

Executive Summary

Water Use Planning was introduced by the Minister of Employment and Investment (MEI)¹ and the Minister of Environment, Lands and Parks (MELP)² in 1998 as an approach to ensuring provincial water management decisions reflect changing public values and environmental priorities. A Water Use Plan (WUP) is a technical document that, once reviewed by provincial and federal agencies and approved by the provincial Comptroller of Water Rights defines how water control facilities will be operated. The purpose of water use planning is to understand public values and develop recommendations defining a preferred operating strategy using a consultative process. As such it involves the licensee, government agencies, First Nations, other key interested parties, and the general public. BC Hydro initiated a Water Use Planning process for the Cheakamus Generating facility in May 1999. This report describes the results of the consultative process (Steps 2-8).

The Cheakamus generating system consists of the Daisy Lake Dam and Reservoir and the Cheakamus Powerhouse in the Squamish Valley connected by a tunnel through Cloudburst Mountain. The Daisy Lake Dam and Reservoir are located on the Cheakamus River about 40 km north of Squamish. The generating station is located about 40 km north of Squamish along the upper Squamish River. Its twin turbines have a generating capacity of 157 megawatts. Power production has varied with both climate and regulation.

The Cheakamus plant produced approximately 790 GWh per year prior to implementation of the Interim Flow Agreement (IFA) in 1998. After implementation of the IFA, the Cheakamus plant produced approximately 590 GWh per year.

The Cheakamus watershed is in the Squamish-Lillooet Regional District and borders the community of Whistler to the north and the communities of Squamish and Brackendale to the South. The watershed is a major transportation corridor being bisected by both the Sea-to-Sky Highway and the BC Rail line to the interior. The Cheakamus River is productive by coastal standards providing spawning and rearing habitat for several salmon species that in turn support other wildlife, such as the large fall/winter congregations of bald eagles that feed on salmon carcasses. The river is a popular recreational destination that provides rafting, kayaking, and sportfishing opportunities. A portion of the watershed is within the Barrier Civil Defense Zone and is off-limits for recreational and domestic use. The Cheakamus watershed is entirely within the traditional territory of the Squamish Nation whose members have traditionally relied on the river and its watershed for food, transportation and cultural practices.

In June 1999, the Cheakamus Consultative Committee (CC) was created in accordance with Step 3 of the Provincial Water Use Planning guidelines and in conjunction with the announcement of the Cheakamus WUP. Its 20 members represented Federal, Provincial, Regional, and Municipal governments; the Squamish Nation; BC Hydro; environmental and recreational interests; and local stakeholders (Table ES.1). The CC agreed to a broad consultation process leading to identification of hydro operations that recognize multiple water uses in the Cheakamus and Squamish River systems, and competing interests and needs. Consultation was supplemented by field trips, expert presentations, a Fisheries Technical Committee and a Power Studies Technical Committee. A Facilitator was hired to assist the CC through the consultative process. The consultative process extended from June 1999 to January 2002 and

¹ The Ministry of Employment and Investment was renamed in 2001 to the Ministry of Energy and Mines.

² The Ministry of Environment, Lands and Parks was reorganised in 2001 into the Ministry of Water, Land and Air Protection and the Ministry of Sustainable Resource Management.

included 25 meetings to work through the WUP steps outlined in the provincial *Water Use Plan Guidelines*. The length of the process was partially due to FTC needs; there was only one CC meeting between June 2000 and April 2001 while the FTC completed the field studies necessary to support development of the fisheries models for calculating performance measures.

Table ES.1: Cheakamus WUP Consultative Committee composition.

