Cheakamus Project Water Use Plan

Monitoring Programs Annual Report: 2020

Implementation Period: November 2019 to October 2020

- **CMSMON-1A Cheakamus River Juvenile Salmonid Outmigrant Enumeration Monitoring**
- **CMSMON-1B Cheakamus River Chum Salmon Escapement Monitoring and Mainstem Spawning Groundwater Survey**
- **CMSMON-2 Trout Abundance Monitor in Cheakamus River (Daisy Lake Dam to Cheakamus Canyon)**
- **CMSMON-3 Cheakamus River Steelhead Adult Abundance, Fry Emergence-timing, and Juvenile Habitat Use and Abundance Monitoring**
- **CMSMON-4 Monitoring Stranding Downstream of Cheakamus Generating Station**
- **CMSMON-5 Monitoring Stranding Downstream of Daisy Lake Dam**
- **CMSMON-6 Monitoring Groundwater in Side Channels of the Cheakamus River**
- **CMSMON-7 Cheakamus River Benthic Community Monitoring**
- **CMSMON-8 Monitoring Channel Morphology in Cheakamus River**
- **CMSMON-9 Cheakamus River Recreational Angling Access Monitoring**

For Conditional Water Licences 110107 and 114268

November 30, 2020

BC Hydro Cheakamus Project Water Use Plan Monitoring Programs Annual Report: 2020

1 Introduction

This document represents a summary of the status and the results of the Cheakamus Project Water Use Plan (WUP) monitoring programs to October 31, 2020, as per the Cheakamus Order under the *Water Act,* dated February 17, 2006. There are ten monitoring programs and no physical works.

2 Status

The following table outlines the dates that Terms of Reference (TOR) for the Cheakamus WUP monitoring programs were submitted to and approved by the Comptroller of Water Rights (CWR).

Table 2-1: Dates of Cheakamus WUP TOR Submissions and Approvals by the Comptroller of Water Rights

Monitoring Program & Physical Works TOR	Order Clause	Original ToR Submission		Most Recent ToR Resubmission	
		Date Submitted	Date Approved	Date Submitted	Date Approved
CMSMON-1A Cheakamus River Juvenile Salmonid Outmigrant Enumeration Monitoring	Clause 4.i	Nov 20, 2006	Nov 26, 2006	Dec 13, 2012	Dec 18, 2012
CMSMON-1B Cheakamus River Chum Salmon Escapement Monitoring and Mainstem Spawning Groundwater Survey	Clause 4.i	Feb 23, 2007	Mar 22, 2007	Nov 30, 2017	Dec 12, 2017
CMSMON-2 Trout Abundance Monitor in Cheakamus River	Clause 4.ii	Feb 23, 2007	Mar 22, 2007	Sep 23, 2015	Nov 18, 2015
CMSMON-3 Cheakamus River Steelhead Adult Abundance, Fry Emergence-timing, and Juvenile Habitat Use and Abundance Monitoring	Clause 4.iii	Feb 23, 2007	Mar 22, 2007	Jan 31, 2018	Feb 14, 2018
CMSMON-4 Monitoring Stranding Downstream of Cheakamus Generating Station	Clause 4.v	Feb 23, 2007	Mar 22, 2007	-	-
CMSMON-5 Monitoring Stranding Downstream of Daisy Lake Dam	Clause 4.vi	Feb 23 2007	Mar 22, 2007	-	-
CMSMON-6 Monitoring Groundwater in Side Channels of the Cheakamus River	Clause 4.vii	Feb 23 2007	Mar 22, 2007	-	-
CMSMON-7 Cheakamus River Benthic Community Monitoring	Clause 4.viii	Feb 23 2007	Mar 22, 2007	-	-
CMSMON-8 Monitoring Channel Morphology in Cheakamus River	Clause 4.ix	Feb 23 2007	Mar 22, 2007	Aug 31, 2015	Nov 05, 2015
CMSMON-9 Cheakamus River Recreational Angling Access Monitoring	Clause 4.x	Feb 23 2007	Mar 22, 2007	-	-

3 Schedule

The following table outlines the current schedule for the monitoring programs being delivered for the Cheakamus WUP.

