2022 Source Water Strategy

August, 2022

Submitted to:
District of Lillooet
615 Main Street
P.O. Box 610
Lillooet, BC
V0K 1V0

Prepared by:
Agua Consulting Inc.
3660 Anderson Road
Kelowna, BC
V1X 7V8

Agua Consulting Inc.
"Engineered Water Solutions"

Water Abbreviations / Terminology

ADD	Average Daily Demand	MIgpd	Million Imperial gallons per day
AO	Aesthetic Objective	NTU	Nephelometric Turbidity Unit
CCI	Construction Cost Indices	O & M	Operations and Maintenance
Cl_2	Chlorine or sodium hypochlorite	PHD	Peak Hour Demand
CPI	Consumer Price Index	PRV	Pressure Reducing Valve
DBP	Disinfection by-product	PStn	Pump Station
DBP	Disinfection by-product	psi	pounds per square inch (pressure)
DWPA	Drinking Water Protection Act	PLC	Programmable Logic Controller
DWPR	Drinking Water Protection Regulation	PST	Provincial Sales Tax
EPA	Environment Protection Agency	PZ	Pressure Zone (normal HGL in metres)
FF	Fire flow		
FUS	Fire Underwriters Survey	RPBA	Reduced Pressure Backflow Assembly
GCDWQ	Guideline for Canadian Drinking Water Quality	SCADA	Supervisory Control and Data Acquisition
HGL	Hydraulic Grade Line (slope of water in m/m)	SFE	Single Family Equivalent (equivalent to SF lot)
Igpd	Imperial Gallons per day	SDWR	Safe Drinking Water Regulation
Igpm	Imperial Gallons per minute	SWTR	Surface Water Treatment Rule
IHA	Interior Health Authority	TCU	True Color Units
L	litre	TDH	Total Dynamic Head
L/ca/d	Litres per capita per day	THM	Trihalomethane
L/s	Litres per second (flow rate)	TOC	Total Organic Carbon
m^3/s	cubic metre per second, (flow rate)	TWL	Top Water Level (metres)
mg/L	milligrams/litre (parts per million)	UFW	Unaccounted for Water
MAC	Maximum Acceptable Concentration	µg/L	micrograms / litre (parts per billion)
MCC	Motor Control Centre	uS /cm	micro siemens (conductivity measurement)
ML	Megalitre (one million litres = 1,000 m^3)	USgpm	US gallons per minute
ML/day	Megalitres per day	UV	Ultraviolet
MDD	Maximum daily demand	UVT	Ultraviolet Transmissivity (water parameter)

Image Credit: Front Page – Google Earth - Aerial view of Service area

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"Engineered Water Solutions"
Agua file: 037-07

August 26, 2022

District of Lillooet
615 Main Street, PO Box 610,
Lillooet, BC
V0K 1V0

Attention: Mr. Don Darling, Interim Director of Public Works and Utilities

RE: 2022 SOURCE WATER STRATEGY REPORT

Dear Don:

We are pleased to provide the 2022 Source Water Strategy Report summarizing the potential raw water sources that may be available to the District of Lillooet for municipal use. The report summarizes the capacity and reliability of the sources and provides recommended direction for how to utilize and develop additional source water capacity for Lillooet.

This report specifically includes:

- A summary of water licensing currently held by Lillooet including recent groundwater licensing applications;
- A summary of historic and current water demands by the community;
- An assessment of the capacity and the reliability of each water source;
- An assessment of the raw water quality and variability of each water source including expected processes needed to treat the raw water;
- Considerations are provided for each source with respect to their acceptability from the regulator and the public;
- Recommendations are provided for the direction for Lillooet to take in the development of additional water supply capacity.

Please review this report and contact us if you have any issues that you wish to discuss.

Yours truly,
Agua Consulting Inc.

Bob Hrasko, P.Eng.
Principal

Aug 26. 2022.
PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
R. J. HRASKO

PERMIT TO PRACTICE
The Association of Professional Engineers and Geoscientists of the Province of British Columbia has authorized
AGUA CONSULTING INC.
to engage in reserved practice in British Columbia
PERMIT NUMBER 1001105

Agua Consulting Inc.
"Engineered Water Solutions"
3660 Anderson Road, Kelowna, BC, V1X 7V8
Phone (250) 212-3266

CONTENTS

1. INTRODUCTION

1.1 GENERAL

This report sets out the historic data with regards to quantity and quality for the water sources surrounding the District of Lillooet. Lillooet is surrounded by many potential water sources, all with varying benefits and risks. This report documents the quantity, quality and reliability expected from each of the water sources.

The sources identified include:

1. Seton Lake Water Treatment Plant (WTP);
2. Seton River Fan Aquifer (Infiltration Wells near WTP);
3. Seton Lake and/or BC Hydro Bypass Channel;
4. Cayoosh Creek watershed;
5. Town Creek watershed;
6. Dickey Creek watershed;
7. Aquifer at Recreation Centre;
8. Conway Park Wells No. 1 & 2;
9. 14th Ave. Groundwater Spring;

In assessing these water sources, consideration is given to legal access to the source (licensing) the source capacity, raw water quality, cost to treat and operate, ability to integrate the source into the Lillooet water system, and the risks and stability of each source for drinking water. Significant investment has been made by Lillooet in the existing water treatment plant. The value of this asset is significant and is recognized within this report, however for redundancy, other supply sources should be considered.

1.2 REPORT OBJECTIVES

Currently the Lillooet is experiencing operational challenges with the Seton River source and the water treatment plant. The plant is relatively new, commissioned in July of 2015. The Pall Membrane Filtration plant has the capacity to treat up to 6 ML/day with the ability to expand to 10 ML/day.

The District of Lillooet is being approached by external organizations for the supply of potable water. The objectives of this report are as follows:

- Identify all reasonable sources of raw water and determine if the source is viable as a potable water source for the District of Lillooet;
- Review all feasible sources and document information on each source with respect to quality, quantity, risks and feasibility for the source to connect to the Lillooet water system;
- Evaluate each source with respect to the criteria set out in Section 2 of this report.
- Provide recommendations for Lillooet with respect to data to be collected and gaps in information that can be collected prior to taking the next steps in development of additional source water
- To be accessible to the public and reflect and consider the views of the public interest in Lillooet regarding water supply.

1.3 WATER SUPPLY GUIDING PRINCIPLES

The guiding principles provided in this section are the ones we believe are most applicable to the District of Lillooet. When approaching complex decisions, grounding those decisions in solid principles provides a solid foundation for decisions to be made.

Principle 1: Recognize the Inherent Value of Water: Water is a precious and finite natural resource that has an inherent value. Clean water is necessary to support healthy ecosystem functions, aesthetic values, safe drinking water, and the spiritual values of the community;

Principle 2: Control Pollution at its Source: Like air, water has an enormous ability to transfer contamination from one source to a much larger area. Reducing or preventing contamination from entering surface or ground source water is an important and cost-effective way of maintaining cleaner water for all uses and values.

Principle 3: Protect and Enhance Ecological Stability: The natural filtration process in healthy watershed ecosystem is the most sustainable and cost-effective means to maintain high water quality. Water management committed to protecting and restoring ecosystems will ensure that local and cumulative impacts on sensitive habitats are considered in land & water management decisions.

Principle 4: Promote a Culture of Responsible Water Use: Reducing water wastage and promoting the efficient use of water is central to ensuring the value of water is respected and is sufficient now and in the future. Education, an appropriate level of metering, and adaptation are all key components to maintaining and improving water-use efficiency.

Principle 5: Ensure Water Supplies are Flexible and Resilient: Even with improved conservation and water use efficiencies, water capacity faces the stresses created by climate change and environmental functions. Improving the resiliency of supply includes the ability of people to adapt and change their water use habits when the normal supplies are not available.

Principle 6: Encourage Active Community Engagement in Water Management Decisions: Transparent decision-making processes, opportunities for information sharing, and open communication are essential for sustaining public commitment to water stewardship. The greater public will accept the decisions made by if they are provided with meaningful opportunities to consult, advise, and participate directly in activities that support sustainable water management.

It is recommended that the District of Lillooet consider these principles, adopt them, and refer to them as the foundation for making decisions related to their water supply. These principles are in-line with best practices in the water supply industry. They will assist the community when faced with difficult water-related decisions.

1.4 LIMITATIONS OF REPORT

Following is a list of assumptions and limitations of this report. Use of this report results in acceptance of the following assumptions and limitations:

- The work provided by Agua represents Agua's best assessment and judgement of the natural conditions and the condition of District assets. This is based on our visual assessment, relying on Agua's experience on similar infrastructure of water suppliers throughout BC;
- This report utilizes and documents the report and work by other consultants and includes this information, where stated, in the report. Only the information that appears reasonable and well researched is brought forward for documenting each of the sources;
- This report does not address specific water sources including the Fraser River, the groundwater aquifer on the east side of the Fraser River, and new groundwater from the aquifer on the west side of the river except where specifically stated;
- This report does not address environmental risks or conditions. It may identify system deficiencies with respect to new regulations, however it does not provide design details for the correction of those deficiencies;
- The information generated in this report is based our best knowledge and information provided. Agua Consulting Inc. does not assume any responsibility for use of any information in this report for purposes other than its primary intent;
- This report is based on factual local information and our experience on other community water systems in the BC Southern Interior.

2. CRITERIA

2.1 INTRODUCTION

The administration and operations of a water utility must address requirements of various Provincial and Federal regulatory agencies. This section provides a brief summary of the requirements of those agencies that may have influence on the source water supply.

Criteria used in this report is provided for the following:

- Provincial Ministry requirements;
- Water quality requirements;
- Source water assessment criteria.

2.2 WATER ACTS AND REGULATIONS

As a District municipality, Lillooet follows three levels of regulation, Federal regulations which includes oversight by the Department of Fisheries and Navigable Waters, Provincial regulations including those controlling source water, and those of the water regulator Interior Health, whose authority is delegated to them by the Province.

The Provincial and Federal Acts set out the governing acts and regulations that apply to water. The Acts set out the governing principles and the regulations typically set out the functional details for implementation. The regulations that most affect water supply are the Provincial Drinking Water Act & Regulation and the Forest and Range Practices Act.

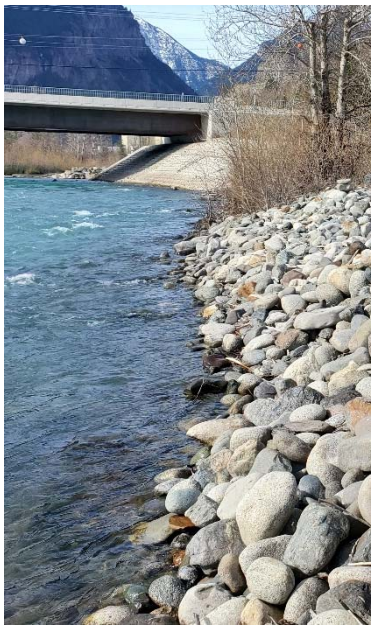
A summary of the Provincial regulations affecting water are listed on Table 2.1 on the next page.

Table 2.1 - Water Acts and Regulations

Provincial Acts & Regs.	
Dam Safety Regulation	Last amended Feb 29, 2016; Provides dam rating criteria and classification, requirements for Operation, Maintenance and Surveillance, Dam Emergency plans, reporting and record keeping, and the assessment of hazardous activities at a Dam;
Drinking Water Protection Act.	Assented to April 11, 2001; Sets out the requirements for the protection of drinking water with the assignment of Drinking Water Officers, Operating permits, qualified system operators, emergency response and contingency plans, water quality monitoring requirements, protection of systems, etc.
Drinking Water Protection Regulation	Last amended Nov. 15, 2018; Sets out standards for Potable water, treatment, construction permits, operating fees, temporary facilities, public reporting, Emergency response and contingency plans, well floodproofing, etc.
Environmental Management Act	Assented to Oct 23, 2003; Sets out prohibitions and authorizations related to the public, municipal waste management, contaminated sites, water management facilities pollution prevention and Conservation Officer service and enforcement tools;
Forest and Range Practices Act.	Assented to Nov 21, 2002; is currently in the process of being upgraded. This act sets out Forest Stewardship plans, plans for range and forestry in the watershed including requirements for the protection of the environment and protection of resources;
Groundwater Protection Regulation	Last amended June 10, 2016; Sets out the requirement for registration of wells and drillers, defining wells for water supply, permanent dewatering or site recharge wells, including details on liners, surface seals, well yield testing, well caps and identification
Mines Act	Current to Sept 4, 2019; Act that sets out authority, powers to inspectors, permitting, engineering reporting, manager appointment, supervision and mining plans, and reporting;
Riparian Areas Regulation	Last amendments to Feb 29, 2016; Provides framework for the protection of riparian areas, stream banks, lakeshore and sets out the requirements for assessment reports prior to development, including development of strategies for monitoring, enforcement and education;
Water Sustainability Act	Replaced the Water Act, Enacted Feb 29, 2016.
Water Sustainability Regulation	Last amended March 6, 2019. Sets out rules and requirements for water licensing, applications for drilling, amendments to water licenses, transfers of appurtenances, and licensing application procedures;
Water Utility Act	Current to Sept 4, 2019 Act that does not apply to a municipality but does apply to private suppliers that provide water and receive compensation;

2.3 WATER QUALITY CRITERIA

The critical Acts and Regulations for Lillooet are the Water Sustainability Act, the Drinking Water Protection Act and Regulation, and the Forest Range and Practices Act. These laws are all tied to water quantity and quality.



For domestic water supply, Lillooet is obligated to meet the provincial Drinking Water Act and Regulation that sets out the standards for water supply for public and private utilities. The regulation is outcome based and does not set out stringent requirements for individual water quality parameters such as turbidity, colour, etc., but leaves this to the discretion of the Drinking Water Officer. The powers of the Drinking Water Officer are delegated by the Province to the local Health Authority. For the District of Lillooet, that authority lies with the Medical Health Officer at Interior Health.

Regarding water quality parameters, Interior Health has improved their policies in the past 10 years and is in conformance with the larger industry criteria for drinking water following the Guidelines for Canadian Drinking Water Quality for specific physical parameters of water such as turbidity, colour, disinfection of protozoa and monitoring and reduction of THMs.

For the design of new water systems and the supply of drinking water the IHA engineering group, who review all plans and specifications require that water meet the 4, 3, 2, 1, 0 protocol.

The Lillooet Water Treatment Plant provides treatment through membrane filtration to produce a high-quality treated water. The plant currently is able to treat flows up to 6 ML/day, with the capacity to expand to 10 ML/day.

Interior Health Authority Requirements

The Interior Health Authority has stated that they expect that the following water quality 4,3,2,1,0 protocol be achieved by all water utilities in the Interior Health jurisdiction. Their treatment protocol consists of the following criteria:

- 4 log (99.99%) removal and/or inactivation of Viruses;
- 3 log (99.9%) removal and/or inactivation of *Giardia Lamblia and Cryptosporidium;*
- 2 types of treatment processes including at least one form of disinfection;
- Less than 1.0 NTU Turbidity units year-round;
- Zero *Fecal Coliforms* in the distribution system

2.4 SOURCE WATER ASSESSMENT CRITERIA

Numerous water sources are reviewed within this report. In the following section, each source is assessed under the following criteria. An explanation of each of the water source criteria is described below.

