Somass Basin Watershed Management Plan

Climate change adaptation for ensuring Alberni salmon futures

BC Conservation Foundation

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Introduction and Executive Summary

The impetus for the Somass Basin Watershed Plan came about in 2006 / 2007 because of several concerns about the future of Alberni salmon populations - especially Sockeye salmon.

Since 1990, there had been five significant summer droughts and warm water events resulting in major Sockeye salmon pre-spawning mortalities, disease and loss of reproductive fitness. There were predictions of more frequent & longer droughts in future on account of climate change and variability. Great Central Lake Dam already provided for optimal fisheries flows to offset drought impacts on salmon, steelhead and resident fish, but there were serious concerns about aging infrastructure and a suitable ownership arrangement. The historic fibre mat in Alberni Inlet was also expected to be a potential additional threat to sockeye migration under adverse river and oceanographic conditions.

*Living Rivers – Georgia Basin/ Vancouver Island (*established in 2006 / 2007) teamed up with Fisheries and Oceans Canada and consulted local government staff, First Nations and local stewards to determine their interest in pursuing a collaborative Somass Basin Watershed management plan. Following a very positive response, submissions were made to the Living Rivers Trust Fund and the Pacific Salmon Commission Southern Endowment Fund for launching a Somass Basin Watershed Plan to address these concerns collaboratively with local partners. Initial funding of $200,000 was obtained by the BC Conservation Foundation (BCCF) from the BC Living Rivers Trust Fund and Pacific Salmon Commission Southern Endowment Fund and this has been augmented since then by other partners - most notably in excess of $2 Million by Catalyst Paper and Hupacasath First Nation in preliminary work and rebuilding of the Robertson Creek saddle dam, approximately $100,000 from Natural Resources Canada's Regional Adaptation Collaborative and additional funding from the Living Rivers Trust Fund as well as many other contributions from the local stewardship community, local and senior governments, etc.

The SBWMP has always been considered to be a living plan that must be implemented in stages to reach its ultimate long term goals. The first major infrastructure goal has been obtained with the rebuilding of the Robertson Creek Saddle Dam. A great deal of complex technical work that is foundational to moving forward has been undertaken over the past four years and plans are being prepared to augment this body of work if additional funding can be obtained. The next stage is to establish a viable long-term ownership capability of the Great Central Lake dams. A new owner needs to be sustainable financial capability to not only operate and maintain the existing infrastructure, but to extensively renovate it to improve its current functionality and provide for cold water flows that will be essential for long term resilience of Somass sockeye populations. Hupacasath First Nation (HFN) may become that new owner.

In the meantime the plan also calls for a number of action points that can be done over the next few years to further resilience and recovery of all species of Alberni salmon. Raising broad awareness of the issues is a critical requirement in moving forward before another major climate event causes serious harm to Alberni salmon.

1. Overview and Purpose

This report provides an update and current status of the Somass Basin Watershed Management Plan (SBWMP) as of June 2012. It highlights key remaining challenges, and proposed short to medium term action steps to address four stages of the plan.

The planning process was originally funded by the Pacific Salmon Commission (Southern Endowment Fund) and Living Rivers – Georgia Basin/Vancouver Island. Additional support was received between January 2010 and March 2012 from Natural Resources Canada for climate adaptation through the BC Regional Adaptation Collaborative (RAC – Appendix A6). The overall initiative has been managed to date by the BC Conservation Foundation (BCCF) with Robert Gunn providing local coordination. An ad hoc Somass Basin Watershed Management Committee was established and broader community group called the “Forum” has met periodically as the plan has developed and foundational technical work was undertaken. Hupacasath First Nation (HFN) and BCCF entered into a Letter of Understanding in February 2010 to further implementation of the plan in their territory.

The SBWMP has evolved since the first meeting of the “Forum” on August 27, 2007 to the most recent on November 24, 2011 with a consistent focus on developing solutions and implementing actions that will address key watershed climate-related issues particularly with respect to infrastructure renewal and adaptation requirements. These elements are essential for the long-term resilience of Alberni salmon that provides vital economic social and cultural values for the valley residents as well as supporting very important coastal commercial and recreational fisheries as far away as Alaska.

Note: Land use issues were clearly of concern to folks attending the forum sessions who feel that federal and provincial regulatory standards for riparian protection are not good enough - particularly on private land. Concern was also expressed about documenting and conserving wild Chinook salmon biodiversity as a key element in climate change adaptation. The SBWMP management committee will need to decide in future on whether it can expand the scope of the plan to address one or both of these concerns.

This report brings together the results of all the previous work, reflects the collaborative efforts to date and outlines actions taken and yet to be taken to reach future stages of development.

1.1 Somass Basin and its Values

The Somass Basin drains an area of about 1,426 km^2 into the head of the Alberni Inlet (Fig. 1), a typical west coast Vancouver Island fjord. The basin consists of three major sub basins: Sproat (387 km^2), Great Central (651 km^2) and Ash (388 km^2). Much of the area is pristine, with high natural beauty and ecosystem values. The area has a long history of First Nations settlement and use, especially the lower Somass and the large Sockeye spawning lakes.

