Cheakamus Project Water Use Plan

Monitoring Programs Annual Report: 2007

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

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BC Hydro Cheakamus Project Water Use Plan Monitoring Programs Annual Report: 2007

1 Introduction

This document represents a summary of the status and the results of the Cheakamus Project Water Use Plan (WUP) monitoring programs to 31 October 2007, as per the Cheakamus Order under the *Water Act,* dated 17 February 2006. There are ten monitoring programs and no physical works:

1a) Cheakamus River Juvenile Salmonid Outmigrant Enumeration Monitoring

1b) Cheakamus River Chum Salmon Escapement Monitoring and Mainstem Spawning Groundwater Survey

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

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

4) Monitoring Stranding Downstream of Cheakamus Generating Station

5) Monitoring Stranding Downstream of Daisy Lake Dam

6) Monitoring Groundwater in Side Channels of the Cheakamus River

7) Cheakamus River Benthic Community Monitoring

8) Monitoring Channel Morphology in Cheakamus River

9) Cheakamus River Recreational Angling Access Monitoring

2 Background

The water use planning process for BC Hydro's Cheakamus project was initiated in 1996 and completed in April 2002. Consensus was not achieved at the Consultative Committee table. Some of the conditions proposed in the WUP for the operation of the project reflect the recommendations of the Cheakamus Project WUP Consultative Committee. Additional conditions were included by the Comptroller based on public input following the water use planning process.

In October 2005, the Cheakamus WUP was submitted to the Comptroller.

On 17 February, 2006, BC Hydro was ordered to implement the conditions proposed in the Cheakamus WUP and prepare the monitoring programs terms of reference (TOR).

On 20 November 2006, the Cheakamus River Juvenile salmonid outmigrant enumeration monitoring program was submitted to the Comptroller for review and approval. On 28 November 2006, the TOR for this study was accepted by the Comptroller.

On 23 February 2007, the remaining nine WUP monitoring programs TOR were submitted to the Comptroller for review and approval. On 22 March 2007, the TOR for these monitoring programs was accepted by the Comptroller.

As outlined in the Cheakamus WUP, a review of the Water Use Plan is recommended within 5 years of its implementation and may be triggered sooner if significant new risks are identified through analysis of the monitoring results.

3 Status

The following table outlines the status and schedule for the Cheakamus WUP monitoring programs.

Table 3-1: Status of Cheakamus WUP Monitoring Programs Implementation

Monitoring Programs	2007 WLR YR1	2008 WLR YR2	2009 WLR YR3	2010 WLR YR4	2011 WLR YR5	2012 WLR YR6 Review
1a) Cheakamus River Juvenile Salmonid Outmigrant Enumeration Monitoring	u/w	■	■	■	■	
1b) Cheakamus River Chum Salmon Escapement Monitoring and Mainstem Spawning Groundwater Survey	u/w	■	■	■	■	■
2) Trout Abundance Monitor in Cheakamus River (Daisy Lake Dam to Cheakamus Canyon)	u/w	■	■	■	■	■
3) Cheakamus River Steelhead Adult Abundance, Fry Emergence-timing, and Juvenile Habitat Use and Abundance Monitoring	u/w	■	■	■	■	■
4) Monitoring Stranding Downstream of Cheakamus Generating Station		■	■	■	■	
5) Monitoring Stranding Downstream of Daisy Lake Dam	×	■				
6) Monitoring Groundwater in Side Channels of the Cheakamus River	u/w	■	■	■	■	■
7) Cheakamus River Benthic Community Monitoring		■	■	■	■	
8) Monitoring Channel Morphology in Cheakamus River	u/w	■	■	■	■	■
9) Cheakamus River Recreational Angling Access Monitoring			■			

Legend:
- ■ = Program to be undertaken/initiated in identified year
- u/w = Project is underway
- ✓ = Program completed for the year
- × = Program started, but encountered operational or hydrological delays

4 Cheakamus WUP Monitoring Programs

This section outlines the status of the Cheakamus WUP monitoring programs as per the Order under the *Water Act,* dated 17 February 2006.