Table 3-1: Monitoring Programs Schedule as of October 31, 2020

2012 Interim Review ↓

Monitoring Programs	2007 WLR YR1	2008 WLR YR2	2009 WLR YR3	2010 WLR YR4	2011 WLR YR5	2012 WLR YR6	2013 WLR YR7	2014 WLR YR8	2015 WLR YR9	2016 WLR YR10	2017 WLR YR11	2018 WLR YR12	2019 WLR YR13	2020 WLR YR14
CMSMON-1a Cheakamus River Juvenile Salmonid Outmigrant Enumeration Monitoring	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓F	
CMSMON-1b Cheakamus River Chum Salmon Escapement Monitoring and Mainstem Spawning Groundwater Survey	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓F	
CMSMON-2 Trout Abundance Monitor in Cheakamus River (Daisy Lake Dam to Cheakamus Canyon)	✓	✓	✓	✓	✓	✓		✓F						
CMSMON-3 Cheakamus River Steelhead Adult Abundance, Fry Emergence-timing, and Juvenile Habitat Use and Abundance Monitoring	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓F
CMSMON-4 Monitoring Stranding Downstream of Cheakamus Generating Station		✓	✓	✓	✓F									
CMSMON-5 Monitoring Stranding Downstream of Daisy Lake Dam	×	✓F												
CMSMON-6 Monitoring Groundwater in Side Channels of the Cheakamus River	✓	✓	✓	✓	✓F									
CMSMON-7 Cheakamus River Benthic Community Monitoring		✓	✓	✓	✓F									
CMSMON-8 Monitoring Channel Morphology in Cheakamus River		✓	✓	✓*	✓*	✓	✓	✓	✓	✓	✓F			
CMSMON-9 Cheakamus River Recreational Angling Access Monitoring			✓F											

Legend:
- ■ = Program to be undertaken/initiated in identified year
- ✓ = Program completed for the year
- × = Program started, but encountered operational or hydrological delays
- * = No report was produced for this year due to a change in the contractor for this project.
- □ = Under review
- ✓F = All field work for this project is complete. No further field work is planned.

4 Monitoring Programs Terms of Reference

The monitoring programs being implemented under the Cheakamus WUP are described in Terms of Reference and the reports for work completed to date can be found here:

http://www.bchydro.com/about/sustainability/conservation/water_use_planning/lower_mainland/cheakamus.html

5 Status of Monitoring Programs

5.1 CMSMON-1A Cheakamus River Juvenile Salmonid Outmigrant Enumeration Monitoring

The intent of this project was to assess the impact of the WUP operating regime on production of juvenile salmon (Chum and Pink fry, Coho, Steelhead and Chinook smolts) in the Cheakamus River and key side channels. The objective was to collect the data necessary to estimate the annual outmigration of juvenile salmonids. Juvenile outmigration for all salmonid species were enumerated with traps and counters at the outlets of key side channels.

Data from this study will be used in conjunction with data from other monitoring programs to develop stock-recruitment relationships to separate effects of spawning escapement from flow-related changes in survival during incubation and freshwater rearing.

The program is a continuation and expansion of a program initiated during the consultative process to monitor juvenile outmigration under the Interim Flow Order (IFO) and became a WUP project in 2007.

This program was initiated in 2007 and was completed in 2019.

5.2 CMSMON-1B Cheakamus River Chum Salmon Escapement Monitoring and Mainstem Spawning Groundwater Survey

The main project components, which have examined the effects of the WUP flow regime on Chum salmon spawning and incubation in the mainstem of the Cheakamus River and major side channels, have been completed. The two monitoring components completed are:

i) Estimating annual escapement of adult Chum salmon in the Cheakamus River; and

ii) Examining the relation between discharge, groundwater upwelling, and the selection of spawning habitat by Chum salmon in the mainstem.