Group	Representatives
Fisheries and Oceans, Coast Guard (CCG)	1
Fisheries and Oceans, Water Use Section (DFO)	1
Ministry of Water, Land and Air Protection (WLAP)	1
District of Squamish (DoS)	1
BC Hydro (BCH)	2
Ministry of Energy and Mines (MEM)	1
Squamish Lillooet Regional District (SLRD)	1
Squamish Residents (SR)	1
North Vancouver Outdoor School (NVOS)	1
Ministry of Sustainable Resource Management (MSRM)	1
Squamish Nation (SN)	1
Sierra Legal Defense Fund (SLDF)	1
Squamish River Watershed Society (SRWS)	1
Cheakamus Residents (CR)	1
Angling: Whistler Angling Club (WAC), Steelhead Society (SS), Totem Fly Fishers (TFF)	3
Resort Municipality of Whistler (RMW)	1
Outdoor Recreation Council of BC (ORC)	1

In Steps 2 through 4 of the WUP process, the CC explored issues and interests affected by facility operations and agreed to the following six fundamental objectives for the Cheakamus Water Use Plan (not listed in order of importance).

1. Power: Maximise economic returns from power generated at Cheakamus Generating System.
2. First Nations: Protect integrity of Squamish First Nation's heritage sites and cultural values.
3. Recreation: Maximise physical conditions for recreation.
4. Flooding: Minimise adverse effects of flood events through operation of the Cheakamus Generating system.
5. Fish: Maximise wild fish populations.
6. Aquatic Ecosystem: Maximise area and integrity of the aquatic and riparian ecosystem.

At their meeting on April 30,2001, the CC agreed to a set of performance measures for evaluating how well different operating alternatives met these objectives. The performance measures were modelled quantitatively as a function of the flow, but varied in the strength of their linkage to particular values. The Squamish Nation evaluated the impact of flow on integrity of Squamish First Nation's heritage sites and cultural values in two separate studies to maintain confidentiality about the location of these sites.

The Consultative Committee accepted FTC recommendations and PMs based on the information and understanding as of April 30th, 2002. New issues and concerns came forward later in the process (e.g., groundwater linkages, off channel habitat and fish production linkages) for which no data existed to support development of performance measures. Hybrid dam operation alternatives and short- and long-term monitoring plans were developed to address these concerns, but not all CC members accepted this approach (see Section 6.5.1.1 and NVOS comments in Appendix 9).

In accordance with Step 5 of the WUP process, the CC and its supporting technical groups gathered the information and data necessary for developing the models used to calculate the performance measures. Part of this process included expert presentations to the CC on various aspects of the Cheakamus system (e.g., hydrology, flood control, ongoing studies). The Hydro Operations and Power Studies Committee (HOPSC) organised data required to develop a model of river flows, reservoir operations and power production. The Fisheries Technical Committee first conducted preliminary studies to understand the distribution of fish within the Cheakamus system. They then used this information to develop a set of impact hypotheses about the potential impacts of dam operations on attributes of fish populations and the aquatic ecosystem. The impact hypothesis process allowed the FTC to focus on important scientific uncertainties that affect decisions on operations, and prioritise studies that could provide the most useful information about these uncertainties within the timeframe and budget of the WUP process. They used the empirical field data from these studies to develop their models of fish and aquatic ecosystem performance measures. The key things learned about dam operations from FTC studies and modelling were:

