

Alouette Project Water Use Plan

Monitoring Program Terms of Reference

- **ALUMON#1 Smolt Enumeration**
- **ALUMON#2 Kokanee Out-migration**
- **ALUMON#3 Substrate Quality**
- **ALUMON#4 Sockeye Adult Enumeration**
- **ALUMON#5 Water Temperature**
- **ALUMON#6 Kokanee Age Class Structure**
- **ALUMON#7 Archaeological Monitoring**

October 15, 2009

Alouette Project Monitoring Program Terms of Reference

1.0 OVERVIEW

This document presents Terms of Reference for both the fisheries and archaeological monitoring programs recommended by the Alouette Water Use Plan Consultative Committee and required per the 20 October 2009 Water Act Order issued by the Comptroller of Water Rights (Table 1). These monitoring programs involve effectiveness monitoring to assess the response of the aquatic environment to licenced BC Hydro operations as well as monitoring to assess the effects of BCH operations on archaeological sites situated within the drawdown zone of the Alouette Lake Reservoir and a section of the South Alouette River.

Table 1. Alouette Fisheries and Archaeological Monitoring Plan Terms of Reference Submission Information

Name of Monitoring Program	Order Clause Fulfilled	Submitted with this Package	Previously Submitted To CWR	Submission Date	Leave to Commence
ALUMON#1 Smolt Enumeration	Section 16.a	Yes	No	20 Oct 2009	-
ALUMON#2 Kokanee Out-migration	Section 16.b	Yes	No	20 Oct 2009	-
ALUMON#3 Substrate Quality	Section 16.c	Yes	No	20 Oct 2009	-
ALUMON#4 Sockeye Adult Enumeration	Section 16.d	Yes	No	20 Oct 2009	-
ALUMON#5 Water Temperature	Section 16.e	Yes	No	20 Oct 2009	-
ALUMON#6 Kokanee Age Class Structure	Section 16.f	Yes	No	20 Oct 2009	-
ALUMON#7 Archaeological Monitoring	Section 16.g	Yes	No	20 Oct 2009	-

Fisheries Monitoring Program Terms of Reference

1.0 INTRODUCTION

As the Alouette Lake Water Use Plan (WUP) reached completion, a number of uncertainties were identified regarding the effect of BC Hydro operations on aquatic resources. The primary consequence of these uncertainties was a limited ability to predict the response of fish and wildlife populations to operational changes as a result of WUP implementation. This in turn highlighted the general uncertainty surrounding the likelihood that the expected fish and wildlife benefits of the WUP operation will be realised.

The framework for WUP process requires that it be reviewed on a periodic and ongoing basis. Therefore, in the years subsequent to the implementation the WUP, there will be a need for compliance monitoring and effectiveness monitoring to gain the information necessary to address these uncertainties. Compliance monitoring consists of monitoring activities to ensure that BC Hydro complies with the conditions of its water license. Effectiveness monitoring is more complex. It involves the observation, measurement, and evaluation of streamflows, fish and wildlife habitat, and population changes to test the efficacy of the WUP.

Effectiveness monitoring for the Alouette Lake system will require the collection of data in order to quantify relationships between specific fish population parameters and different aspects of BC Hydro operations. Monitoring will assess whether a predicted biological response to changes in operations actually occurred as predicted, and thereby assess whether the objectives of greater abundance and/or diversity were met.

2.0 OVERVIEW

At the conclusion of the Alouette Lake WUP Review process, the Consultative Committee (CC) recommended several key changes to the way Alouette Dam is operated. They are believed to have at least some impact to the ecology of resident fish species. The proposed changes are in addition to the operational changes made in 1996 as part of the original water license review process:

1. Spring surface release starting April 15 and ending June 14.
2. A higher reservoir elevation (122.5) during the peak recreation season starting June 15 and ending Labour Day (September 5).
3. Short recreation shoulder season ending Sep 15 when water levels are above 121.25m.
4. Removing the need for a prescribed flushing flow to clear fine sediments

When recommending these operational changes, the CC acknowledged that there was a need for additional fish related information that would add greater certainty to their decision making, but could not be collected at the time of the WUP review process or had to be monitored *in situ* to confirm their assumed consequences. In particular, the CC identified the following critical uncertainties:

1. Long term impact on Alouette River smolt output
2. Success of surface release in allowing kokanee to leave to reservoir and begin their seaward migration.
3. Long term impact on the transport of fine sediments in Alouette River.
4. Success of the kokanee re-anadromisation initiative, and hence an evaluation of the need for the surface release.
5. Water temperature impacts on the Alouette River.
6. Long term impact on the kokanee reproductive success.