- **Licensing:** The water source must have available licensing and not be a source that is fully allocated and licensed to others. Including these criteria addresses the legal access to raw source water;

- **Quantity:** The quantity of water available is assessed for each source. The larger and more robust the supply, the more reliable a source it is for the District;

- **Raw Water Quality:** As the water will be used for domestic purposes, the raw water quality should be as high as possible without the need for significant additional treatment. The water source should be of sufficiently high quality with minimal risk of human contamination or contamination caused by extreme weather events;

- **Physical Location of Source Access:** The physical location of the source will impact on accessibility and costs. The further away the source from the water distribution grid, the more costly the option will be. A source at higher elevation will have lower long term pumping costs, but may have higher treatment costs. A gravity supply has significant cost and operational advantages;

- **Water Treatment Costs:** the need to run the water through filtration or two types of disinfection are items that will factor into the long-term operating costs for the District;

- **Risks and Variability:** There are human caused risks and nature caused risks that are possible for each of the sources. Having a source that is able to withstand both risk categories is an objective.

- **Supplemental Issues:** These include considerations that are unique to that source that require consideration as they impact on the decision of the feasibility of whether or not the source is viable for Lillooet.

3. EXISTING WATER SUPPLY

3.1 INTRODUCTION

This section provides a summary of the existing water licenses in place including those sources where Lillooet has applied for groundwater licenses. It also provides a recent summary of the total water consumption from each of the sources.

Information on Lillooet's water sources is provided. Following the existing sources is a review of the potential sources considered for the District of Lillooet. The factors considered for each source include:

- Licensing or potential to obtain license;
- Capacity and reliability of the source;
- Raw water quality and requirement to treat the water;
- Location of the source and the costs to connect to the Lillooet water system;
- Capital and Operating costs for the source;
- Source risks from climate variability and from human activities.

Figure 3.1 District of Lillooet – Aerial View from SE

Image source: Google Earth

3.2 EXISTING WATER LICENSING

The water for Lillooet is available from numerous water sources, however only five sources are presently used, Seton River, the infiltration wells along the Seton River, and the Recreation Centre Well, the Industrial Park well and the Airport Well. Licenses are still held on sources previously used including Town Creek and Dickey Creek.

Water is licensed by the Province of BC to the end user, usually in the form of a "Conditional License". Links to critical licensing web pages are provided as follow:

Provincial Water License Query webpage is: http://a100.gov.bc.ca/pub/wtrwhse/water_licences.input

Provincial Scanned Water License Directory is: http://www.env.gov.bc.ca/wsd/water_rights/scanned_lic_dir/

The licenses are typically issued by the Province to communities in one of three forms:

- **Waterworks Local Authority (WWLA):** WWLA licensing is a usage license. It is the normal license issued for typical domestic water uses by a community. It can be used any time during the year for the purposes of domestic, industrial, lawn and home irrigation, commercial uses and any other typical uses within a community. This type of license is reported by the Province in the form of cubic metres per year (MY). Lillooet holds several of these licenses;
- **Irrigation (IRR):** Irrigation licensing is also a usage license. It is the normal license issued for irrigation activities to support agriculture. These licenses have time frames of when the water can be used, typically from April 1 to September 30 annually. They are typically issued in conjunction with storage licenses. These licenses are issued in the form of cubic metres per year (MY) per year. The irrigation license is typically assigned to a water supplier with a defined service area. Lillooet does not hold any Irrigation licenses.
- **Storage: (STO)** This type of license allows the water supplier to hold excess runoff water from a stream in a storage reservoir and then release it during lower flow times of the year in a manner that will not have a negative impact on lower downstream flow requirements in the creek (such as water for conservation or fisheries). This type of license is reported in the form of cubic metres per year (MY). Storage licensing is tied to either WWLA licensing or IRR licensing. Lillooet does not hold any storage licenses;

The watersheds of Town Creek and Dickey Creek are relatively steep with no obvious sites that would be suitable for upper watershed storage. Storage naturally exists in these watersheds in the form of snowpack that is typically present at the highest elevations of the watershed for much of the year.

Table 3.1 provides a summary of all surface water licenses currently held by the District of Lillooet. The licenses are listed in cubic metres per year. Please note that although there are 14 lines of licensing, there are only 11 licenses. Two of the licenses have multiple points of diversion (PD) from which water can be withdrawn at more than one location on a stream course.

Table 3.1 District of Lillooet – Existing Water Licences Summary *(Current as of June 1, 2022)*

Licence No	Stream Name	Purpose	Quantity	Units	m3/year
C020501	Town Creek	Waterworks: Local Provide	331864.57	MY	331,865
C023618	Town Creek	Waterworks: Local Provide	16593.229	MY	16,593
C024551	Dickey Creek	Waterworks: Local Provide	331864.57	MY	331,865
C027544	Town Creek	Waterworks: Local Provide	60731.216	MY	60,731
C028496	Town Creek				
"	Tyee Jimmie Creek	Waterworks: Local Provide	331864.57	MY	331,865
C046313	Murray Spring	Domestic	2.273	MD	830
C048889	Dickey Creek	Waterworks: Local Provide	962407.253	MY	962,407
C102701	Seton River	Comm. Enterprise: Enterpr	6.819	MD	2,489
"	Seton River	Domestic	2.273	MD	830
"	Seton River	Lwn, Fairway & Grdn: Wate	7400.88	MY	7,401
C130020	Seton River	Waterworks: Local Provide	3318645.7	MY	3,318,646
F004752	Dickey Creek	Waterworks: Local Provide	962407.253	MY	962,407
F018412	Dickey Creek	Domestic	4.546	MD	1,659
		TOTAL			**6,329,587**
		Seton River			3,329,365
		Dickey Creek			2,258,338
		Town Creek			741,054
		Murray Spring			830

MD - m^3/day
MY m^3/year

Groundwater Licensing

In addition to the surface water licenses, Lillooet also has applied for groundwater licenses for their existing wells. These licenses are in the process of being reviewed by the Province. Application has been made for the groundwater licenses and annual amounts.

Well Name	Annual	Max Flow	Applic. No.
• Recreation Centre Well 2	239 ML/yr.	163 L/s	100377433
• Airport Well	300 ML/yr.	1.2 L/s	100379172
• Industrial Park Well	23 ML/yr.	10 L/s	100368692
• Conway Park Well No. 1	75 ML/yr.	15 L/s	100379186
• Conway Park Well No. 2	75 ML/yr.	15 L/s	100379305
TOTAL (pending)	**712 ML/yr.**		

The Province was contacted regarding groundwater licensing of the Infiltration Wells. These wells are considered to be groundwater under the influence of surface water. Lillooet was informed that they fall under the existing surface water license for the Water Treatment Plant.

RESIDUAL WATERSHED LICENSES

A license database search was conducted to determine the volume of water licensed in the watersheds that are not controlled by Lillooet. The licenses and their volumes are listed below.

- **Seton River Mainstem Watershed:**

21	Total Licenses	4,592,001 ML/yr.
5	Flow through Licenses (conservation / Power)	4,588,371 ML/yr.
16	Consumptive Licenses (all)	3,629 ML/yr.
3	Lillooet - consumptive license	3,329 ML/yr.

- **Dickey Creek Watershed:**

18	Total Licenses	2,551 ML/yr.
14	Licenses held by others	293 ML/yr.
4	Licenses held by Lillooet	2,258 ML/yr.

- **Town Creek Watershed + Diversion (Tyee Jimmie Creek):**

18	Total Licenses	775 ML/yr.
14	Licenses held by others	34 ML/yr.
4	Licenses held by Lillooet	741 ML/yr.

It is noted that there are very few groundwater licenses held in the Seton River watershed. The capacity of that watershed is significant, particularly with the BC Hydro diversion from the Bridge River water system.

The Dickey Creek watershed also has a minimal number of groundwater wells below; however, it is noted that the Town Creek watershed has numerous wells downstream that are fed from the watershed.

3.3 Existing Water Supply

Based on the 2021 census, Lillooet has a population of 2,302 persons and provides domestic water to the majority of the population as well to persons on peripheral lands that surround Lillooet. Table 3.1 provides a summary of demands from the primary water sources for Lillooet.

Table 3.1 - District Water Demand (m3/month)

	ALL SOURCES	M3 / MONTH											
YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
2015	48,374	39,462	50,533	84,115	136,771	180,081	131,889	174,839	116,879	71,714	52,680	52,831	1,140,168
2016	52,566	47,978	51,783	111,289	155,897	183,912	174,978	155,157	100,353	62,994	56,159	64,110	1,217,176
2017	62,864	51,180	56,572	60,808	125,400	182,274	244,170	226,970	150,772	65,739	54,306	57,873	1,338,928
2018	63,971	57,504	63,455	71,596	168,012	182,434	229,718	188,680	102,482	70,019	63,990	62,893	1,324,754
2019	62,601	57,870	61,231	69,711	139,800	149,907	154,863	172,483	119,863	59,585	47,153	41,401	1,136,468
2020	54,923	50,491	58,006	86,066	139,657	147,020	137,181	151,651	157,861	77,782	52,202	51,545	1,164,385
2021	50,904	53,246	58,893	80,099	159,626	213,738	155,349	173,886	86,955	67,633	57,187	57,869	1,215,385
AVERAGE 2015-2021													**1,219,609**
	PALL FILTRATION	M3 / MONTH											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
2015	0	0	0	0	0	0	31,425	142,207	113,833	70,100	51,700	52,761	462,026
2016	51,971	47,978	51,783	109,126	146,798	151,761	157,721	142,808	99,948	62,994	55,243	64,110	1,142,241
2017	61,415	51,180	56,199	55,066	63,737	33,351	141,347	137,708	138,037	65,739	51,248	57,873	912,900
2018	63,331	57,195	63,455	26,722	29,852	111,428	146,716	123,449	102,482	70,019	63,990	62,893	921,532
2019	62,179	56,616	58,030	67,133	80,264	55,373	80,042	89,403	54,680	59,585	40,347	41,401	745,053
2020	54,923	50,491	56,960	49,351	34,167	26,989	18,786	51,182	133,441	74,530	48,006	50,291	649,117
2021	35,301	45,233	57,416	63,738	129,518	93,165	74,699	124,621	84,323	62,746	38,049	33,212	842,021
AVERAGE 2016-2021													**868,811**
	INFILTRATION WELLS	M3 / MONTH											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
2015	47,556	35,940	47,805	55,633	65,177	100,899	37,077	3,364	0	0	0	0	393,451
2016	0	0	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	4,370	53,232	50,567	44,339	0	0	0	0	152,508
2018	0	0	0	9,573	92,549	24,638	19,385	41,032	0	0	0	0	187,177
2019	0	0	0	0	26,719	38,583	30,373	25,003	31,715	0	0	0	152,393
2020	0	0	0	7,464	47,526	63,513	67,672	46,009	2,561	0	0	0	234,745
2021	0	0	0	0	4,732	74,217	53,553	36,021	1,686	0	0	5,850	176,059
AVERAGE 2017-2021													**180,576**
	REC CENTRE WELL	M3 / MONTH											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
2015	818	3,522	2,728	28,482	71,594	79,182	63,387	29,268	3,046	1,614	980	70	284,691
2016	595	0	0	2,163	9,099	32,151	17,257	12,349	405	0	916	0	74,935
2017	1,449	0	373	5,742	57,293	95,691	52,256	44,923	12,735	0	3,058	0	273,520
2018	640	309	0	35,301	45,611	46,368	63,617	24,199	0	0	0	0	216,045
2019	422	1,254	3,201	2,578	32,817	55,951	44,448	58,077	33,468	0	6,806	0	239,022
2020	0	0	1,046	29,251	57,964	56,518	50,723	54,460	21,859	3,252	4,196	1,254	280,523
2021	15,603	8,013	1,477	16,361	25,376	46,356	27,097	13,244	946	4,887	19,138	18,807	197,305
AVERAGE 2015-2021													**223,720**

Table 3.1 provides the recent monthly water demands for Lillooet. During high demand conditions, the Pall Water Treatment Plant provides 68% of the demand with the Infiltration wells providing 12% and the Rec Centre Well No. 2 providing 20% of the monthly demand.

Yellow shading indicates highest month on record for total usage, July 2017.

Table 3.2 - District Water Demand (Average m^3/day / month)

	ALL SOURCES		AVERAGE m3/DAY FOR EACH MONTH									
	January	February	March	April	May	June	July	August	September	October	November	December
2015	1,560	1,409	1,630	2,804	4,412	6,003	4,254	5,640	3,896	2,313	1,756	1,704
2016	1,696	1,714	1,670	3,710	5,029	6,130	5,644	5,005	3,345	2,032	1,872	2,068
2017	2,028	1,828	1,825	2,027	4,045	6,076	7,876	7,322	5,026	2,121	1,810	1,867
2018	2,064	2,054	2,047	2,387	5,420	6,081	7,410	6,086	3,416	2,259	2,133	2,029
2019	2,019	2,067	1,975	2,324	4,510	4,997	4,996	5,564	3,995	1,922	1,572	1,336
2020	1,772	1,803	1,871	2,869	4,505	4,901	4,425	4,892	5,262	2,509	1,740	1,663
2021	1,642	1,902	1,900	2,670	5,149	7,125	5,011	5,609	2,899	2,182	1,906	1,867
2022	0	0	0	#VALUE!	0	0	0	0	0	0	0	0
	PALL FILTRATION		AVERAGE m3/DAY FOR EACH MONTH									
	January	February	March	April	May	June	July	August	September	October	November	December
2015	0	0	0	0	0	0	1,014	4,587	3,794	2,261	1,723	1,702
2016	1,676	1,714	1,670	3,638	4,735	5,059	5,088	4,607	3,332	2,032	1,841	2,068
2017	1,981	1,828	1,813	1,836	2,056	1,112	4,560	4,442	4,601	2,121	1,708	1,867
2018	2,043	2,043	2,047	891	963	3,714	4,733	3,982	3,416	2,259	2,133	2,029
2019	2,006	2,022	1,872	2,238	2,589	1,846	2,582	2,884	1,823	1,922	1,345	1,336
2020	1,772	1,803	1,837	1,645	1,102	900	606	1,651	4,448	2,404	1,600	1,622
2021	1,139	1,615	1,852	2,125	4,178	3,106	2,410	4,020	2,811	2,024	1,268	1,071
2022	0	0	0	0	0	0	0	0	0	0	0	0
	INFILTRATION WELLS		AVERAGE m3/DAY FOR EACH MONTH									
	January	February	March	April	May	June	July	August	September	October	November	December
2015	1,534	1,284	1,542	1,854	2,102	3,363	1,196	109	0	0	0	0
2016	0	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	141	1,774	1,631	1,430	0	0	0	0
2018	0	0	0	319	2,985	821	625	1,324	0	0	0	0
2019	0	0	0	0	862	1,286	980	807	1,057	0	0	0
2020	0	0	0	249	1,533	2,117	2,183	1,484	85	0	0	0
2021	0	0	0	0	153	2,474	1,728	1,162	56	0	0	189
2022	0	0	0	0	0	0	0	0	0	0	0	0
	REC CENTRE WELL		AVERAGE m3/DAY FOR EACH MONTH									
	January	February	March	April	May	June	July	August	September	October	November	December
2015	26	126	88	949	2,309	2,639	2,045	944	102	52	33	2
2016	19	0	0	72	294	1,072	557	398	14	0	31	0
2017	47	0	12	191	1,848	3,190	1,686	1,449	425	0	102	0
2018	21	11	0	1,177	1,471	1,546	2,052	781	0	0	0	0
2019	14	45	103	86	1,059	1,865	1,434	1,873	1,116	0	227	0
2020	0	0	34	975	1,870	1,884	1,636	1,757	729	105	140	40
2021	503	286	48	545	819	1,545	874	427	32	158	638	607
2022	0	0	0	0	0	0	0	0	0	0	0	0

As listed in Table 3.2, the average daily demand for each month is provided. July of 2017 was the highest demand year over the last six years.