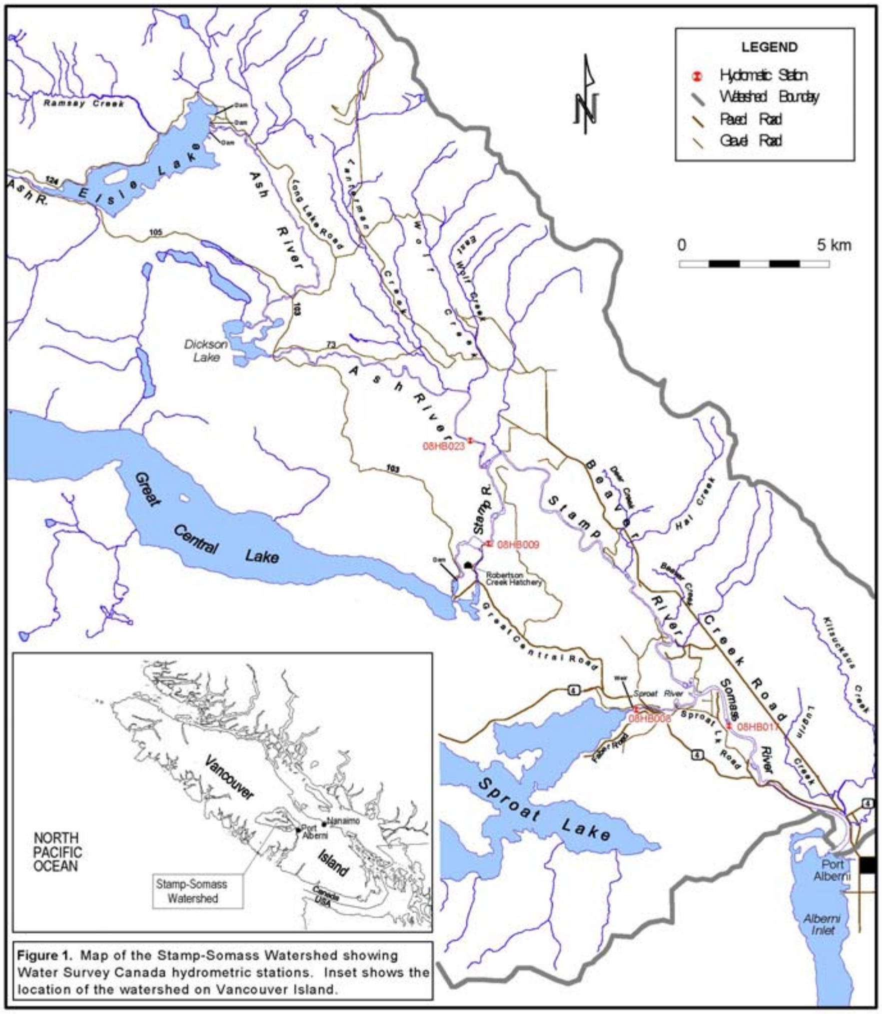

Figure 1. Map of the Stamp-Somass Watershed showing Water Survey Canada hydrometric stations. Inset shows the location of the watershed on Vancouver Island.

Figure 1 Location map of Somass Basin.

BC Hydro maintains and operates the Ash River storage facility in the upper watershed, which diverts water from Elsie Lake via penstock/tunnel down to a generation facility situated on the north shore of Great Central Lake. There is interest in the potential for micro-hydro to be developed at the Great Central Lake dam, and possibly at Elsie Lake as well.

The Somass Basin as a whole supports the largest sockeye population on BC's southwest coast, and significant Chinook, Coho, Steelhead and resident trout resources. Management of in-stream flows and lake levels is inextricably linked to support of diverse and highly valuable stocks and fisheries. DFO's Robertson Creek Hatchery draws its water supply from Great Central Lake supporting the production of significant numbers of Chinook, Coho and Steelhead smolts annually. Enhanced Sockeye and Chinook returns support substantial social and economic benefits that have become increasingly important to the Alberni Valley over the last 20-30 years.

The Somass Basin's salmon resource supports a diverse and regionally significant Aboriginal fishery. In particular, both the Tseshaht and Hupacasath First Nations have relied on salmon for food, social and ceremonial purposes over generations. Hyatt (2003) estimated the aggregate economic value of Somass wild and hatchery salmon commercial and recreational fisheries at $4-9M/year.

The lower Somass River and Sproat Lake are currently popular recreation destinations. As populations continue to grow and economic diversification becomes more important, demand for waterfront land and water-based recreation opportunities will increase.

1.2 Water Control Structures at the Outlets of Great Central Lake

The water control structures at Great Central Lake (Figure 2) provide significant benefits for salmon resources particularly during critical periods of drought and low flow and have the potential to play an even greater role in the future when climate change is expected to increase frequencies of high water temperatures and drought conditions.