4.1 Program #1a: Cheakamus River Juvenile Salmonid Outmigrant Enumeration Monitoring

4.1.1 Overview

The objective of this monitor is to collect the data necessary to estimate the annual outmigration of juvenile salmonids from the Cheakamus River mainstem and key side channels. The species of interest are: chum and pink fry, and coho, steelhead and Chinook smolts, though it can be a challenge to obtain precise mainstem estimates for each species. In-stream movement of other species and life-stages captured will also be documented, including steelhead parr, coho fry, coast range sculpin (*Cottus aleuticus*) and the Pacific lamprey (*Entophenus tridentatus*).

The monitoring approach is to annually estimate the total juvenile outmigration for each salmon species using downstream trapping methods. This time series of data will be used to examine the effects of flow on juvenile production, productivity, and habitat capacity by comparing variation in juvenile production and discharge. It is anticipated that both differences in the pre-WUP and WUP flow regime, as well as the natural annual variation in seasonal discharge will provide good contrast in flow to examine the effects of discharge on spawning, egg incubation, juvenile rearing, and ultimately juvenile production. Juvenile production is a useful measure that integrates the effects of flow over these many life stages.

Monitoring Indicator: (a) Number of outmigrating juvenile salmonids each year.

This monitoring program involves the following four main components; Mainstem Rotary Screw Trap Trapping; Sidechannel Trapping; Biosampling; and Temperature Logging. In addition, there will be project coordination, data analysis and reporting components.

4.1.2 Status

This program was initiated in January 2007 and will be carried out until 2011 for a total of five years of monitoring. The first program report is expected in December 2007.

4.1.3 Interpretation of Data

At this time there are no data to interpret for this monitoring program.

4.2 Program #1b: Cheakamus River Chum Salmon Escapement Monitoring and Mainstem Spawning Groundwater Survey

4.2.1 Overview

The monitoring program has been developed to examine the effects of the WUP flow regime on chum salmon spawning and incubation in the mainstem of the Cheakamus River and major side channels. The objectives of the program are:

1) Using a stratified marking and recapture regime obtain annual chum salmon spawning escapements for the Cheakamus River upstream of the established juvenile out migration monitoring station.

2) Conduct preliminary surveys to determine if groundwater flows through chum spawning grounds are related to river discharge.

Monitoring Indicators: (a) Annual chum salmon spawning escapement.

This monitoring program will include two main components: estimating annual escapement of adult chum salmon in the Cheakamus River; and examining the relation between discharge, groundwater upwelling, and the selection of spawning habitat by chum salmon in the mainstem.

4.2.2 Status

This program was initiated in July 2007 and will be carried out over five years. The first program report is expected in early summer 2008.

4.2.3 Interpretation of Data

At this time there are no data to interpret for this monitoring program.

4.3 Program #2: Trout Abundance Monitor in Cheakamus River (Daisy Lake Dam to Cheakamus Canyon)

4.3.1 Overview

The purpose of the monitor is to relate changes in trout abundance to changes in Daisy Lake Dam operations if such a relation exists.

The abundance of resident trout downstream of Daisy Dam was considered by the Consultative Committee (CC) to be a critical component in the WUP trade-off process. There were two reasons for this importance. First, was resident trout's inherent value to CC members who consider it to be an indicator of ecological health. The second and probably more important reason was because there was a general perception among CC members that trout abundance was highly susceptible to changes in Daisy Lake Dam flow releases, particularly relative to pre-WUP dam operations. Because of its relative importance and a WUP fish management objective, as well as the high level of uncertainty surrounding the consequence of flow regime changes, the CC members recommended that a monitor be carried out to track the status of rainbow trout populations.

Monitoring Indicators: Abundance of juvenile and adult rainbow trout.

This program is comprised of two main components: sampling of juvenile rainbow trout using electrofishing; and sampling adults using a standardized angling effort. In addition, there will a data analysis and reporting component.

4.3.2 Status

This program was initiated July 2007 and will be carried out over the next 5 years. The first program report is anticipated in spring 2008.

4.3.3 Interpretation of Data

At this time there are no data to interpret for this monitoring program.