This program was initiated in 2008. In December 2017, the CWR approved additional funds to investigate the behavioral response of Chum salmon to increased fall flows during spawning site selection for up to two additional years. The two-year extension of the CMSMON-1b program was completed in late 2018.

This program was initiated in 2007 and was completed in 2019.

5.3 CMSMON-2 Trout Abundance Monitor in Cheakamus River (Daisy Lake Dam to Cheakamus Canyon)

The intent of this project was to relate changes in trout abundance to changes in Daisy Lake Dam operations relative to pre-WUP dam operations for the resident trout population located immediately downstream of the Daisy Lake Dam.

Data such as fish density, relative abundance, distribution of fish age classes and fish health were used in conjunction with data from other monitoring programs to investigate the relationship between the Cheakamus River discharge and fish production in this study.

This project was initiated in 2007 and field work completed in 2014.

5.4 CMSMON-3 Cheakamus River Steelhead Adult Abundance, Fry Emergence-timing, and Juvenile Habitat Use and Abundance Monitoring

The intent of this project is to examine the effects of the WUP flow regime on juvenile and adult Steelhead in the Cheakamus River to determine how river flows affect Steelhead production in this system. The study specifically investigates whether increased summer flows negatively affect emergent Steelhead parr using an annual abundance index which is then combined with

young of the year samples to obtain a robust estimate of the production of Steelhead smolts.

The main project components, to examine the effects of the WUP flow regime on juvenile and adult Steelhead in the Cheakamus River to determine how river flows affect Steelhead production in this system, have been completed.

In early 2018, the CWR approved extending a portion of the tasks to assess whether certain ramp rates in late summer have population effects. However, concerns about the potential impacts of these flows were identified by DFO prior to implementing the summer pulse flows. Consequently, the project is under review.

In 2018 a supplementary study to improve the understanding of effects of the Cheakamus Generating Station on discharge in the Squamish River and potential effects on fish populations was undertaken.

The 2018-19 Year 12 report updated with 2020 data collected for the Cheakamus Adaptive Stranding Protocol is currently being finalized and is planned to be submitted by January 2021. No further report submission will be prepared and the project will be complete with the final report.

5.5 CMSMON-4 Monitoring Stranding Downstream of Cheakamus Generating Station

The intent of this project was to monitor whether fish stranding in the tailrace channel below the Cheakamus powerhouse is sufficient to affect local fish populations and therefore warrant mitigation. Because a threshold value of stranding is not defined for this location, the project approach was to use a modelling technique to identify the duration of sustained high flows prior to the dewatering event that cause fish to enter the tailrace channel and become stranded.

This program was initiated in 2008 and was completed in 2011.

5.6 CMSMON-5 Monitoring Stranding Downstream of Daisy Lake Dam

The intent of this project was to define a minimum level of acceptable stranding (MALS) below the Daisy Lake Dam and measure if the fish stranding rate exceeds the MALS to determine if significant stranding is observed under two scenarios:

i) When flows are reduced from seven cubic metres per second (cms) to three cms on November 1, 2008 immediately downstream of the dam.

ii) When the rate of stage change between Daisy Dam and Rubble Creek is less than 2.5 cm per hour when flows are reduced from seven to three cms on November 1, 2008.

This program was initiated in 2008 and completed within the same year.

5.7 CMSMON-6 Monitoring Groundwater in Side Channels of the Cheakamus River

The intent of this project was to determine if there is a correlation between the Cheakamus River flows and sub-surface flows in the side channels between Culliton and Cheekye creeks; in particular whether there are seasonal and annual changes in groundwater direction, water quality and temperature in these side channels.