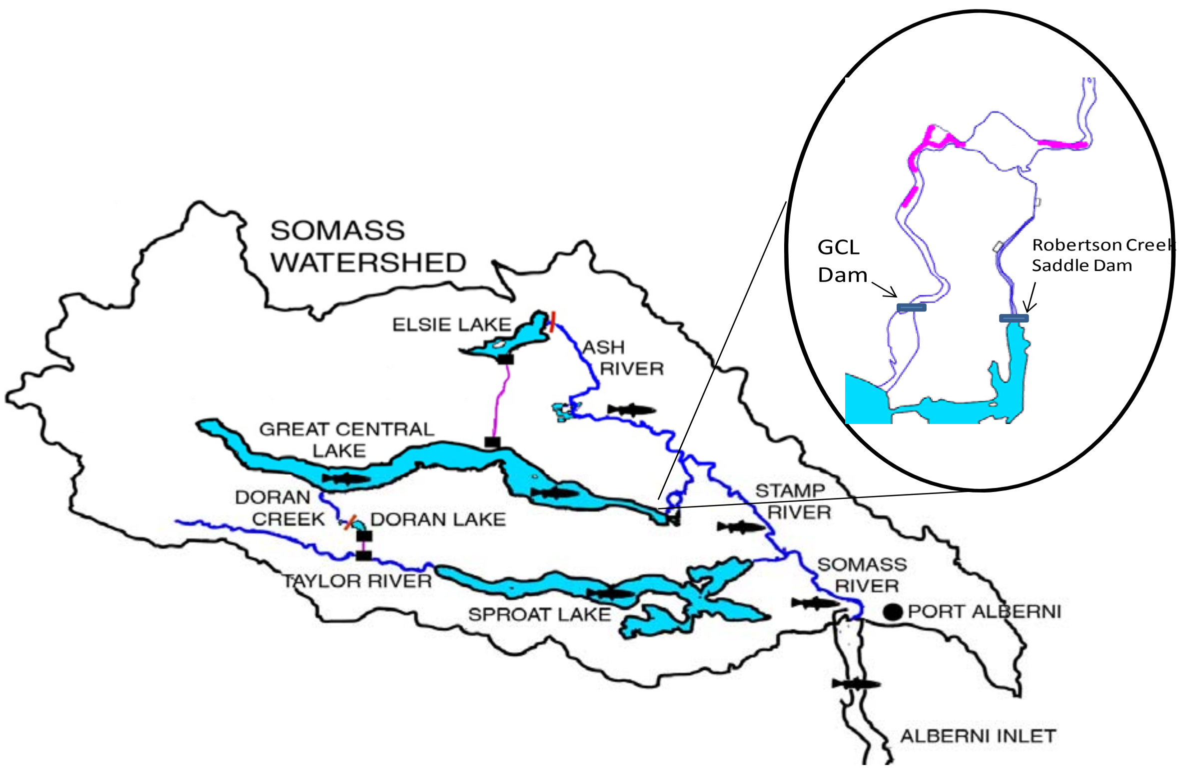

Figure 2 Somass Basin and GCL dams.

The original purpose of Catalyst Paper Corp.'s Great Central Lake (GCL) Dam was to help dilute and mitigate the impact of pulp mill effluent releases into Alberni Harbour using the additional flows that are provided by storage. Over several decades, as pulp mill processes evolved and technology improvements were implemented, the need for industrial water releases from GCL was eliminated. As a result, by 2004 the pulp mill's water license on GCL was amended to serve the 'general purpose' of fish conservation. Although not built or licensed for the purpose of flood control, the operation of the dam can either reduce or exacerbate downstream peak flows depending on how lake levels and flow releases are managed and the timing and magnitude of peak inflow events.

Catalyst's Robertson Creek Saddle Dam works in conjunction with the GCL main dam to impound Great Central Lake. The Department of Fisheries and Ocean's Robertson Creek Hatchery is located a short distance downstream of this dam and draws its water from GCL. For over 40 years, GCL water levels were managed during the sockeye spawning period (peak from mid-October to mid-November) to minimize the potential for dewatering eggs deposited in shallow beach areas. Dam safety concerns, identified at the Robertson Creek saddle dam in 2008, necessitated that GCL be drafted lower than previous managed levels by November 1st each year, which resulted in lakeshore drawdown and re-watering events affecting Sockeye egg and juvenile Coho and trout survivals.

The Somass Basin Watershed Management Committee agreed that replacing the Robertson Creek Saddle Dam was the highest short-term priority for making progress on the complete plan. It took more than two years for negotiations to take place and development of an acceptable concept for the project to proceed. Catalyst Paper and Hupacasath First Nation commissioned a detailed proposal for renewal of the existing structure that was presented to the regulatory agencies in late November 2010. This was intended to be an integral part of transfer of the water licences between the parties.

Following a meeting with all regulatory agencies on January 24, 2011, Catalyst Paper commissioned Sigma Engineering (and BCCF as one of the subcontractors) to design a new structure and associated habitat compensation measures. Regulatory approvals were received by late June 2011 with construction commencing shortly thereafter and being completed by September 15th 2011. The new $2-Million structure provides a safe and economical replacement dam that can withstand all operational conditions and lake levels, including a probable maximum flood (PMF) of 3,430 cubic metres per second. It also provides for downstream passage of juvenile fish and a gated gravity water supply for Robertson Creek.

Improvements to the main concrete dam at GCL are also required now that the Robertson Creek Saddle Dam has been replaced. Modernization of the 1950's stop-log design (by installation of hydraulically-controlled gates) would alleviate operational difficulties and improve seasonal water storage control. As dam improvements are designed and costs estimated, there is a significant related interest in evaluating: 1) the potential for micro-hydro development at the facility, and 2) the potential for incorporating cold water withdrawal capability to moderate downstream water temperatures during the adult Sockeye migration period (see climate change risks below). A proforma assessment of the potential for micro-hydro development as well as engineering concepts and preliminary cost estimates for cold water withdrawal capability of up to 10 cms of 6°C water have both been completed and are discussed later in this report and in the appendices.

