values exceeding the Guidelines for Canadian Drinking Water Quality (GCDWQ).

Table 2-1 Source Water Quality Parameters

PARAMETERS	UNIT	GCDWQ	COUNT	RANGE	MEDIAN
Temperature	°C	AO ≤ 15	195	3.7-21.2	12.0
pH	pH unit	7.0-10.5	19	6.33-7.16	6.67
Hardness (as $CaCO_3$)	mg/L	None	14	14.1-18.6	16.1
Total Coliform	CFU	0/100 ml	128	0-4300	158
Total Organic Carbon (TOC)	mg/L	None	8	2.96-6.83	4.1
Total Dissolved Solids (TDS)	mg/L	AO ≤ 500	5	48-65	56
Turbidity	NTU	<1	118,900	0.05-5.01	1.15
True Colour	TCU	<15	24	9.4-23	14.0
Total Iron (Fe)	mg/L	AO ≤ 0.3	14	0.115-0.387	0.147
Total Manganese (Mn)	mg/L	MAC < 0.12 AO ≤ 0.02	14	0.034-0.125	0.056
Total Algal	NU/ml		49	659-38,683	6,283

AO : Aesthetic Objective MAC : Maximum Allowable Concentration

From the provided data, it is understood that the main issue with the Wilfred Reservoir is its proneness to turbidity spikes between 1.0 to 5.0 NTU lasting between 8 to 13 hours. Table 2-2 summarizes the occurrence of the turbidity events longer than 2 hours duration in the Wilfred Reservoir between 2016 and 2020.

Table 2-2 Wilfred Reservoir Turbidity Events (2016 to 2020)

YEAR	NO. OF EVENTS	AVG. DURATION (HRS)	AVG. TURBIDITY (NTU)
2016	138	13.0	1.51
2017	55	10.1	1.89
2018	32	7.7	1.64
2019	29	9.7	1.55
2020*	26	12.9	1.53

*As per record data up to August 24th, 2020.

The Wilfred Reservoir can be characterized as a moderately high organic water source based on True Colour. Nonetheless, the mean True Colour of 14.0 TCU is below the GCDWQ recommended maximum of 15.0 TCU. Both alkalinity and pH in the source water are relatively low, with the median pH of 6.67 being slightly lower than the recommended minimum of 7.0.

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Total manganese in the water exceeds the aesthetic objective of 0.02 mg/L, but is generally below the Maximum Acceptable Concentration (MAC) of 0.12 mg/L. The provided data also indicates increases in algal concentrations in the months of June and July. It has been reported that algal bloom during summer typically contributes to elevated turbidity in the source water (CRD, 2019) resulting in frequent replacements of the WTP filter cartridges.

Source water quality is expected to be vulnerable to climate change, such as extreme rainfall and runoffs in spring and winter and prolonged summer droughts. The increased precipitation and runoffs will amplify the turbidity spikes in the source water and the prolonged droughts in the summer will likely increase turbidity, algal, manganese, and organics concentrations in the water. This is discussed in further detail in WSP's Source Water Vulnerability Assessment.

2.2 TREATED WATER QUALITY

The existing treatment system is housed in two modular buildings. The raw water pump station, cartridge filtration and UV are located within the primary treatment building which has a footprint of approximately 4.6 m x 3.5 m. The existing treatment system consists of a raw water pumping system with a capacity of 3.0 L/s at 30 m Total Dynamic Head (TDH), two (2) parallel trains of a 25-micron and 5-micron cartridge filters followed by three (3) parallel UV reactors. In 2017, a prefiltration stage was added upstream of the system consisting of a 50-micron cartridge filter and a 20-micron cartridge filter in series. The existing UV units are Trojan PRO MAX-30 with individual capacity of approximately 160 m^3/day at 40 mJ/cm^2.

The disinfection building is approximately 2.4 m x 6.0 m and contains chlorine and ammonia storage, metering pumps and injectors. The existing system was designed based on an MDD and ADD of 260 m^3/day and 45 m^3/day, respectively. Treated water is stored in two (2) existing treated water tanks with a combined capacity of 250 m^3. Table 2-3 summarizes the treated water quality between January 1st, 2015 and July 9th, 2020 as provided by the CRD. The red coloured numbers indicate values exceeding the Guidelines for Canadian Drinking Water Quality (GCDWQ).

Table 2-3 Treated Water Quality Parameters

PARAMETERS	UNIT	GCDWQ	COUNT	RANGE	MEDIAN
Temperature	ºC	AO ≤ 15	1044	0.97-20.9	11.2
pH	pH unit	7.0-10.5	18	6.45-8.86	6.89
Hardness (as $CaCO_3$)	mg/L	None	5	15.3-18.1	16.1
Total Coliform	CFU	0/100 ml	184	0-1*	0
Total Organic Carbon (TOC)	mg/L	None	N/A	N/A	N/A
Total Dissolved Solids (TDS)	mg/L	AO ≤ 500	N/A	N/A	N/A
Turbidity	NTU	<0.3/1.0/0.1**	380	0.15-5.8	0.72
True Colour	TCU	<15	22	6.3-18	12
Total Iron (Fe)	mg/L	AO ≤ 0.3	6	0.052-0.244	0.1075
Total Manganese (Mn)	mg/L	MAC < 0.12 AO ≤ 0.02	6	0.011-0.092	0.042
Total Trihalomethanes (TTHMs)	mg/L	0.100	31	0.001-0.160	0.004***
Total Haloacetic Acids (HAAs)	mg/L	0.08 ALARA	4	0.005-0.22	0.016

AO : Aesthetic Objective MAC : Maximum Allowable Concentration N/A : Not Available *6 occurrences of >0/100 ml

**Limits vary with treatment technologies: 0.3NTU for conventional and direct, 1.0NTu for slow sand, and 0.1NTU for membrane.

***Median is skewed by high average THM concentration from Ambience Pl Cell 1-North and Ambience Pl Cell 2-South.

Almost all positive coliform counts observed in the distribution system were at 563 Wilderness Place. The presence of coliforms is likely related to Wilderness Place being at the far end of the distribution system. The increased water age provides a greater opportunity for bacterial growth. The highest incidence of positive coliform tests recorded in the distribution system was in 2016, with four (4) events in a single year. In 2019, three (3) positive coliform tests were recorded at the water treatment plant, which is a sign of likely breakthrough in the filtration system.

The treated water quality data indicates that turbidity levels do exceed the 1.0 NTU maximum required by VIHA on occasions, indicating that although some reduction in turbidity is being achieved through treatment, the existing filtration system is not adequate for reducing the turbidity in the source water. Boil Water Advisories have coincided with periods of high turbidity. In addition, the CRD has also noted that some of the turbidity breakthroughs may be due to the frequent changes of the cartridge filters. Table 2-4 presents the number of events with treated water turbidity greater than 1.0 NTU between 2015 and present days.

Table 2-4 Treated Water Turbidity Events > 1.0 NTU

	NO. OF EVENTS
2015	4
2016	13
2017	5
2018	8
2019	6
2020*	3

*As per record data up to September 2nd, 2020.

The treatment system appears to marginally improve both colour and the total manganese concentration, although total manganese is still above the recommended AO. The total thrihalomethane (THM) and haloacetic acid (HAA) concentrations in the treated water are generally acceptable, although rare occasions of THMs and HAAs exceeding GCDWQ do occur – predominantly at Ambience Pl Cell 1-North and Ambience Pl Cell 2-South. Water pH remains lower than the recommended range for drinking water. Low pH in water can cause corrosion issue in domestic plumbing systems and can degrade water quality through leaching of the metals, such as lead, copper and iron.

The existing disinfection system uses chloramination for disinfection. Benefits of chloramination compared to standard chlorination include a reduction in the formation of harmful Disinfection By-Products (DBPs), and the ability to maintain a disinfection residual in the system for a longer timespan. However, chloramination typically requires significantly more contact time (CT) than standard chlorination to achieve primary disinfection.

Because there is no dedicated chlorine contact tank in the existing facility, the system relies on the distribution network for contact time. At peak treatment system flows, the current system provides approximately 25 minutes of contact time at the first customer (706 Cains Way), while the required contact time for chloramination is typically several hours.

The addition of a chlorine contact tank would allow the order of chloramination to be reversed. Virus disinfection would be achieved with chlorine only, followed by a contact tank with adequate CT. Ammonia would be injected as a final step to stabilize the free chlorine in the water. This recommendation is discussed further in our treatment system recommendations.

2.3 CURRENT WATER DEMAND

Four years of demand data between April 27, 2016 and August 24, 2020 were provided by CRD to WSP to determine the current water consumption by the community. The data consist of the instantaneous reading of the existing treatment plant's feed water flowmeter, as recorded by the CRD's supervisory control and data acquisition (SCADA) system. From the 25,139 received data points, 197 indicated erroneous instantaneous flows of greater than 27 L/s and were therefore removed from the analysis. Daily flow values were calculated from the data based on the instantaneous flow values and timestamps for each data point. For each data point, the flow volume was assumed to be equal to the instantaneous flowrate multiplied by the time elapsed between readings.

Looking at the water consumption trend, there is a sharp increase in demand between 2016 and 2017. The increase in annual water demand in 2017 can be partially explained by the addition of an auto-flush system installed at the

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end of Wilderness Place in 2017. The auto-flush system uses approximately 2,000 m^3 of water per year. There are likely other factors responsible for the observed increase in demand. Between 2017 and 2019 there is fluctuation but no clear increasing trend in water demands. Annual consumption for 2020 is projected to be similar to 2018 consumption.

