FSCI **Biological Consultants**

April 10, 2022 Our File No.: FSCI-20-0015

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V0N 3A1

Re: Initial Environmental Flow Needs (EFN) review using the BC Environmental Risk Management Framework for Chapman Creek (WSC: 900-120400)

Dear Remko:

In 2016, in consultation with the BC Ministry of Forests, Lands and Natural Resource Operations and Rural Development (FLNRORD), the SCRD amended its instream flow release (IFR) for Chapman Creek. The agreed instream flow was set at 0.20 m^3/s and was based on an estimated flow required to facilitate adult Pink salmon migration (*Bates*, 2016). This IFR was subsequently referred to as the Environmental Flow. While referred to as the EFN, the determination of the IFR was not set using the newly introduced EFN Policy (Spring 2016) within the newly released Water sustainability Act.

In 2020, the SCRD elected to revisit the current IFR and has proposed reducing the instream flow from 0.20 to 0.16 m^3/s for June and July and 0.18 m^3/s for August and September, agreeing that increased release could occur is conditions in a particular year create unsuitable conditions for rearing juvenile salmonids or adults returning to spawn. The months of October through May would not have any required IFR release, removing the current 0.20 m^3/s from the water license. This proposed change would allow for a smaller volume release at Chapman Lake, “retaining/storing” water in the lake for future potable water demands during the summer.

In order to re-negotiate a lower flow release from Chapman Lake ***FSCI*** Biological Consultants began a more formal review of the environmental flow needs for Chapman Creek. This process outlined under the Provincial Water Sustainability Act must be completed in support of any establishment or amendment of an existing EFN and follows a process outlined in the Provincial EFN Policy. The EFN Policy applies to all applications and amendments to water use licenses and uses an environmental risk framework.

This document summarizes the results of the EFN process and policy using existing hydrologic data and the process detailed in *Hatfield* et al (2016). Assumptions presented are provide direction as the SCRD continues to balance domestic water use and protection of aquatic values in the lower anadromous length of Chapman Cheek.

Background

Chapman Creek is the principle potable water source for the lower sunshine coast, providing water to approximately 20,000 residents. In a typical year, snow and rainfall ensure the headwater lakes (Chapman and Edwards) are full and stored water is allowed to flow, unimpeded over the dam structures. As water use increases and the lakes drop below the dam sills, the SCRD releases water to ensure flows for both potable water and the river. The combined capacity of Chapman and Edwards Lakes is approximately 1.7 million m^3 (*AECOM*, 2016).

In drier years, Chapman and Edwards Lakes, have been drawn to within their maximum permitted levels, resulting in Stage 4 water restrictions and severe curtailment of use. During these years severe water restriction, the SCRD must ensure a minimum instream flow (IFR) below their water intake to safely support and maintain resident and anadromous salmonid populations, maintain aquatic habitat function and provide potable water for the Sunshine Coast residents.

At the present time, the SCRD water licenses allow a total of 0.39 m^3/s to be diverted. In addition, they must provide a minimum IFR, below the intake, of 0.20 m^3/s (Water License No.: C016599, 22345, 65258, 69217, 69999 and C107474). This IFR volume, set in 2016, was recommended to facilitate adult Pink salmon (*Oncorhynchus gorbuscha*) migration (*Bates*, 2016) as they enter in August and early September. At that time, the proposed instream flow of 0.20 m^3/s was considered acceptable for support and protection of rearing juvenile anadromous salmonids, where lower instream flows had, in the past occurred and not had a documented impact of juvenile salmonids (SIB, unpubl).

In recent years the minimum flow threshold has become challenging when balancing the lake drawdown and population needs. In particular, during a dry low snowpack (2019) where water demand was high and snow/rainfall scarce hampering the re-charge of Chapman and Edwards Lakes. In order to help facilitate and provide more flexibility in managing storage on Chapman Creek, it has been proposed that the minimum release, below the intake, during the late spring and summer be reduced to 0.16 (June and July) and 0.18 (August and September) m^3/s.