1.3 Sproat Lake Weir

The Sproat Lake Weir, owned and operated by Catalyst, supports lake levels that help to provide and maintain the pulp mill's water supply, downstream fish passage and the potential for future municipal water supplies. Preliminary work has been done to evaluate the potential for incorporating cold water withdrawal capability in support of long-term salmon migration concerns. Engineering concepts involving a hypolimnetic air lift pump and pipeline design have been prepared by nhc Ltd. (Northwest Hydraulic Consultants Ltd.) to convey up to 5cms of 6°C water for strategic release at the lake's outlet in the late June – early July sockeye migration period. (Appendix A4)

1.4 Upper Alberni Inlet and Somass Estuary

At times, when Somass River temperatures reach or exceed 19°C, migrating Sockeye salmon are forced to hold in Upper Alberni Inlet at favorable water temperatures but at low dissolved oxygen levels. This can impact their ability to migrate when conditions improve and/or on spawning success if they are able to migrate at all. In Alberni Inlet oceanographic features play a large role in the low DO risk for salmon. (Appendix A5)

Figure 3: Approximate location of the fibre mat in Alberni Harbour

A fibre mat near the pulp mill outfall built up as a result of historic Kraft pulp operations (prior to 1993; Figure 3) of previous owners of the pulp and paper mill. The mat has been recognized as a longstanding threat for DO decline in Alberni Harbour. The fibre mat is gradually being consumed by bacteria, using the dissolved oxygen in the lower water column. Because of this, Catalyst is required to conduct regular sampling of water quality, marine plants and invertebrates, and DO in the eastern end of the Inlet.

It was decided to use the historic data collected through this Environment Canada designed sampling program and data from an augmented 2009 sampling schedule, in order to model the dissolved oxygen demand (“sink”) in the area of principal concern.

Results: The impact of fibre mat on DO has been reduced by river-borne sediments gradually covering it. As a result, the mat size has decreased from 1.03km^{2}to 0.3-0.6 km^2. Though the study did determine a reduction in the threat, there is still a current oxygen use by the matt, estimated at 252-2500 kg/day. It will be important therefore, to continue long-term monitoring of the situation and also to check the fibre mat sediment cover after any major disturbance.

In other waters with low DO levels, innovative Speece Cones have been used to inject super liquid oxygen-saturated water into a low DO area. A preliminary (2010) study showed that this technology would be suitable in Alberni Harbour and would improve holding conditions for Somass Sockeye. It was decided however, to postpone an experimental application for now once it was known that the threat from the historic fibre mat itself has lessened. Priority will be given instead to monitoring the fibre mat and reducing water temperatures in the rivers to allow Sockeye to move steadily to safe refugia in Sproat and Great Central lakes.

Since the primary natural oceanographic phenomena and configuration of Alberni inlet are the major reason for low DO, the threat to holding salmon has not gone away.

In order to plan for overcoming this potential impact, DFO can predict potential barriers to migration in April, based on prevailing oceanographic conditions and long-range weather forecasts. By doing this, DFO can work with fish harvesters to develop a pre-harvest plan that results in achieving overall escapement targets even if fish are expected to being delayed at the mouth of the river with the onset of warm water temperatures, as early as late June. Reduced harvest rates would be negotiated in June and more of the total allowable catch (TAC) would be concentrated later into July and August when adverse migrating conditions are expected. This strategy would result in a higher percentage of the TAC to be taken from later migrating fish that might not be able to reach Sproat and Great Central Lakes in any case due to predation, and reduced health due to holding in deep water with Low DO.

Delaying harvest timing is always a difficult "sell" pre-season because fishers are always concerned that they might "miss" harvesting and much of the potential harvest will get by them.

Therefore long-term climate change adaptation strategies need to be developed which reduce exposure to both low oxygen levels in Upper Alberni Inlet and high water temperatures in the Somass watershed. These will ensure that enough Sockeye can migrate to Sproat and Great Central lakes to meet spawning escapement targets.

The Somass Estuary is also a critically important habitat for other salmonids - especially for wild Chinook smolts making the transition from fresh to salt water. However it has been highly impacted by development (approximately 70% of the intertidal area). Today, only a small portion of the original delta, including Johnstone Island and parts of Shoemaker Bay, remains relatively undisturbed. This area is low-lying terrain subject to tidal inundation. It includes mudflats, salt marshes, meadow-type vegetation, shrubs and a small stand of trees. The intertidal, marine and river portions of the estuary together are of major importance for fisheries, waterfowl and botanical values.

DFO has approved the restoration of Christie Slough as habitat compensation project in the estuary for the expanded footprint of the Robertson Creek Saddle Dam. BCCF commissioned the required design work in 2011, but the project was not completed by Catalyst in September 2011 as originally planned. DFO has ordered a new larger culvert pipe and contracted BCCF to complete this installation with funding remaining from Catalyst Paper, as well as additional funding from the BC Living Rivers Trust Fund and local community partners. The new culvert will greatly improve the intertidal productivity of this important slough in the Somass estuary at a total cost of approximately $60,000. Target date for in-stream work is mid July 2012.

The local stewardship community has sponsored other estuary restoration projects in the past and it is anticipated that more proposals will be developed in future years to improve habitat productivity.

1.5 Climate Change and Variation Impacts on Salmon Migration

Since 1990, five significant summer droughts and warm water events have resulted in major Sockeye pre-spawning mortalities, disease and loss of reproductive fitness. There is growing concern that warmer temperatures in the basin, in response to climate change, could increase the frequency and intensity of such events. These occurrences threaten the sustainability of this increasingly valuable salmon resource.

A warm water event during late June / early July 2009 served as a graphic reminder of the potential risk. Sockeye migration stopped when river temperatures rose above 20°C. Large- scale migration restarted quickly when water cooled for a few days, but was then stopped again for three weeks (Fig. 4). The primary concern related to interruption of migration is the risk of viral disease and loss of reproductive fitness (and ultimately stock productivity) when sockeye are exposed for lengthy periods to warm river water and low DO tidal water off Port Alberni.