In addition to the uncertainties above, the CC also recommended that an Alouette Monitoring Review Committee be created to oversee the general progress of the monitor, review all reports before general release, and recommend changes regarding the monitoring program's implementation as deemed necessary. Committee membership is to include representatives from BC Hydro, BC Ministry of Environment, Fisheries and Oceans Canada, Katzie First Nation, District of Maple Ridge, and Alouette River Management Society.

3.0 COST

The total cost of the 7 year monitoring program, including year 1 (2008) and a component of year 2 expenditures through July 2009, is estimated to be roughly \$1,316,879 (in 2006 dollars). When incorporating a future annual inflation rate of 2%, the anticipated cost of the program is expected to be closer to \$1,437,623. Average annual cost for the remaining 5 full implementation years is expected to be \$185,258 (in 2006 dollars), but will vary between \$172,107 and \$203,909 depending on the tasks to be completed or the equipment to be purchased.

ALUMON-3

Substrate Quality

1.0 PROGRAM RATIONALE

1.1 Background

In 1995, a substrate quality monitor was initiated that comprised of Toe-Pebble count assessments of substrate composition at 23 randomly selected sites (using a stratified random sampling design) downstream of the Alouette Dam to the 216th St. Bridge (Higgins 2005). The monitor was successful in tracking changes in surface sediment composition through time, and was able to demonstrate a net improvement through time since the start of the monitor. This occurred despite the fact the prescribed substrate flushes were not implemented in the years following the 1996 as per the WUP agreement. Most of the flushing activities occurred incidentally and followed periods of high salmonid escapements whose spawning activity was believed to contribute significantly to the improved substrate condition. This in turn led to the conclusion that prescribed flushes were perhaps unnecessary, especially if the high salmonid escapement numbers were to continue.

The FTC however, expressed some unease regarding this decision to abandon the concept of a prescribed flush. This uneasiness stemmed primarily from uncertainty in the accuracy of the Toe-Pebble count procedure in reflecting substrate quality within the deeper layers of the channel bed. Also contributing to this uneasiness was some uncertainty in the < 20% fines threshold that was used to judge whether substrate quality was an issue or not. Finally, there was some uncertainty in whether the incidental flushing events experienced in the past would continue in to the future and therefore maintain or further improve the current level of substrate quality.

To address these uncertainties, the CC recommended that the substrate quality monitor done in the past 10 years be continued annually until the next WUP review in 2014. The CC recommended that the monitor also include a literature search component to clarify some of the uncertainties identified in the monitor's methodology, and to include a provision to carry out a second methodology to specifically quantify spawning gravel quality if deemed necessary. The latter would be used to qualify/calibrate the Toe-Pebble count results.

1.2 Management Questions

The FTC identified three management questions that are to be addressed through the kokanee out-migration monitor:

1. Do the results of the Toe-Pebble count procedure reflect the general composition of bed materials within the channel downstream of the Alouette Dam?
2. Is the < 20% fines threshold adequate to distinguish a state in substrate quality that would require a prescribed flushing event?
3. Is an alternative methodology required to qualify/calibrate the results of the Toe-Pebble count procedure?
4. For each year of the monitor, is a prescribed flushing flow necessary given the current state of substrate quality?

1.3 Summary of Hypotheses

The first three management questions identified in Section 1.2 do not easily lend themselves to hypothesis testing. Rather, they are issues to be addressed through weight of evidence. The first two management questions will rely primarily on literature reviews to carry out the assessment. The second management question, pertaining to the 20% fines threshold criterion, will also rely on relative egg to smolt data collected in Monitor 1 as part of the assessment. The results of the first two management questions will form the basis of assessment for the third management question. The only management question that does lead itself to hypothesis testing pertains to the need for annual assessments of substrate quality:

H₀1: The proportion of fine sediments < 2mm in size measured in the substrate monitor does not exceed 20% of the total composition of bed materials.

The hypothesis is based on the current definition of 'quality substrate', but can be reframed to accommodate changes that may arise from the literature search results.

1.4 Key Water Use Decision

Results of this monitor are linked to the decision to abandon the prescribed flushing flow regimes described in the 1996 WUP and to rely on incidental flush events that arise through pre-spilling operations for flood control (believed to occur every 2 years on average). Because of uncertainty as whether these incidental flushes would indeed occur as predicted, the CC recommended that the possibility of prescribing a flush not be fully abandoned, but be linked to the accumulation of fine sediments above the a threshold (presently set a 20% of total bed material composition) in the context of an effectiveness monitor

Results of the literature search and the chum relative egg to smolt survival will be used to address management questions 1 to 3 with the aim of confirming the validity of the 20% threshold value, and possibly propose an alternative threshold value should it be necessary.