- Dam operations do not affect the mainstem juvenile rearing area for salmon or steelhead except at very low dam releases. Two independent methods for calculating juvenile rearing area in relation to flow gave similar results: the cumulative weighted usable rearing area was relatively insensitive to flows greater than those associated with a 5 cms release from the Dam. This finding agrees with previous work by WLAP prior to the Cheakamus WUP process and is due mainly to two factors:
 1. Tributary inflows augment low releases from the Dam, particularly flow from Rubble Creek, which, during non-freshet periods, is fed by seepage through the porous lava dyke (the Barrier) from Garibaldi Lake and thus maintains a relatively constant base flow throughout the winter low flow periods (2.5-5.5 cms, average of 4 cms). Other tributaries show more variable inflows (BCH 2002b)
 2. The confined nature of a significant portion of the river channel below Daisy Dam (due to canyons, historical dyking and other works for flood and erosion protection built subsequent to the Dam) constrains the ability of flows to spread out over the flood plain to create more juvenile rearing habitat (See Section 4.7).
- Rainbow trout rearing area (in the reaches just downstream of the Dam) appears to be somewhat more sensitive to dam operations, though fewer field studies were conducted for this species.
- Dam operations probably affect chum spawning success. Using historical chum escapement records and the area required for spawning, the FTC found chum to be the only salmon species limited by spawning area. The chum effective spawning area performance measure was highest for lower flow operating alternatives.
 - Dam operations affect the benthic community, but fish are not currently food limited in the main rearing areas. Field studies found that the Cheakamus benthic community was depressed immediately below the Dam because it prevents the downstream movement of benthos, but that the community recovered quickly further downstream. These studies also found a relationship between benthic biomass, flow and flow variability. However, the Cheakamus River is rich in nutrients relative to most coastal rivers due to the volcanic geology of its watershed. Most nutrients below the Dam arrive through tributary inflow rather than from above the Dam.

Additionally, fish stomach content analyses showed that the fish ate the same organisms sampled in the benthic studies. For these reasons, the FTC concluded that while flow may affect the benthic community, the fish rearing in the Cheakamus River are not food limited.

In Step 6 of the WUP process, the CC created operating alternatives designed to meet various objectives. In total, twenty-five alternatives were run through the BC Hydro operations model. There were four types of alternatives:

1. alternatives that specified releases from Daisy Dam based on a certain percentage of previous reservoir inflows (e.g., as under the Interim Flow Agreement, or current operations);
2. alternatives that specified a minimum average daily release from Daisy Dam (e.g., “7Dam”);
3. alternatives that specified a minimum average daily flow at the Canada Water Survey gauge near Brackendale (e.g., “20Min”); and
4. alternatives that specified a combination of both a minimum release at Daisy Dam and a minimum flow at the Brackendale gauge (e.g., “20Min7Dam”). These constraints could vary by season.

In Step 7 of the WUP process the CC evaluated how well each alternative met the objectives using the performance measures. Evaluation proceeded as an iterative process of modelling, evaluation, and revision designed to narrow the range of alternatives. A key part of the process was making tradeoffs explicit and eliciting values and concerns, with the goal of reaching consensus. The evaluation process spanned six meetings from May 2001 to January 2002 (Figure ES.1). At the early meetings the CC was able to easily drop alternatives using the agreed to performance measures. As the range of flows within alternatives narrowed, distinctions based on performance measures were less clear for some CC members and values became more important in the discussions. Towards the end of the process, the CC divided. Some CC members accepted the performance measures approved by the CC at their April 30, 2001 meeting, and used these PMs for decision making. Other CC members felt that these performance measures were insufficient because they did not include engineered side channels as fish habitat. The first group favoured somewhat lower flow alternatives supported by the performance measures, which they considered to be sufficient for engineered side channels. The second group preferred somewhat higher flow alternatives they considered to be more precautionary for maintaining ground water flow to engineered side channels. The two groups also differed in the relative importance they placed on engineered side channels vs. the mainstem and its connected side channels. This split resulted in non-consensus at the penultimate meeting on October 24th, 2001. At this point the two most favoured alternatives were a hybrid 15_20Min3_7Dam option and a 20Min7Dam option.

As part of Step 8 of the WUP process, a final evaluation meeting was held on January 11th, 2002 to try once more to reach consensus and to clearly document areas of agreement and disagreement. This meeting was held because several CC members felt that another meeting would be fruitful. Only a narrow range of flows separated the two most preferred alternatives (15-20Min3-7Dam and 20Min7Dam), and the CC members who did not accept the performance measures had clearly expressed their concerns. The WUP Project Team reviewed the main concerns and proposed a 1-year monitoring and evaluation plan to address critical scientific uncertainties relating to groundwater in side channels, as well as two new hybrid alternatives designed to address CC concerns about the two most favoured alternatives from the October 24th meeting.