This variable IFR (0.16 - 0.18 m^3/s), while seemingly low, is consistent with the 10-yr 7-day low flow estimates for June through September (*Ahmed*, 2017), expected in a drier than “normal” years. While the 0.16 m3/s appears low, its anticipated that the baseflows would be higher when the watershed contributions below the lake are considered. Certainly, the question of going lower will be raised for the later part of the summer but in dropping instream flows further than 0.18 m^3/s in August and September, the risk of measurable impacts to fish and fish habitat is expected to increase, placing the SCRD in a position that would require long-term compensation from regulators, with associated costs and risks.

The proposed reduction in IFR would include June through September, with compliance monitoring continuing at the SCRD creek monitoring station below the intake. The important metrics will be water temperature, rearing salmonid behaviour and adult access above Reach 2 (above the hatchery diversion). Presently, water temperature is being monitored at 5 locations within the anadromous length of stream. This data will be summarized following the completion of the 2021 calendar year. Rearing salmonid behaviour including stranding risk monitoring has been proposed at two locations in Reach 3 and 4 (see map). Details to be provided in a proposed monitoring report. The focus of the monitoring of salmonid behaviour and response to seasonal low flows, will concentrate on August and September of each year.

In order to “apply” for an amendment to the current interim water license, the Province of BC requires a review of environmental flow needs, as defined under the Environmental Flow Needs (EFN) Policy and the Water Sustainability Act.

The Provincial EFN policy provides an initial coarse screening for assessing risk to the environmental. The specific objectives are intended to avoid fish-flow conflicts and evaluate location specific ecological risk to streams where water diversion is proposed. This process is a risk-based assessment that considers fish presence/absence, baseline hydrologic conditions and the size of a stream in the analysis (**Figure 1**). The framework, which best suits streams prior to significant changes and diversions includes the following steps.

- Identifying the Area of Influence (AOI)
- Application risk
- Fish bearing status including sensitive species,
- Flow sensitivity
- Size of the target stream,
- Proposed cumulative withdrawal within the AOI
- Preliminary Risk Ratings.

The purpose of this document is to apply the EFN framework to current and proposed water needs, specifically for supporting fisheries values, and to determine the period of highest risk to the downstream, anadromous portion of Chapman Creek. This will direct further examination and monitoring of reduced/base flow during the highest risk periods.

Area of Influence

Chapman Creek is a moderate sized coastal watershed that drains from the Tetrahedron Park area to the Salish Sea (**Figure 2**). The total watershed area is approximately 63.1-km^2, with a median elevation of 978-m at the former Water Survey of Canada (WSC) Station 08GA060 above the current intake as the terminus point. (**Figure 2**). The SCRD point of diversion (POD) is immediately downstream of this station.

The study area or area of influence (AOI) for this review is the length of lower Chapman Creek that extends from the falls below the SCRD water intake downstream to the intake location for the hatchery. This length of Chapman Creek extends approximately 5800-m and consists of 5 reaches (**Figure 2**). Future detailed assessment and monitoring will target the most important and productive reaches, namely; Reaches 3, 4 and 5. These stream lengths support the majority of the rearing and spawning habitats and a significant portion of Reach 5 is dominated by bedrock canyon and associated macrohabitats. Reach 1 and 2, while providing some spawning and rearing habitats has been channelized and modified anthropogenically since the 1950’s, including water diversion for the hatchery.