2.0 PROGRAM PROPOSAL

2.1 Approach

The substrate monitor will continue as was established in 1996 where a Toe Pebble procedure is used to quantify the distribution of sediments through out the South Alouette River between the dam and 216th St Bridge. Details of the methodology are as described by Higgins (2005), but will be carried out more frequently and at regular of sampling intervals. Rather than be opportunistic, the monitor will be carried out each year during mid summer when water levels are typically low and there are no incubating eggs or alevins in the substrate. For safety reasons, the annual assessment will be carried out by a crew of 2 people. Where possible, the same crew should be used each year to control the effects of observer bias.

The first year of assessment will include a literature review to address some of the uncertainties in the Toe-Pebble-count methodology. This information, along with the relative egg to fry survival estimates of chum salmon, will be used to determine whether calibration is necessary for future WUP monitoring.

2.2 Objective and Scope

The objective of this monitor is to collect the data necessary to test the hypotheses outlined in Section 1.3 and hence, address the management questions presented in Section 1.2. The following aspects define the scope of the study:

1. The study area will consist primarily of the riverine habitat located downstream of the Alouette Dam to the 216th St. Bridge.
2. All sites will be the same as those used for monitoring during the last 10 years. To minimise the effect of observer bias, the same survey crew should be used to collect the data.
3. Year 1 of the monitor will include an assessment of the Toe-Pebble Count procedure based on a review of published literature.
4. The monitor will be carried out annually until the next WUP review period (2014).
5. A data report, including an executive summary and short presentation, will be prepared annually summarising the data collected to date, as well as discuss inferences and present conclusions as they pertain to the impacts of the WUP over time. Included will be an assessment whether a prescribed flush would be necessary. Year 1 of the monitor will include a section on the precision and accuracy of the Toe-Pebble count methodology.

6. A final report will be prepared at the end of the monitor that summarises the results of the entire monitoring program, discusses inferences that can be drawn from the data pertaining to the impacts of the WUP over time, and presents conclusions concerning the hypotheses and the management questions in Section 1.2.

2.3 Methods

2.3.1 Field Methods

Field methods will be the same as that described in Higgins (2005), which incorporates a modified Toe Pebble Count procedure to quantify relative sediment distribution at pre-selected sites long the length of the South Alouette River. These sites are to be the same used since the start of the monitor almost 10 years ago and are described in detail by Higgins (2005). Where possible, the same observer will be used as in the past so as to minimise the effect of observer bias in the monitor.

The only difference in methodology from that of Higgins (2005) is a change in the frequency and timing of sampling. Unlike the opportunistic strategy described in the Higgins (2005) report, sediment quality assessments will now be carried out annually during the low flow summer period (August-September). Such a standardised sampling regime will greatly improve the resolution and robustness of the monitor.

To further improve the monitor's resolution and robustness, the field crew is encouraged to develop a standard method of substrate sampling that can be repeated each year. One such method could involve the use of shoreline benchmarks and two lines to triangulate the location of set sampling locations (Figure 1). Water filled buckets can serve as the benchmark anchors so that they are easy to carry, yet be heavy enough not to move when in use. Light weight ropes with triangulation markings can be used as triangulation lines. A survey staff equipped with a pointed tip and level can be used to transfer the triangulated position to a location of the stream bed.

Triangulated points can be chosen at random by computer, which can then be used to determine the length of line needed for triangulation in the field. A set of 'triangulation lines' can be developed for each sample site where each line may have several (all) triangulation lengths marked on it. The order of marks on the triangulated lines can be set in advance to optimise the movement of the crew through the site.

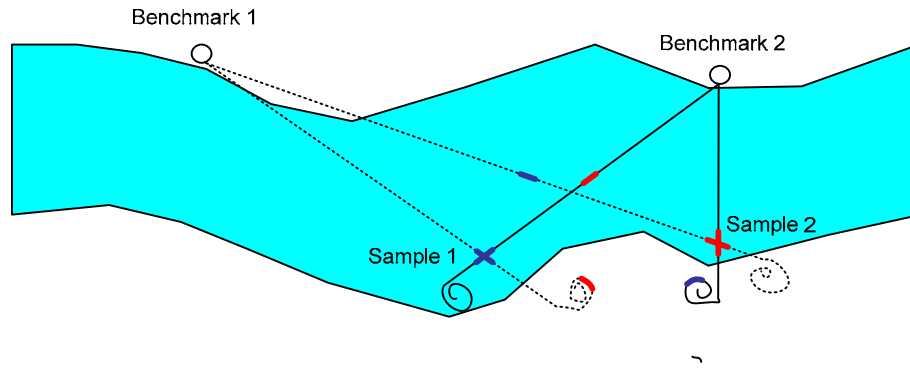


Figure 1. Schematic diagram illustrating the use of benchmarks and triangulation lines to determine sampling locations in the field by matching like-colored or marked segments.