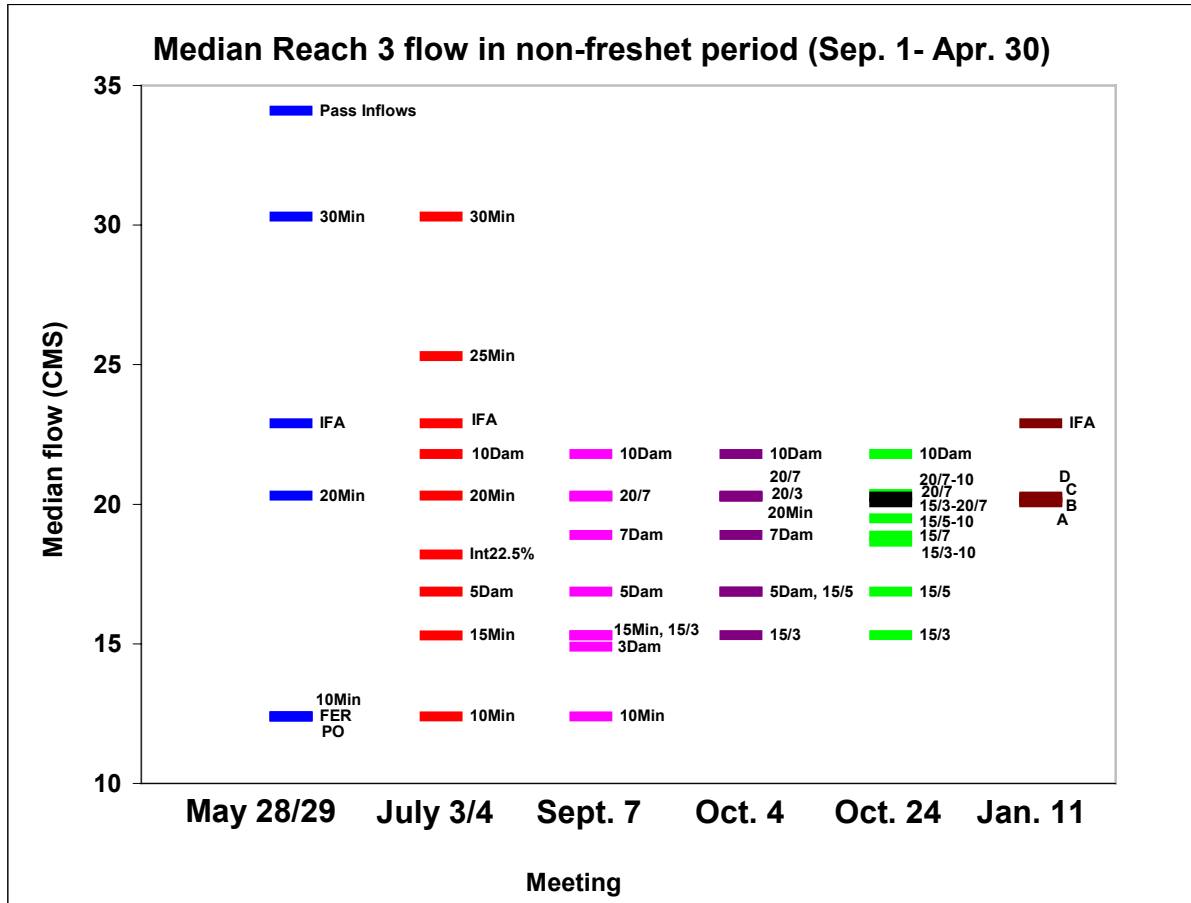


Figure ES.1: Narrowing the range of alternatives over the evaluation process. This figure shows the number and range of alternatives considered at each Cheakamus Consultative Committee evaluation meeting. IFA represents conditions under the Interim Flow Agreement. The 15_20Min3_7Dam option (abbreviated as 15/3_20/7) and the 20Min7Dam option (20/7) were the 2 most favoured alternatives at the October 24th, 2001 meeting (indicated by the darker bar). The A, B, C and D alternatives were the final four presented to the CC on January 11th, 2002. A and D are the 15/3_20/7 and 20/7 alternatives (Table ES.2).