Table 2-5 and Figure 2-1 present the annual water consumptions of the Mount Matheson Estates between 2016 and 2020. From the provided data, the current maximum daily demand (MDD) is 260 m^3/day, determined by the highest daily consumption within the assessed period. The current average daily demand (ADD) is 70 m^3/day, determined by taking the linear average of the daily consumptions over the assessed dates. The average winter flow is 45 m^3/day and summer is 90 m^3/day.

Table 2-5 Water Consumption for Mount Matheson Estates

ANNUAL WATER CONSUMPTION (M^3)

2016	2017	2018	2019	2020*
16,901	22,780	25,432	22,793	17,232

*As per record water consumption data up to August 24th, 2020.

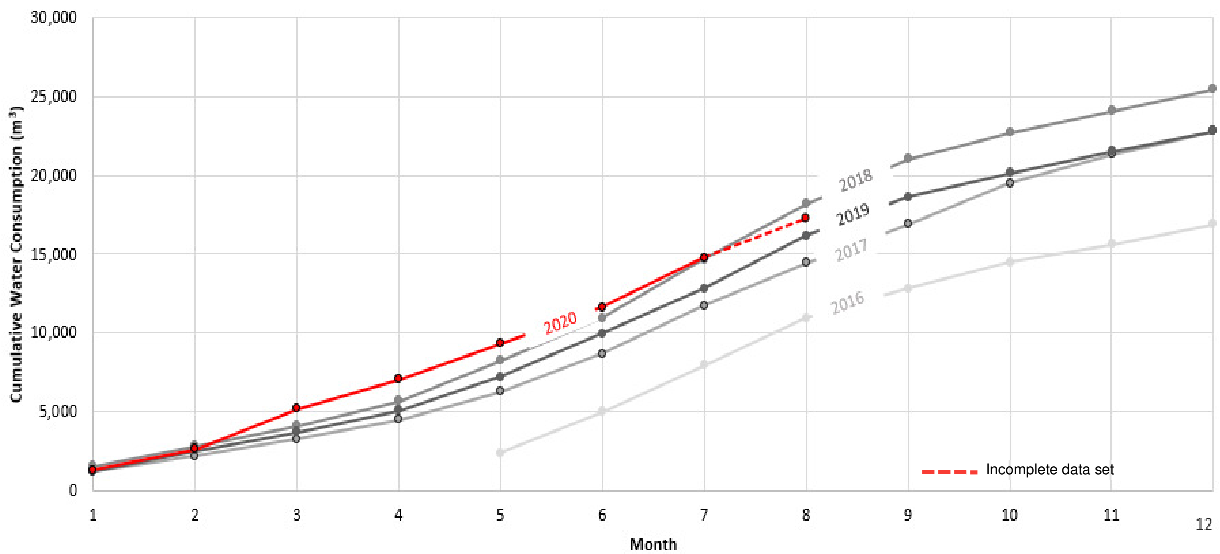

Figure 2-1 Water Consumption for Mount Matheson Estates

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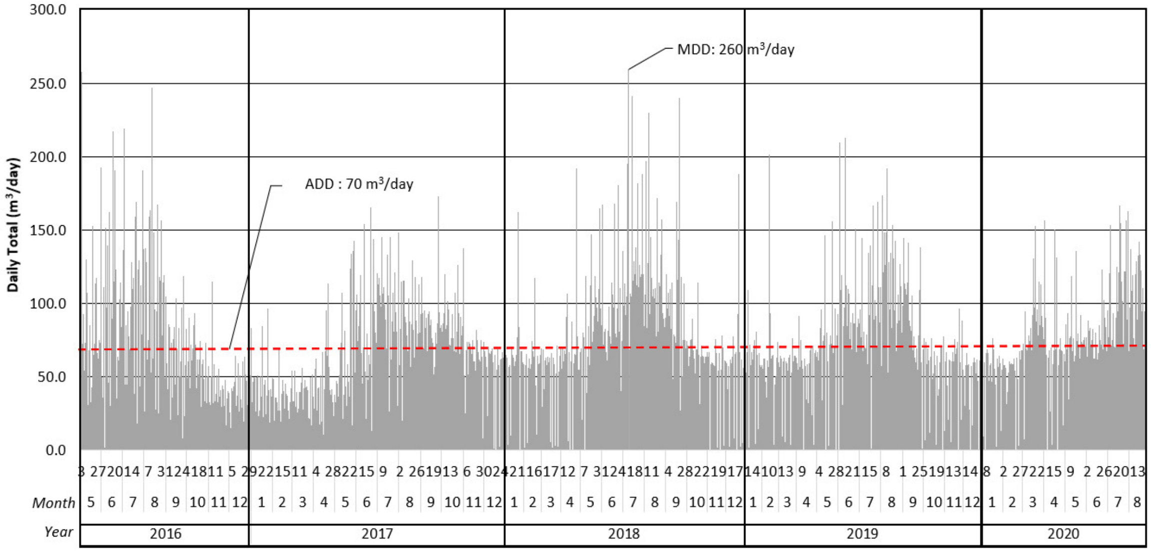

Figure 2-2 Daily Water Consumption Mount Matheson Estates

3 TREATMENT OBJECTIVES

British Columbia regulates municipal drinking water quality through its *Drinking Water Protection Act* (DWPA) and *Drinking Water Protection Regulation* (DWPR). The Act and Regulation on Vancouver Island are administered by VIHA who mandate that the "4-3-2-1-0" treatment objective[2] for surface water supplies as follows:

— 4-log (99.99%) reduction or inactivation in viruses, normally achieved through chlorine disinfection with contact time.

— 3-log (99.9%) reduction or inactivation in protozoa (Giardia cysts and Cryptosporidium oocysts), typically achieved through filtration, or UV disinfection, or both.

— 2 treatment processes for surface water; combining more than one process for treatment allows for a multi-barrier approach against a range of microorganisms.

— 1 NTU turbidity or less; well established filtration technologies can consistently reduce turbidity in the water to <0.1 to 1 NTU.

— No detectable E.coli, fecal coliforms, and total coliforms, typically achieved through disinfection (such as chlorination and/or UV disinfection) or a combination of disinfection and filtration.

— Provide adequate chlorine contact (CT) time prior to supplying the first customer.

In addition to the 4-3-2-1-0 objective, the treatment system must also address the potential for elevated concentrations of disinfection by-products in the water following chlorination. Table 3-1 summarizes the treatment targets for the proposed upgrade to the treatment plant.

Table 3-1 Water Treatment Objectives

PARAMETER	UNIT	TARGET
pH	pH unit	7.0 - 10.5
Turbidity	NTU	< 1.0
Virus Inactivation	%	> 99.99 (4-log)
Crypto/Giardia Removal/Inactivation	%	> 99.9 (3-log)
Minimum chlorine residual in treated water		0.2 mg/L
Total Trihalomethanes (TTHMs) Total Haloacetic Acids (HAAs)	ug/L ug.L	100 80

[2] *Health Protection and Environmental Services Policy 3.3 Treatment Objectives for Surface Water Supplies and the Drinking Water Treatment Objectives (Microbiological) for Surface Water Supplies in British Columbia (SWTOMSWSBC).*

4 RECOMMENDED TREATMENT

The proposed upgraded water treatment system for the Wilderness Water System consists of:

- Intake pump system (new, floating intake);
- Roughing Filters (new)
- Rapid sand bio-filtration system (new);
- Future provision for spiral-wound nanofiltration (NF) membrane (new);
- UV disinfection (existing);
- Chloramination (existing); and
- Corrosion control system (new).

Raw water from the Wilfred Reservoir will be pumped from a new floating intake system to the new roughing filters for algae removal prior to sand biofiltration. Both the roughing filters and bio-filtration systems will be installed outdoors on a concrete slab. The biofiltration pumping system and controls, along with the corrosion control system will be housed in an enclosed shipping container (sea-can). Space would be allocated on-site to allow for a future container to house the nanofiltration membrane system, should it be required. The existing UV and chloramination systems will be retained. Approximately 16 m x 18 m fenced area is approximated to contain the proposed treatment systems. A process flow diagram and a conceptual equipment layout of the proposed system are provided in Appendix A.

Although NF is included as a provisional item, its application will result in reduced manganese as well as organics loading which will subsequently, lead to reduced disinfection by-products (DBP) in the distribution system. The need to treat the manganese and organic loading will become more apparent in the future with the anticipated decline in the source water quality. A vulnerability study on the source water supply is currently underway.

4.1 DESIGN FLOWS

The proposed MDD design value for the system is 360 m^3/day. This value is 40% higher than the maximum historical flow observed, which provides a level of resilience to account for:

— Possible increases to demand beyond the historic maximum of 260 m^3/day and
— Allowance for backflushing of treatment system which reduces effective capacity.
— Deterioration in future source water quality which is likely to reduce the effective capacity of the treatment system due to additional required backflushing.

Based on our preliminary assessment, the Wilfred Reservoir appears to have adequate capacity to meet this demand under current conditions. However, the treatment capacity may eventually exceed the source water availability due to climate change, which would require more stringent water conservation measures. This is discussed in further detail in WSP's Source Water Vulnerability Assessment.

Table 4-1 presents the average, maximum and peak daily demands used to size the upgraded treatment system.

Table 4-1 Design Treatment Capacity

	CURRENT m^3/day (L/s)	DESIGN m^3/day (L/s)
Average Daily Demand (ADD)	70	145 (1.7)
Maximum Daily Demand (MDD)	260	360 (4.1)
Peak Hour Demand (PHD)*	Not known	1,080 (12.5)

* Calculated as 3 x MDD

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4.2 ROUGHING FILTERS

The proposed roughing filter is a chemical-free treatment that will consist of three (3) - 1.2m diameter x 2.1m height pressurized fibre reinforced plastic (FRP) tanks operated in parallel and installed outdoors. A specially treated glass media, such as an activated filter media or AFM, is proposed for its high resistance to bio-fouling to filter out any presence of algae and suspended particles in the water that can immediately foul the upstream sand bio-filtration system. The filters will be operated at an approximate flux rate of 5.0 m/h superficial velocity (water approach velocity to the media). The frequency of filter backwash will be dependant on the raw water quality; such that during an algae bloom period backwash may be required every few hours and may be as infrequent as once per week outside the algae bloom period. The spent backwash water is expected to be relatively low in suspended solids concentration and can be directly discharged to the soakaway basin (see Section 4.7).