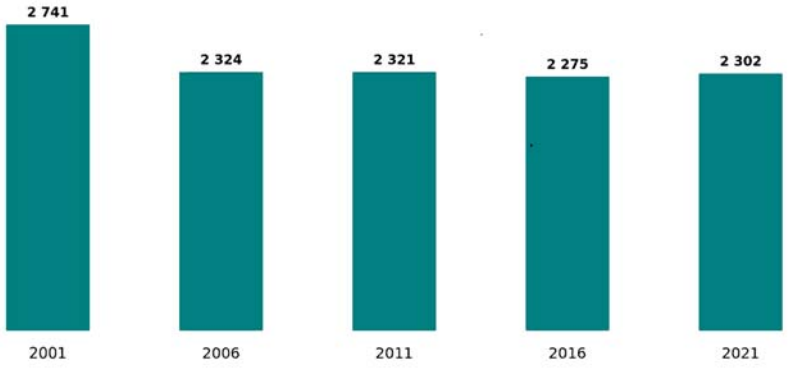
3.4 PROJECTED WATER DEMANDS

Projected growth rate for Lillooet, as per the 2008 True Consulting report, was based on the Official Community Plan. The projected growth rate at that time was set at 0.90%. Over 20 years this would have seen the Maximum day demand increase to 12.0 ML/day. The True report indicated that with demand management measures such as water meters, that amount could only rise to 9.0 ML/day.

The 2017 draft Associated Engineering Master Water Plan projected a 1.0 % growth rate resulting in 2850 persons by the year 2036 and a Maximum Day Demand forecasted in 2036 of 9.17 ML/day.

The August 2021 Official Community Plan predicted that the population would grow slowly from 2016-2021 to 2369 persons and by 2026 the population would increase to 2586 persons. The recent census data was available early this year and a population of 2302 was the population for Lillooet in 2021. Based on the most recent 2021 Census shows that the population has been stable and has not changed significantly over the past 20 years. The OCP predicts a 1.70% growth rate for the next five years.

Figure 3.1 Lillooet Population – Source Census Canada



It is expected that the population will remain stable with slight growth, with the largest potential population impact on growth being outlying lands wanting to connect to the potable water system via bulk water or water servicing agreement. Population is not expected to be the primary factor that impacts changes in water demand.

3.5 CLIMATE CHANGE CONSIDERATIONS

The population data leads us to conclude that changes in water demand will be the result of factors other than population. Recent events from climate change have been more extreme flooding and more intensive drought combined with higher temperatures, such as the heat dome experienced in 2021. In 2021, the water demand numbers for Lillooet during June and July did not signfiicantly change from prior years.

A reasonable objective for the District of Lillooet could be to have more water available in times of extreme heat and to encourage persons to use water to keep the town, vegetation and buildings throughout town at a lower risk for a fire to occur. Restricting water during the extreme heat times will only reduce operating costs, however those costs are very low in comparison to a community fire event such as what happened in Lytton. The costs Lytton is facing is very large in comparison to the cost to invest in additional water supply infrastructure.

EMERGENCIES AND EXTREME EVENTS

Water source planning can be based on population projections or, the community can plan to increase water supply capacity based on having increased resiliency and redundancy. This is a slightly different approach and may be needed in the future when there is less stability with the weather and natural runoff in the local watersheds.

Planning for resiliency and redundancy comes with the understanding that the community will, at some time in the future, need to provide water services during an emergency. To do so, emergency procedures must be in place and there must be defined ways to communicate with the public as to the availability of water, the quality and safety of water, and how the community can protect itself and its natural resources.

Lillooet has been wise to maintain their previously-used water sources in case of emergency. These water sources may be needed at some time in the future if there is an extended power failure or mechanical failure that occurs on any of the primary water supply sources.

To plan for emergencies, redundant water supplies such as the high elevation creek intakes with required disinfection provides the most cost effective method to provide additional water to the urban areas of Lillooet. Upgrading works on these sources can be staged and integrated specifically as emergency sources. As the required treatment components are added to these water sources, they can become a full-time alternate supply sources for Lillooet. This is discussed in Section 4 of this report.

Regarding community fire protection, setting maximum available fire flow limits and promoting the use of fire sprinkler systems in larger industrial and commercial buildings can greatly cut back on fireflow needed from the water system. The sprinkler systems are costly but provide quicker response and reduce volumes of water needed to be sitting in reservoir storage in the event of a fire.

3.6 WATER METER CONSIDERATIONS

The operations and administration of a water metering program was likely a requirement of getting funding for the Water Treatment Plant. Currently with global supply chain challenges, it is difficult to get parts and equipment to maintain the water meters. In addition, the design of the water meters is one that is required to receive battery replacement every 10 to 12 years. For a 19mm diameter domestic meter, the $40 battery cannot be replaced on many of the meters unless the entire register being replaced and thrown away costing some $250 for the part. Lillooet should review who their meter supplier is and determine if there is a better more environment responsible option for a water meter supplier.

Meters are a monitoring tool and only provide value in correcting abuse. The equity provided is somewhat misleading as 85% of the cost to supply the water is fixed regardless of use. The arguments that meters provide equity are misleading as they provide equity on only 15% of the cost, i.e. the variable cost component of water supply. A more cost-effective approach would be to request that the residents be responsible or if found not to be, they would then get a water meter.

4. WATER SOURCE ASSESSMENT

4.1 INTRODUCTION

An assessment of Lillooet's available water sources is provided in this section. The sources are reviewed with documentation of the existing information of each source. A number of factors have been considered for each source to determine whether or not the development of that source would be beneficial to Lillooet. The factors reviewed for each source are listed in Section 2.3 of this report. They include:

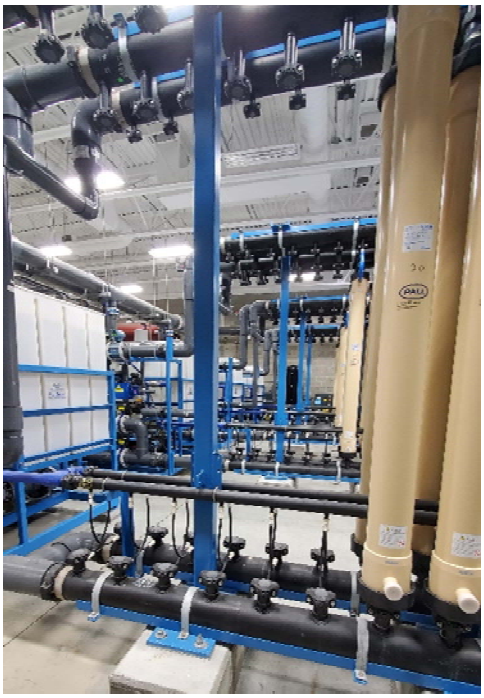
- Licensing or potential to obtain license;
- Capacity and reliability of the source;
- Raw water quality and requirement to treat the water;
- Location of the source and the costs to connect to the Lillooet water system;
- Capital and Operating costs for the source;
- Source risks from climate variability and from humans.

4.2 Seton River Intake – Water Treatment Plant

Description:	This intake is the primary water source for Lillooet supplying 68% of the total annual flow. Water is drawn off the river at elevation 194 m and pumped to the water treatment plant through, the PALL membrane filtration system, chlorinated and held in a 300m3 wet well and then pumped to the Million gallon Reservoir at elevation 327m. The water quality provided is high, the plant costs money to run and upkeep and there are operational challenges with respect to the silting of the intake and intake pumps.
Licensing	Sufficient surface water licensing is in place for the Water Treatment Plant (WTP). Lillooet holds 3318 ML/yr. of domestic licensing at this site which also covers the two infiltration wells.
Quantity	Water supply capacity at this site is very large and very stable. The Seton Lake watershed is very large in comparison with Lillooet's water demands. BC Hydro controls water flow to Seton Lake and also the outlet from Seton Lake. There is long term data at Water Survey of Canada Station 08ME003 for water leaving Seton Lake. Also upstream is Cayoosh Creek that has a catchment area of 892 km^2.
Raw Water Quality	Raw water at this site is generally of high quality with respect to microbiological safety. The river flows are large and stable and there is minimal time for stagnant water to be created. The influence of Cayoosh Creek on this site during spring freshet are diluted by the flows from Seton Lake. Seton Lake water has fine Glacial Loess silt within its waters that originate from the Bridge Glacier, some 140 kilometres to the northwest. The silt is so fine that it does not settle out. Consideration should be given to testing for coliforms and E.Coli in the raw water to better understand the microbiological risks that are challenging the WTP.
Location	Raw water is obtained at an intake on the north bank of the river some 150m east of the Highway 99 bridge over Seton River. This location is the lowest point of the Lillooet water supply and distribution system. All water has to be pumped up from elevation 194m (river) to Million-gallon Reservoir (327m). The location has a high volume of available source water, but increased operational costs for water treatment and pumping.
Treatment Requirements	This water source requires treatment of filtration to remove the fine silt, which is followed by chlorine disinfection. The existing water treatment system is a PALL membrane filtration system with rated capacity of 6.6 ML/day and operational capacity of 6.0 ML/day. The plant is expandable to 10.0 ML/day. There is a 300 m^3 clearwell at the end of the water treatment process from where the water is pumped to Lillooet. The plant has operational challenges due to the fine silt in the water that does not settle out in the lake.
Risks and Variability	The Seton River is insulated from climate risks as the river is buffered by the residence time for the water within Seton Lake. The flows from Cayoosh Creek are also buffered by the supply of water from Seton Lake. BC Hydro controls a great deal of the inflow and outflow for Seton Lake. A noted risk is the shallow river intake, public access to the intake. The District should consider restricting access to this part of the river. There is also a BC railway running along the north edge of the lake.
Supplemental Considerations	Supply through the Pall Filtration Water Treatment Plant from the Seaton River source provides the highest quality water for domestic consumption. This source has operational challenges with respect to the silt in the source water. The WTP is a critical piece of Lillooet water supply infrastructure. It is the most reliable source water in the event of a drought. Although there is still public disappointment as to how this WTP was selected and funded, it is part of Lillooet and an important facility.
Summary	The WTP is expandable from 6.0 ML/day to 10.0 ML/day. Prior to investing in expanding the WTP capacity Lillooet should consider alternate supplies to increase resiliency and redundancy and to reduce operating costs.

Photos

Intake location along the Seton River



Pall Membrane Filtration system at the WTP (right).

4 – 125 hp Duty Pumps that lift water from the 300m^3 clearwell up to the Million Gallon Reservoir pressure zone (PZ 327m)

4.3 Seton River Fan Aquifer (Infiltration Wells No. 1 & 2)

Description: The infiltration wells were drilled in 2011 and are an excellent supplemental water source for Lillooet. There is a test well with a 200 mm casing near Infiltration Well No. 1. The wells are on the Seton River fan near the mouth of Seton River to the Fraser River. The wells are of sufficient depth to access water from both rivers. Well No. 1, Well ID 17887 is 16.5m deep, 300mm casing, rated pump capacity 19.5 L/s (actual is less) Well No. 2, Well ID 17886 is 19.0m deep, 300mm casing, rated pump capacity 44.3 L/s (actual is less)
Licensing These infiltration wells are considered to be groundwater under the influence of surface water. Lillooet must verify with the province that these wells either fall under the existing surface water license for the WTP off of Seton River, or if groundwater licensing is required.
Quantity Average water usage over the past 5 years from these wells is 181 ML/year. The highest annual use was 235 ML/year. The wells are able to be run at a rate of 25 L/s each, with better capacity when the river is at a higher elevation. Although the wells are rated to a fairly high pumping rate, if they are run at too high a rate, the aquifer from the river is drawn down too low. At higher flows, there is a higher chance of drawing in too much glacial silt from Seton Lake into the aquifer, binding off the ground soils. Staff are careful to use this system sparingly and only when needed to supplement the other sources.
Raw Water Quality The water quality from these wells is high. It is basically filtered river water without the silt. E. Coli and Total coliforms should be tested prior to disinfection to confirm low contamination. There are no exceedances of water quality parameters in comparison with the Maximum Acceptable Concentrations (MACs) from Health Canada. The ultra-violet light transmissivity (UVT), which is a measurement of clarity of water and UV disinfection system efficiency is very high at 97%. The pH of the water is stable and the corrosiveness potential is low.
Location These wells are close to the Lillooet WTP and are connected to the system. Operational costs are moderate from this source as there are pumping / electrical costs. Treatment requires UV disinfection followed by chlorination which is very low-cost treatment, both from a capital and an operational perspective.
Treatment Requirements Although the water is considered groundwater under the influence of surface water, the source water is clean and turbidity is low. Treatment to meet the Interior Health 4,3,2,1, 0 treatment objective is only UV disinfection followed by chlorination. UV disinfection is by a single reactor, Trojan Swift Model D-06, six lamps with variable output, 240V.
Risks and Variability Seasonal variations and water quality variations due to climate change would be considered low to moderate. The largest risk would be operator error of running the wells too hard and either dropping the aquifer level too low, or running the wells too hard and binding off the aquifer with the fine silts in the Seton River. The elevation of the wells in comparison with extreme flood levels of the Seton and Fraser Rivers should be checked.
Supplemental Considerations This source is considered a supplemental water source and does not have dual reactors in case one goes out-of-service. The overall operating cost would be considered to be moderate as the location of the wells results in high pumping costs, but the treatment is minimal and the cost to provide UV disinfection followed by chlorination is considered to be low.
Summary This aquifer source is expandable with room for more infiltration wells on the Seton River fan. The water quality from this source is high, however the risk of the aquifer binding up from this water exists so the withdrawals could be located closer to the Fraser River to have less influence from the Seton River silts. Further development of this source will require input from a hydro-geotechnical engineer. For additional well development, licensing requirements for the proposed wells would have to be verified with the Province of BC.

Photos

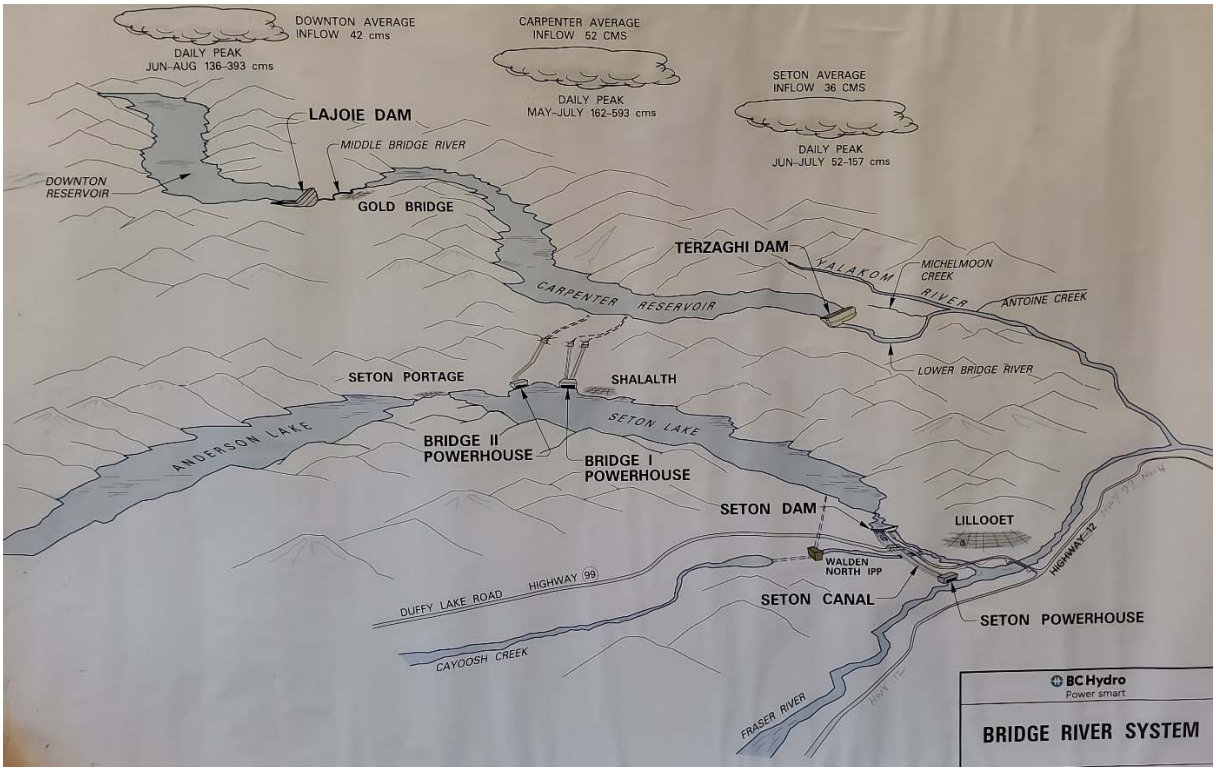
Infiltration Well Site - Two wells are located in the left side of this picture looking eastward Wells are approx. 30 metres north from the north bank of the Seton River.