2.3.2 Safety Concerns

A safety plan will have to be developed for all aspects of the study in accordance to BCH procedures and guidelines. It is important to note that the substrate quality assessment must always be carried out by two crew members and that appropriate check-in and checkout procedures must be followed.

2.3.3 Data Analysis

Data analysis will follow the same procedures described in Higgins (2005) for testing the presence of temporal and spatial trends. Where possible, attempts should be made to link these trends to known hydrological or geological events in the basin (e.g., spills, floods events, bank erosion, construction activities, etc.). This will require that a log of potentially significant watershed events be kept for each year. This component of the analysis will determine the extent to which data can be pooled for further analysis, as well as aid in the interpretation of results.

Test of H_01 will be qualitative within any given year (a pass/fail test of whether the proportion of fines is below the 20% threshold) and will rely primarily on the pooled data for river as a whole, though the analysis can be segregated based on habitat type (pool, run, riffle, cascade) or river reach/segment. As a time series of test data develops, a test for serial randomness will be carried out to determine the likelihood that there is a persistent trend of deteriorating substrate quality (Zar 1974). Because there is some uncertainty in the linkage between the substrate quality index above and spawning success, independent corroboration is needed to draw conclusions with certainty. In this case, it is the pattern of chum relative egg to fry survival rate (Monitor2). Should a correlated trend in substrate quality become evident, it may trigger the need for a prescribed flushing flow.

It should be noted that the threshold level of sediments (presently set a 20% fine materials less than 2mm in diameter) is subject to change depending on the results of a literature review. The way the data will be analysed however, will remain the same.

2.3.4 Literature Review

A cursory review of published literature will be carried out to evaluate the merits and shortcomings of the Wolman Toe-Pebble count methodology, particularly as it relates to spawning gravel quality, and how it is used in the context of the present monitor. An attempt should be made to relate Wolman Toe Pebble count data to meaningful ecological events (spawning success, quality of cover, over-wintering survival etc.)

2.3.4 Reporting

Project reporting will consist of annual data reports and a comprehensive final report at the conclusion of the monitor. The annual data reports will summarise the year's findings and include a short discussion of how the year's data compare to that of previous years. It will include a brief description of methods, present the data collected that year, and report on the results of all analyses. During the first year of the monitor, the data report will also contain the results of a literature review on the utility of the methodology used here, its possible shortcomings, and its biological relevance. Results of the review are to include recommendations on how to appropriately tailor the methodology the context of the present monitor.

At the conclusion of the monitor, a final comprehensive report will be prepared based on all of the annual reports written to date that:

1. Re-iterates the objective and scope of the monitor,
2. Presents the method of data collection and analysis,
3. Describes the compiled data set and presents the results of all analyses,
4. Describes the outcome of all hypothesis testing and address the management questions described in Section 1.2.
5. Discusses the consequences of these results as they pertain to the current WUP operation, and how it may factor into future decision making.

All reports will be submitted to the Alouette Monitoring Committee for review and comment prior to being finalised for general release.

2.4 Interpretation of Results

A persistent state of gravel quality that is less than the threshold deemed suitable for successful spawning (presently set at < 20% of material < 2mm diameter, though this may change following the results of the literature review), in conjunction with declining chum relative egg to fry survival (Monitor 1), would indicate the need to consider remedial action, in particular the need for a prescribed flushing flow. The magnitude and duration of such a flow regime would have to be developed in consultation with the Alouette Monitoring Committee to balance the need for a flush with its potential impact on other values in the watershed, particularly on the risk of downstream flooding.

2.5 Schedule

The substrate quality will be carried out annually until the next WUP review period in 2014. The monitor will be carried during mid summer when flows are low and there are no incubating embryos in the gravel. A data report and executive summary of the year's data will be due the 1st week of February the following year. The final report will be due just prior to the start of the next WUP review process in 2014, though the precise due date will be set at BC Hydro's discretion.

2.6 Budget

The total cost of the 7-year substrate quality monitor enumeration monitor, including February 2008 (year 1) through July 2009 (portion of year 2) expenditures of \$13,095, is estimated to be \$58,719 in 2006 dollars. Taking into account an average inflation rate of 2%, the total cost is expected to be closer to \$51,143 over the remaining 6-year implementation period. The average annual cost of the monitor, not taking into account inflation, is expected to be \$8,284 per year.

2.7 References

Higgins, P. 2005. An assessment of the effectiveness of flushing flows for managing fine sediment in fish habitat of the South Alouette River. *Prepared for the Alouette Management Committee*. October 2005. 33 pp.

Zar, J.H. 1974. *Biostatistical Analysis*. Prentice-Hall, Inc. Englewood Cliffs, N.J. 620 pp.