4.3 SAND BIO-FILTRATION

The proposed sand bio-filtration (henceforth referred as "bio-filtration") as supplied by Manz Engineering, operates much like a rapid gravity filter except at a much lower filtration rate of less than 1.0 m/hr, as opposed to the typical RGF rate of 6 to 12 m/hr. Raw water is gravity filtered through a sand bed without any coagulation or pre-chlorination prior to filtration. Due to the low filtration rate, the sand media is colonized with beneficial bacteria providing effective biofiltration removal of turbidity and bio-available organics. Different from the conventional slow sand filtration, the proposed sand bio-filtration is backwashed using the filtrate water. Backwash frequency is expected to range from once every 2-3 weeks to every other month and uses much lower backwash water volume than conventional RGFs. The biofiltration vessels will consist of three stainless steel modules, located outdoors, each 2 meters wide x 4 meters long x 2 meters tall. Filtrate water from the bio-filters will be stored in a 3,000-gallon filtrate tank that supplies water for filter backwashes. Filtrate water can be disinfected (refer to Section 4.5) or "polished" through a nanofiltration membrane for further removal of organics and colour (refer to Section 4.4). The pumping and control system of the bio-filtration system will be housed in an enclosed, standard shipping container (sea-can) of 2.4m (W) x 6.1m (L). The spent backwash water is stored in a backwash tank for solids settling, as discussed in Section 4.7.

4.4 SPIRAL WOUND NANOFILTRATION MEMBRANE (NF)

Nanofiltration (NF) is a water purification process that uses a partially permeable membrane to remove some ions, unwanted molecules and larger particles from drinking water. In nanofiltration, an ayeapplied pressure is used to force water through nanometer sized pores that pass through the membrane. Nanofiltration can remove many types of dissolved and suspended chemical species as well as biological ones (principally bacteria and virus) from water, and is commonly used in both industrial processes and the production of potable water. However, not all of the water supplied to an NF membrane passes through the membrane. The two water streams of differing water quality are produced in the NF process. The water stream that passes through the membrane is purified and referred to as "permeate".

As the feed water stream passes along the membrane and loses water to the permeate stream, the concentration of contaminants on the feed water side increases. For this reason, the feed stream quality declines along the membrane and is often referred to as "concentrate" when it exits the membranes. This technology is proposed as an optional treatment to further polish the filtrate quality from the bio-filtration, in particular with respect to organics and colour. Nanofiltration membranes have extremely small pore sizes of less than 2 nm, which can effectively filter large molecular weight organic molecules as well as suspended solids in one process step without the need for any chemical coagulation. Subsequently, the retained organics and solids in the concentrate stream can be discharged to the soakaway pit to exfiltrate back to the reservoir since there are no chemical additions. Nanofiltration can typically reduce colour to less than 5 TCU and 80% to 90% of dissolved organic carbon (DOC).

The proposed spiral wound nanofiltration (NF) system is an established water treatment process that uses a physical barrier to retain any particulates greater than the barrier's pore size. Spiral-wound modules filters water through a series of membrane surfaces in a spiral configuration. A membrane envelope is formed by sealing two sheets of flat-sheet membrane material, with the active membrane layer facing out. A permeate carrier spacer material inside the envelope prevents the inside from collapsing and provides a flow path for the filtrate inside the envelope.

During operation, the vessel is pressurized to drive the feed water through the first membrane surface. The filtrate will flow tangentially from the membrane surface and spirally toward the permeate collection tube, located in the centre of the module. A continuous bleed from the membrane vessel will maintain the solids concentration within the vessel. The bleed will be directly discharged to the soakaway basin. The recovery rate for the NF is anticipated to be 85%.

Approximately twice a year, the membrane will have to be chemically cleaned using a chlorine, sodium hydroxide and/or hydrochloric acid solution. The resultant chemical wastes constitute less than 0.1% of the total treatment flow and are the only waste stream that requires special handling and disposal. It may be possible to neutralize these cleaning solutions and then discharge them to the sludge bag filter soakaway basin.

The addition of a Nanofiltration system would require additional equipment following the bio-filtration system, including a set of feed pumps, a filtrate tank, as well as a clean-in-place (CIP) tank for membrane cleaning. The new nanofiltration system will be housed in an enclosed 2.4m (W) x 12m (L) sea-can, but would require an expansion to the fenced footprint provided in Section 4.2. Figure 4-1 below shows a mass balance flow diagram of a NF membrane process.

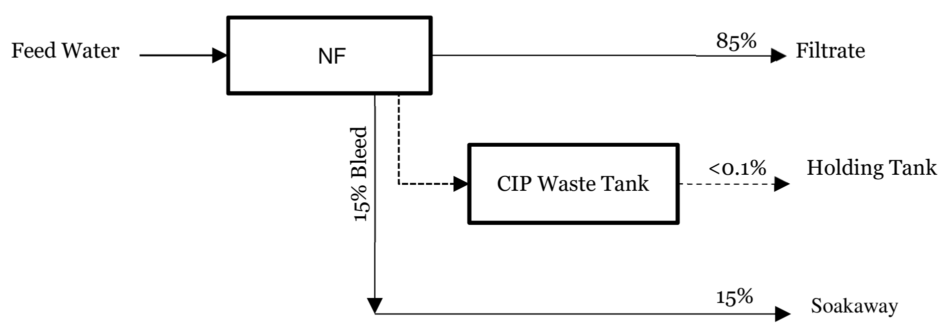

Figure 4-1: Simplified Mass Balance for NF System

4.5 DISINFECTION

Filtered water from the bio-filtration or nanofiltration will be disinfected with the existing UV units and chloramination system prior to distribution. UV disinfection is needed to provide the 3-log *Giardia and Cryptosporidium* removal credit following filtration, whereas chlorination is required to meet the 4-log removal of viruses. The ammonia addition is to stabilize the reactivity of chlorine by chloramination to reduce the formation of disinfection byproducts and prolong residual chlorine in the distribution system. However, if NF treatment is included the requirement for ammonia addition could be re-evaluated. Although chloramination is beneficial for reducing chlorine degradation in the system, it would no longer be required for reducing disinfection by-products, since the organics in the water would be removed by the NF system.

Each of the three (3) existing UV reactors (Trojan PRO MAX-30) has a treatment capacity of 160 m^3/day and can therefore meet the proposed upgraded capacity. The existing chloramination will need to be modified to provide the required contact time (CT) for a 4-log virus removal by sodium hypochlorite prior to ammoniation. Approximately a 2,000-gallon contact tank is required to achieve the required 4-log virus removal, estimated at a minimum CT of 9.2 mg/L-min CT and a minimum reservoir temperature of 3.7°C (refer to Table 2-1). It is assumed at this point that the new CT tank will be located adjacent to the existing chloramination building.

Ammoniation can be achieved with the existing system, although the exact capacity of the current system is unknown to WSP and will need to be confirmed. Should nanofiltration be added to the system, the reduced organic

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contents in the final filtrate will allow the removal of the ammonia addition phase, using sodium hypochlorite only to achieve both primary and secondary disinfection.

4.6 CORROSION CONTROL

Corrosion control by means of pH adjustment is recommended to bring the low water pH to meet the GCDWQ range of 7.0-10.0. Note that the fine pores in NF will remove some of the dissolved nutrients in water, resulting to a further drop in pH. It is, therefore, a common practice for systems with NF to correct pH after treatment.

pH adjustment can be achieved through a number of treatments, including a base solution injection, such as soda ash, hydrated lime, or caustic soda, or through a limestone contactor. For the purpose of minimizing chemical use and special safety procedure, a pre-packaged limestone contactor is proposed for this project. An online pH analyzer will be used to confirm treatment. The limestone contactor will be located, either inside, or adjacent to the proposed 2.4m (W) x 12m (L) bio-filtration sea-can.

4.7 RESIDUAL MANAGEMENT

Spent backwash from the roughing filters can be directly discharged to ground through a soakaway basin or a constructed wetland that will eventually lead back into the Wilfred reservoir. Under normal conditions, this discharge will contain very little solids. However, under an algae bloom period, it is anticipated that the suspended solids concentration and turbidity of this discharge will increase.

The spent backwash from the biofilters will be directed into a 12,000 litre (approximate) tank for solids settling. To better accommodate settling and separation of the solids, a cone bottom tank may be considered. As the tanks will be installed for outdoor use, the use of black HDPE tanks is recommended to provide protection against UV rays and algae growth inside the tank. The decant of the spent backwash can be discharged to the same soakaway basin or constructed wetland as the roughing filters' spent backwash. The settled sludge from the backwash tank can be discharged to a sludge bag filter for gravity dewatering and eventual disposal. The sludge bag filter could be located above the treatment facility near Cains Way to improve accessibility for occasional disposal by truck. Further development of options will be considered at the preliminary design phase.

The filtrate from the bag filter can also be discharged to a soakaway basin. However, due to the anticipated poor filtrate quality, it is recommended that the receiving soakaway be located such that it does not flow back into the Wilfred Reservoir.