UV disinfection system for this water source at the WTP. Extra berth location for a second UV reactor is shown in the photo.

4.4 SETON LAKE AND/OR BC HYDRO BYPASS CHANNEL

Description: This option considers obtaining water directly from Seton Lake either via transmission main or via the BC Hydro bypass channel that runs along the south side of Seton River. This option would eliminate the occurrence of high turbidity water from Cayoosh Creek being drawn into the Seton WTP intake. Seton Lake is 22 km long with a surface area of 26.2 km^2. Its depth reaches 140m and the lake is dammed 4.0km west of Lillooet at the 243m elevation. The origin of the water from Seton Lake is from Anderson Lake and from the Bridge River watershed via the BC Hydro diversion from Carpenter Reservoir, Downton Reservoir and Bridge Glacier.
Licensing Lillooet holds licensing at the Seton River WTP. Should water be required from Seton Lake or the bypass channel, the existing licensing could be utilized by applying for an alternate Point-of-Diversion (POD) for the same licenses.
Quantity This source produces a high volume of runoff. The watershed is stable and managed by BC Hydro, which allows for BC Hydro to buffer the flood and drought cycles through reservoir management. Regarding access to water from the BC Hydro by-pass channel, permitting access to the channel may create difficulties for BC Hydro. They will not likely allow the provision of raw water to Lillooet interfere with their hydro-generation operation.
Raw Water Quality Seton Lake provides excellent removal of large particulate matter. Unfortunately, the lake is heavily burdened with a Glacial Loess silt that is very small, likely in the 25-micron size range. The Bridge River diversion into Seton Lake is the source of the glacial silt which causes the dull turquoise colour of the lake. Historical reports state that the lake was a clearer blue prior to the BC Hydro diversion. The glacial silt originates from the Bridge Glacier, some 140 km west of Lillooet at the head of the Bridge River valley.
Location The route for a transmission main from Seton Lake to the WTP is 4.2 km including a River crossing. The route rom the bypass channel to the WTP is only 1.37 km, but access across First Nations land would be required.
Treatment Requirements A soil size settling table with settling times is provided on the adjacent page. Stokes law that calculates settling times for particle sizes is provided for a range of materials. Should this source water be used, it will be required to be treated at the WTP.
Risks and Variability Potential man-made risks to the water would include the BC Rail line along the north shore of Seton Lake. There is also Highway 99 that runs along the river channel for a short distance. These risks are the same as for the existing Seton WTP. There is no reduction in risk by selecting this option. It is noted that the microbiological risks associated with this source would be considered very low.
Supplemental Considerations The costs for this option are high as the distances for the development of a transmission main from the lake or bypass channel are significant. The routes would cross First Nations land.
Summary Developing either of these options to obtain water more directly from Seton Lake provides little improvement in the reduction of risks and no significant advancement in gaining higher quality raw water. Regardless of where the water is accessed, Lillooet will have a silting issue to deal with from this water.

BC Hydro – Bridge River Water Diversion



Stokes Law for Particle Settlement

Stokes law, named after Gabriel Stokes in 1851, sets out the relationship for the frictional force of a spherical object as it passed through a fluid. The solving equation includes the gravitational force, the mass density and the buoyancy of the sphere.

Particle Size (mm)	Material	Fall Velocity (m/s)	Time to Fall 1.0m
0.50 – 1.00	Coarse Sand	0.012	83 sec.
0.25 – 0.50	Medium Sand	0.00298	335 sec.
0.125 – 0.250	Fine Sand	0.000765	1,307 sec.
62.5 – 125 μm	Very Fine Sand	0.000196	5,102 sec. (1.4 hrs)
3.9 – 62.5 μm	Silt	0.0000266	37,532 sec. (10.4 hrs)
25 μm	Glacial Loess Silt	0.0000001359	7,358,350 (85 days)
0.98 – 3.9 μm	Clay	0.000000087	11,494,000 sec (133 days)

4.5 CAYOOSH CREEK WATERSHED

Description:	Cayoosh Creek is the largest local creek in the region with a catchment area of 892 km^2. Highway 99 to Pemberton runs along the creek to Duffy Lake. The creek is a generally in a natural state with minimal contamination or activity by humans.
Licensing	Lillooet has no licensing on Cayoosh Creek however with licensing on Seton River, it may be possible to obtain an alternate point of diversion (POD) for a portion of the existing Seton River license to apply to Cayoosh Creek. The largest licensee on the creek is Cayoose Creek Power LP. They hold 3.398 m^3/s of water flow for the generation of power.
Quantity	Streamflow data for Cayoosh Creek was obtained from the BC Streamflow Inventory report prepared by C.Coulson and W. Obedkoff. The data from that report included on the facing page. Estimates are provided for the average monthly runoff. In 2021, flow in Cayoosh Creek peaked at 82 m^3/s.
Raw Water Quality	The natural raw water quality for this creek should be relatively high. The watershed is in the Coastal Mountains with very little logging or surface activities taking place in the watershed. Highway follows the creek up to Duffy Lake. This water should have E. Coli and Total Coliform counts higher than Seton Lake, however, during spring runoff, spikes in turbidity would be expected on this source This source would not have less fine silt that the water from Seton Lake and may be less problematic to treat.
Location	For connecting to this source, the distance from a new intake on Cayoosh Creek to the WTP would be in the range of 2,900 metres. The point of connection would be just upstream of the confluence of Cayoosh Creek and Seton River. The transmission main route would cross First Nations land.
Treatment Requirements	To be available for year-round use, this source would require filtration. If only used as a back up source, treatment requirements may be less for 8 to 9 months per year with the water treated requiring only UV disinfection followed by chlorination. Health approval would be required for this variation.
Risks and Variability	Activities in the watershed are minimal with limited logging activities. The slopes adjacent to the creek are very steep and there are no landscape activities that would disturb the natural setting. The largest impact on the watershed is Duffy Lake Road.
Supplemental Considerations	The water from Cayoosh Creek is already accessed through the Seton River intake. There are times of year when this water is of better water quality that the water from Seton Lake. There are times during the spring runoff when the Cayoosh Creek water is of lower quality than that in the Seton River.
Summary	The cost to develop this source is significant. Currently the source does form a part of the flow in the Seton River. Prior to any significant investment in this source, it is recommended that monitoring of water quality data be conducted to determine if there is any tangible benefit in investing in this source.

Cayoose Creek Power LP Site

Cayoosh Creek – Annual Runoff Table (flows in ML)

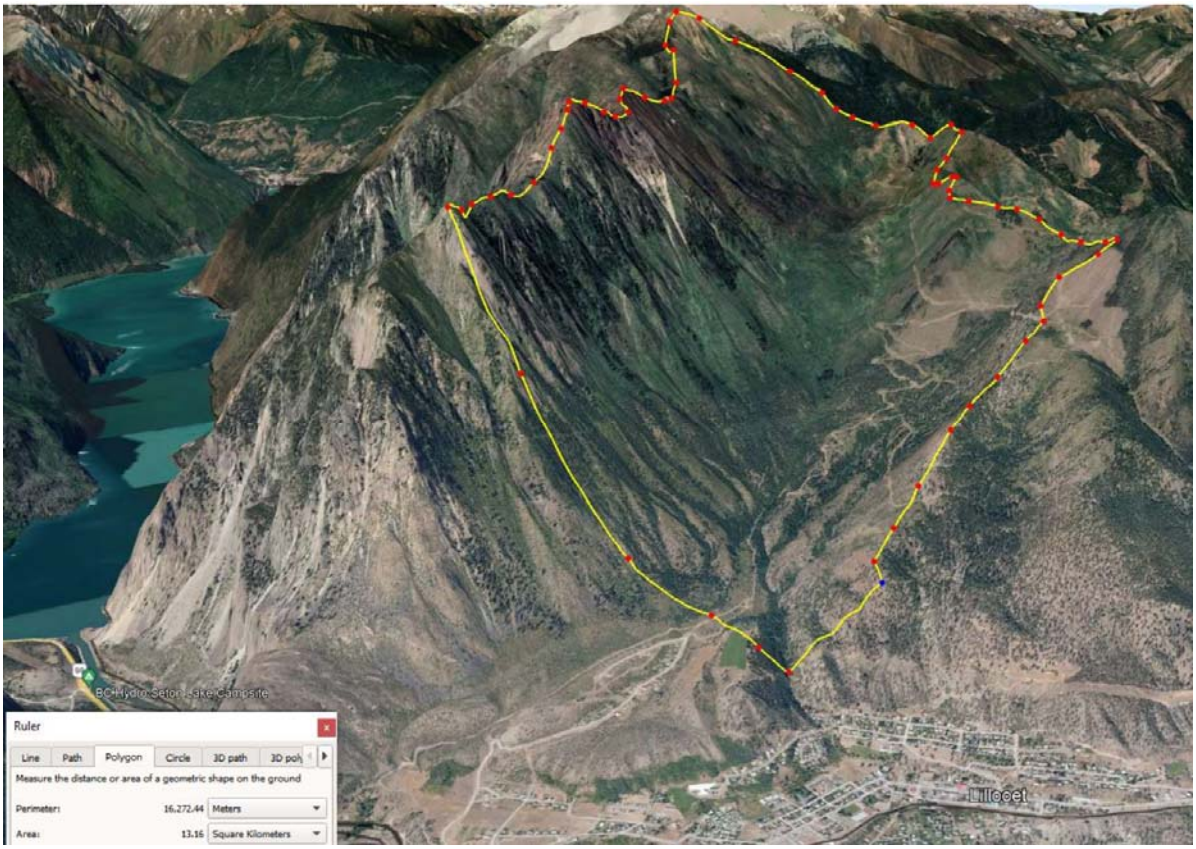
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
% Runoff	3.0%	2.0%	2.0%	4.0%	15.0%	29.0%	22.0%	9.0%	4.0%	4.0%	3.0%	3.0%	100.0%
ML / mo.	16,650	11,100	11,100	22,200	83,250	160,951	122,101	49,950	22,200	22,200	16,650	16,650	555,002
Est 1:10 (0.55)	9,158	6,105	6,105	12,210	45,788	88,523	67,155	27,473	12,210	12,210	9,158	9,158	305,251
Est. 1:25 (0.45)	7,493	4,995	4,995	9,990	37,463	72,428	54,945	22,478	9,990	9,990	7,493	7,493	249,751
Est. 1:100 (0.33)	5,828	3,885	3,885	7,770	29,138	56,333	42,735	17,483	7,770	7,770	5,828	5,828	194,251
892	km2	622.2	mm runoff depth			555002	(ML) Total Runoff						

The 1:10, 1:25 and 1:100-year drought estimates are based on the percentages shown in the table. Although not calculated for this creek these numbers provide an order of magnitude of the reduced flow per month in a drought return-period year.

4.6 Town Creek Watershed

Description:	Town Creek was one of the two primary sources of water supply for Lillooet prior to the 2009 fire. The total watershed area is 15.1 km^2 of which 13.1 km^2 is above the Town Creek water intake at elevation 370 m. The upper watershed has minimal human and industrial activity. It is recovering from the 2004 and 2009 forest fires that burned most of the watershed. The watershed rises to the summit of Mt. McLean at an elevation of 2,426 m.
Licensing	Water licensing is in place for 741 ML / year to be withdrawn from Town Creek of which 332 ML/year is tied to the Tyee Jimmie Creek diversion which diverts water from the Dickey Creek watershed to Town Creek. There are four water licenses in place and the volumes work out to sufficient licensing for a daily demand in the range of 30 L/s.
Quantity	The quantity runoff per year from the watershed is estimated on the table on the next page. The runoff volumes for Cayoosh Creek were reviewed and the watershed here is located at an average lower elevation and on the eastern slopes of the Coastal Mountains. Less runoff is predicted here than for Cayoosh Creek as it is predicted to average between 250 and 300mm average runoff depth from this watershed.
Raw Water Quality	Lillooet records the raw water turbidity in Town Creek to monitor the recovery of the watershed after the 2009 forest fire. The creek has turbidity levels under 1.0 for most of the year with exceedances that occur during spring runoff, annually from mid-May to mid-July. The natural water quality should be very high with minimal logging activity and limited contamination by human activity.
Location	The location of the intake on Town Creek is ideally suited to service the town. The intake elevation at 370m allows the water from this source to be provided to town with no pumping. The creek is central and because the downstream channel to the Fraser River is extremely steep with houses built up above, there should be minimal fish flow requirements at this site.
Treatment Requirements	If the water is to be used year-round, filtration may be required and should be planned for. Should the water be needed for 9-10 months of the year when turbidity levels are below 1.0 NTU, then UV disinfection and chlorination should be sufficient to provide water that meets the 4,3,2,1,0 Treatment Objective. There is power to the site. Development of the site could be staged initially with UV and chlorination, then additional works such as filtration could be added over time. A staged approach at this site is recommended getting the system on-line for 9-10 months a year with UV and chlorination. The addition of filters to reduced the turbidity levels in the remaining two months could be considered at a later day. A small generator and transfer switch would be needed for emergency power for the disinfection system.
Risks and Variability	The supply risks associated with this source include the risk of forest fire, and the risk of creek bank scouring during times of extremely high runoff. As a supplemental source, an on-line turbidity meter and other monitoring instrumentation could provide the Operators with early warning and source shut down during times of water quality deviation.
Supplemental Considerations	There are persons is Lillooet that prefer this water supply over the high-quality water produced at the WTP. The development of this site is viable and its development may have some political benefits in aligning the customer base in doing the next right steps.
Summary	This source is viable. To bring this source on-line, water quality data must be collected to prove out UV disinfection is applicable, i.e., that water transmissivity is high (> 80%) and that turbidity levels are also below 1.0 NTU while the water is running. The system should be set up so that pressure or cartridge filters can be added at some time in the future and that there are automatic controls to shut off the source under a water quality deviation.