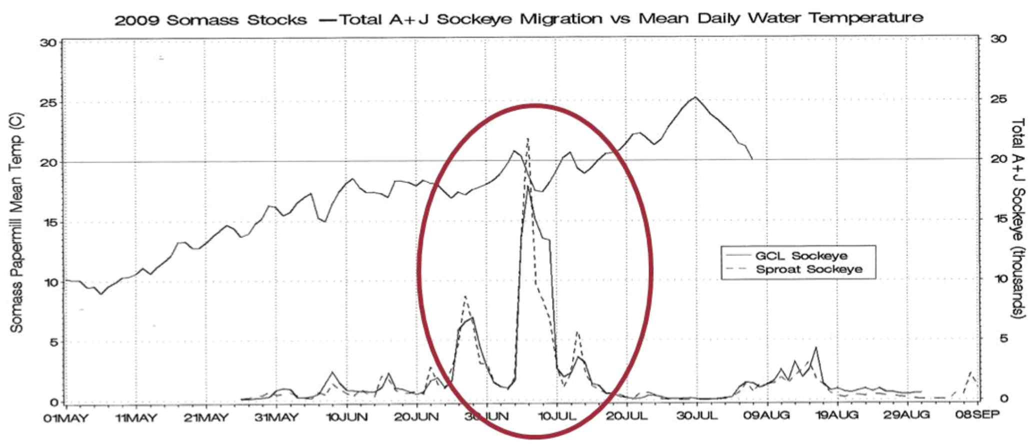

Figure 4. Sockeye migration in relation to Somass R. temperature during summer 2009.

1.6 Climate Adaptation Strategies for meeting Sockeye Salmon Escapement Targets

There are four principal climate adaptation strategies that could be pursued to conserve sockeye salmon:

a) Ensure overall Somass sockeye escapement targets will be met by the earliest arrivals when high water temperatures are expected later in the summer;

b) Reduce migration delay points within the Somass Basin including Great Central, Stamp Falls and Sproat Falls fishways; (This will require improvements to DFO counting facilities to reduce long “backups” during heavy migration periods and provide permanent lights at Stamp Falls and possibly the other fishways to encourage sockeye to continue to migrate through “white water” areas at night under cooler water temperatures.).

c) Strategically reduce water temperatures through new infrastructure at Great Central and Sproat Lake dams to allow for safe passage of sufficient spawners to achieve escapement targets in the June to August migration period; and

d) Improve dissolved oxygen levels in near shore Marine and estuary holding areas through Speece Cone technology when Sockeye salmon are forced to wait until water temperatures cool in the Somass River. (N.B. This is less desirable than option c) and may only be partially effective depending on the future state of the fibre mat – as discussed previously.)

2. Management Objectives and Recommended Actions

(Completed, in Progress and Future)

2.1 Great Central Lake

Management Objectives

For Great Central Lake, the primary management objectives are to:

- Maintain or enhance overall fish productivity by:
  - Protecting or improving Sockeye spawning habitat (focus on upper shore spawners);
  - Improve lake productivity through annual nutrient enrichment (presently needs a science-based effectiveness review);
  - Maintain or improve Coho/resident trout rearing habitat in shallow lakeshore areas through improved effective/responsive lake level management practices; and
  - Protect lake tributary habitats through full application of streamside riparian buffers and well-regulated forest management practices.
- Minimize flood risk to downstream public safety and infrastructure.
- Maintain gravity hatchery water supplies over a range of lake storage above 369ft MB datum.

For GCL outflows, the primary management objectives are to:

- Maintain acceptable salmon and steelhead migration and rearing flows (15cms is the preferred minimum from July 1 to October 31).
- Strategically cool river temperatures to <19°C (measured at Paper Mill Dam) to ensure successful sockeye spawning migration, annually.
- Add micro-hydro power generation to main GCL dam, if economically and environmentally feasible and develop alternative sources of capital, operational and maintenance revenue for the dam owner to support recommended improvements.

Proposed Actions

The urgent need for infrastructure renewal (particularly at Robertson Creek Dam), coupled with interest in micro-hydro power generation at GCL dam and the potential for cooling the river's temperature regime during future warm water/drought events, raised significant questions that required an integrated evaluation of technical feasibility, economic viability and biological implications for this site.

In response, a series of proposed actions were developed:

Action 1	**Rebuild the Robertson Creek Saddle Dam.** This infrastructure renewal project was an urgent first priority action and was completed in September 2011 as discussed elsewhere in this report.