5 COST ESTIMATES

5.1 CAPITAL COST

The Class 'C' cost estimates for the proposed systems are presented in Table 5-1 and detailed in Appendix B-1. A 30% allowance is included based on the level of estimate. An additional 10% project contingency is recommended for budgetary planning, based on EGBC's Budget Guidelines for Consulting Engineering Services. The estimates below do not include costs associated with modifying the existing treatment plant, including system demolition and/or a new contact tank to meet the 4-log virus removal as discussed in Section 4.5.

Table 5-1 Class C Project Cost Estimates

	COMPLETE SYSTEM			W/O NANOFILTRATION		
GENERAL	$	148,000	7%	$	110,000	7%
CIVIL	$	257,000	11%	$	241,000	14%
STRUCTURAL	$	110,000	4%	$	71,000	3%
ARCHITECTURAL	$	49,000	2%	$	49,000	3%
TREATMENT	$	1,319,000	59%	$	839,000	50%
MECHANICAL	$	50,000	2%	$	50,000	3%
ELECTRICAL	$	324,000	14%	$	324,000	19%
Sub-Total	**$**	**2,257,000**	**100%**	**$**	**1,685,000**	**100%**
CLASS C Accuracy (30%)	$	678,000		$	506,000	
Engineering (20%)	$	587,000		$	439,000	
Est. Project Cost	**$**	**3,522,000**		**$**	**2,630,000**	
Project Contingency (10%)	$	350,000		$	260,000	
Proposed Capital Budget	**$**	**3,872,000**		**$**	**2,890,000**	

5.2 OPERATIONS AND MAINTENANCE COST

The estimated operating and maintenance (O&M) costs for the proposed system are presented in Table 5-2 and are detailed in Appendix B-2. The provisional NF system is anticipated to marginally increase the annual O&M costs to account for the routine membrane replacements and chemical consumables from the CIP. Labour costs assume two six-hour visits per week at an operator charge-out rate of $115/hr, which is consistent with CRD rates.

Table 5-2 Estimated Annual Operating and Maintenance Costs

	ANNUAL COST	
POWER	$	14,000
LABOUR	$	72,000
NF O&M	$	2,200
SLUDGE DISPOSAL	$	2,000
Estimated O&M Cost	**$**	**91,000**

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5.3 ASSET RENEWAL COST

The asset renewal cost for the proposed system is presented in Table 5-3. The analysis is based on a linear depreciation on the estimated construction costs and the expected life expectancy of the assets. The estimated annual cost is an estimate of the total amount of funds to be set aside annually in 2020 dollars. Further analysis would be required to account for reserved balances and revenues, interest rates and annual cost replacement for future renewals.

Table 5-3 Estimated Annual Renewal Cost

	CAPITAL COST	EST. LIFE EXPECTANCY	EST. ANNUAL COST
CIVIL	$ 218,000	100	$ 2,180
STRUCTURAL	$ 110,000	80	$ 1,375
ARCHITECTURAL	$ 49,000	50	$ 980
TREATMENT	$ 1,269,000	25	$ 50,760
MECHANICAL	$ 50,000	25	$ 2,000
ELECTRICAL	$ 234,000	25	$ 9,360
INSTRUMENTATION	$ 60,000	20	$ 3,000
Estimated Asset Annual Renewal Cost			**$ 70,000**

5.4 LIFE CYCLE COST ASSESSMENT

The life cycle cost (LCC) of the proposed system is presented in Table 5-4, estimated based on a 25-year life cycle span which is typical for drinking water plants. A rate-of-return of 3% was used. The rate was applied to the annual O&M and asset renewal costs over 24 years following the construction year. Annual costs are based on 2020 dollars.

Table 5-4 Estimated Total Lifecycle Cost

	EST. COST COMPLETE SYSTEM	EST. COST W/O NF
O&M COST	$ 91,000	$ 80,000
ASSET RENEWAL	$ 71,000	$ 52,000
24-yr PW @ 3%	**$ 2,744,000**	$ **2,236,000**
PLUS CAPITAL COST	$ 3,872,000	$ 2,890,000
EST. 25-YR LIFECYCLE COST	**$ 6,616,000**	**$ 5,126,000**

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APPENDIX

A

PROPOSED TREATMENT

HIGH-RATE SAND BIO-FILTRATION

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A-1 PROCESS FLOW DIAGRAM

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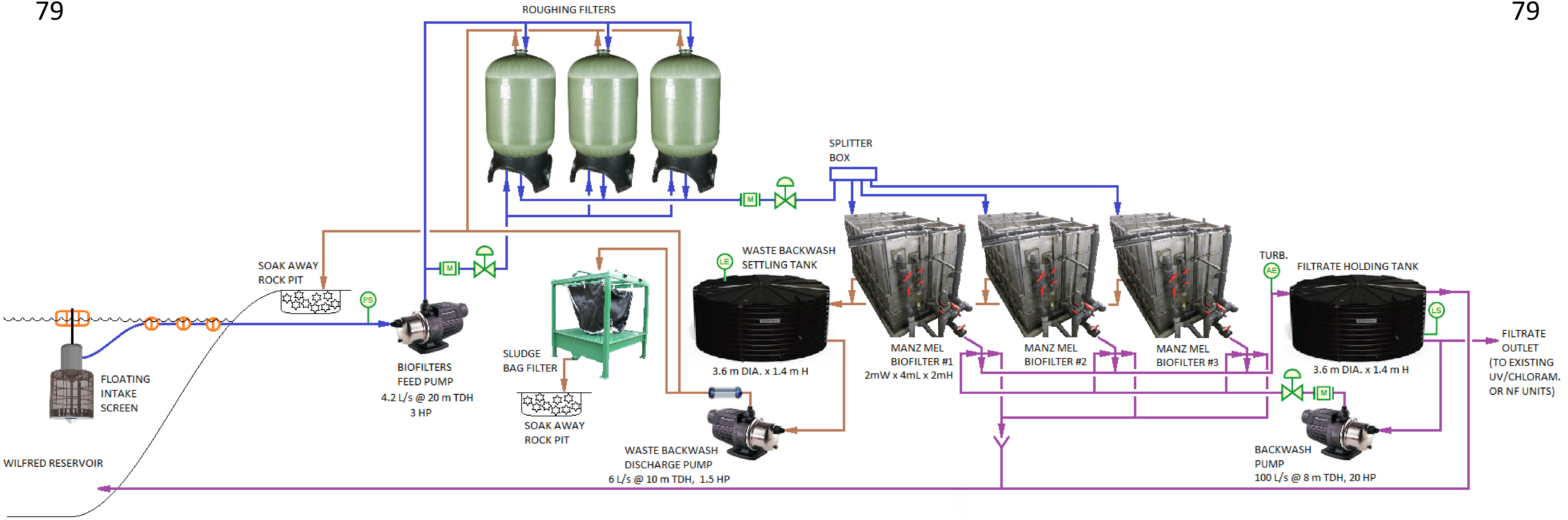
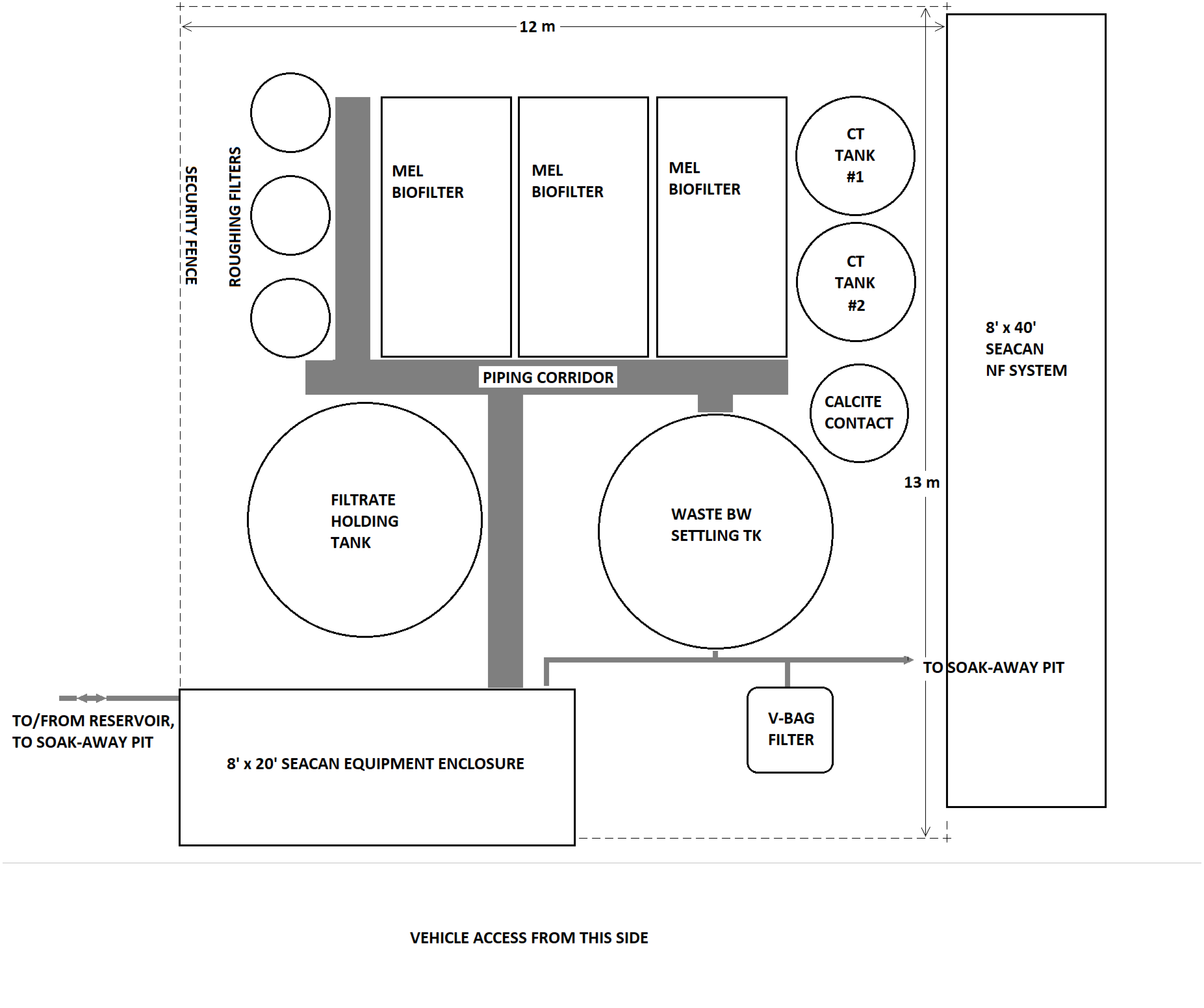