The CC did not reach consensus on an operating alternative at their final meeting. Each of four alternatives presented for evaluation was blocked by at least four CC members (Table ES.2). Participants were permitted to express a preference for alternatives other than the four presented. Eight of 16 CC members preferred continuing the current Interim Flow Agreement (IFA) for approximately another 3-5 years to provide information to thoroughly assess its effects (8 CC members representing the following organizations: CR, NVOS, ORC SWRS, SN, SR, WAC, WLAP; Table ES.1 defines these abbreviations). The CC had previously agreed to drop this alternative at the second evaluation meeting held July 3rd/4th, 2001 (Figure ES.1). One of the 8 CC members preferring the IFA (WLAP) favoured an adaptive management program that monitored the IFA for about 5 years before switching to the 15Min3Dam alternative. One BCH CC member preferred that 15Min3Dam be implemented. Some CC members expressed concerns about re-instating the IFA given that it had previously been dropped (CC members representing BCH, DFO, MEM). These CC members were also concerned that two of the CC members favouring the IFA (the members for the CCG and the WAC) had not previously actively participated in the evaluation process.

Table ES.2: Summary of the Cheakamus Consultative Committee preferences at the final evaluation meeting (January 11th 2002). Cell contents show how many CC members assigned the indicated rating to each alternative. The acronyms in the cells below alternatives A, B, C and D indicate which CC representatives gave that rating. Table ES.1 provides a key to these acronyms.

	<i>Alternative</i>				
	A. Hybrid	B. Revised Hybrid 'B'	C. Revised Hybrid 'C'	D. 20Min7Dam	Other Preferences
Period: Nov. – Dec	15Min3Dam	15Min3Dam	15Min3Dam	20Min7Dam	
Jan. – Mar.	15Min3Dam	15Min5Dam	20Min7Dam	20Min7Dam	
Apr. – Oct.	20Min7Dam	20Min7Dam	20Min7Dam	20Min7Dam	
Preferred	1 (BCH)	1 (DFO)		3 (SR, SLRD, SLDF)	1 (or 2*) 15Min3Dam 8 (or 7*) IFA
More Acceptable	5 (or 4*) (BCH, DFO, DoS, MEM, WLAP*)	4 (or 3*) (BCH, DoS, MEM, WLAP*)	3 (or 2*) (SLRD, DoS, WLAP*)	5 (or 4*) (DOS, WLAP*, CCG, SWRS, ORC)	3 did not prefer IFA, but did not block it
Less Acceptable	3 (SR, SLRD, CCG)	4 (SR, SLRD, CCG, BCH)	7 (BCH, SR, DFO, MEM, CCG, ORC, SLDF)	2 (WAC, NVOS)	
Not Part of Consensus if Selected (Block)	5 (or 6*) (CR, NVOS, WLAP*, SWRS, ORC, SLDF)	5 (or 6*) (CR, NVOS, WLAP*, SWRS, ORC, SLDF)	4 (or 5*) (CR, NVOS, WLAP*, BCH, SWRS)	4 (or 5*) (2xBCH, DFO, MEM, WLAP*)	4 blocked IFA
Total ratings possible for A, B, C, and D based on submitted rating forms. Not all ratings at the meeting were submitted by rating sheet.	14	14	14	14	
* Indicates that the WLAP rating is contingent on whether or not an adaptive management approach is used where the IFA is implemented first and then switched to 15Min3Dam. If this were to take place the WLAP member gave a rating of 2 to alternatives A, B, C, and D. If the IFA were not implemented first then the WLAP member gave a rating of 4 to alternatives A, B, C and D.					