4.4 Program #3: Cheakamus River Steelhead Adult Abundance, Fry Emergence-timing, and Juvenile Habitat Use and Abundance Monitoring

4.4.1 Overview

The primary objective of the monitor is to improve our understanding of the effects of flow on steelhead production in the Cheakamus River. The population bottlenecks limiting freshwater production and their relationship with flow are uncertain. The monitor therefore indexes the abundance of four life stages; spawners, Young of Year (YoY) in the fall shortly after emergence, YoY in the spring when the fish are approximately nine months old from date of hatch; and parr in the spring that are 1.9 years and older (1+, 2+, and 3+ parr).

The monitoring program consists of enumerating adults using snorkel counts in the spring, sampling YoY steelhead during the emergence and post emergence periods in the summer and fall by backpack/shore-based electrofishing, and sampling larger YoY and parr by electrofishing and snorkel-based surveys during the early spring.

Monitoring Indicator: Abundance of adult and juvenile steelhead.

This monitoring program involves the following five main components: Spawner Escapement; Emergence Timing; Habitat Surveys; Fall and Spring Backpack/Shore-Based Electrofishing Surveys; and Springtime Parr Surveys. In addition, there will be project coordination and reporting components.

4.4.2 Status

This program was initiated July 2007 and will be carried out over the next 5 years. The first program report is anticipated in the fall of 2008.

4.4.3 Interpretation of Results

At this time there are no data to interpret for this monitoring program.

4.5 Program #4: Monitoring Stranding Downstream of Cheakamus Generating Station

4.5.1 Overview

This monitor will test whether fish stranding in the tailrace channel, given the operation of the Cheakamus powerhouse turbines under Water Use Planning, is sufficient to affect fish populations, and therefore warrant mitigation. The monitor incorporates the use of many models (hydraulic, hydrological, turbine operations, etc.) to assess the stranding risk of juvenile and adult fish in the tailrace channel.

During the scoping phase of the Cheakamus River WUP process, the Fish Technical Committee (FTC) introduced and discussed the hypothesis that the peaking operations at the Cheakamus powerhouse (located on the eastern bank of the Squamish River) resulted in tailrace water level fluctuations that could strand redds

or juvenile fish. The FTC recommended that this monitor be developed to further investigate stranding.

Monitoring Indicator: Rate and extent of fish and redd stranding in the tailrace

This monitoring program involves project coordination, data collection, data analysis and reporting components. The main component, data collection, includes collecting existing information, conducting topographical surveys and fish use assessments, studing juvenile colonization rates, collecting system hydrology and water quality, model development, and conducting stranding workshops and stranding surveys.

4.5.2 Status

This program will be initiated in the spring of 2008 and will be carried out over the next 3 years. The first program report is anticipated in the spring of 2009.

4.5.3 Interpretation of Results

At this time there are no data to interpret for this monitoring program.

4.6 Program #5: Monitoring Stranding Downstream of Daisy Lake Dam

4.6.1 Overview

The objective of this program is to monitor stranding downsteam of Daisy Lake Dam when the minimum flow from the dam is changed from 7 to 3 $m^3 \bullet s^{-1}$ on November 1st.

Some concern had been raised by the Fisheries Technical Committee and others that the change in base flow prescribed in the Water Use Plan (WUP) could lead to the stranding of resident trout rearing immediately downstream of the dam. This concern stems from the fact that under the WUP, flow conditions downstream of the dam will become more stable and have a slightly higher base level during the growing season, and hence may be more habitable to rearing fish. It has been hypothesized that a sudden drop in base flow following such stable growing conditions could lead to some stranding of these individuals. Such a drop would occur annually during the Nov 1st decrease in the minimum flow release requirement from 7 to 3 $m^3 \bullet s^{-1}$. Given the expected small areal extent of suspected stranding, monitoring of one stranding event during Nov 1 decrease in minimum flow release was recommended to reduce uncertainty related to stranding.

The general approach to the monitor will be to base it on a standard fish salvage operation, the only difference being is that all occurrences of stranding will be documented for analysis. In order for hypothesis test to be carried out, it is necessary that a minimum acceptable level of fish stranding (MALS) be defined. This should be carried out in consultation with regulatory agencies in a small workshop setting. The objective would be to define the threshold value of MALS and to define the units of measurement such that it is testable given the data collected in the field.