Town Creek Watershed Boundary - Aerial View of Catchment Boundary



Town Creek – Annual Runoff Table (flows in ML)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
% Runoff	3.0%	2.0%	2.0%	4.0%	15.0%	29.0%	22.0%	9.0%	4.0%	4.0%	3.0%	3.0%	100.0%
ML / mo.	102	68	68	136	511	988	749	307	136	136	102	102	3,406
Est 1:10 (0.55)	56	37	37	75	281	543	412	169	75	75	56	56	1,873
Est. 1:25 (0.45)	46	31	31	61	230	444	337	138	61	61	46	46	1,533
Est. 1:100 (0.33)	36	24	24	48	179	346	262	107	48	48	36	36	1,192
13.1 km2		260 mm runoff depth			3406 (ML) Total Runoff								

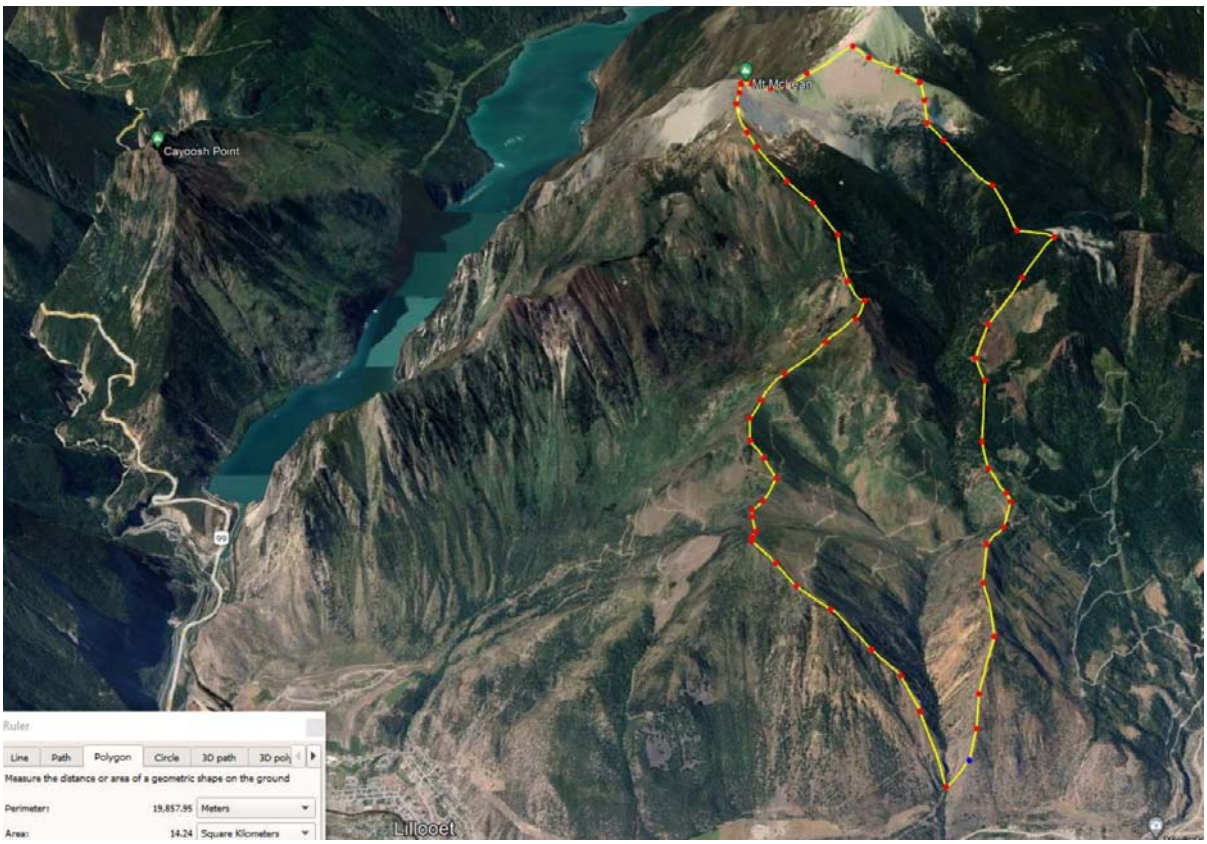
The 1:10, 1:25 and 1:100-year drought estimates are based on the percentages shown in the table. Although not calculated for this creek these numbers provide an order of magnitude of the reduced flow per month in a drought return-period year.

If Tyee Jimmie Creek diversion is functional it diverts 1.80 km^2 area of runoff from Dickey Creek to the Town Creek watershed. When in-service, the maximum diversion permitted within the license is 909 m^3/day or 331 ML/year.

4.7 DICKEY CREEK WATERSHED

Description:	Dickey Creek was also one of the two primary sources of water supply for Lillooet prior to the 2009 fire. The total watershed area is approximately 15.0 km^2 of which 14.2 km^2 is above the water intake at elevation 380 m. The watershed has very low activity within and is extremely hard to access. It is recovering from the forest fires. The watershed rises to the summit of Mt. McLean at elevation 2,426m and is more sheltered than the Town Creek watershed with less southern exposure and a higher runoff per square kilometer.
Licensing	Water licensing is in place for 2,258 ML / year to be withdrawn from Dickey Creek of which 332 ML/year is tied to the Tyee Jimmie Creek diversion which diverts water to Town Creek. Four water licenses are in place for this watershed with the volumes available to sufficient licensing for a daily demand in the range of 45 L/s.
Quantity	The quantity runoff per year from the watershed is estimated on the table on the next page. The runoff volumes for adjacent watersheds were reviewed and applied here. Less runoff that the Cayoosh Creek runoff is predicted with averages in the range of 270 to 320mm average depth of runoff estimated from this watershed.
Raw Water Quality	Lillooet records the raw water turbidity in the adjacent creek but does not have instrumentation on Dickey Creek. It is expected that as the creek surfaces continue to recover from the fires, the creek will have turbidity levels under 1.0 for most of the year with exceedances that occur during storms and spring runoff. The natural water quality should be very high with limited contamination by human activity and minimal logging or forestry activity in the watershed. Sampling on this creek should take place at such time prior to the source being considered to be brought back on-line.
Location	The physical location of Dickey Creek with intake at 380m elevation, is ideally suited to service the town. The intake can supply to the majority of Lillooet with no pumping. The location of the intake itself is problematic as the site is extremely steep, without power or communications and is extremely difficult to access. Investment in this site should include for remote controls and monitoring.
Treatment Requirements	If the water is to be used year-round, filtration will be required. Should the water be needed for 9-10 months of the year when turbidity levels would be expected to be below 1.0 NTU, then UV disinfection and chlorination may be sufficient to provide water that meets the Interior Health 4,3,2,1,0 Treatment Objective. If this system were developed with UV and chlorination, those works would be lower down and near to the Dickey Creek concrete reservoir below. A staged approach is recommended for getting this water source on-line. Start with water supply for 8-9 months a year with only UV and chlorination. The addition of filters at some later time would reduce the turbidity levels for the remaining months. Emergency power is recommended for the disinfection for this system.
Risks and Variability	The supply risks associated with this source include the risks of forest fire, and the risks of creek scouring during times of extremely high runoff. As a supplemental source, an on-line turbidity meter and other monitoring instrumentation could provide the Operators with early warning of water quality deviations and automatic shut down of the source.
Supplemental Considerations	Similar to Town Creek, there is interest by Lillooet residents to invest in these local gravity creek sources. The development of this site is viable however there are physical challenges in constructing and operating this intake in the steep conditions that exist.
Summary	This source is viable. To bring this source on-line, water quality data should be collected to prove out UV disinfection is applicable, i.e., that water transmissivity is high (> 80%) and that turbidity levels are also below 1.0 NTU while the water is running. Like Town Creek, this water system could be set up with filters and with automatic controls to shut off the source under a water quality deviation.

Dickey Creek Watershed Boundary - Aerial View with Boundary



Dickey Creek – Annual Runoff Table (flows in ML)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
% Runoff	3.0%	2.0%	2.0%	4.0%	15.0%	29.0%	22.0%	9.0%	4.0%	4.0%	3.0%	3.0%	100.0%
ML / mo.	124	82	82	165	618	1,194	906	371	165	165	124	124	4,118
Est 1:10 (0.55)	68	45	45	91	340	657	498	204	91	91	68	68	2,265
Est. 1:25 (0.45)	56	37	37	74	278	537	408	167	74	74	56	56	1,853
Est. 1:100 (0.33)	43	29	29	58	216	418	317	130	58	58	43	43	1,441
14.2 km2		290 mm runoff depth			4118 (ML) Total Runoff								

The 1:10, 1:25 and 1:100-year drought estimates are based on the percentages shown in the table. Although not calculated for this creek these numbers provide an order of magnitude of the reduced flow per month in a drought return-period year.

If Tyee Jimmie Creek diversion is functional it diverts 1.80 km^2 area of runoff from Dickey Creek to the Town Creek watershed. When in-service, the maximum diversion permitted within the license is 909 m^3/day or 331 ML/year.

4.8 AQUIFER FOR RECREATION CENTRE WELL NO. 2

Description:	Lillooet has two wells at this site. Rec. Centre Well No. 1 was drilled in Dec. 1996. It is not in use due to low flow capacity of less than 6.3 L/s. Arsenic levels were also higher in Rec Centre No. 1 as the well drew water from deeper in the aquifer. Rec Centre Well No. 2 has been in service since April 14, 2010. Rec.Centre Well No. 2h has a 300mm diameter casing and is drilled to a depth of 77.8m. It is a primary source for the supply of domestic water for Lillooet. The water is chlorinated and pumped directly to the water distribution grid.
Licensing	Rec. Centre Well No. 2 is not presently licensed but the license has been applied for in the amount of 239 ML/year. There are no know issues that would cause concern for the Province in their review and issuance of groundwater license at this site. Rec Centre Well No. 1 has BC Well ID No. 753. Tag Number 87437 Rec Centre Well No. 2 has BC Well ID No. 19576, Tag Number 87435
Quantity	The pump in Rec Centre Well No. 2 is capable of pumping at a rate of 45 L/s (163 m3/hr). The wells at this site draw water from the Lillooet Aquifer, no 325 west of the Fraser River. There are numerous springs and wells in this aquifer. Water to the aquifer originates from precipitation in the Town Creek watershed.
Raw Water Quality	Water quality readings show hardness levels at 360 mg/L of $CaCO_3$. Although the water is somewhat hard, it does not exceed any of the maximum acceptable concentration (MAC) levels for any of the reviewed physical water quality parameters.
Location	The location of the site is excellent and the source is in the centre of the water distribution grid. Water from this well is directly pumped in to the Million Gallon Reservoir pressure zone, with a hydraulic grade line of 327 metres elevation (PZ 327).
Treatment Requirements	Treatment requirements are only chlorination. UV disinfection is not required. The water has a higher than desired level of hardness however the amount is not significant to warrant treatment for the well flow.
Risks and Variability	The aquifer has a capture zone with human activity above in the upper lands immediately above Lillooet. The monitoring of land use and the education of the public in protecting groundwater are reasonable first steps for leading a community to look after its groundwater resource.
Supplemental Considerations	This site is fully developed. Lillooet should seek advice as to what to do with Rec. Centre Well No. 1. There is investment in this well and no flow. With the majority of the infrastructure in place for the first well, consideration for investing in a pump for this well should be considered. Water quality data for this well may have led to the decision to abandon it.
Summary	Maintain Rec Centre Well No. 2 as is as a primary water supply source for Lillooet. Obtain costs for an ion-exchange system for Well No. 1 to assess costs vs. benefits for this well. Confirm whether or not Rec. Centre Well No. 1 should be recommissioned or decommissioned.

Photos

Recreation Centre Well Building Exterior

Recreation Well Building – Interior process pipe works

4.9 CONWAY PARK WELLS NO. 1 & 2

Description: Both Conway Park wells are located in the SE corner of Conway Park. The wells were drilled in 1994 and commissioned and operational in 1995. The wells have reasonable capacity but have water quality issues with higher than acceptable concentrations of arsenic. The wells have not been used since Sept. 2010. Conway Park Well 1 Well Tag 72316, Well ID 751, 150mm casing, near building, 168.2m depth, static water at 36.6m depth, Gould's – 5ChC – 19 stage Conway Park Well 2: Well Tag 72285, Well ID 752, 250mm casing, in building, 166.2m depth, static water at 40.5m depth, Gould's 7CHC – 7 stage pump Conway Park Wells 1 & Well 2 have issues with regards to the casing for both wells being compromised and not straight making well pump servicing very difficult. Reinvestment in this site is in question.
Licensing Application for groundwater licensing was made in February 2022 as an emergency back-up well for the other water sources in town. The Province is currently reviewing the application.
Quantity The quantities from these wells are noted: Conway Park Well 1 rated at 14.1 L/s Highest recent usage – July 2010 – 27,083 m3 Conway Park Well 2 rated at 19.8 L/s Highest recent usage - July 2010 – 20,130 m3
Raw Water Quality The raw water quality from the wells has not been sampled for several years. Arsenic levels were reported to be high and it is not foreseen that this will change. Levels were tracked closely in 2010 and 2011 along with the volume of water drawn from the wells. This is shown on the table on the next page.
Location The location of the wells is in a location where the water can be pumped directly into the water distribution system into the pressure zone of Million Gallon Reservoir (PZ 327). No additional works are needed on the distribution system to bring these wells on-line.
Treatment Requirements The wells are unchlorinated. If the well pumps could be raised to confirm that there is less arsenic at a higher location. If groundwater can be found lower than the limits in the guidelines, then the well could be used if it meets all other parameter for drinking water. There is treatment media available for arsenic removal, however for the flows for these wells, a new building and full process piping and building would be required. The building would house pressure filters that contain an arsenic absorptive granular media where the arsenic would pass through and be adsorbed onto the surfaces of the positively charged media.
Risks and Variability With the known high arsenic levels, even in an emergency, should either well be used, the public will not accept this decision knowing that there has been time to either decommission or deal with the arsenic.
Supplemental Considerations The arsenic levels did drop in the wells with higher usage with Well No. 1 being below the Max Acceptable Concentration of 0.010 mg/L. With the wells being so close, only three metres apart, and at roughly the same depth, within 2.0m depth of each other. the arsenic content was expected to be very similar. This is not the case with Well No.1 having consistently lower arsenic levels. This would lead us to believe that the
Summary Prior to investing in treatment, the physical condition of the well casing should be verified to determine if the well casings are intact and straight. If not, it may not be viable to invest in these wells. The approach to treatment would be to first determine why the well water quality varies so much for two wells that are supposed to be in the same aquifer at the same elevation within 3.0m of each other. The water is clearly different and the arsenic levels vary dependent on water volume used.