The main points of disagreement on the proposed alternatives were:

- Those who preferred or accepted the proposed alternatives (A, B, C or D) accepted the FTC models and PMs as a basis for decision making, and felt that these flows were sufficient to maintain engineered side channels.
- Those preferring the IFA did not accept the FTC models and PMs as a basis for decision making, primarily because of the exclusion of engineered side channels from fish habitat PMs; they also felt that there were too many remaining uncertainties to justify changing from current operations now.

The eight CC members who had not preferred the IFA were asked if they would object to bringing the IFA back onto the table for consideration. Four said they would not be part of a consensus that included the IFA (2 BCH, DFO, MEM) while three said they would not object (SLDF, SLRD, CCG). The member for the District of Squamish noted that the flood control concerns of the District were met by all alternatives (including the IFA); therefore he was comfortable supporting any of the proposed alternatives.

Table ES.3 summarizes the performance measures for the preferred alternatives at the end of the January 11th, 2002 meeting. This table shows only the results for the reduced set of objectives and performance measures used by the CC at that meeting.

Table ES.3: Consequence Table for the final preferred alternatives. This table shows only the reduced set of objectives and performance measures used at the final CC evaluation meeting, January 11th, 2002. Alternatives “A”, “B”, “C”, and “D” were proposed to the CC prior to the meeting. Some CC members also preferred the 15Min3Dam and IFA alternatives at the meeting.

Fundamental Objectives	Performance Measures	Alternatives					
		15Min3Dam	15-20Min3-7Dam "A"	15-20Min3-5-7Dam "B"	15-20Min3-7Dam "C"	20Min7Dam "D"	IFA
1. Maximize economic returns from power generation.	Average power revenue (\$M/yr)	35.6	34.3	34.0	33.0	32.3	26.9
2. Protect integrity of SFN heritage sites and cultural values.		Addressed by flood PMs and other studies					
3. Maximize physical conditions / access for recreation (kayaking, rafting, sportfishing).	Kayaking (Avg. #days/yr)	124	200	202	222	242	199
	Sportfishing (Avg. #days/yr)	58	83	142	125	193	107
5. Maximize wild fish populations	(m ² x 10 ³)						
	RUA Resident Habitat	35.8	42.5	42.5	42.5	42.5	40
	Effective Spawning Area	9.8	9.7	9.7	9.5	7.3	6
6a. Maximize area and integrity of aquatic ecosystem	Resident Riffle Benthic Biomass (g x 10 ⁶)	3.4	2.9	2.9	3.0	2.9	2.2

At the final meeting, the CC also reviewed the monitoring plan and rated its components. This was done for two reasons. First, individual CC preferences for particular alternatives were potentially dependent on the ability to revise decisions based on monitoring. Second, it is important for the Provincial Comptroller of Water Rights to know which elements of the monitoring plan are most critical to future water management decisions. Fifteen CC members rated the components using two criteria: 1) the likelihood that their results would change their decisions and 2) the relative importance of the component for the monitoring plan. Table ES.4 below summarises the results. The CC generally endorsed all components of

the monitoring plan. It gave the highest ratings to “Statistical Methods”, “Salmon” and “Groundwater”. An intermediate level of support was given to “Resident Trout” and “Squamish Stranding”. Less support was given to the “Channel Morphology” and “Benthos” monitoring components, though about two thirds of the CC members who rated these components considered them to be of medium to high importance (Table ES.4).

Table ES.4: Summary results for Cheakamus Consultative Committee ratings of monitoring plan components at the final meeting (January 11th, 2002). The estimated costs per year for each component is shown below its main heading. These costs are split into the costs for the first year and the annual costs for subsequent years of monitoring. These costs include the costs of monitoring a control river.