Monitoring Indicator: Rate and extent of fish stranding

This monitoring program involves project coordination, data collection, data analysis and reporting components. The main component, data collection, includes meeting with agencies to define the MALS and conducting a fish salvage operation.

4.6.2 Status

This program was scheduled for 1 November 2007 but has been delayed until 1 November 2008. The program had to be delayed one year because flows through the hollow-cone valve could not be reduced below 5 $m^3 s^{-1}$ because of mechanical issues. Maintenance scheduled for the summer of 2008 will allow the 3 $m^3 s^{-1}$ flow to be attained on 1 November 2008. The delay in this study does not cause delay in any of the other studies. Formal notification to the Comptroller of Water Rights for the one year delay is underway. The first program report is anticipated in the spring of 2009.

4.6.3 Interpretation of Results

At this time there are no data to interpret for this monitoring program.

4.7 Program #6: Monitoring Groundwater in Side Channels of the Cheakamus River

4.7.1 Overview

Both the Cheakamus River Water Use Plan (WUP) Consultative Committee (CC) and the Fisheries Technical Committee (FTC) have identified monitoring of groundwater side channels as a high priority for the system. It is uncertain whether the WUP mainstem flows will affect floodplain groundwater levels, and thereby potentially negatively affect salmonid side channel production near the North Vancouver Outdoor School and the Department of Fisheries and Oceans' Tenderfoot hatchery. To reduce the uncertainty with groundwater, this study includes a shallow groundwater and side channel monitoring plan aimed at characterising the linkages between Cheakamus River mainstem flows, floodplain groundwater systems, and side channel upwelling.

Monitoring Indicator: Not applicable. The monitoring approach for this program does not follow a monitoring indicator approach.

The approach to this monitor includes four linked components:

i) Measurements of groundwater levels, characteristics and horizontal gradients.

ii) Measurements of side channel hydrology.

iii) Measurements of side channel fish habitat, as it relates to flow and water quality.

iv) Measurement of fish production from side channels (note: fish will be enumerated under another monitoring program).

4.7.2 Status

This program was initiated in October 2007. The first program report is anticipated at the end of 2008.

4.7.3 Interpretation of Results

At this time there are no data to interpret for this monitoring program.

4.8 Program #7: Cheakamus River Benthic Community Monitoring

4.8.1 Overview

The effects of flow regulation on the benthic community was an important uncertainty during the Water Use Planning process. To reduce uncertainties, the Consultative Committee (CC) unanimously endorsed implementation of a monitoring plan to fill in data gaps, reduce scientific uncertainty, and provide information to better inform the CC members during future planning processes. One component of the monitoring plan was updated modeling to examine the importance of Cheakamus River flow on the abundance and composition of benthic communities that indicate "ecosystem health" and are fish food organisms. This program will monitor benthic communities and habitat attributes that determine the composition and abundance of those communities in the Cheakamus River.

The objective of the benthos monitoring is to continue development of the Cheakamus Benthos Model (CBM) for use in evaluating river health among flow alternatives. River health will be indicated by attributes of the benthic invertebrate and periphyton communities. The model will be a decision support tool for future planning initiatives.

The monitoring approach is to collect physical and biological data from the river to add to an existing database of collected data, and use this expanded dataset to refine a model that predicts various benthic endpoints from the physical variables. The effect of flow variables on these benthic endpoints will be a key relationship examined.

Monitoring Indicator: Not applicable. This program focuses on continuing development of the CBM, and thus does not follow a monitoring indicator approach.

This monitoring program involves the following five main components: Site Selection and Field Preparation; Field Sampling and Analysis in Laboratories; Fish Sampling and Analysis of Fish Diet; Analytical Methods; and Performance Measure Development. In addition, there will be project coordination and reporting components.

4.8.2 Status

This program will be initiated in the spring of 2008 and will be carried out over the next 3 years. The first program report is anticipated in the spring of 2009.

4.8.3 Interpretation of Results

At this time there are no data to interpret for this monitoring program.

4.9 Program #8: Monitoring Channel Morphology in Cheakamus River

4.9.1 Overview

During the Water Use Planning process the Fish Technical Committee identified uncertainties with respect to the role of Daisy Lake Dam operation on the frequency, magnitude and duration of intermediate flows that transport and re-distribute sediment input during large events, and effect other finer scale shaping of the channel and side channels; features that are important to biota.