Action 2	– **Undertake a *Pro Forma* analysis of micro-hydro potential at GCL dam.** Nhc Ltd and Compass Resource Management were engaged to perform this proforma. The analysis was completed in the late fall of 2011 and reported out to the Forum in November 2011. The report was finalized January 2012. The Results of this analysis were as follows: After careful study of potential alternative technologies, the consultants chose one versatile "fish-friendly' *Eco-bulb* turbine as opposed to several smaller units. An operational model was developed to estimate daily power generation and project optimization techniques were used to determine a notional plant capacity for a detailed financial *proforma* model. Preliminary quantity take-offs and scaling was used to estimate construction and equipment costs to a Class D level. Capital costs associated with construction of a project are relatively high ranging from \$5.8M to \$3.8M per MW installed. Conceptual costs to provide fish protection with permanent screens, additional fish passage with fishways and fish barrier at the tailrace add to the already high capital costs. This assessment also considered scenarios where no fish screens were installed at the intake, but plant operations are curtailed to protect downstream smolt migration. The optimum plant size identified was approximately 4.2 MW at a flow of 70 m^3/s, and utilizing the sixteen year historical hydrological data string, the proposed plant produces an average of 21.6 GWh per year (±3.4 GWh = 1-STDEV). Excluding fish screens and shutting down for the month of April was found to be more attractive than installing screens and continuing operation during this time. Under the above described configuration, with the highest acceptable leverage (which would deliver the highest possible returns), the equity IRR was determined to be 7.2%, below the target IRR range of 10% - 15% for projects of this type. On account of the significant regulatory implications and uncertainties associated with a micro hydro project at Great Central Lake, the consultants were also asked to assess any other possible potential new micro-hydro projects in the Somass watershed. A similar proforma was developed for an Elsie Lake Dam Hollow Cone Valve instream flow release opportunity. Based on the same financing and revenue assumptions. This optional project could generate 3,000 MWh per year with total costs of \$5.2 million. The equity provider would earn a return of 5.8%, which is considerably below the target return range. " While the Elsie Lake option is expected to be much simpler to implement from a regulatory perspective, it has limited projected surplus cash flow that could be applied by a new dam owner for operations and maintenance of the Great Central Lake facilities. Details are found in Appendix A2 At the time of writing, HFN had not made a decision on whether to explore either option any further.

Action 3	**Conduct a feasibility study of a cold water release structure at GCL dam.** This required establishing a network of temperature data loggers and a HEC-RAS water temperature model for the Somass Basin (nhc ltd. 2009). Engineering design work was completed to the conceptual level with preliminary capital cost estimates prepared and reported out to the management committee. (nhc ltd.) Details are found in Appendix A4
Action 4	**Develop an overall financial strategy for GCL infrastructure renewal.** This work remains to be done once a new dam owner is in place. An overall strategy should be developed that describes total capital cost requirements, operating costs, sources of capital and potential revenues.
Action 5	**Conduct an assessment of the GCL carrying capacity, nutrient enrichment program design, logistics & performance measures.** GCL carrying capacity is influenced by the effectiveness of the enrichment program and/or the spawning carrying capacity. It is not clear which currently governs and both could possibly be improved. This work remains to be done.
Action 6	**Conduct a sensitivity analysis of GCL storage levels in relation to downstream winter flood risks and the need to maintain recruitment from shore spawning and rearing fish populations.** The following work is recommended for refining rule curves and operating practices in the event of a transfer of the GCL water licenses. Tasks include: – Flood frequency analysis relative to variable GCL storage levels on November 1, starting at ~370ft MB datum with 0.5m incremental increases to 373ft MB datum (previous winter low before saddle dam safety risk was identified by TROW Assoc. in a 2008 report for Catalyst Paper Corp.). – Analysis identifying risk to downstream human safety and infrastructure at Robertson Creek Hatchery, provincial/municipal/residential properties, roads and bridges.

2.2 Sproat Lake

Management Objectives

For Sproat Lake, the primary management objectives are to:

- Protect known sockeye spawning beaches from urban and industrial developments;
- Maintain or enhance fish habitat productivity in the Taylor River and other lake influent tributaries for anadromous and resident species; and
- Monitor key water quality parameters with respect to non-point source pollution and implement best management practices to reduce and/or eliminate same.

For Sproat Lake outflows, the primary management objectives are to:

- Maintain acceptable spawning migration flows (for Sockeye, Coho, Chinook and steelhead); and
- Strategically cool the river's summer temperature regime to enhance successful migration by Sockeye.

Proposed Actions

The objective to improve the river temperature regime during future warm water/drought events parallel those of GCL and raise similar questions regarding technical feasibility, economic viability and biological requirements. In response, a series of proposed actions were developed:

Action 1	**Complete a feasibility study for a cold water release structure at Sproat Lake weir.** Tasks identified and partially completed were as follows: – Conceptual engineering design work and preliminary capital costs estimates were completed by nhc ltd. for a technically feasible project for reducing outflow water temperatures from Sproat Lake, but – there remains a number of biological questions and logistical details that need to be worked addressed before moving to consultations with local residents and others; and – Biological issues to be resolved would benefit from another year of PIT tagging when adverse Sockeye migration conditions are anticipated. (See section 2.4 Task 4 below.)
Action 2	**Develop a financial strategy that describes the total capital cost requirements, operating costs, sources of capital, etc**. This future task should include: Sourcing possible funds for developing a pilot-scale cold water supply experiment as early as the summer of 2014 if PIT tagging is done in 2013 and results point to the value of strategic cold water releases.
Action 3	**Conduct an assessment of Sproat Lake sockeye carrying capacity in relation to current target escapements.** This task is recommended for early action and could include: Assessing the relationship between zooplankton biomass, pre-smolt density, length of growing season and mean water column temperatures through multi-variant statistical analysis.

2.3 Stamp River – Somass River Salmon Migration

Management Objectives

At the Stamp Falls Fishway, the primary management objectives are:

- As required, maintain the fishway in a highly serviceable condition, free from obstructions and structural defects.
- Enhance Sockeye migration through the fishway by employing lights to encourage night time migration, thus taking advantage of more amenable diurnal

water temperature fluctuations (i.e., lowest temps are typically recorded between 0200-0600hr).

- Develop a new fisheries interpretive centre (or web-cams feeding downtown Port Alberni locations) that provides public education opportunities consistent with Stamp River Provincial Park and Alberni Valley community needs.