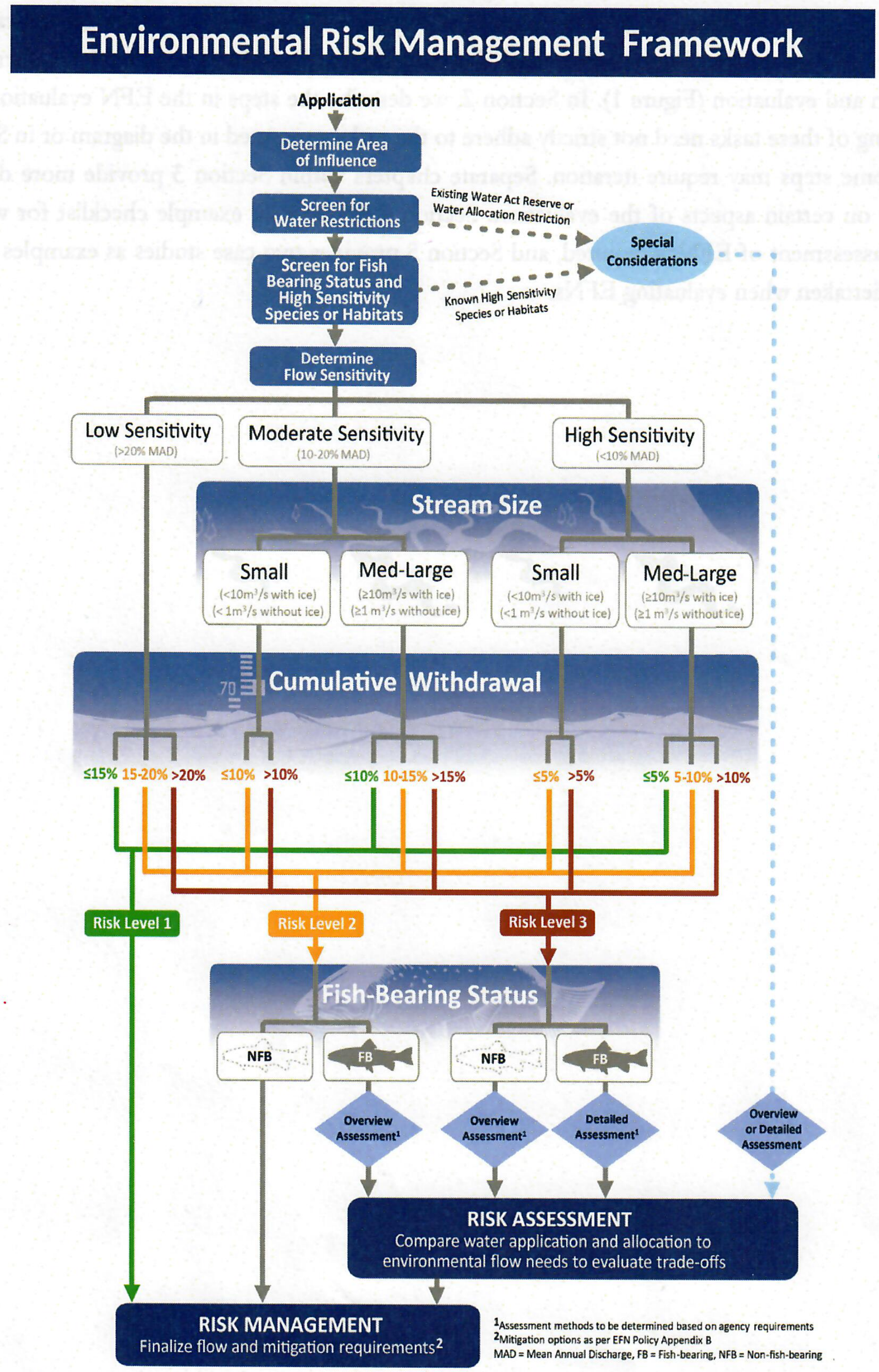

Figure 1: Information review and decision-making process chart for considering the Environmental Flow Needs within the Water Sustainability Act (*Hatfield* et al, 2016).