PHOTOS

Conway Park Well No. 1 - South of controls building

Conway Park Well 1 (150mm casing foreground) Conway Park Well 2 (250mm casing) further to west

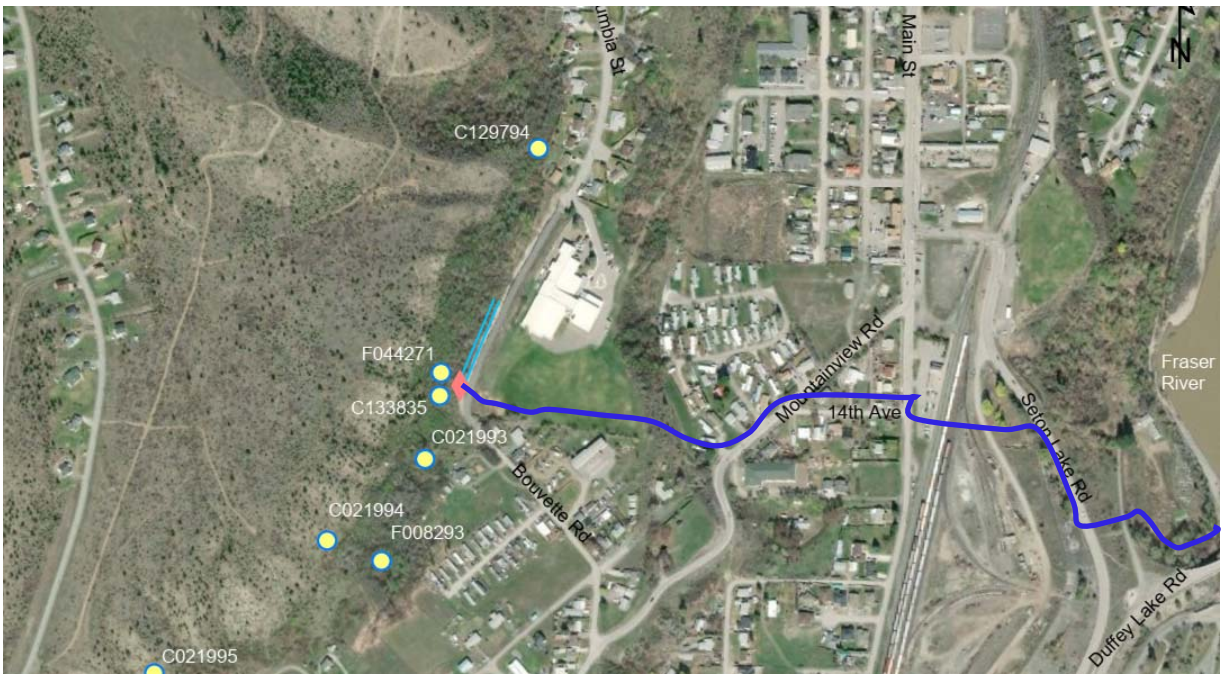
Arsenic Levels in mg/L – Conway Park Wells – Jan 2010 to July 2011 (MAC = 0.010 mg/L)

	Well 1		Well 2	
Date	m3/ mo	Arsenic	m3/ mo	Arsenic
January 1, 2010	5	0.0189	5	0.0262
February 10, 2010	5	0.0071	5	0.0117
March 30, 2010	5	0.0077	5	0.0108
April 13, 2010	3030	0.0109	4486	0.0141
May 18, 2010	18548	0.0074	5541	0.0135
June 8, 2010	24352	0.0100	17526	0.0225
July 22, 2010	27083	0.0044	20130	0.0075
August 5, 2010	22831	0.0086	14130	0.0139
August 17, 2010		0.0057		0.0061
September 13, 2010	5684	0.0127	370	0.0282
September 28, 2010		0.0167		0.0320
October 14, 2010	104	0.0139	125	0.0368
November 10, 2010	5	0.0202	6	0.0175
November 24, 2010	5	0.0126	5	0.017
		0.0147	5	0.0126
January 12, 2011	5		5	
February 22, 2011	5	0.0207	5	0.0194
March 10, 2011	5	0.0153	5	0.0370
April 18, 2011	5	0.0203	5	0.0315
May 17, 2011	5	0.0308	5	0.024
June 14, 2011	5	0.0204	5	0.0246
July 11, 2011	5	0.0144	5	0.0325

4.10 14TH AVENUE GROUNDWATER SPRING

Description:	This spring surfaces on the hillside in the vicinity of Lillooet High School. It is captured and conveyed in a pipe system that takes it across the bench to Seton Lake Road where the road enters Lillooet. At this location is enters the road ditch and is conveyed down to the lower bench and to the Fraser River. The 2020 report by ISL Engineering Ltd. provided significant data on this source including catchment area, water quality data, and expected volumes of water that the spring could produce.
Licensing	The spring is not licensed. If used, water would be withdrawn from Provincial Aquifer No. 325 which is the groundwater aquifer on the west side of the Fraser River. There are seven licensed springs in this aquifer with four registered to the T'it'q'et First Nations. The remainder to local land owners. The total licensed allocation to the licensees is 80.23 ML/year as both domestic and irrigation licenses. It is expected that the use of this spring by Lillooet would not conflict with other withdrawals as this water would be extracted after those licensees.
Quantity	The spring draws from a 1.82 km^2 catchment area that is part of Town Creek watershed. The measured volumes in the spring by ISL averaged 3.4 L/s from Jan-April and only 0.67 L/s in May and June of 2020. The volume could be even less in July through September with local withdrawals by upper license holders. It is also noted that regionally, 2020 was a wetter year with higher overall runoff than average. Based on the numbers provided by ISL, the volume of water annually could be in the range of 65,000 m^3 / year (65 MLD).
Raw Water Quality	Full parameters were measured for the spring water by ISL. There were parameters such as turbidity that were slightly over the 1.0 NTU maximum level but most parameters were acceptable for drinking water. Potential cross connection to the Lillooet drainage system is of concern as the spring source would have to be isolated and safely conveyed to the Lillooet water treatment plant. Total Coliforms and E.Coli were measured and present in the spring water and must be treated for by an approved disinfection method (chlorination).
Location	With the spring being a distance away from any other facilities. Additional pipework would be needed to collect this spring at a location close to where it exits the ground and then to safely convey this water to the Water Treatment Plant. The pipes in place that are connected to manholes on the system would need to be secured so that no contamination can enter the conveyance system.
Treatment Requirements	If directed to the water treatment plant, then the water should be run through the water treatment plant membrane filtration system followed by chlorination.
Risks and Variability	Risk with the system are the volume of water available, the reliability of the source, the granting of a groundwater license for the source, and then dealing with the raw water quality and contamination of that water.
Supplemental Considerations	The key concern with this source is the annual volume of water available and the capacity of this source to make a significant difference in the supply of water should there be issues at the Water Treatment Plant (WTP). If the raw water is directed to the WTP and there are issues with the plant, this source would not offer a secondary supply source.
Summary	Although the Lillooet drainage system near this spring has notable volumes of water running through it, collecting that water or utilizing the groundwater is not recommended. The volume of water from this spring is relatively small. Development of this source does not provide Lillooet with a significant volume of alternate source water. This water also has *E.coli* and *Total Coliforms* present which indicate that there may be contamination from the septic tanks or other human activity upstream.

14th Avenue Spring - Route to Fraser River (Blue line)



Base Map: ISL 2020 Report to Lillooet showing licensed groundwater in the vicinity of the spring.

4.11 COMPARISON OF OPTIONS

This section summarizes the assessment of nine water sources. The intent of this exercise is to evaluate the water sources and provide Lillooet with guidance on which source may be the best to invest in for the future.

There is subjectivity in assessing the nine water sources. Because of the factors involved, it is not realistic to set up a numerical criterion and comparing one against another is also not a fair approach. The highest considerations were lifecycle costs for the option, ease of operation for Lillooet staff, and ability for the source option to provide safe water that would compliment the existing supply sources.

In terms of licensing, the WTP, infiltration wells, Dickey Creek and Town Creek are all in order. Licensing for the existing groundwater wells is pending Provincial approval.

Regarding quantity, the majority of the sources would provide a reliable additional supply of water for Lillooet with the exception of the 14th Avenue ground water spring.

The best raw water quality of all of the sources requiring the least treatment is the infiltration well site aquifer. The wells are influenced by surface water from Seton River and possibly from the Fraser River. If the well sites are closer to the Fraser River, it is expected that the fine silt load from Seton River would have less influence on the well capacity.

The cost to develop the source is a criterion that carries significant weight on the source ranking. The water sources have different costs to bring them on-line. The WTP requires more membrane filtration units, the infiltration wells require the well, the connection to the WTP and another UV disinfection unit. The development of Cayoosh Creek or going to Seton Lake is extremely costly due to the transmission main requirements plus treatment afterwards. Town Creek and Dickey Creek require intake controls, UV disinfection and chlorination. Conway Park requires treatment for arsenic and the groundwater source requires conveyance piping and treatment at the WTP.

The operational and maintenance costs include the costs to run the pumping and treatment. It also includes consideration for the amount of infrastructure added and the cost over the lifecycle of that infrastructure to renew the asset. The membrane modules on the WTP have a relatively short lifespan and a significantly higher lifecycle cost than using disinfection only.

Source risks include the exposure to flood and/or drought, the possibility of forest fire impacts, or risks to external contamination by humans.

Supplementary considerations may include the perceptions by the residents of Lillooet. The supplementary considerations also include how the source would integrate and compliment the existing water supply. Having a variety of water sources to lessen the climate change impacts to any one source is considered to be advantageous.

Any expansion in water supply capacity for Lillooet should be reliable, safe, can withstand the impacts of climate change and natural events, and be cost effective in the long term. A gravity supply is always an objective as it results in lower operating costs and less pumping, however water quality and cost also factor into the assessment. Table 4.1 provides a summary of the factors considered for each water source. The blue cells indicate a positive assessment and orange cells negative.

Table 4.1 - Summary of Water Sources

Source	License Availability	Source Water Quantity	Raw Water Quality	Cost to Develop	Cost to Treat & Operate	Supply Risks	Suppl. Consid.	Overall Rank
Expand WTP								3
Add Infiltration Wells								2
Access Seton Lake								8
Access Cayoosh Creek								9
Connect Town Creek								1
Connect Dickey Creek								4
Add Well at Rec Centre								5
Treat & use Conway Park Wells								7
Connect 14th Ave Spring								6

Colour coding Legend							
	Most Positive	Positive	Above Ave	Neutral	Below Ave	Negative	Most negative

EXPLANATION OF RANKING ORDER

Rank 8-9 - Cayoosh Creek Watershed and/or Seton Lake
These sources are ranked low solely due to the cost of the transmission main required plus the additional cost to run the water through the WTP. The development of either source does not improve the reliability or provide any assurances of alternate supply in the event of a major flood, drought or forest fire.

Rank 7 - Conway Park Wells
This well site has arsenic in the groundwater from both wells, yet notable differing water quality. This source would require treatment for arsenic to bring the wells on-line. The treatment would be some form of ion exchange media and would be costly to operate. In addition, the condition of the well casings are poor in that their alignment is compromised making the insertion or removal of the well pump very difficult.

Rank 6 - 14th Avenue Groundwater Spring
This source has a very small supply capacity. The groundwater spring comes from an area where there is human activity and possible contamination from above. Isolation and protection of the conveyance of this water to the WTP is also necessary.

Rank 5 Recreation Centre Groundwater Aquifer
Development of another well in this area is an option for Lillooet as the aquifer has capacity and has the nearby infrastructure of where to connect. There is risk with this site in terms of arsenic as Recreation Centre well no. 1 was decommissioned due to water quality issues.

Rank 4 Dickey Creek Watershed
This site is connected to the water distribution system; however, the site is extremely difficult to access and requires as a minimum UV disinfection followed by chlorination. The site requires power and remote controls and monitoring. The site has significant capacity and would be ranked higher except that Town Creek is able to serve the same purpose with lower cost and less access difficulties.

Rank 3 Expand WTP
Expansion of this site is high on the list as the plant is designed to be expandable and has room for additional Pall membrane filtration modules. The WTP capacity expansion is not ranked as high as the next two options due to the operational challenges and that expanding this source puts too much of the water supply at one facility, making the overall supply less resilient and adaptable.

Rank 2 Expanded Infiltration Well Capacity
This site is ranked high as it provides high quality water, a reliable source, and only UV and chlorine disinfection. The costs are high due to the need for an additional UV disinfection reactor at the WTP. There are operational pumping costs that are similar to the source water provided by the WTP.

Rank 1 Town Creek Watershed
The Town Creek option is attractive as the watershed above Lillooet has recovered significantly since the 2009 forest fire. The source appears to be clean enough to utilize only UV disinfection and chlorination for the majority of the year. There would have to be more water quality testing required to provide a baseline of water quality data to inform any future UV designs. Parameters to be collected would be those that would be needed to design and install a UV disinfection reactor. Raw water tests should include turbidity, ultra-violet light transmissivity, and E. Coli and Total Coliform tests on the raw water over a variety of conditions.

4.12 LIFECYCLE COST ESTIMATES

With the initial ranking of the water sources, further analysis was conducted to provide a cost comparison of the four highest ranked options. A lifecycle cost estimate was developed for Options 1 through 4 considering both the initial capital cost and the longer-term operations and maintenance costs. The summary of this exercise is provided within Appendix A.

A lifecycle cost estimate is an estimate of costs for a system over a longer time period, accounting for the initial capital cost to install the works and also the cost to maintain and operate the works over time. The four options being considered all exist at different stages in their lifespan. This lifecycle cost analysis is carried out to a 50-year horizon assuming that the existing infrastructure would be functional through that time and the cost moving forward would be accounted for. The capital cost for each option is the cost to bring the water source on-line to a functional standard. The operating costs over 50 years is the cost that would have to be set aside today to fund the project over its lifespan. It is noted that for both the infiltration wells and for the water treatment plant, that the lifespan of the pumps and the membranes was set with renewal investment required at 25 years. The capital cost in 25 years would be the inflated cost discounted by the amount of money required if the investment were made today. (i.e. inflation minus the interest rate).

The amount of water supplied for operational costs was set at a fixed number of 400 ML per year, as each source should be able to provide that annual volume. Some of the options could produce a greater volume than others and these numbers are listed in the Table 4.2.

Photo – Existing Infiltration Wells

Table 4.2 - Summary of Lifecycle Costs

NO.	DESCRIPTION	SOURCE CAPACITY (ML/yr) *	LIFECYCLE SUPPLY (ML/yr) **	INITIAL CAPITAL COST ($$)	INITIAL O&M COST ($$)	TOTAL LIFECYCLE COST	50 YEAR LIFECYCLE COST / ML
1	TOWN CREEK	400	400	$ 437,500	$ 18,650	$ 2,873,372	$ 144
2	INFILTRATION WELLS	480	400	$ 450,000	$ 46,866	$ 6,652,403	$ 333
3	EXPAND WTP	500	400	$ 475,000	$ 56,070	$ 8,204,517	$ 410
4	DICKEY CREEK	500	400	$ 668,750	$ 34,380	$ 5,159,114	$ 258
	** Source capacity is the annual additional capacity that can be provided by the source*						
	** Lifecycle supply is the capacity provided by the source for comparitive costing*						

The costs resulting from the analysis show that the development of the creek sources is less than for the infiltration wells or water treatment plant. The issue with the creek sources is that this estimate does not include filtration and assumes that the water in the creeks can be used provided the turbidity remains below 1.0 NTU for the majority of the year.

The infiltration well is assumed to be operational year-round. The expanded Water Treatment Plant (WTP) is assumed to be functional most of the year except when there is exceptionally heavy silt loading from Seton River.

Photo – Town Creek Intake structure

5. SUMMARY

5.1 INTRODUCTION

In November of 2021, the Province of BC experienced the impacts of an intense precipitation event that was unprecedented. The damage to critical transportation infrastructure and to municipal water supplies was experienced in the Fraser Valley and extended into the BC Southern Interior. The communities of Merritt, Princeton, Abbotsford and Chilliwack experienced the worst impacts.

The event has resulted in many communities having to re-evaluate the reliability of their water supplies. Lillooet is reliant on their water treatment plan (WTP) & water intake from the Seton River, two infiltration wells that are nearby to the WTP, and the Recreation-Centre Well No. 2 groundwater source. The WTP supplies the largest volume of water to Lillooet and in the past few years, there have been challenges in operating the WTP as the silt load from Seton River binds off the membranes equipment and requires constant maintenance of the river intake system.