	Statistical Methods	Salmon		Resident Trout		Squamish Stranding		Ground water		Benthos		Channel Morph.	
\$/yr, year 1	\$25,000	\$414,700		\$32,300		\$10,000		\$41,000		\$48,170		\$70,000	
\$/yr, year 2 +	--	\$326,000		--		--		\$3,200		\$48,170		\$10,000	
Rating	Importance	Likelihood	Importance	Likelihood	Importance	Likelihood	Importance	Likelihood	Importance	Likelihood	Importance	Likelihood	Importance
High	14	13	14	9	9	6	8	11	12	4	6	6	6
Medium				4	5	4	4	1	2	3	3	3	4
Low						3	2			6	5	3	3
No rating recorded		1		1		1		1		1		2	2
Abstained	1	1	1	1	1	1	1	1	1	1	1	1	1

The CC also reviewed and rated a set of recommendations identified during the course of the WUP and designed to address concerns both within and beyond the scope of the WUP process. Recommendations within the scope of the WUP relate to issues that can be affected by dam operations. Recommendations beyond the scope of the WUP relate to actions identified that would likely have benefits, but do not relate to facility operations and therefore not the responsibility of BC Hydro. The CC members indicated whether they approved, were indifferent, or disapproved of each recommendation (Table ES.5). In general, most CC members approved of all the recommendations, though there were some concerns that adding sediment and woody debris could confound the ability to monitor the impacts of changes in hydro operations.

To complete Step 8 of the consultation process, this consultative report was prepared on behalf of the CC's. Its purpose is to summarise the consultation process for the Provincial Comptroller of Water Rights and to inform the development of BC Hydro's draft Cheakamus Water Use Plan (Step 9). It went through two rounds of revisions; the CC reviewed and commented on a draft- and draft-Final report. CC review comments, clarifications and additions were incorporated into the main body of the report where they were consistent with the written records and the facilitators' recollections of meetings. Commentary that did not meet these criteria was included in Appendix 9 and referenced in the main text.

Table ES.5: Summary results for the Cheakamus Consultative Committee's ratings of recommendations at the final meeting (January 11th, 2002).

Recommendation	Approve	Indifferent	Disapprove	Other
Recommendations within the scope of the WUP process				
1. Provide appropriate transitions between seasonally varying flow regimes to prevent stranding.	13	0	1	0
2. Use recommended minimum flows as targets, but allow some operational flexibility.	14	0	0	0
Other Recommendations beyond the scope of the WUP process				
1. Monitor and maintain Farpoint channel flow.	12	1	1	
2. Explore habitat enhancement opportunities on Squamish River.	10	3	0	1
3. Increase co-ordination between interested parties to achieve integrated watershed management.	14	0	0	0
4. Maintain sediment supply.	11	1	0	0
5. Add large woody debris.	10	2	2	0
6. Identify floodplain areas for restoration.	11	2	0	1
7. Move bridge above NVOS to promote lateral movement of mainstem.	10	3	0	1
8. Improve communication between recreationalists and Squamish Nation.	12	1	0	1

Summary:

Despite making considerable progress in filtering alternatives, the Cheakamus Consultative Committee (CC) was ultimately unable to reach consensus on a single operating alternative for the Water Use Plan. At their final evaluation meeting on January 11th 2002, the CC examined the two most preferred alternatives from the previous meeting, plus two intermediate alternatives designed to meet various concerns. At the meeting, the CC was generally split into two groups (Figure ES.2). One group accepted the FTC models and PMs as a basis for decision making, and found 2 to 4 of the final four alternatives to be acceptable. The other group ultimately did not accept the FTC models and PMs as a basis for decision making, primarily because of the exclusion of engineered side channels from fish habitat PMs. This group rejected 3 to 4 of the final four alternatives, and recommended continuing with the current Interim Flow Agreement (IFA) for another 3-5 years before deciding if different operations were warranted. They felt that there were too many remaining uncertainties to justify changing operations now. Despite considerable effort, the CC could not find common agreement on operating alternatives among these two groups.