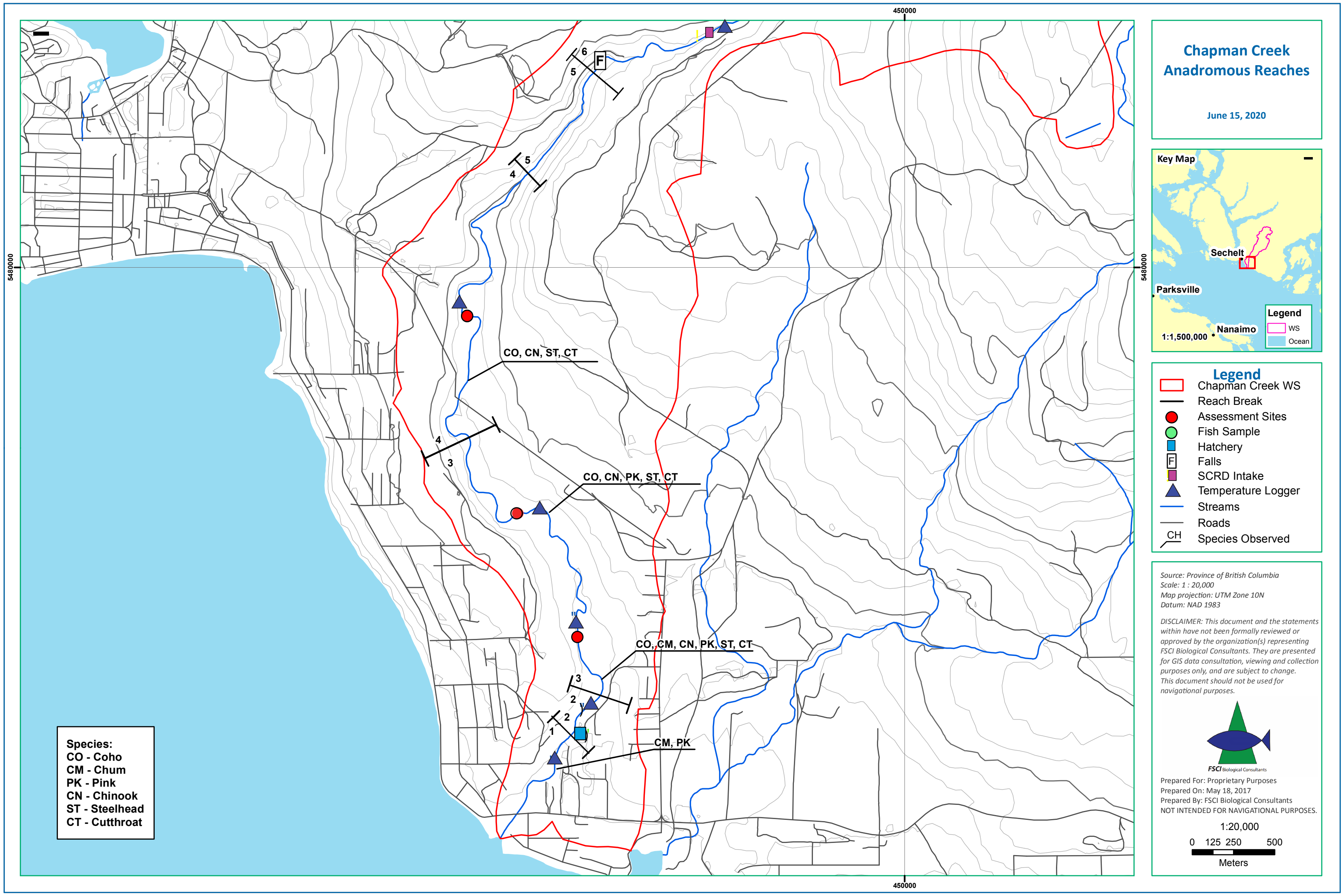

Figure 2: Chapman Creek (WSC: 900-120400) near Sechelt, BC. The reach breaks are shown along with proposed and current monitoring locations. Reaches 3 and 4 present the areas of the most valuable fish habitat.

Fisheries Values

The health of a stream ecosystem is assessed on a variety of characteristics and features. While it is recognized that characteristics like changes in water chemistry and macroinvertebrate diversity may be used as a metric of watershed health, identification of rearing salmonid populations is a more prevalent metric.

The current EFN Policy relies heavily on fish presence/absence in stream reaches potentially affected by water diversion. The species presence and required rearing duration must be considered in the risk assessment.

Chapman Creek is divided into anadromous and non-anadromous reaches. The portion of Chapman that is of concern is the anadromous length (5800-m) of Chapman Creek below the anadromous barrier (below the POD). This length of the stream supports 4 species of Pacific salmon and 2 species of anadromous trout. **Table I** summarizes the species present, life history stage and in river timing for various life stage flow requirements.