A review the currently identified water sources available to Lillooet is documented in this report. The major conclusions and recommendations of our investigation are as follows:

5.2 CONCLUSIONS

C-1 This report focuses on raw water sources that could supply water to the urban areas of Lillooet on the west side of the Fraser River and north of Seton River;

C-2 This report reviewed 9 sources of water including the existing water sources, previous used water sources and regional water sources;

C-3 A key objective for the community of Lillooet is to receive water from the most natural water source with the minimal amount of treatment or handling/pumping as possible;

C-4 Lillooet has numerous options available for the supply of domestic water to the community. The three current sources of water used are the Seton River WTP, the two infiltration wells near the WTP, and Recreation Centre Well No. 2;

C-5 The existing sources of water are adequate to meet the maximum daily demands for Lillooet, however if any one source is out of service during these periods of high demand, water restrictions would have to be called as Lillooet may not be able to provide the maximum daily demand;

C-6 The largest source of water available to Lillooet is the Seton River whose flows are mostly controlled by BC Hydro. The water from Seton River appears to be of high quality, however the BC Hydro diversion of the water from the Bridge River watershed to the north and Bridge Glacier has resulted in a fine silt powder being introduced into Seton Lake. The silt material is problematic in terms of operations and treatment as it plugs the intake facilities and creates

more frequent backwash requirements for the membrane units at the WTP, which reduces the plant capacity;

C-7 Although the operation of the WTP can be challenging at times, Lillooet must not lose sight that this facility is the primary domestic water supply source for the community. It must be valued, maintained and protected. The WTP produces very high-quality water but does so at a cost. Should Lillooet wish to pursue lower cost water such as the creek sources, then the water quality provided to the customers may be reduced;

C-8 The Seton River intake for the WTP is subject to extreme weather events similar to other intakes on other creeks and rivers. The potential for high water (flooding) or low water (drought) at this intake is reduced significantly in comparison with other intakes as BC Hydro operates the water inflow and releases from Seton Lake, thus buffering the extreme events;

C-9 Opportunities exist to provide safe domestic water at a lower cost; however, the residents of Lillooet must be made aware of the compromises made, if these alternate water sources are to be developed;

C-10 The Infiltration gallery is a supplemental source of drinking water for Lillooet and can be expanded. There are concerns over the capacity of the two existing wells however the Seton River fan and the nearby Fraser River are strong sources of raw water. Locating the infiltration wells closer to the Fraser River may reduce the silting issue from the Seton River, but could increase the chance of the well heads being submerged by the Fraser River during extreme flood events;

C-11 In terms of licensing, Lillooet holds sufficient domestic water licensing for the foreseeable future and no changes are required. The direction that Lillooet pursues for the source water will dictate if licensing amendments are necessary;

C-12 Lillooet is awaiting feedback from the province for their groundwater licensing applications that were submitted in February of 2022;

C-13 Lillooet is fortunate in that they have water from three different locations, Seton River, the Seton River fan for the infiltration wells, and the Groundwater aquifer supplying Rec-Centre Well No. 2. Under extreme water demand conditions, Lillooet needs all three water sources to be on-line and producing;

C-14 This report was circulated while in draft form to the persons in the community with a keen interest and background in the water sources and water supply for the community. The comments received were reviewed and this report was adjusted. With this information, Lillooet can consider where and how they can move forward on making their water supply more secure;

C-15 A lifecycle analysis was carried out on the four highest ranked options. The creek sources priced out as the lowest lifecycle costs for a 50-year duration. It is noted that the operations and maintenance costs have the highest impact on the total lifecycle costing.

5.3 RECOMMENDATIONS

Recommendations for further source development are as follows:

R-1 In the review of the nine source water options, it is recommended that the Town Creek and the Infiltration Well site be considered as the most viable water sources to provide domestic water to Lillooet. Proving that the raw water quality is reliable, stable and the disinfection and treatment can meet the 4,3,2,1, 0 Interior Health treatment objective, these sources would be used to reduce the dependence on the Seton River WTP. These two options offer differing benefits. The Infiltration well option offers stability and reduced demand on the filtration system at the water treatment plant. Town Creek offer redundancy and added system capacity at a very low operating cost;

R-2 Consideration should be given in proceeding with the development of the Town Creek source and the further development of the Infiltration Wells as the earliest possible time;

R-3 Of the nine source water options, the ones ranked from 5 to 9 should be considered as non-viable for varying reasons. Decommissioning of district assets for the Conway Park wells and at Rec-Centre Well No. 1 should be planned;

R-4 Should the Town Creek water source be confirmed, additional raw water quality data should be collected using on-line monitoring equipment for UV transmissivity, turbidity, pH, conductivity, and temperature. In addition, a flow monitoring device should be installed on Town Creek to record raw water flow rates in the creek at all times. As additional data is recorded, it can be used for the design of the water disinfection system;

R-5 Investigation should take place to verify the condition of the diversion to Town Creek from the Dickey Creek watershed. An assessment in the condition, location, viability and if there is any additional area to collect by means of this diversion, should be conducted;

R-6 The infiltration well site on the Seton River fan is also another site that should be considered for expansion. The water quality from this source is high and only requires UV disinfection, chlorination, and pumping up to the service area;

R-7 Should Lillooet experience a severe heat wave similar to June and July of 2021, the District should develop a contingency plan to protect the town from forest or grassland fire. Many communities are developing forest fire contingency plans for the forest interface with their communities. These plans typically utilize all available water. In this case, water could be accessed from the existing supply plus the Town Creek and Dickey Creek water sources. The water would be used to saturate the perimeter of the town so that ground is damp and the fire is directed to less humid areas. Contingency plans such as this should be developed by the Lillooet fire department and emergency services staff;

R-8 Prior to proceeding with further water source development, Interior Health should be issued a copy of this report for their review and input. Although this report does not recommend expansion of a filtered supply, but does provide a practical and cost-effective means in which to provide significantly more microbiologically safe water to Lillooet for a reasonable cost;

R-9 Should Lillooet look to add UV disinfection equipment at any of their sources, we would recommend that they install the same type of UV reactor that is at the WTP. The Trojan UV-Swift reactor is appropriate technology with Low Pressure High Output lamps that draw only minimal power to disinfection the water. Having the same type of reactor also reduces any duplication in backup parts and assists operators being familiar and confident in the operation of their equipment;

R-10 This report recommends the development of additional source water capacity with technology that is reliable, simple and has a low cost to operate. By utilizing UV disinfection technology on the cleanest raw water sources, additional supply that is redundant and robust can be provided at a reasonable cost. This report recommends further monitoring and planning for development of the Town Creek source and expansion of the Infiltration Well site.

R-11 The next steps in source water development would be the collection of raw water quality data at both sites, specifically Total Coliforms and E.Coli over time along with seasonal full water quality parameters. Once the data is collected, a hydro-geotechnical consultant should be retained to develop a feasibility report for the infiltration well expansion. A civil consultant can be retained to carry out a pre-design for the Town Creek intake and a future disinfection building.

APPENDIX A - LIFECYCLE COST COMPARISON

With the initial ranking of the water sources, further analysis was conducted out to provide a cost comparison of the four highest ranked options. A lifecycle cost estimate was developed for Options 1 through 4 considering both the initial capital cost and the longer-term operations and maintenance costs. The summary of costs is provided in Table A.1. Details for each option are provided in this section.

Table A.1 – Summary of Lifecycle Options

NO.	DESCRIPTION	SOURCE CAPACITY (ML/yr) *	LIFECYCLE SUPPLY (ML/yr) **	INITIAL CAPITAL COST ($$)	INITIAL O&M COST ($$)	TOTAL LIFECYCLE COST	50 YEAR LIFECYCLE COST / ML
1	TOWN CREEK	400	400	$ 437,500	$ 18,650	$ 2,873,372	$ 144
2	INFILTRATION WELLS	480	400	$ 450,000	$ 46,866	$ 6,652,403	$ 333
3	EXPAND WTP	500	400	$ 475,000	$ 56,070	$ 8,204,517	$ 410
4	DICKEY CREEK	500	400	$ 668,750	$ 34,380	$ 5,159,114	$ 258
	** Source capacity is the annual additional capacity that can be provided by the source*						
	** Lifecycle supply is the capacity provided by the source for comparitive costing*						

DISTRICT OF LILLOOET Page 1

OPTION 1 - TOWN CREEK - RE-ACTIVATE SOURCE, ADD UV Source Assessment

last update August 23, 2022

TOTAL ANNUAL DEMAND	400	ML/yr	
AVERAGE DAILY DEMAND	1.32	ML/day	15.2 L/s (242 USgpn assumes 10 mo. /year
MAXIMUM DAILY DEMAND	2.72	ML/day	31.5 L/s (500 USgpm)
PEAK HOUR DEMAND	2.72	ML/day	31.5 L/s (500 USgpm)

ASSUMPTIONS

Plant is run for 10 months per year when turbidity is below 1.0 NTU
Source Capacity is estimated at 400 ML/year
At time when filtration is added, UV reactor moved to new space with filters
Room in new space for additional filters and for 2 UV reactors, (not in this comparative estimate)

CAPITAL COSTS	No.	Unit		Unit Price		Extension
Weir across Town Creek - Flow monitoring	1	each	$	15,000	$	15,000
Add conduits to building for flow, for communications/instrumentation	1	LS	$	15,000	$	15,000
WQ Monitoring devices, supply/install- UVT, pH, conductivity, press tranducer	4	ea	$	5,000	$	20,000
Siteworks	1	LS	$	5,000	$	5,000
Refurbish Intake structure - fish screens	1	LS	$	30,000	$	30,000
Add building expansion to north of existing building	40	m2	$	2,500	$	100,000
UV disinfection reactors (1) (with room to add second)	1	each	$	60,000	$	60,000
UV reactor - install / commission	1	each	$	30,000	$	30,000
Process piping to accommodate reactors	1	LS	$	30,000	$	30,000
Flow meter - 150mm dia - existing	0	each	$	3,500	$	-
Electrical - Instrumentation SCADA - labour - materials	1	ea	$	35,000	$	35,000
Building Mechanical	1	LS	$	10,000	$	10,000
Subtotal , Construction Cost Estimate					**$**	**350,000**
Contingency 25%					$	87,500
TOTAL CAPITAL COST					**$**	**437,500**

ANNUAL O & M COSTS

$ / kw-hr	$	0.1250					
Price / 100m lift electricity	$	0.0426					
Enter Head		0	m				
Pumping Electrical Costs (none)		0.00	-	m3	$	0.0635	$ -
UV Lamps - Electricity, lamp replacemen	304	days	7,300	hr/year	$	0.50	$ 3,650
Operational Labour Cost, access, monitoring lamp cleaning			200	hr/year	$	75.00	$ 15,000
TOTAL O & M COSTS, YEAR 2022 CDN DOLLARS							**$ 18,650**

Assumption that UV reactor can fit within existing building.
May have to locate above existing pipeworks and extend pipe outside of north wall of building in order to get sufficient straight sections of pipe before the reactor

Pipework within valve building below Town Creek Steel Tank Reservoir

DISTRICT OF LILLOOET						Page 2
OPTION 1 - TOWN CREEK - RE-ACTIVATE SOURCE, ADD UV						Source Assessment
						August 23, 2022
					PROGRAM INPUT DATA	
COMMENTS					**2.00%**	Interest (Discount) rate
					4.00%	Inflation Rate
Power cost is based on rate of 12.5 cents/kw-hr in current day dollars					**1.50%**	Water Demand growth rate
Water demand from this source is constant withdrawal over the time period					$ 437,500	Initial Capital Investment
i.e. does not increase					$ 18,650	Initial Operating Cost
					100	Lifecycle Period
					1.32	Capacity of Option ML/day
					2022	Starting Year
		105.56%		2.00%		
Year	Capital Cost	O&M Cost	Total Annual Cost	Discounted Cap. Cost	Discounted O&M Cost	Discounted Annual Cost
		$	$	$	$	$
2022	**437,500**	**18,650**	**456,150**	**437,500**	**18,650**	**456,150**
2023		19,687	19,687	-	19,301	19,301
2024		20,782	20,782	-	19,975	19,975
2025		21,937	21,937	-	20,672	20,672
2026		23,157	23,157	-	21,393	21,393
2027		24,444	24,444	-	22,140	22,140
2028		25,803	25,803	-	22,913	22,913
2029		27,238	27,238	-	23,712	23,712
2030		28,752	28,752	-	24,540	24,540
2031		30,351	30,351	-	25,396	25,396
2032		32,039	32,039	-	26,283	26,283
2033		33,820	33,820	-	27,200	27,200
2034		35,700	35,700	-	28,149	28,149
2035		37,685	37,685	-	29,132	29,132
2036		39,780	39,780	-	30,149	30,149
2037		41,992	41,992	-	31,201	31,201
2038		44,327	44,327	-	32,290	32,290
2039		46,792	46,792	-	33,417	33,417
2040		49,393	49,393	-	34,583	34,583
2041		52,140	52,140	-	35,790	35,790
2042		55,038	55,038	-	37,039	37,039
2043		58,099	58,099	-	38,332	38,332
2044		61,329	61,329	-	39,670	39,670
2045		64,739	64,739	-	41,054	41,054
2046		68,338	68,338	-	42,487	42,487
2047		72,138	72,138	-	43,970	43,970
2048		76,149	76,149	-	45,505	45,505
2049		80,383	80,383	-	47,093	47,093
2050		84,852	84,852	-	48,737	48,737
2051		89,570	89,570	-	50,438	50,438
2052		94,550	94,550	-	52,198	52,198
2053		99,807	99,807	-	54,020	54,020
2054		105,356	105,356	-	55,905	55,905
2055		111,214	111,214	-	57,857	57,857
2056		117,397	117,397	-	59,876	59,876
2057		123,925	123,925	-	61,966	61,966
2058		130,815	130,815	-	64,128	64,128
2059		138,088	138,088	-	66,367	66,367
2060		145,766	145,766	-	68,683	68,683
2061		153,870	153,870	-	71,080	71,080
2062		162,425	162,425	-	73,561	73,561
2063		171,456	171,456	-	76,128	76,128
2064		180,989	180,989	-	78,785	78,785
2065		191,052	191,052	-	81,535	81,535
2066		201,675	201,675	-	84,381	84,381
2067		212,888	212,888	-	87,326	87,326
2068		224,724	224,724	-	90,374	90,374
2069		237,219	237,219	-	93,528	93,528
2070		250,409	250,409	-	96,792	96,792
2071		264,331	264,331	-	100,171	100,171
			Net Present Value	**$ 437,500**	**$ 2,435,872**	**$ 2,873,372**
				Capital	**O & M**	**TOTAL**

DISTRICT OF LILLOOET								Page 3
OPTION 2 - INFILTRATION WELLS in SETON RIVER FAN								Source Assessment
TOTAL ANNUAL DEMAND	400	ML/yr				last update		August 23, 2022
AVERAGE DAILY DEMAND	1.32	ML/day						
MAXIMUM DAILY DEMAND	2.72	ML/day						
PEAK HOUR DEMAND	2.72	ML/day						
ASSUMPTIONS								
Assumption that infiltration wells will be spaced approx 75 m apart and in the Seton River Fan								
Source capacity increase of up to 40 ML/month (480 ML / year) but expect only to use 200 ML/year								
Power extended from WTP, water main at existing Infiltration wells can be extended								
Output assumed to be duplicate of existing infiltration well production.								
MDD of 35 L/s each, Annual use is lower at 100 ML/yr each								
Pumps changed out after 25 years								
CAPITAL COSTS			**No.**	**Unit**		**Unit Price**		**Extension**
Drill shallow infiltration well - Casing			2	each	$	50,000	$	100,000
200mm dia watermain, Extend from existing well			130	m	$	250	$	32,500
Electrical Power for wells - extend 3 phase from WTP			250	m	$	150	$	37,500
Well Pump - supply and install - pump to WTP (25 hp size)			2	each	$	20,000	$	40,000
Additional UV reactor within WTP - supply			1	LS	$	50,000	$	50,000
Additional UV reactor within WTP - install / commission			1	LS	$	20,000	$	20,000
Siteworks - access			1	LS	$	5,000	$	5,000
Environmental permitting			1	each	$	20,000	$	20,000
Electrical SCADA			1	LS	$	25,000	$	25,000
Building Mechanical			1	LS	$	30,000	$	30,000
Subtotal , Construction Cost Estimate							**$**	**360,000**
Contingency 25%							$	90,000
TOTAL CAPITAL COST							**$**	**450,000**
ANNUAL O & M COSTS								
	$ / kw-hr	$	0.1250	kw-hr				
	Price / 100m lift electricity	$	0.0426					
	Enter Head		25	m				
Pumping Electrical Costs (well up to WTP)	25.00		400,000	m3	$	0.0107	$	4,260
Pumping Electrical Costs (WTP-200m up to 329m)	140.00		400,000	m3	$	0.0596	$	23,856
Operational Costs - Labour			250	hr/year	$	75.00	$	18,750
TOTAL O & M COSTS, YEAR 2022 CDN DOLLARS							**$**	**46,866**