The monitoring approach is to use repeated air photo mapping and GIS analysis to monitor changes in channel morphology. This approach will provide information and resolution to detect coarse scale changes in the channel parameters of interest. This monitor will rely heavily on the use of air photographs and GIS technology to capture changes in channel morphology through time. This monitoring program will also monitor inflow (discharge) from major tributaries.

Monitoring Indicator: Relative change in the extent of channel features

This monitoring program involves project coordination, data collection, data analysis and reporting components. The main component, data collection, consists of air photography, GIS Analysis and tributary flow monitoring.

4.9.2 Status

This program was initiated in October 2007 and will be carried out over the next 5 years. The first program report is anticipated in the fall of 2008.

4.9.3 Interpretation of Results

At this time there are no data to interpret for this monitoring program.

4.10 Program #9: Cheakamus River Recreational Angling Access Monitoring Overview

With consideration of arguments from all participants, the Water Comptroller selected an operating regime similar to the one that was favoured by some members of the Consultative Committee (CC). To benefit recreational angling access, the flow regime selected by the Water Comptroller included a minimum flow from Daisy Dam of 5.0 $m^3 s^{-1}$ from 1 January to 31 March, rather than the 3.0 $m^3 s^{-1}$ minimum release during this period that was favoured by the Fisheries Technical Committee and some CC members. Recreational angling access refers to the availability of fishable locations under a given minimum flow release from Daisy Dam. The benefits to recreational angling access were uncertain, and the Water Comptroller ordered that these benefits be monitored. This program will monitor these benefits.

The monitoring approach is to:

1) Characterize angling that occurs during 1 January to 31 March.
2) Identify important river sections for recreational angling during 1 January to 31 March.

The monitoring approach focuses on collecting and summarizing data on angler use of this river section during 1 January to 31 March. Inferences on the potential benefits to angling access will be based on this general information on angler use.

Monitoring Indicator: Rate of angler use during 1 January to 31 March.

This monitoring program involves project coordination, identifying angling use and reporting components.

4.10.1 Status

This program will be initiated in the spring of 2009 and will be carried out over a 3 month period. The first program report is anticipated in the summer of 2009.

4.10.2 Interpretation of Results

At this time there are no data to interpret for this monitoring program.

5 Cheakamus WUP Monitoring Programs Costs

The following table summarizes the Cheakamus WUP monitoring programs costs approved by the Comptroller on 22 March 2007 and the actual costs to 31 October 2007.

Table 5-1: Cheakamus WUP Monitoring Programs Costs

Description		Costs Approved by Comptroller of Water Rights	Actual Costs to 31 Oct 2007
Monitoring Programs			
1a) Cheakamus River Juvenile Salmonid Outmigrant Enumeration Monitoring	Direct Management	$100,385	$29,024
	Implementation	$1,674,868	$386,453
1b) Cheakamus River Chum	Direct Management	$84,586	$17,969
	Implementation	$1,148,747	$133,069
2) Trout Abundance Monitor in Cheakamus River (Daisy Lake Dam to Cheakamus Canyon)	Direct Management	$40,396	$13,242
	Implementation	$171,706	$0
3) Cheakamus River Steelhead	Direct Management	$100,814	$19,631
	Implementation	$979,846	$61,323
4) Monitoring Stranding Downstream of Cheakamus Generating Station	Direct Management	$42,414	$10,779
	Implementation	$195,960	$0
5) Monitoring Stranding Downstream of Daisy Lake Dam	Direct Management	$12,992	$6,026
	Implementation	$16,074	$0
6) Monitoring Groundwater in Side Channels of the Cheakamus River	Direct Management	$62,279	$13,928
	Implementation	$245,018	$0
7) Cheakamus River Benthic Community Monitoring	Direct Management	$38,153	$2,985
	Implementation	$266,218	$0
8) Monitoring Channel Morphology in Cheakamus River	Direct Management	$73,102	$12,629
	Implementation	$196,562	$0
9) Cheakamus River Recreational Angling Access Monitoring	Direct Management	$14,426	$5,831
	Implementation	$13,802	$0