In reviewing **Table I** is should be noted that the important species and life history requirements vary and for the purpose of the EFN the important life stages that overlap with the critical summer flow periods are Coho salmon, Steelhead and Cutthroat trout juvenile rearing and Pink salmon adult migration. While Pink salmon do tend to migrate upstream in August and September (along with a small number of Chinook salmon), these populations are of hatchery origin and historically present in Chapman Creek in very low numbers. In recent years returns from the hatchery efforts have been lower, but regardless of the escapement, the instream flow must ensure returning adults can access upstream spawning area. In the event, flow is not adequate to facilitate upstream movement, additional flows may have to be released (*Bates*, 2017). This is specifically targeting Pink Salmon returns in odd years (south coast dominant return tears).

Flow Sensitivity

Available and consistent flow data for Chapman Creek varies depending on the source organizations, which include Water Survey Canada, BC Ministry of Environment and Climate Change Strategy and the Sunshine Coast Regional District. In recent years, the SCRD has monitored water flow at both the lake and below the domestic source intake. The in-river monitoring of flow below the intake ensures minimum instream flow volumes are met, ensuring fish and fish habitat values (including riparian) are protected at reduced seasonal flows.

In order to complete a flow sensitivity analysis, flow data was selected from *Ahmed* (2017) and *Obedkoff* (2003) using the WSC records between 1970 and 1988. Data was collected at station 08GA060 located above the current SCRD intake. The proximity of this station to Chapman falls, the anadromous passage barrier, is considered very close to justify the use of the data for this analysis.

This initial flow analysis is calculated using the Mean Annual Discharge (MAD) of 4.37 m^3/s and yearly flow distribution from 2017 (*Ahmed*, 2017). Monthly flow distribution is also included from *Obedkoff* (2003) for comparison. In addition, to the estimated yearly

Table I: Generalized life history table for anadromous salmonids found in Chapman Creek (WSC: 900-120400).

Species	Life Stage Activity	J	F	M	A	M	J	J	A	S	O	N	D
Coastal Cutthroat trout	Migration												
	Spawning												
	Incubation												
	Rearing*												
	Smolt Out												
Steelhead trout	Migration												
	Spawning												
	Incubation												
	Rearing*												
	Smolt Out												
Coho salmon	Migration												
	Spawning												
	Incubation												
	Rearing**												
	Smolt Out												
Chum salmon	Migration												
	Spawning												
	Incubation												
	Rearing												
	Smolt Out												
Pink salmon+	Migration												
	Spawning												
	Incubation												
	Rearing												
	Smolt Out												
Chinook salmon+	Migration												
	Spawning												
	Incubation												
	Rearing												
	Smolt Out												

Note:

*Juvenile Cutthroat and Steelhead rear in the mainstem for 2 years before smolting and migrating.
**Coho juveniles rear for a year in the mainstem before smolting and migration out of the river.
+ Pink and Chinook salmon are introduced into Chapman Creek by the local Sunshine Coast Salmonid Enhancement Society. The Pink salmon are an odd year run.

MAD, the analysis was also run using the estimated 10-yr low flow MAD of 3.33 m^3/s (*Ahmed*, 2017).

The flow sensitivity under the EFN policy is used to determine or describe the level of risk associated with water withdrawal (*Hatfield*, et al, 2016). Sensitivity is determined for each calendar month and is based on whether the average monthly flows are >20% mean annual discharge (low sensitivity), 10-20% MAD (moderate sensitivity) or <10% MAD (high sensitivity). A ratio of monthly to annual greater than 20% is considered to have a low sensitivity (*Hatfield* et al, 2016)

To determine the flow sensitivity and potential effects of withdrawal, the "expected" flow for Chapman Creek was determined at the POD. The flow was established using monthly distribution (*Ahmed*, 2017; *Obedkoff*, 2003).

Using these relationships, the individual monthly discharge at the SCRD intake and subsequently, lower Chapman Creek were calculated. **Table II and III** summarize the data and present mean monthly discharge for the expected average and for the 1-in-10-yr low flow average. These values are then applied to the EFN process to sensitivity of Chapman Creek to water withdrawal (**Table II**) and the sensitivity after water withdrawals for domestic use and I stream flows to support fish and fish habitat (**Table III**).