Along the Stamp River – Somass River corridor as a whole, the management objectives are:

- Improve the basic understanding of Sockeye migration timing and vulnerabilities to high water temperatures and low flows related to droughts.
- Protect riparian and in-stream habitat conditions to at least federal-provincial regulatory standards and BMP's.

Proposed Actions

The concept of installing seasonal fishway lighting and building a Stamp Falls Interpretive Centre has received initial support from the SBWMP Management Committee and key partners including BC Parks, HFN, West Coast Aquatic and DFO Fisheries Management. However there are site issues at Stamp Falls (i.e. slope stability hazard) that make installation of web-cams feeding one or more locations in Port Alberni a more desirable alternative, at least in the short-term.

The proposed actions are:

Action 1	**Conduct additional testing to refine the best approach to fishway lighting and quantify potential fish passage benefits of a permanent installation.** In 2013, field trials could include: – Extending lights further down Stamp Falls canyon (Fig. 5 to influence a larger pool of migrating sockeye; – Testing the benefits across a wider range of river temperature/weather conditions; and – Conducting a preliminary review of lighting potential at the GCL dam and Sproat River fishways.
Action 2	**Develop a conceptual design and approval for the proposed Stamp Falls Interpretive Centre or an alternative web-cam installation if bank stability and other issues preclude an on-site centre.** Tasks include: – Confirming or otherwise if there is a feasible site near Stamp Falls that minimizes the construction footprint while ensuring safe public access and long-term facility integrity (i.e., flood-proof); – Developing CAD or graphic design images of the physical structure(s) at the preferred location consistent with BC Parks' standards; – Ensuring DFO salmon enumeration equipment is incorporated in building design; and Acquiring a Park Use Permit for the site, while finalizing construction

	designs and logistics and/or - developing a web-cam option and securing locations in Port Alberni that would develop greater public awareness of salmon migration issues.
Action 3	**Develop a financial strategy for fishway lighting and the interpretive centre.** The strategy should integrate the financial components of Actions 1 and 2 into an overall plan that describes total capital cost requirements, operating costs, sources of capital and cost-sharing arrangements.
Action 4	**Consider repeating a Sockeye PIT tagging study in 2013 to track the movement of fish through the Stamp—Somass system in response to flow, water temperature, barometric pressure and fishery factors.** Results from the 2010 study determined that it would be desirable to modify some study elements in a future program including tagging of Henderson Lake stocks as well as Somass. Ideally this study would proceed when climatic and oceanographic factors are expected to be somewhat adverse to better define detailed design considerations for a potential pilot cold water release facility at Sproat Lake.
Action 5	**Work with FN's, local governments, forest companies and other private land owners to improve streamside/lakeside management practices and protection of riparian corridors.** Support for an enhanced role is required either as part of the SBWMP or a broader Barkley process currently being coordinated by West Coast Aquatic.

Fig. 5 Stamp Falls with fishway entrance at lower right and lighting array in mid July 2009.

2.4 Somass Estuary

Management Objectives

The primary management objectives are:

- Progressively restore estuary habitat capacity for wild salmon smolts making the transition from fresh to saltwater;
- Ensure safe passage of adult salmon migrating upstream to spawn;
- Maintain ongoing regular assessments of water quality especially after any major disturbances that might degrade DO levels or release contaminants; and
- Maintain a "watching brief" on technologies such as Speece Cones that might be employed to improve DO levels in the estuary and near-shore marine areas in Alberni Inlet.

Proposed Actions

Previous work by the Alberni Enhancement Association and others has documented the extent of degradation and alienation of intertidal areas in the Somass estuary and resulted in implementation of successful restoration projects (pursuant to the Somass Estuary Management Plan 2003). Apart from a focus on the Christie Slough project as habitat compensation for increased footprint of the new Robertson Creek Saddle Dam, the SBWMP committee has not been involved to date in the full scale plan for the estuary, but it could be done in future years.

Catalyst Paper is required to conduct biannual monitoring of water quality in the vicinity of its mill outfall and the SBWMP Management Committee has been able to augment that monitoring (in 2009) to obtain a better understanding of conditions affecting Sockeye salmon migration and holding.

Proposed actions to build on work to date are:

Action 1	**Complete upgrading of Christie Slough flow passage in 2012 and follow up with additional restoration of degraded habitat in Somass estuary in future years.**
Action 2	**Under take further tagging and monitoring programs to better determine Sockeye holding and migration patterns under various temperature and oceanographic conditions.** Tasks include: – Designing and implementing a collaborative PIT tagging program as early as spring 2013; and Augmenting regular biannual EECM monitoring carried out for Catalyst Paper and Environment Canada to gain additional required information.

2.5 Basin Wide Considerations

In addition to the location specific actions listed above, there are a number of Basin Wide actions that are necessary to develop and support the ongoing development and implementation of the SBWMP.

Proposed Actions

Action 1	**Work towards establishing a Somass Basin Watershed Board or Council that uses consensus decision-making to achieve agency and community objectives for water and fisheries management.** This can be modeled after the Cowichan Watershed Board that was established in early 2010 to oversee implementation of the Cowichan Basin WMP on south-east Vancouver Island.
Action 2	**Develop a basin-specific climate forecast model to predict future air temperature and precipitation changes for Barkley Sd. /Alberni Inlet/Somass Basin (i.e., 25-50 years from present).** This task may well have to be undertaken after about five to ten years of data collection from the existing hydro-meteorological data logger network established in 2008. This is because current larger-scale climate models do not have sufficient resolution for downscaling into the micro climate of the Somass Basin.
Action 3	**In the interim, continue to use the SBWMP Management Committee in water planning oversight role.** Tasks include: – Monitor developments regarding water licence transfer and GCL dam ownership and provide strategic support, where possible; – Support may include fund-raising, enhanced partnerships and political persuasion; – Review results of technical studies and provide technical/administrative direction; and Continue to the lay the groundwork for development of a local Watershed Board or Council for long term community leadership, accountability and governance.
Action 4	**Facilitate public outreach and education through periodic open houses, SBWMP Forum meetings and media relations.** Tasks include: – Preparation of brochures, installation of web-cams, river tours for decision makers and the media.