The FTC developed a comprehensive monitoring plan to address the critical points of scientific uncertainty and disagreement within the CC and to better inform the next WUP; the CC members strongly supported its main components. The CC recognised that it is essential to address critical scientific uncertainties that can affect future decision making, and to comprehensively assess the response

of the system to whichever operating alternative is implemented. It is very important to refine the statistical and sampling methods to be used.

Monitored ecological indicators should include (in general order of priority): salmonid spawning and juvenile production; groundwater levels and fish production in groundwater-fed side channels in the Cheakamus River; rainbow trout habitat utilisation; stranding of juvenile fish in the Squamish River; riparian vegetation and channel morphology; and benthos, periphyton and nutrients. The plan should also monitor indicators related to Squamish Nation Heritage and Cultural values, and the influence of flow and other factors on recreational usage of the river.

The CC also strongly supported several other recommendations. In particular, one non-WUP recommendation recognised the need for a more integrated watershed approach that better co-ordinates activities in the region among all the various groups involved in the Cheakamus process.

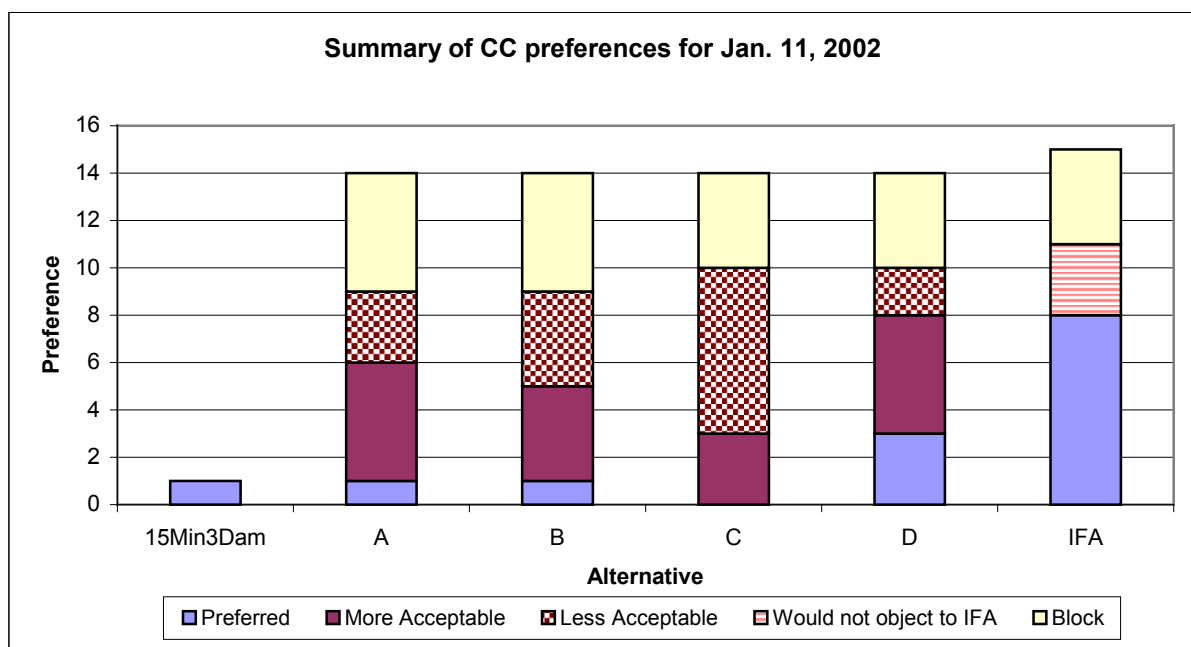


Figure ES.2: Cheakamus Consultative Committee preferences for operating alternatives at the final evaluation meeting, January 11th, 2002. Note that no “Blocks” were expressed for the 15Min3Dam alternative because although one Consultative Committee member expressed a preference for it, the entire Consultative Committee was not asked during the meeting if it would consider putting this alternative back on the table and so no other preferences were recorded for it.