The process for this analysis varies slightly. In **Table III** the diversion amounts are shown for 3 periods. The critical flow period of June through July has been reduced from the current 0.20 m^3/s to 0.16 m^3/s, the period August and September from 0.20 m^3/s to 0.18 m^3/s and from October through May from 0.20 m^3/s to 0.0 m^3/s. These water volumes are the effective IFR and area added back into the natural predicted volume recorded at the WSC Station. This approach is used because the water can be released from the lake by the SCRD and is therefore over and above what the watershed is expected to produces naturally.

Cumulative Withdrawal

The assessment uses the current SCRD water treatment plant design capacity as the target withdrawal. This amount, is 0.28 m^3/s, less than the current licensed volume of 0.39 m^3/s.

In this analysis, the flow presented represents the volume of water required to pass below the SCRD POD to "support" aquatic values in the lower river. instream flow needs.

The targeted instream requirement is proposed to be 0.18 m^3/s below the POD. This volume has been added back into the remaining flow, estimated to be available from the "natural" flow, after SCRD withdrawal and the volume that the SCRD can control from the source (Chapman Lake).

Table II: The natural flow, expressed as a percentage of the total average annual, for Chapman Creek above the POD (SCRD intake). Percentage data is from *Ahmed* (2017) and *Obedkoff* (2003) and is based on flow data collected at WSC Station 08GA060 between 1970 and 1988. The monthly percentages are applied to the total mean annual flows using the long-term mean annual discharge (LTMAD) of 4.37 m^3/s, the 10-yr low annual mean discharge of 3.33 m^3/s (*Ahmed*, 2017) and 10-yr high annual mean discharge of 5.21 m^3/s (*Ahmed*, 2017), above the POD. Flow sensitivity is then determined using the Provincial Environmental Risk Management framework (BCMECCS, 2016).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly Distribution (%) (*Ahmed*, 2017)	9	10	9	9	17	12	5	1	3	10	10	9
Monthly Distribution (%) (*Obedkoff*, 2003)	8	7	8	9	14	12	6	2	3	8	11	11
Mean Monthly Q (m^3/sec) (*Ahmed*, 2017)	5.04	5.60	5.04	5.04	9.53	6.72	2.80	0.56	1.68	5.60	5.60	5.04
Mean Monthly Q (m^3/sec) (*Obedkoff*, 2003)	4.45	3.92	4.45	5.04	7.84	6.72	3.36	1.12	1.68	4.45	6.16	6.16
10-yr Low Flow Monthly Q (m^3/sec) (*Ahmed*, 2017)	3.60	4.00	3.60	3.60	6.79	4.79	2.00	0.40	1.20	4.00	4.00	3.60
10-yr High Flow Monthly Q (m^3/sec) (*Ahmed*, 2017)	5.63	6.25	5.63	5.63	10.63	7.50	3.13	0.62	1.88	6.25	6.25	5.63
Ratio - Monthly/MAD (%) (*Ahmed*, 2017)	115	128	115	115	218	154	64	13	38	128	128	115
Ratio - Monthly/MAD (%) (*Obedkoff*, 2003)	103	90	102	115	179	154	77	26	38	102	141	141
Ratio – 10-yr Low Monthly Flow/MAD (%) (*Ahmed*, 2017)	108	120	108	108	204	144	60	12	36	120	120	108
Sensitivity (*Ahmed*, 2017)	Low	Low	Low	Low	Low	Low	Low	Mod	Low	Low	Low	Low
Sensitivity (*Obedkoff*, 2003)	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Sensitivity - 10-yr Low (*Ahmed*, 2017)	Low	Low	Low	Low	Low	Low	Low	Mod	Low	Low	Low	Low

Table III: Estimated cumulative withdrawal under the current license allowing diversion for potable water. The IFR (Instream Flow Release) is the amount of water that must be provided below the intake to sustain rearing anadromous salmonids. This IFR amount is currently 0.20-cms throughout the year. The proposed change in the IFR is reflected by eliminating a required IFR until late spring and summer months (June through September) allowing for retaining water within Chapman Lake. The Risk Management Level highlights the possible need to complete a more detailed assessment that considers quantitative changes in available habitat below the point of diversion.