ROUGHING FILTERS
SPLITTER
BOX
SOAK AWAY
ROCK PIT
PS
M
M
WASTE BACKWASH
SETTLING TANK
LE
TURB.
AE
FILTRATE HOLDING TANK
LS
FLOATING
INTAKE
SCREEN
BIOFILTERS
FEED PUMP
4.2 L/s @ 20 m TDH
3 HP
SLUDGE
BAG FILTER
SOAK AWAY
ROCK PIT
3.6 m DIA. x 1.4 m H
MANZ MEL
BIOFILTER #1
2mW x 4mL x 2mH
MANZ MEL
BIOFILTER #2
MANZ MEL
BIOFILTER #3
3.6 m DIA. x 1.4 m H
FILTRATE
OUTLET
(TO EXISTING
UV/CHLORAM.
OR NF UNITS)
M
WILFRED RESERVOIR
WASTE BACKWASH
DISCHARGE PUMP
6 L/s @ 10 m TDH, 1.5 HP
BACKWASH
PUMP
100 L/s @ 8 m TDH, 20 HP

80

A-2 EQUIPMENT LAYOUT


N
Proposed new treatment facility
Existing pumphouse and primary treatment building
Demolish existing dock and intake
Chloramination building
18.00 m
16.00 m
0 5 10 15 20
226
228
232
234
236
238
240
242
244
246
248
252
254
256
258
260

82


12 m
13 m
SECURITY FENCE
ROUGHING FILTERS
MEL BIOFILTER
MEL BIOFILTER
MEL BIOFILTER
CT TANK #1
CT TANK #2
CALCITE CONTACT
8' x 40' SEACAN NF SYSTEM
PIPING CORRIDOR
FILTRATE HOLDING TANK
WASTE BW SETTLING TK
TO SOAK-AWAY PIT
V-BAG FILTER
TO/FROM RESERVOIR, TO SOAK-AWAY PIT
8' x 20' SEACAN EQUIPMENT ENCLOSURE
VEHICLE ACCESS FROM THIS SIDE

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APPENDIX

B

COST ESTIMATES

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B-1 *CLASS C COST ESTIMATES*

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Making a difference...together

Containerized Manz MEL Biofilters + NF

Div.	Description or Classification of Work	Qty	Unit	Unit Price		Total Price
1	Mob/Demob, Bonding and Insurance	1	LS	148,000.00	$	148,000
	Subtotal Division 1 - Mob/Demob, Bonding and Insurance				**$**	**148,000**
2	**Civl Works**					
2.1	Earthworks					
	a) Geotechnical Evaluation	1	LS	35,000.00	$	35,000
	b) Site preparation (clear, grub, excavation and disposal)	270	m^2	46.00	$	13,000
	c) All Siteworks (site grading and drainage)	270	m^2	230.00	$	63,000
	d) Import Structural Fill for Container/Filter Foundations	135	m^3	138.00	$	19,000
	e) Fencing	1	m	10,000.00	$	10,000
2.2	Waterworks					
	a) Yard piping and Surface intake	400	m	80.00	$	32,000
	b) Waste soak-away sump pit	2	Ea.	35,000.00	$	70,000
2.3	Demolition	1	LS	15,000.00	$	15,000
	Subtotal Division 2 - CIVIL WORKS				**$**	**257,000**
3	**Concrete**					
	a) Container/filter foundations footings					
	Biofilters	7	m^3	2,700.00	$	20,000
	Roughing filters	3	m^3	2,700.00	$	9,000
	2x Containers	23	m^3	2,700.00	$	63,000
	b) Outside sidewalk	10	m^3	1,800.00	$	18,000
	Subtotal Division 3 - CONCRETE				**$**	**110,000**
5	**Miscellaneous Metalwork and Fibreglass**					
	a) All miscellaneous metalwork and fibreglass for water treatment	4	Ea.	6,000.00	$	24,000
	Subtotal Division 5 - MISC. METALS & FIBREGLASS				**$**	**24,000**
9	**Corrosion Protection, Painting, Insulation**					
	a) Architectural	1	LS	10,000.00	$	10,000
	b) Mechanical piping and equipment	1	LS	15,000.00	$	15,000
	Subtotal Division 9 - CORROSION PROTECTION & PAINTING				**$**	**25,000**
11	**Treatment Equipment**					
	a) 20' Container (w/ Pumps, valves, instr., controls)	1	Ea.	180,000.00	$	180,000
	b) Roughing filters (1200mm diam.)	3	Ea.	22,500.00	$	68,000
	c) Manz MEL 2m x 4 m x 2m filters	3	Ea.	150,000.00	$	450,000
	d) Process Tanks (Filtrate and BW)	2	Ea.	13,000.00	$	26,000
	e) 40' Container (w/ NF system)	1	Ea.	480,000.00	$	480,000
	f) Contact/calcite vessel	1	Ea.	39,000.00	$	39,000
	g) Sludge bulk bag & stand	1	Ea.	26,000.00	$	26,000
	h) Start-up, testing and commissioning	1	LS	50,000.00	$	50,000
	Subtotal Division 13 - TREATMENT EQUIPMENT				**$**	**1,319,000**
15	**Mechanical**					
	a) Mechanical piping and equipment	1	LS	49,500.00	$	50,000
	Subtotal Division 15 - MECHANICAL				**$**	**50,000**
16	**Electrical**					
	a) Electrical Distribution Kiosk – Service Entrance	1	LS	48,000.00	$	48,000
	b) Kiosk Pad and Installation	1	Ea.	12,000.00	$	12,000
	c) Standby Electric Power Genset	1	Ea.	60,000.00	$	60,000
	d) Genset Installation and Options	1	Ea.	18,000.00	$	18,000
	e) B.C. Hydro 3-phase Service	1	LS	96,000.00	$	96,000
	g) Instrumentation	1	LS	60,000.00	$	60,000
	h) Commissioning	1	LS	30,000.00	$	30,000
	Subtotal Division 12 - ELECTRICAL				**$**	**324,000**
	SUBTOTAL DIVISIONS 1 though 16				**$**	**2,257,000**
	CLASS C ACCURACY	**30%**			**$**	**678,000**
	ENGINEERING	**20%**			**$**	**587,000**
	TOTAL EST. PROJECT COST (EXCLD. GST)				**$**	**3,522,000**
	CONSTRUCTION CONTINGENCY	**10%**			**$**	**350,000**

*Total Prices have been rounded to the nearest $1,000.

Containerized Manz MEL Biofilters

Div.	Description or Classification of Work	Qty	Unit	Unit Price	Total Price
1	Mob/Demob, Bonding and Insurance	1	LS	111,000.00	$ 111,000
	Subtotal Division 1 - Mob/Demob, Bonding and Insurance				**$ 111,000**
2	**Civl Works**				
2.1	Earthworks				
	a) Geotechnical Evaluation	1	LS	35,000.00	$ 35,000
	b) Site preparation (clear, grub, excavation and disposal)	225	m^2	46.00	$ 11,000
	c) All Siteworks (site grading and drainage)	225	m^2	230.00	$ 52,000
	d) Import Structural Fill for Container/Filter Foundations	113	m^3	138.00	$ 16,000
	e) Fencing	1	m	10,000.00	$ 10,000
2.2	Waterworks				
	a) Yard piping and Surface intake	400	m	80.00	$ 32,000
	b) Waste soak-away sump pit	2	Ea.	35,000.00	$ 70,000
2.3	Demolition	1	LS	15,000.00	$ 15,000
	Subtotal Division 2 - CIVL WORKS				**$ 241,000**
3	**Concrete**				
	a) Container/filter foundations footings				
	Biofilters	7	m^3	2,700.00	$ 20,000
	Roughing filters	3	m^3	2,700.00	$ 9,000
	1x Containers	9	m^3	2,700.00	$ 24,000
	b) Outside sidewalk	10	m^3	1,800.00	$ 18,000
	Subtotal Division 3 - CONCRETE				**$ 71,000**
5	**Miscellaneous Metalwork and Fibreglass**				
	a) All miscellaneous metalwork and fibreglass for water treatment	4	Ea.	6,000.00	$ 24,000
	Subtotal Division 5 - MISC. METALS & FIBREGLASS				**$ 24,000**
9	**Corrosion Protection, Painting, Insulation**				
	a) Architectural	1	LS	10,000.00	$ 10,000
	b) Mechanical piping and equipment	1	LS	15,000.00	$ 15,000
	Subtotal Division 9 - CORROSION PROTECTION & PAINTING				**$ 25,000**
11	**Treatment Equipment**				
	a) 20' Container (w/ Pumps, valves, instr., controls)	1	Ea.	180,000.00	$ 180,000
	b) Roughing filters (1200mm diam.)	3	Ea.	22,500.00	$ 68,000
	c) Manz MEL 2m x 4 m x 2m filters	3	Ea.	150,000.00	$ 450,000
	d) Process Tanks (Filtrate and BW)	2	Ea.	13,000.00	$ 26,000
	e) 40' Container (w/ NF system)	0	Ea.	480,000.00	$ -
	f) Contact/calcite vessel	1	Ea.	39,000.00	$ 39,000
	g) Sludge bulk bag & stand	1	Ea.	26,000.00	$ 26,000
	h) Start-up, testing and commissioning	1	LS	50,000.00	$ 50,000
	Subtotal Division 13 - TREATMENT EQUIPMENT				**$ 839,000**
15	**Mechanical**				
	a) Mechanical piping and equipment	1		49,500.00	$ 50,000
	Subtotal Division 15 - MECHANICAL				**$ 50,000**
16	**Electrical**				
	a) Electrical Distribution Kiosk – Service Entrance	1	LS	48,000.00	$ 48,000
	b) Kiosk Pad and Installation	1	Ea.	12,000.00	$ 12,000
	c) Standby Electric Power Genset	1	Ea.	60,000.00	$ 60,000
	d) Genset Installation and Options	1	Ea.	18,000.00	$ 18,000
	e) B.C. Hydro 3-phase Service	1	LS	96,000.00	$ 96,000
	g) Instrumentation	1	LS	60,000.00	$ 60,000
	h) Commissioning	1	LS	30,000.00	$ 30,000
	Subtotal Division 12 - ELECTRICAL				**$ 324,000**
	SUBTOTAL DIVISIONS 1 though 16				**$ 1,685,000**
	CLASS C ACCURACY	**30%**			**$ 506,000**
	ENGINEERING	**20%**			**$ 439,000**
	TOTAL EST. PROJECT COST (EXCLD. GST)				**$ 2,630,000**
	CONSTRUCTION CONTINGENCY	**10%**			**$ 260,000**