Data from this study was used in conjunction with data from other monitoring programs to measure fish production response to side channel conditions to determine if a relationship exists between groundwater flows and fish production.

This program was initiated in 2007 and completed in 2011.

5.8 CMSMON-7 Cheakamus River Benthic Community Monitoring

The intent of this project was to develop a Cheakamus Benthos Model (CBM) for use in evaluating the composition, abundance, and biomass of benthic invertebrates in the Cheakamus River. Data was collected over two years supplementing pre-WUP data to evaluate the relative importance and the magnitude of effects on benthic invertebrate biomass from Daisy Dam water releases in determining the composition, abundance and biomass of benthic communities in the Cheakamus River.

This program was initiated in 2008 and completed in 2011.

5.9 CMSMON-8 Monitoring Channel Morphology in Cheakamus River

The intent of this study was to assess if there has been a change in the overall availability of suitable spawning substrates in the Cheakamus River from the present state, if there is a change in the utility of the naturally occurring side channels as fish habitat, and to what extent the hydrology of Rubble Creek, Culliton Creek and Swift Creek contribute to the general hydrology of the lower Cheakamus River in attenuating the effects of Daisy Lake dam operations.

Data from this 10-year study (2008-2018) such as substrate type and configuration was used in conjunction with data from other monitoring programs to investigate the relationship between substrate type and fish production.

This program was initiated in 2008 and completed in 2017.

5.10 CMSMON-9 Cheakamus River Recreational Angling Access Monitoring

The intent of this project was to measure angling use in the Cheakamus River outside the sport fishing season (the period from January 1 to March 31) between Daisy Dam and the Cheakamus Canyon and assess whether access to recreational angling locations in that period improves under a WUP flow regime of 5 cms compared to a 3 cms minimum flow release. The performance measure used for this project was developed by the recreation subgroup of the consultative committee to measure angling in the sport fishing season, defined

as mid-March to May 1 and August to December when the flow rates are much higher (19.4 cms and 68.4 cms) than in the January to March period.

This program was initiated in the spring of 2009 and completed within the same year.

6 Monitoring Programs Costs

The following table summarizes the Cheakamus WUP monitoring programs costs approved by the Comptroller and the actual costs to October 31, 2020.