Licensed Amount (m^3/s)	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
C016599, 22345, 65258, 69217, 69999, C107474	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
Current IFR	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Proposed Change to IFR	0.00	0.00	0.00	0.00	0.00	0.16	0.16	0.18	0.18	0.00	0.00	0.00
New Total for Use and IFR	**0.39**	**0.39**	**0.39**	**0.39**	**0.39**	**0.55**	**0.55**	**0.57**	**0.57**	**0.39**	**0.39**	**0.39**
“Natural” Flow at Intake (m^3/s)	**5.04**	**5.60**	**5.04**	**5.04**	**9.53**	**6.72**	**2.80**	**0.56**	**1.68**	**5.60**	**5.60**	**5.04**
10-yr Low Flow (m^3/s) (*Ahmed*, 2017)	**3.60**	**4.00**	**3.60**	**3.60**	**6.79**	**4.79**	**2.00**	**0.40**	**1.20**	**4.00**	**4.00**	**3.60**
Design Capacity of SCRD Treatment Plant (m^3/s)**	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
Deliberate IFR release from lake during summer low flow period providing base flow at intake	0.00	0.00	0.00	0.00	0.00	0.16*	0.16*	0.18*	0.18*	0.00	0.00	0.00
WR Ratio using 10-yr low flow (%)	8	7	8	8	4	6	13	48	20	7	7	8
Species Sensitivity	Juvenile salmonids rearing all months											
Flow Sensitivity (*Ahmed*, 2017)	Low	Low	Low	Low	Low	Low	Low	Mod	Low	Low	Low	Low
Stream Size	Medium-Large											
Risk Management Level	1	1	1	1	1	1	1	3	2	1	1	1

Table III: Continued

Risk Management Level

1. Sufficient "natural" water availability for the prosed withdrawal period and cumulative water withdrawals are below a specified threshold. This does not mean no risk, and requires monitoring and possible adaptive management strategies during years where watershed re-charging falls outside the normal.
2. Aquatic environment is flow-limited during the withdrawal period. Adaptive management strategy required to ensure water release can occur when needed.
3. Aquatic environment is very flow-limited and rigorous review and monitoring may be required. Adaptive management strategy required to ensure water release can occur when needed.

* Additional water released from storage (Chapman Lake) that matches the proposed EFN. This volume in fish bearing reaches may be higher if natural contribution changes.

Risk Assessment

The EFN policy provides a risk management framework with risk broken into three levels. These levels are described as:

- Risk 1 – a period in which sufficient natural flows are available for the proposed withdrawal and that cumulative withdrawals are below a specified threshold.

- Risk 2- aquatic environment is where the aquatic environment is flow-limited for the proposed withdrawal period. Or cumulative withdrawal is greater than threshold of concern.

- Risk 3 – the aquatic environment is very flow limited.

In reviewing the risk levels for lower Chapman Creek below the POD (**Table III**), the level is considered low at Risk 1, suggesting adequate flows exist through the months of October to July. Then, depending on the year, August has a Risk 3 and September, Risk 2, suggesting withdrawal may have an influence on the available habitat in the river. In this case accessible juvenile rearing habitat, although in Pink salmon return years adequate flow for upstream migration may be critical. Certainly, the most critical month remains as August, shown as Risk 3 confirming that the aquatic environment is flow limited.

Summary

The dominant factor for the final risk assessment is fish and fish habitat, but it is also recognized that the EFN process is intended to address ecological linkages. These other linkages, such as sensitive riparian areas (i.e., floodplain cottonwood forests), off-channel rearing areas and wetlands, are not an issue in lower Chapman Creek. Therefore, the main focus of the EFN risk assessment focuses on fish and their required habitat.

The results of the EFN Risk analysis are not surprising. It's generally understood that the summer months provide limited flow for supporting rearing salmonids and therefore the bottleneck to stream salmonid production. This is characteristic of most BC south coastal streams.