*Total Prices have been rounded to the nearest $1,000.

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B-2 *OPERATIONS AND MAINTENANCE COST ESTIMATES*

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OPERATIONS AND MAINTENANCE COST

						Annual Cost	Assumptions
Power					$	14,000.00	@ $0.15/kWh
		L/s	TDH (m)	HP		Cost	
1.1	Bio-filtration				$	4,900.00	
	Feed Pump	4.2	20	3	$	3,000.00	runs 24/7
	Filtrate Pump	100	10	20	$	140.00	run 10min/wk
	BW Pump	6	10	1.5	$	10.00	runs 60min/wk
	HVAC		2kW x 2mo + 1kW + 12mo.		$	1,750.00	
1.2	NF				$	8,802.00	
	NF Feed Pump			1	$	600.00	2 Pumps, runs 30% of the time
	NF High Pressure Pump			10	$	6,000.00	2 Pumps, runs 30% of the time
	CIP pumps			2	$	2.00	
	HVAC		4kW x 2mo + 1kW + 12mo.		$	2,200.00	
		hrs	$/hr			Cost	
Labour		6	$115		$	72,000.00	2 visits/wk
NF O&M					$	2,200	
	NF membrane replacement				$	2,000	
	CIP cost				$	200	
Sludge Residual Disposal					$	2,000	2000 L/yr sludge cake
Renewal Cost					$	71,000	over 25 years
		Capital Cost	Est. Life Expectancy			Cost	
	CIVIL	257000	100		$	2,570	
	STRUCTURAL	110000	80		$	1,375	
	ARCHITECTURAL	49000	50		$	980	
	TREATMENT	1269000	25		$	50,760	
	MECHANICAL	50000	25		$	2,000	
	ELECTRICAL	234000	25		$	9,360	
	INSTRUMENTATION	60000	20		$	3,000	
				TOTAL O&M	**$**	**162,000**	

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Agenda Item #6
WM2020-08

REPORT TO WILDERNESS MOUNTAIN WATER SERVICE COMMISSION
MEETING OF TUESDAY, NOVEMBER 24, 2020

SUBJECT **2021 Operating and Capital Budget**

ISSUE SUMMARY

To present the 2021 Operating and Capital Budget for Commission approval, pursuant to Bylaw No 3511, "Wilderness Mountain Water Service Commission Bylaw No. 1, 2008".

BACKGROUND

The Capital Regional District (CRD) is required by legislation under the Local Government Act (LGA) to prepare an annual operating and capital budget and a 5 year financial plan including Operating Budgets and Capital Expenditure Plans annually. CRD staff have prepared the financial plan shown in Appendix A to this report for the Wilderness Mountain Water Service.

The Operating Budget includes the regular annual costs to operate the service. The Capital Expenditure Plan shows the anticipated expenditures for capital additions. These may include purchases of new assets or infrastructure as well as upgrades or improvements to existing assets.

In preparing the Operating Budget, CRD staff took into account:

1. Actual expenditures incurred between 2018 and 2020.
2. Anticipated changes in level of service (if any).
3. Maximum allowable tax requisition.
4. Annual cost per taxpayer and per Single Family Equivalent (SFE).

Factors taken into consideration in the preparation of the Capital Expenditure Plan included:

1. Available funds on hand.
2. Projects already in progress.
3. Condition of existing assets and infrastructure.
4. Regulatory, environmental, and health and safety factors.

Adjustments for surpluses or deficits from 2020 may be made in January 2021. The CRD Board will give final approval to the budget and financial plan in March 2021.

The Financial Plan for the years 2022 – 2025 may be changed in future years.

BUDGET OVERVIEW

Operating Budget

It is anticipated that operating expenses in 2020 will be approximately $1,989 over budget, due primarily to an increased frequency of filter changes at the water treatment plant.

The 2020 operating revenue is projected to be on budget. This results is an overall deficit of $1,989 for this service. Staff recommend that this deficit be carried forward to the 2021 budget.

The 2021 total operating costs have been increased by $4,656 (4%) over the 2020 budget. This increase is primarily to account for core inflation and increased supply costs related to replacing filters on an ongoing basis.

Municipal Finance Authority (MFA) Debt

Loan Authorization Bylaw 3504 (LA3504) to borrow $281,000, was approved and adopted in 2008 to upgrade/construct water supply and distribution facilities in Wilderness Mountain Service Area. Table 1 below summarizes the detailed information for existing MFA debt issue related to LA3504.

Table 1 – Existing Debt Summary

MFA Issues	Term	Borrowing Year	Retirement Year	Refinance Year	Interest Rate	Principal	Principal Payment	Interest Payment	Total Annual Debt Cost
LA3504-118	15	2012	2027	2022	3.40%	$281,000	$14,033	$9,554	$23,587

Operating Reserve Fund

The Operating Reserve Fund (ORF) is used to undertake maintenance activities that typically do not occur on an annual basis. Typical maintenance activities include reservoir cleaning, valve exercising, and distribution system flushing. The operating reserve also funds the procurement of equipment and supplies that are not purchased on an annual basis. Additionally, the operating reserve could be used for unplanned emergency repairs, should there be sufficient funds available.

It is proposed that transfers to the operating reserve increase from $1,640 to $5,000 in 2021 to ensure future maintenance activities are fully funded, and an optimum minimum balance in the reserve fund be maintained. There is $14,500 of planned maintenance to be funded by the Operating Reserve over the next five years.

The Operating Reserve Fund balance at the end of 2020 is projected to be approximately $1,640.

Capital Reserve Fund

The Capital Reserve Fund (CRF) is to be used to pay for capital expenditures that are not funded by other sources such as grants, operating budget or debt.

It is proposed that the 2021 Capital Reserve Fund transfer be set at $5,000 to have sufficient funds to support anticipated expenditures to the 5-year capital expenditure plan. While the projects have not been identified yet, the expectation is that the Island Health Authority will have requirements that arise from the Source Water Vulnerability Study. The balance of the Capital Reserve Fund at the end of 2020 is projected to be approximately $49,382.

Capital Expenditure Plan

The 5-year plan includes $120,000 of expenditures to be funded by a combination of the Service's Capital Reserve Fund ($40,000) and grant ($80,000) to complete *Floating Intake* project in 2021.

Capital Projects Fund

As specific capital projects are approved, the funding revenues for them are transferred into the Capital Project Fund from multiple funding sources if applicable, including Capital Reserve Fund (CRF), grant funding, external contributions and debt. Any funds remaining upon completion of a project will be transferred back to its original funding source(s).

The projects of *2018 Options Study*, *Source Water Vulnerability Study* and *2020 Water Service Projects* are anticipated to be complete by the end of 2020.

User Charge and Parcel Tax

The service is funded by parcel tax, fixed user charges and fixed water consumption charge. Properties connected to the water system pay the annual user charge and water consumption charge, and all properties within the local service area are responsible for the parcel tax. The 2021 water rate for consumption charge remains unchanged from 2020.

Table 2 below summarizes the 2021 over 2020 changes for parcel tax and user charge.

Table 2 – Parcel Tax and User Charge Summary

Budget Year	Parcel Tax	Taxable Folios Numbers	Parcel Tax per Folio*	User Charge	SFE Numbers	User Charge per SFE	Parcel Tax & User Charge
2020	$63,859	82	$819.66	$65,658	73	$899.42	**$1,719.08**
2021	$69,441	82	$891.30	$69,442	73	$951.26	**$1,842.56**
Change ($)	$5,582	0	$71.64	$3,784	0	$51.84	**$123.48**
Change (%)	8.7%	0%	8.7%	5.8%	0%	5.8%	**7.2%**

* Includes the 5.25% admin fee charged by the Ministry of Finance (not CRD revenue)

RECOMMENDATION

That the Wilderness Mountain Water Services Commission:

1. Approve the 2021 Operating and Capital Budget as presented, and recommend that any deficit be brought forward as an expense in the 2021 budget, and a surplus be transferred to the Capital Reserve Fund;
2. Recommend that the Electoral Areas Committee recommend that the CRD Board approve the 2021 Operating and Capital Budget and the five year Financial Plan for the Wilderness Mountain Water Service as presented.