Table 6-1: Cheakamus WUP Monitoring Programs Costs

Monitoring Programs	Phase	Costs approved by CWR	Life to Date Actuals (LTD)	Estimated to Complete (Forecast)	Total Forecast (LTD and Forecast)	Variance Total to Approved	Explanation	Corrective Action
Cheakamus WUP Annual Report		**$17,888**	**$14,881**	**$0**	**$14,881**	**$3,007**		
CMSM01A Juvenile Salmonid	**Phase 1**	**$2,112,685**	**$1,786,106**	**$0**	**$1,786,106**	**$326,579**	Project Complete	Phase 1 and Phase 2 are the same project for financial tracking.
CMSM01A Juvenile Salmonid - ONR DM		$91,450	$94,108	$0	$94,108	($2,658)		
CMSM01A Juvenile Salmonid - ONR Imp		$2,021,235	$1,691,998	$0	$1,691,998	$329,237		
CMSM01A Juvenile Salmonid	**Phase 2**	**$1,695,092**	**$1,966,516**	**$0**	**$1,966,516**	**($271,424)**	Project Complete	Phase 1 and Phase 2 are the same project for financial tracking.
CMSM01A Juvenile Salmonid - ONR DM		$32,735	$70,660	$0	$70,660	($37,925)		
CMSM01A Juvenile Salmonid - ONR Imp		$1,662,357	$1,895,856	$0	$1,895,856	($233,499)		
CMSM01B Chum Salmon Monitor		**$2,340,317**	**$2,315,984**	**$0**	**$2,315,984**	**$24,333**	Project Complete	n/a
CMSM01B Chum Salmon Monitor - ONR DM		$93,475	$86,465	$0	$86,465	$7,010		
CMSM01B Chum Salmon Monitor - ONR Imp		$2,246,842	$2,229,519	$0	$2,229,519	$17,323		
CMSM02A Trout Abundance Mon		**$250,341**	**$250,199**	**$0**	**$250,199**	**$142**	Project Complete	n/a
CMSM02A Trout Abundance Mon - ONR DM		$46,359	$46,217	$0	$46,217	$142		
CMSM02A Trout Abundance Mon - ONR Imp		$203,982	$203,982	$0	$203,982	$0		
CMSM03A Steelhead Spawner	**Phase 1**	**$1,080,660**	**$1,104,037**	**$0**	**$1,104,037**	**($23,377)**	Project Complete	Phase 1 and Phase 2 are the same project for financial tracking.
CMSM03A Steelhead Spawner - ONR DM		$100,814	$58,308	$0	$58,308	$42,506		
CMSM03A Steelhead Spawner - ONR Imp		$979,846	$1,045,729	$0	$1,045,729	($65,883)		
CMSM03A Steelhead Spawner	**Phase 2**	**$1,553,930**	**$1,374,420**	**$260**	**$1,374,680**	**$179,250**	Project Complete	Phase 1 and Phase 2 are the same project for financial tracking.
CMSM03A Steelhead Spawner - ONR DM		$17,595	$171,898	$260	$172,158	($154,563)		
CMSM03A Steelhead Spawner - ONR Imp		$1,536,335	$1,202,522	$0	$1,202,522	$333,813		
CMSM04A Stranding RiskMonitor		**$238,374**	**$218,966**	**$0**	**$218,966**	**$19,408**	Project Complete	n/a
CMSM04A Stranding RiskMonitor - ONR DM		$42,414	$42,391	$0	$42,391	$23		
CMSM04A Stranding RiskMonitor - ONR Imp		$195,960	$176,574	$0	$176,574	$19,386		
CMSM05A Dam downstrm strand		**$29,066**	**$31,853**	**$0**	**$31,853**	**($2,787)**	Project Complete	n/a
CMSM05A Dam downstrm strand - ONR DM		$12,992	$14,523	$0	$14,523	($1,531)		
CMSM05A Dam downstrm strand - ONR Imp		$16,074	$17,330	$0	$17,330	($1,256)		
CMSM06A Groundwater Linkage		**$307,297**	**$286,425**	**$0**	**$286,425**	**$20,872**	Project Complete	n/a
CMSM06A Groundwater Linkage - ONR DM		$62,279	$32,039	$0	$32,039	$30,240		
CMSM06A Groundwater Linkage - ONR Imp		$245,018	$254,387	$0	$254,387	($9,369)		
CMSM07A River Benthic monitor		**$304,371**	**$297,615**	**$0**	**$297,615**	**$6,756**	Project Complete	n/a
CMSM07A River Benthic monitor - ONR DM		$38,153	$28,322	$0	$28,322	$9,831		
CMSM07A River Benthic monitor - ONR Imp		$266,218	$269,293	$0	$269,293	($3,075)		
CMSM08A Channel Morphology		**$457,576**	**$434,459**	**$0**	**$434,459**	**$23,117**	Project Complete	n/a
CMSM08A Channel Morphology - ONR DM		$67,733	$69,643	$0	$69,643	($1,910)		
CMSM08A Channel Morphology - ONR Imp		$389,843	$364,816	$0	$364,816	$25,027		
CMSM09A Recreation Angling		**$28,228**	**$20,410**	**$0**	**$20,410**	**$7,818**	Project Complete	n/a
CMSM09A Recreation Angling - ONR DM		$14,426	$8,906	$0	$8,906	$5,520		
CMSM09A Recreation Angling - ONR Imp		$13,802	$11,504	$0	$11,504	$2,298		

OR - Ordered Remissible
ONR - Ordered Non-Remissible

* Red values in parentheses denote overage.