Given the results, the following summarizes and suggests next steps.

- The use of the 10-yr low flow average and associated mean annual discharge (MAD) represents an expected low period and period that could occur frequently. Whether the use of the 10-yr is more appropriate that the 20-yr can be considered (**Table II**). Certainly, using the yearly average rather that the 10-yr average provides a different picture and may not truly represent current or changing conditions in this area. This may require additional consultation with the regulator.

  Regardless of whether the 10-yr low flow or the higher long term mean annual discharge (LTMAD) is used for the risk analysis, it is obvious that the Risk period and need for a designated IFR (EFN) remains.

- The purpose of the EFN review process is to evaluate and assign a risk to a proposed EFN. The SCRD is seeking to reduce the EFN from 0.20 to 0.16 and 0.18 m^3/s during the most storage critical period, June through September. The environmental flow of 0.16 and 0.18 m^3/s is achievable using the operation and controlled release from Chapman Lake and monitoring of the flow at the intake. While the proposed change in the summer months is relatively small, it represents a significant water volume to conserve in the lake for community use.

- The risk to Chapman Creek from withdrawal for domestic use between October and July is low (**Risk 1**). While less of a concern, ongoing monitoring during potential low flow periods in the winter (February) and unusually dry late spring early summer is recommended. Monitoring of base flows would continue at the SCRD gauging site below the intake and/or may also be achieved by monitoring flows near the hatchery (Reach 3). In the event winter or late spring/early summer flows drop below the EFN, options to increase the base flows through diversion of flows from the intake are theoretically possible. This assumes, during the winter, that access and operations of the flow release at the lake are not frozen or inaccessible.

  As noted above, it is not anticipated flow augmentation will be necessary for the months of October to June. Using the results of the EFN and risk assessment, it appears late spring and early summer (June and July) release of 0.16 m^3/s provides a buffer with natural flows and sustains protective flow regime. The proposed reduction during August and September will prove the most critical period, regardless of the release volume and during this time, the SCRD will require diligent monitoring

  While a reduced environmental flow is not expected to result in irreparable harm to fish and fish habitat, the SCRD should develop a monitoring plan that will provide an adaptive approach to ensuring protection of fish and fish habitat. This may require a commitment to divert water from the intake to the river and/or increase release from the lake. The SCRD has indicated that they are willing to commit to such adaptive approach.

- The proposed reduction in EFN, may be accompanied with an appropriate monitoring plan for Chapman Creek. This plan would focus on changes in available habitat quantity and quality with emphasis on stranding and thermal stress. Specific metrics may include spatial changes, including lateral channel habitats, isolation of off-channel habitats (considered low as the main off channel is man-made with flow control) and water temperature and associated relationships.

Conclusion/Recommendation

While the analysis suggests, a reduction (0.20 to 0.16 and 0.18 m^3/s) of instream or environmental flow is possible, there should be some expectation of habitat reduction (*Bates*, 2021). If the reduced EFN, and restricted to June through September, is agreed to by regulators, a precautionary approach must be adopted by the SCRD with commitment to accept a monitoring plan(s) with “triggers” for response if decreased flows appear to be detrimentally affecting fish and fish habitat.

At the basic level, the response would be increased base flows.

References

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Hatfield, T, Perkins, T, Cathcart, J, Faulkner, S., Harwood, A., Alexander, C., and Lewis, A. 2016. Environmental flow needs implementation guidance for British Columbia. BC Ministry of Environment, Water Protection and Sustainability Branch. Victoria, BC.

Obedkoff, W. 2003. Streamflow in the Lower Mainland and Vancouver Island. Aquatic Information Branch, BC Ministry of Sustainable Resource Management, Victoria, BC.

Closure

Services performed by ***FSCI*** Biological Consultants for this report have been conducted in a manner consistent with the level of skill ordinarily exercised by members of the fisheries profession practicing under similar conditions in the area in which the services are provided. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this letter. No warranty or guarantee, express or implied is made concerning the results, comments, recommendation, or any other part of this report.

Respectfully submitted

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