Submitted by	Shayne Irg, P.Eng. Senior Manager, Water Infrastructure Operations
Submitted by	Ian Jesney, P.Eng. Senior Manager, Infrastructure Engineering
Submitted by	Rianna Lachance, BCom, CPA, CA, Senior Manager, Financial Services
Concurrence	Ian Jesney, P.Eng., Acting General Manager, Integrated Water Services
Concurrence	Robert Lapham, MCIP, RPP, Chief Administrative Officer

ATTACHMENT

Appendix A – 2021 Wilderness Mountain Water Service Budget

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Appendix A

CAPITAL REGIONAL DISTRICT

2021 Budget

Wilderness Mountain Water

Commission Review

Compiled and Presented by CRD Finance

Nov-20

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Service: 2.691 Wilderness Mountain Water Service **Committee: Electoral Area**

DEFINITION:

To finance, operate and maintain the supply, conveyance, treatment, storage and distribution of water to the Wilderness Mountain Local Service area that is within the JDF Electoral Area. The service was established by Bylaw No. 3503, adopted on May 14, 2008.

PARTICIPATION:

Wilderness Mountain Local Service Area

MAXIMUM LEVY:

Greater of $130,000 or $3.27/ $1,000 of actual assessed value of land and improvements. To a maximum of $212,161.

MAXIMUM CAPITAL DEBT:

Maximum Authorized:	$281,000	(MFA Bylaw No.3504, Wilderness Mountain Water Service adopted on May 14, 2008)
Borrowed:	$281,000	(MFA Bylaw No.3504, Wilderness Mountain Water Service)

COMMISSION:

Wilderness Mountain Water Service Commission established by Bylaw No. 3511 (July 9, 2008).

FUNDING:

Consumption Charge:
Water Consumption charge will be collected from each Single Family Equivalent connected to the water system

User Charge:
Collected as a fixed user fee charged quarterly to each Single Family Equivalent connected to the system

Parcel Tax:
Charged to each taxable parcel in the service area whether connected or not.

RESERVE FUND # 1075:

Approved by Bylaw No. 3535 adopted on November 12, 2008.

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2.691 - Wilderness Mountain Water	2020 BOARD BUDGET	2020 ESTIMATED ACTUAL	BUDGET REQUEST 2021 CORE BUDGET	2021 ONGOING	2021 ONE-TIME	2021 TOTAL	FUTURE PROJECTIONS 2022	2023	2024	2025
OPERATING COSTS										
Contract for Services	900	500	900	-	-	900	920	940	960	980
Allocations	13,450	13,450	13,767	-	-	13,767	14,261	14,549	14,851	15,146
Electricity	6,360	6,360	6,470	-	-	6,470	6,600	6,730	6,860	7,000
Supplies	14,901	17,290	17,580	-	-	17,580	17,940	18,300	18,670	19,050
Labour Charges	68,470	68,470	69,970	-	-	69,970	81,520	73,240	77,980	75,240
Insurance	1,230	1,230	1,250	-	-	1,250	1,270	1,290	1,310	1,330
Other Operating Expenses	10,910	10,910	10,940	-	-	10,940	11,150	11,360	11,580	11,800
TOTAL OPERATING COSTS	**116,221**	**118,210**	**120,877**	**-**	**-**	**120,877**	**133,661**	**126,409**	**132,211**	**130,546**
*Percentage Increase over prior year						4.0%	10.6%	-5.4%	4.6%	-1.3%
Transfer from Operating Reserve Fund	-	-	-	-	-	-	(10,000)	(500)	(4,000)	-
NET OPERATING COSTS	**116,221**	**118,210**	**120,877**	**-**	**-**	**120,877**	**123,661**	**125,909**	**128,211**	**130,546**
*Percentage Increase over prior year						4.0%	2.3%	1.8%	1.8%	1.8%
DEBT / RESERVES										
Transfer to Capital Reserve Fund	-	-	5,000	-	-	5,000	6,000	6,000	6,000	6,000
Transfer to Operating Reserve Fund	1,640	1,640	5,000	-	-	5,000	6,000	6,000	6,000	6,000
MFA Debt Reserve Fund	70	70	80	-	-	80	80	80	80	80
MFA Debt Principal	14,033	14,033	14,033	-	-	14,033	14,033	14,033	14,033	14,033
MFA Debt Interest	9,554	9,554	9,554	-	-	9,554	9,554	9,554	9,554	9,554
TOTAL DEBT / RESERVES	**25,297**	**25,297**	**33,667**	**-**	**-**	**33,667**	**35,667**	**35,667**	**35,667**	**35,667**
TOTAL COSTS	**141,518**	**143,507**	**154,544**	**-**	**-**	**154,544**	**159,328**	**161,576**	**163,878**	**166,213**
FUNDING SOURCES (REVENUE)										
Estimated Balance c/fwd from 2020 to 2021	-	(1,989)	1,989	-	-	1,989	-	-	-	-
Balance c/fwd from 2019 to 2020	5,639	5,639	-	-	-	-	-	-	-	-
User Charges	(65,658)	(65,658)	(69,442)	-	-	(69,442)	(70,839)	(71,963)	(73,114)	(74,282)
Sale - Water	(17,520)	(17,520)	(17,520)	-	-	(17,520)	(17,520)	(17,520)	(17,520)	(17,520)
Other Revenue	(120)	(120)	(130)	-	-	(130)	(130)	(130)	(130)	(130)
TOTAL REVENUE	**(77,659)**	**(79,648)**	**(85,103)**	**-**	**-**	**(85,103)**	**(88,489)**	**(89,613)**	**(90,764)**	**(91,932)**
REQUISITION - PARCEL TAX	**(63,859)**	**(63,859)**	**(69,441)**	**-**	**-**	**(69,441)**	**(70,839)**	**(71,963)**	**(73,114)**	**(74,282)**
*Percentage increase over prior year										
User Charge						5.8%	2.0%	1.6%	1.6%	1.6%
Water Sale						0.0%	0.0%	0.0%	0.0%	0.0%
Requisition						8.7%	2.0%	1.6%	1.6%	1.6%
Combined						**6.4%**	**1.8%**	**1.4%**	**1.4%**	**1.4%**

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Wilderness Mountain Reserves
Summary Schedule
2021 - 2025 Financial Plan

Reserve/Fund Summary

	Estimated	Budget				
	2020	**2021**	**2022**	**2023**	**2024**	**2025**
Capital Reserve Fund	49,382	14,382	20,382	26,382	32,382	38,382
Operating Reserve Fund	1,640	6,640	2,640	8,140	10,140	16,140
Total	**51,022**	**21,022**	**23,022**	**34,522**	**42,522**	**54,522**

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Reserve Schedule

Reserve Fund: 2.691 Wilderness Mountain Water - Capital Reserve Fund - Bylaw 3535

The capital Reserve Fund established to provide for capital expenditures for or in respect of capital projects, land purchases, machinery or equipment necessary for them and extension or renewal of existing capital works or related debt servicing payments.

Surplus monies from the operation of the Wilderness Mountain Water Service may be paid from time to time into the Reserve Fund.

Reserve Cash Flow

Fund:	**1075**	**Estimated**	**Budget**				
Fund Centre:	**101994**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
Beginning Balance		40,732	49,382	14,382	20,382	26,382	32,382
Transfer from Ops Budget		-	5,000	6,000	6,000	6,000	6,000
Transfer from Cap Fund		8,030	-	-	-	-	-
Transfer to Cap Fund		-	(40,000)	-	-	-	-
Interest Income*		620	-	-	-	-	-
Ending Balance $		**49,382**	**14,382**	**20,382**	**26,382**	**32,382**	**38,382**

Assumptions/Background:

* Interest should be included in determining the estimated ending balance for the current year. Interest in planning years nets against inflation which is not included.

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Reserve Schedule

Reserve Fund: 2.691 Wilderness Mountain - Operating Reserve Fund - Bylaw 4242

The Operating Reserve Fund is used to undertake maintenance activities that typically do not occur on an annual basis.

Reserve Cash Flow

Fund: 1500	**Estimated**	**Budget**				
Fund Centre: 105540	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
Beginning Balance	-	1,640	6,640	2,640	8,140	10,140
Transfer from Ops Budget	1,640	5,000	6,000	6,000	6,000	6,000
Transfer to Ops Budget	-	-	(10,000)	(500)	(4,000)	-
Planned Maintenance Activity			Reservoir Cleaning and Inspection	PRV Maintenance	Distribution System Flushing, Valve Exercising	
Interest Income*	-	-	-	-	-	-
Ending Balance $	**1,640**	**6,640**	**2,640**	**8,140**	**10,140**	**16,140**

Assumptions/Background:

* Interest should be included in determining the estimated ending balance for the current year. Interest in planning years nets against inflation which is not included.

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CAPITAL REGIONAL DISTRICT

FIVE YEAR CAPITAL EXPENDITURE PLAN SUMMARY - 2021 to 2025

Service No.	2.691 Wilderness Mountain Water Service	Carry Forward from 2020	2021	2022	2023	2024	2025	TOTAL
	EXPENDITURE							
	Buildings	$0	$0	$0	$0	$0	$0	$0
	Equipment	$0	$0	$0	$0	$0	$0	$0
	Land	$0	$0	$0	$0	$0	$0	$0
	Engineered Structures	$0	$120,000	$0	$0	$0	$0	$120,000
	Vehicles	$0	$0	$0	$0	$0	$0	$0
		$0	**$120,000**	**$0**	**$0**	**$0**	**$0**	**$120,000**
	SOURCE OF FUNDS							
	Capital Funds on Hand	$0	$0	$0	$0	$0	$0	$0
	Debenture Debt (New Debt Only)	$0	$0	$0	$0	$0	$0	$0
	Equipment Replacement Fund	$0	$0	$0	$0	$0	$0	$0
	Grants (Federal, Provincial)	$0	$80,000	$0	$0	$0	$0	$80,000
	Donations / Third Party Funding	$0	$0	$0	$0	$0	$0	$0
	Reserve Fund	$0	$40,000	$0	$0	$0	$0	$40,000
		$0	**$120,000**	**$0**	**$0**	**$0**	**$0**	**$120,000**

CAPITAL REGIONAL DISTRICT CAPITAL PLAN

CAPITAL BUDGET FORM
2021 & Forecast 2022 to 2025

Service #: 2.691
Service Name: Wilderness Mountain Water Service

Proj. No.
The first two digits represent first year the project was in the capital plan.