Route for possible well site back to WTP

DISTRICT OF LILLOOET						Page 4
OPTION 2 - INFILTRATION WELLS in SETON RIVER FAN						Source Assessment
						2022-08-23
COMMENTS					PROGRAM INPUT DATA	
Power cost is based on rate of 12.5 cents/kw-hr in current day dollars					**2.00%**	Interest (Discount) rate
Water demand from this source is constant withdrawal over the time period					**4.00%**	Inflation Rate
i.e. does not increase					**1.50%**	Water Demand growth rate
					$ 450,000	Initial Capital Investment
					$ 46,866	Initial Operating Cost
					100	Lifecycle Period
					1.32	Capacity of Option ML/day
					2022	Starting Year
				$ 50,000	Replacement cost for 2 pumps - 2022	
		105.56%		2.00%		
Year	Capital Cost	O&M Cost	Total Annual Cost	Discounted Cap. Cost	Discounted O&M Cost	Discounted Annual Cost
		$	$	$	$	$
2022	**450,000**	**46,866**	**496,866**	**450,000**	**46,866**	**496,866**
2023		49,472	49,472	-	48,502	48,502
2024		52,222	52,222	-	50,195	50,195
2025		55,126	55,126	-	51,946	51,946
2026		58,191	58,191	-	53,759	53,759
2027		61,426	61,426	-	55,636	55,636
2028		64,842	64,842	-	57,578	57,578
2029		68,447	68,447	-	59,587	59,587
2030		72,253	72,253	-	61,667	61,667
2031		76,270	76,270	-	63,819	63,819
2032		80,510	80,510	-	66,047	66,047
2033		84,987	84,987	-	68,352	68,352
2034		89,712	89,712	-	70,737	70,737
2035		94,700	94,700	-	73,206	73,206
2036		99,965	99,965	-	75,761	75,761
2037		105,523	105,523	-	78,405	78,405
2038		111,390	111,390	-	81,142	81,142
2039		117,584	117,584	-	83,974	83,974
2040		124,121	124,121	-	86,905	86,905
2041		131,023	131,023	-	89,938	89,938
2042		138,307	138,307	-	93,077	93,077
2043		145,997	145,997	-	96,326	96,326
2044		154,115	154,115	-	99,687	99,687
2045		162,684	162,684	-	103,167	103,167
2046		171,729	171,729	-	106,767	106,767
2047	133,292	181,277	314,569	81,246	110,494	191,739
2048		191,356	191,356	-	114,350	114,350
2049		201,995	201,995	-	118,341	118,341
2050		213,226	213,226	-	122,472	122,472
2051		225,082	225,082	-	126,746	126,746
2052		237,596	237,596	-	131,170	131,170
2053		250,806	250,806	-	135,748	135,748
2054		264,751	264,751	-	140,486	140,486
2055		279,471	279,471	-	145,389	145,389
2056		295,010	295,010	-	150,463	150,463
2057		311,413	311,413	-	155,715	155,715
2058		328,727	328,727	-	161,150	161,150
2059		347,004	347,004	-	166,774	166,774
2060		366,298	366,298	-	172,595	172,595
2061		386,664	386,664	-	178,619	178,619
2062		408,163	408,163	-	184,853	184,853
2063		430,856	430,856	-	191,305	191,305
2064		454,812	454,812	-	197,982	197,982
2065		480,100	480,100	-	204,891	204,891
2066		506,793	506,793	-	212,043	212,043
2067		534,971	534,971	-	219,443	219,443
2068		564,715	564,715	-	227,102	227,102
2069		596,113	596,113	-	235,029	235,029
2070		629,257	629,257	-	243,232	243,232
2071		664,244	664,244	-	251,721	251,721
		Net Present Value		**$ 531,246**	**$ 6,121,157**	**$ 6,652,403**
				Capital	**O & M**	**TOTAL**

DISTRICT OF LILLOOET								Page 5
OPTION 3 - EXPAND PALL FILTRATION CAPACITY								Source Assessment
TOTAL ANNUAL DEMAND	400	ML/yr				last update		23-Aug-22
AVERAGE DAILY DEMAND	1.32	ML/day						
MAXIMUM DAILY DEMAND	2.72	ML/day						
PEAK HOUR DEMAND	2.72	ML/day						
ASSUMPTIONS								
Pall addition of 8 modules to each of the existing 8 racks of membranes								
Plant capacity of 80 filtration modules - increases up to 120 filtration modules								
Existing flow capacity of 800 ML/year increases to 1200 ML/year								
Quote provided in 2020 factored up by cost of inflation and Prov. Tax added								
For flow from river, added 10m head / elect cost to push water through membranes								
CAPITAL COSTS			**No.**	**Unit**		**Unit Price**		**Extension**
Purchase Pall Filtration skid			1	LS	$	175,000	$	175,000
Install skid units - commission			1	LS	$	175,000	$	175,000
Instrumentation - electrical			1	LS	$	30,000	$	30,000
additional			0	LS	$	-	$	-
Subtotal , Construction Cost Estimate							**$**	**380,000**
Contingency 25%							$	95,000
TOTAL CAPITAL COST							**$**	**475,000**
ANNUAL O & M COSTS								
	$ / kw-hr	$	0.1250	kw-hr				
	Price / 100m lift electricity	$	0.0426					
	Enter Head		25	m				
Pumping Electrical Costs (well to through membranes)	35.00		400,000	m3	$	0.0149	$	5,964
Pumping Electrical Costs (WTP-200m up to 329m)	140.00		400,000	m3	$	0.0596	$	23,856
Operational Costs - Labour			350	hr/year	$	75.00	$	26,250
TOTAL O & M COSTS, YEAR 2022 CDN DOLLARS							**$**	**56,070**

DISTRICT OF LILLOOET						Page 6
OPTION 3 - EXPAND PALL FILTRATION CAPACITY						Source Assessment
						2022-08-23
COMMENTS						
					PROGRAM INPUT DATA	
Power cost is based on rate of 12.5 cents/kw-hr in current day dollars					2.00%	Interest (Discount) rate
Water demand from this source is constant withdrawal over the time period					4.00%	Inflation Rate
i.e. does not increase					1.50%	Water Demand growth rate
					$ 475,000	Initial Capital Investment
					$ 56,070	Initial Operating Cost
					100	Lifecycle Period
					1.32	Capacity of Option ML/day
					2022	Starting Year
				$ 250,000	Repl. membranes at 25 yrs 2022 costs	
		105.56%		2.00%		
Year	Capital Cost	O&M Cost	Total Annual Cost	Discounted Cap. Cost	Discounted O&M Cost	Discounted Annual Cost
	$	$	$	$	$	$
2022	475,000	56,070	531,070	475,000	56,070	531,070
2023		59,187	59,187	-	58,027	58,027
2024		62,478	62,478	-	60,052	60,052
2025		65,952	65,952	-	62,148	62,148
2026		69,619	69,619	-	64,317	64,317
2027		73,490	73,490	-	66,562	66,562
2028		77,576	77,576	-	68,885	68,885
2029		81,889	81,889	-	71,289	71,289
2030		86,442	86,442	-	73,778	73,778
2031		91,248	91,248	-	76,353	76,353
2032		96,322	96,322	-	79,017	79,017
2033		101,677	101,677	-	81,775	81,775
2034		107,330	107,330	-	84,629	84,629
2035		113,298	113,298	-	87,583	87,583
2036		119,597	119,597	-	90,640	90,640
2037		126,247	126,247	-	93,803	93,803
2038		133,266	133,266	-	97,077	97,077
2039		140,676	140,676	-	100,466	100,466
2040		148,498	148,498	-	103,972	103,972
2041		156,754	156,754	-	107,601	107,601
2042		165,470	165,470	-	111,356	111,356
2043		174,670	174,670	-	115,243	115,243
2044		184,381	184,381	-	119,265	119,265
2045		194,633	194,633	-	123,428	123,428
2046		205,455	205,455	-	127,735	127,735
2047	666,459	216,878	883,337	406,227	132,194	538,421
2048		228,936	228,936	-	136,808	136,808
2049		241,665	241,665	-	141,582	141,582
2050		255,102	255,102	-	146,524	146,524
2051		269,285	269,285	-	151,638	151,638
2052		284,258	284,258	-	156,930	156,930
2053		300,062	300,062	-	162,407	162,407
2054		316,746	316,746	-	168,076	168,076
2055		334,357	334,357	-	173,942	173,942
2056		352,947	352,947	-	180,013	180,013
2057		372,571	372,571	-	186,296	186,296
2058		393,286	393,286	-	192,798	192,798
2059		415,153	415,153	-	199,527	199,527
2060		438,235	438,235	-	206,491	206,491
2061		462,601	462,601	-	213,698	213,698
2062		488,321	488,321	-	221,156	221,156
2063		515,472	515,472	-	228,875	228,875
2064		544,132	544,132	-	236,863	236,863
2065		574,386	574,386	-	245,130	245,130
2066		606,322	606,322	-	253,686	253,686
2067		640,034	640,034	-	262,540	262,540
2068		675,619	675,619	-	271,703	271,703
2069		713,184	713,184	-	281,186	281,186
2070		752,837	752,837	-	291,000	291,000
2071		794,695	794,695	-	301,156	301,156
			Net Present Value	**$ 881,227**	**$ 7,323,289**	**$ 8,204,517**
				Capital	**O & M**	**TOTAL**

DISTRICT OF LILLOOET Page 7

OPTION 4 - DICKEY CREEK - RE-ACTIVATE SOURCE, ADD UV Source Assessment

last update August 23, 2022

TOTAL ANNUAL DEMAND	400 ML/yr			
AVERAGE DAILY DEMAND	1.32 ML/day	15.2 L/s (242 USgpm)	assumes 10 mo. /year	
MAXIMUM DAILY DEMAND	3.26 ML/day	37.8 L/s (600 USgpm)		
PEAK HOUR DEMAND	3.26 ML/day	37.8 L/s (600 USgpm)		

ASSUMPTIONS

Plant is run for 10 months per year when turbidity is below 1.0 NTU
Only 1 UV reactor is priced out in this option
Controls designed to be located below at theh site of the existing PRV station
Capacity of source could be up to 500 ML/year
Room in new space for additional filters and for 2 UV reactors, (Included in this comparative estimate)

CAPITAL COSTS	**No.**	**Unit**		**Unit Price**		**Extension**
Flow monitoring weir with recording pressure transducer	1	each	$	25,000	$	25,000
Add radio link and repeater for communications/instrumentation	2	per site	$	20,000	$	40,000
Power supply (hydro-generation or batteries for instrumentation)	1	LS	$	25,000	$	25,000
WQ Monitoring devices, supply/install- UVT, pH, conductivity, press tranducer	5	ea	$	5,000	$	25,000
Road and Siteworks (upgrade allowance)	1	LS	$	50,000	$	50,000
Adjustments to Intake structure - safety - railings	1	LS	$	25,000	$	25,000
Building enclosure for equipment - at PRV station site	40	m2	$	2,500	$	100,000
UV disinfection reactors supply (1) (with room to add second)	1	each	$	60,000	$	60,000
UV disinfection reactors install	1	each	$	30,000	$	30,000
Process piping to accommodate reactors	1	LS	$	75,000	$	75,000
Flow meter - 150mm dia - existing	1	each	$	5,000	$	5,000
Electrical - Instrumentation SCADA - labour - materials	1	ea	$	50,000	$	50,000
Building Mechanical	1	LS	$	25,000	$	25,000
Subtotal , Construction Cost Estimate					**$**	**535,000**
Contingency 25%					$	133,750
TOTAL CAPITAL COST					**$**	**668,750**

ANNUAL O & M COSTS							
	$ / kw-hr	$	0.1250	kw-hr			
	Price / 100m lift electricity	$	0.0426				
	Enter Head		0	m			
Pumping Electrical Costs (none)	0.00		-	m3	$	0.0635	$ -
UV Lamps - Electricity, lamps	304 days		7,300	hr/year	$	0.60	$ 4,380
Operational Costs - Labour, access, cleaning			400	hr/year	$	75.00	$ 30,000
TOTAL O & M COSTS, YEAR 2022 CDN DOLLARS							**$ 34,380**

DISTRICT OF LILLOOET Page 8
OPTION 4 - DICKEY CREEK - RE-ACTIVATE SOURCE, ADD UV Source Assessment
August 23, 2022

COMMENTS

PROGRAM INPUT DATA

Power cost is based on rate of 12.5 cents/kw-hr in current day dollars — **2.00%** Interest (Discount) rate
Water demand from this source is constant withdrawal over the time period — **4.00%** Inflation Rate
i.e. does not increase — **1.50%** Water Demand growth rate
$ 668,750 Initial Capital Investment
$ 34,380 Initial Operating Cost
100 Lifecycle Period
1.32 Capacity of Option ML/day
2022 Starting Year

		Escalation				
		105.56%		2.00%		
Year	Capital Cost	O&M Cost	Total Annual Cost	Discounted Cap. Cost	Discounted O&M Cost	Discounted Annual Cost
		$	$	$	$	$
2022	**668,750**	**34,380**	**703,130**	**668,750**	**34,380**	**703,130**
2023		36,292	36,292	-	35,580	35,580
2024		38,309	38,309	-	36,822	36,822
2025		40,439	40,439	-	38,107	38,107
2026		42,688	42,688	-	39,437	39,437
2027		45,061	45,061	-	40,813	40,813
2028		47,567	47,567	-	42,238	42,238
2029		50,211	50,211	-	43,712	43,712
2030		53,003	53,003	-	45,238	45,238
2031		55,950	55,950	-	46,816	46,816
2032		59,061	59,061	-	48,450	48,450
2033		62,345	62,345	-	50,141	50,141
2034		65,811	65,811	-	51,892	51,892
2035		69,470	69,470	-	53,703	53,703
2036		73,333	73,333	-	55,577	55,577
2037		77,410	77,410	-	57,517	57,517
2038		81,714	81,714	-	59,524	59,524
2039		86,257	86,257	-	61,602	61,602
2040		91,053	91,053	-	63,752	63,752
2041		96,116	96,116	-	65,977	65,977
2042		101,460	101,460	-	68,279	68,279
2043		107,101	107,101	-	70,663	70,663
2044		113,056	113,056	-	73,129	73,129
2045		119,342	119,342	-	75,681	75,681
2046		125,977	125,977	-	78,323	78,323
2047		132,981	132,981	-	81,056	81,056
2048		140,375	140,375	-	83,885	83,885
2049		148,180	148,180	-	86,813	86,813
2050		156,419	156,419	-	89,843	89,843
2051		165,116	165,116	-	92,979	92,979
2052		174,296	174,296	-	96,224	96,224
2053		183,987	183,987	-	99,582	99,582
2054		194,216	194,216	-	103,058	103,058
2055		205,015	205,015	-	106,655	106,655
2056		216,414	216,414	-	110,377	110,377
2057		228,446	228,446	-	114,229	114,229
2058		241,148	241,148	-	118,216	118,216
2059		254,556	254,556	-	122,342	122,342
2060		268,709	268,709	-	126,612	126,612
2061		283,649	283,649	-	131,031	131,031
2062		299,420	299,420	-	135,605	135,605
2063		316,068	316,068	-	140,337	140,337
2064		333,641	333,641	-	145,235	145,235
2065		352,192	352,192	-	150,304	150,304
2066		371,774	371,774	-	155,550	155,550
2067		392,444	392,444	-	160,979	160,979
2068		414,264	414,264	-	166,598	166,598
2069		437,297	437,297	-	172,412	172,412
2070		461,611	461,611	-	178,430	178,430
2071		487,277	487,277	-	184,658	184,658
		Net Present Value		**$ 668,750**	**$ 4,490,364**	**$ 5,159,114**
				Capital	**O & M**	**TOTAL**