Capital Exp. Type
Study - Expenditure for feasibility and business case report.
New - Expenditure for new asset only
Renewal - Expenditure upgrades an existing asset and extends the service ability or enhances technology in delivering that service
Replacement - Expenditure replaces an existing asset

Funding Source Codes
Debt = Debenture Debt (new debt only)
ERF = Equipment Replacement Fund
Grant = Grants (Federal, Provincial)
Cap = Capital Funds on Hand
Other = Donations / Third Party Funding

Funding Source Codes (con't)
Res = Reserve Fund
STLoan = Short Term Loans
WU - Water Utility

Asset Class
L - Land
S - Engineering Structure
B - Buildings
V - Vehicles
E - Equipment

Capital Project Title
Input Title of Project. For example "Asset Name - Roof Replacement", "Main Water Pipe Replacement".

Capital Project Description
Briefly describe project scope and service benefits.
For example: *"Full Roof Replacement of a 40 year old roof above the swimming pool area; The new roofing system is built current energy standards, designed to minimize maintenance and have an expected service life of 35 years".*

Total Project Budget
This column represents the total project budget not only within the 5-year window.

FIVE YEAR FINANCIAL PLAN

Proj. No.	Capital Exp.Type	Capital Project Title	Capital Project Description	Total Proj Budget	Asset Class	Funding Source	C/F from 2020	2021	2022	2023	2024	2025	5 - Year Total
21-01	New	Floating Intake	Addition of a floating intake for the WTP.	$120,000	S	Res	$0	$40,000	$0	$0	$0	$0	$40,000
					S	Grant	$0	$80,000	$0	$0	$0	$0	$80,000
				$120,000			**$0**	**$120,000**	**$0**	**$0**	**$0**	**$0**	**$120,000**

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Service: **2.691** **Wilderness Mountain Water Service**

Proj. No.	21-01	**Capital Project Title**	Floating Intake	**Capital Project Description**	Addition of a floating intake for the WTP.
Asset Class	S	**Board Priority Area**	0	**Corporate Priority Area**	Water

Project Rationale *As receommended in the 2020 WSP Treatment Assessment Report, addition of a floating intake to draw better quality water from Wilfred Reservoir. Funds are required to retain a consultant and contractor to design and construct the intake and pumps.*

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2.691 - Wilderness Mountain Water

Capital Projects Fund

Updated @ Oct 19, 2020

Year	Project#	Status	Capital Project Description	Total Project Budget	Expenditure Actuals	Remaining Funds	Funding Source		Total Funding in Place	Return Project Surplus After Completion***	
							CRF*	CWF**		CRF*	CWF**
2016	CE.515	Open	William Brook Reservoir	2,500	1,910	590	2,500	-	2,500	-	-
2017	CE.616	Close	WilderM-Source Wtr Vulnerability Study	25,000	5,653	19,347	-	25,000	25,000		3,000
2018	CE.644	Close	Option Analysis	25,000	16,970	8,030	10,000	15,000	25,000	8,030	-
2020	CE.740	Close	2020 Water Service Projects	20,000	3,640	16,360	-	20,000	20,000	-	-
			Totals	**72,500**	**28,172**	**44,328**	**12,500**	**60,000**	**72,500**	**8,030**	**3,000**

* CRF (Capital Reserve Fund)

** CWF (Community Works Fund)

*** Actual project surplus will be finalized at 2020 year end

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Service: 2.691 **Wilderness Mountain Water** **Committee: Electoral Area**

Year	Taxable Folios	Parcel Tax	SFE's	User Charge	Tax & Charges	Water Rate	Bylaw
2012	82	$704.39	69	$550.71	**$1,467.97**	$212.87	3823
2013	82	$782.41	69	$570.59	**$1,569.00**	$216.00	3892
2014	82	$811.73	70	$566.50	**$1,594.23**	$216.00	3924
2015	82	$853.94	70	$613.43	**$1,683.37**	$216.00	3987
2016	82	$584.39	70	$613.43	**$1,413.82**	$216.00	4074
2017	82	$715.44	71	$748.59	**$1,724.03**	$240.00	4170
2018	82	$774.36	71	$849.72	**$1,864.08**	$240.00	4233
2019	82	$796.95	73	$892.11	**$1,929.06**	$240.00	4274
2020	82	$819.66	73	$899.42	**$1,719.08**	$240.00	4337
2021	82	$891.30	73	$951.26	**$1,842.56**	$240.00	

Change from 2020 to 2021

	Parcel Tax	User Charge	Tax & Charges	Water Rate
	$71.64	***$51.84***	***$123.48***	**$0.00**
	8.74%	***5.76%***	***7.18%***	**0%**

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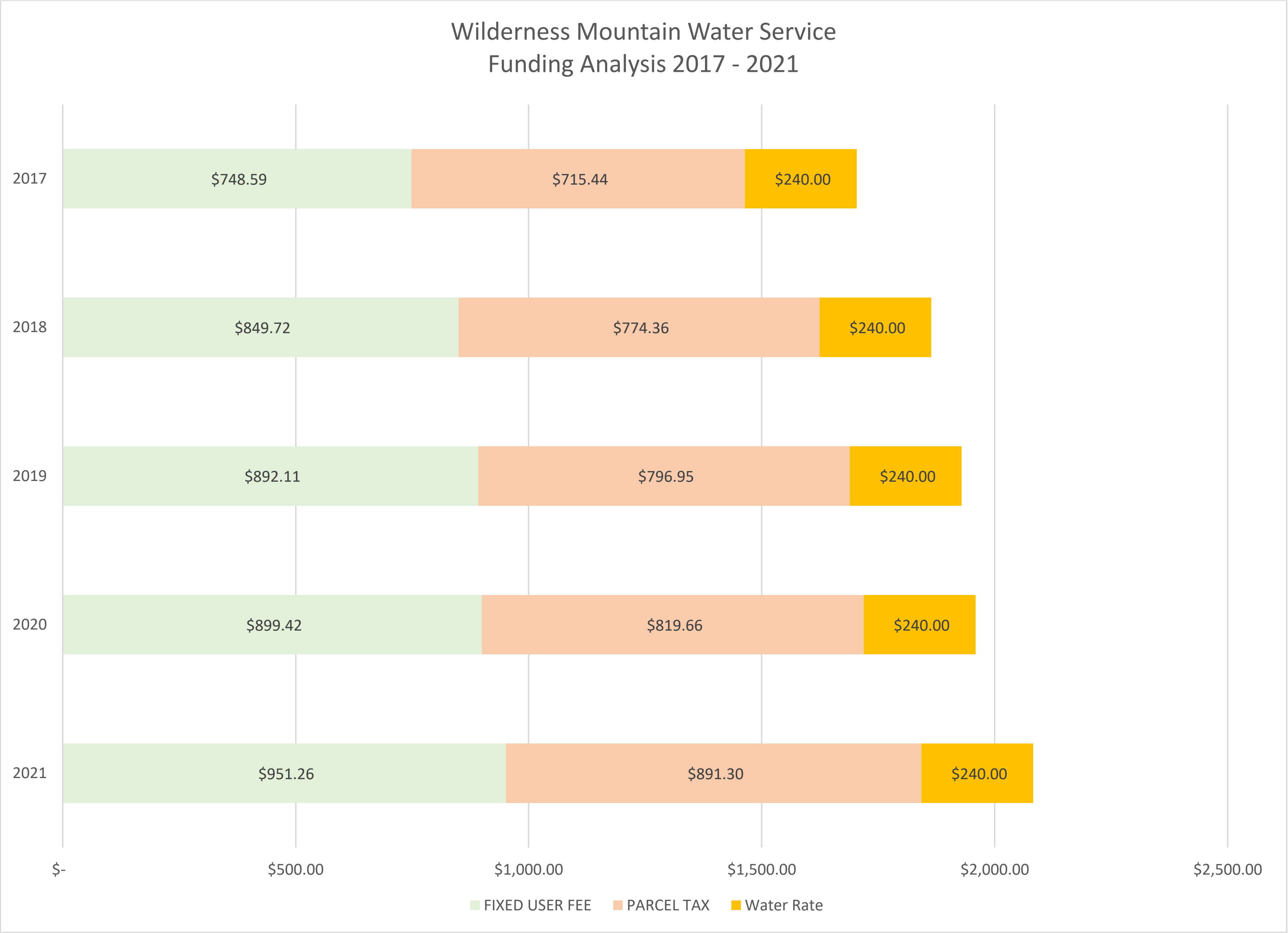
Wilderness Mountain Water Service
Funding Analysis 2017 - 2021
2017
$748.59
$715.44
$240.00
2018
$849.72
$774.36
$240.00
2019
$892.11
$796.95
$240.00
2020
$899.42
$819.66
$240.00
2021
$951.26
$891.30
$240.00
$-
$500.00
$1,000.00
$1,500.00
$2,000.00
$2,500.00
FIXED USER FEE
PARCEL TAX
Water Rate