3. Staged Development and Implementation of the SBWMP

The preceding section provides a list of the actions deemed necessary to achieve a water management regime supporting ecological resilience and community stability over the long term. Overall development and implementation of the SBWMP has, however, been constrained by persistent uncertainty regarding the future ownership of the GCL Dams and water licences. In addition, some of the actions themselves are surrounded by further economic, environmental and related regulatory uncertainties.

In the near term, there is an urgent need to advance priority actions and gain clarity regarding critical policy and management issues. Four stages are proposed below for organizing and advancing a collective work plan for the SBWMP:

- Stage One: Rebuild Robertson Creek Saddle Dam (Completed September 2011), conduct foundational technical studies and implement climate change adaptation and conservation measures not requiring a change of infrastructure at Great Central Lake
- Stage Two: New Long-term Dam Owner
- Stage Three: Robust Watershed Management Structure
- Stage Four: Critical Infrastructure Upgrades at GCL and Sproat Lake

Stage One: Rebuild Robertson Creek Saddle Dam (completed September 2011), conduct foundational technical studies and implement climate change adaptation and conservation measures not requiring a change of infrastructure at Great Central Lake

Rebuilding the Robertson Creek Saddle Dam was an urgent priority to address critical dam safety and risk management issues and, importantly, represented the first tangible step toward building public confidence and fostering partnerships.

Figure 6 newly constructed Robertson Creek Saddle Dam, September 2011.

Rationale:

The indefinite retention of the existing Robertson Creek Saddle Dam was considered untenable by members of the SBWMP's Management Committee. Regardless of the future direction on other aspects of the plan, there was an urgent need to advance the $2 Million project that was completed in September 2011. The considerable body of work done to date has advanced the potential to move to the next stage of development of the plan, but there are significant remaining challenges to be overcome that would be greatly facilitated by resolution of the dam ownership question.

However a number of important steps still need to be taken independent of the required changes in infrastructure at Great Central Lake – most notably pre-season harvest accords, passage improvements in the fishways, further restoration of the estuary, enhanced habitat protection in the watershed and identification / potential conservation of wild Chinook stocks.

Stage Two: New Long Term Owner for the Great Central Lake Dams

Resolving the long-term ownership of infrastructure and water licenses is vital to the development of the plan.

Rationale:

Catalyst Paper and the previous owner, NorskeCanada Ltd., have tried to divest the GCL dams since the water licence purpose was changed to fish conservation in 2004. A new owner is required with the necessary interest, financial resources and management capacity to upgrade, maintain and operate the dams over the long term.

As noted above, Catalyst Paper Corp. continues to own the GCL dams and holds a water licence for conservation purposes. There has been an on-going "offer to purchase" (since 2008) with Hupacasath FN for the dams/licence.

Now that the Robertson Creek Saddle Dam has been rebuilt, any potential new owner has to have opportunities to obtain the necessary capital for infrastructure upgrades and long-term revenues to support dam operations and maintenance.

Hupacasath FN is already an independent power producer and wishes to explore micro-hydro potential at Great Central Lake as an ongoing source of revenue - background engineering and economic assessments are found in the Appendices. Undertaking a *Pro Forma* analysis was central to understanding the potential economic and environmental feasibility of micro-hydro at GCL. As noted previously and in Appendix A2, the results of this study were not very encouraging from economic and regulatory perspectives especially for a potential private IPP operator. However HFN may have access to resources available to First Nations that would make a micro-hydro option more attractive economically to them. We have been advised that HFN has not made a decision as of the time of this report on whether to continue to explore micro hydro options and /or proceed with a transfer of ownership of the dams.

BCCF has continued to implement many of the foundational climate change adaptation action items identified in Section 2, with financial and in-kind partnering from Living Rivers – Georgia Basin / Vancouver Island, Pacific Salmon Commission, DFO and Natural Resources Canada.

However, new partner resources and commitments to collaborative planning are required to make further progress with respect to any major capital infrastructure investments beyond the Robertson Creek Saddle Dam replacement.

There are provisions under Part 4 of the current Water Act where the dam owner and other interested parties could be brought together to complete a formal watershed management plan that might lead to the proactive investments in the climate change adaptation indentified earlier in this report. There is currently no incentive for the present dam owner to make further investments, but that could change with a change in ownership especially if the new owners can count on sustainable funding support and partnering from others who benefit from healthy Somass Basin salmon populations.

Stage Three: Establish a Robust Watershed Management Structure

Establishing a robust management structure capable of integrating all interests and encouraging partnered investments in the watershed will ensure long-term success.

Rationale:

On June 29, 2010[1], the BC Conservation Foundation (BCCF) encouraged all interests who have been participating on the SBWMP to come together and establish a 'Somass Basin Board'. Based on similar success of the Cowichan Watershed Board, the Somass Basin Board could provide a community-based forum for partnering costs while investigations continue and ongoing operational revenue sources are pursued.

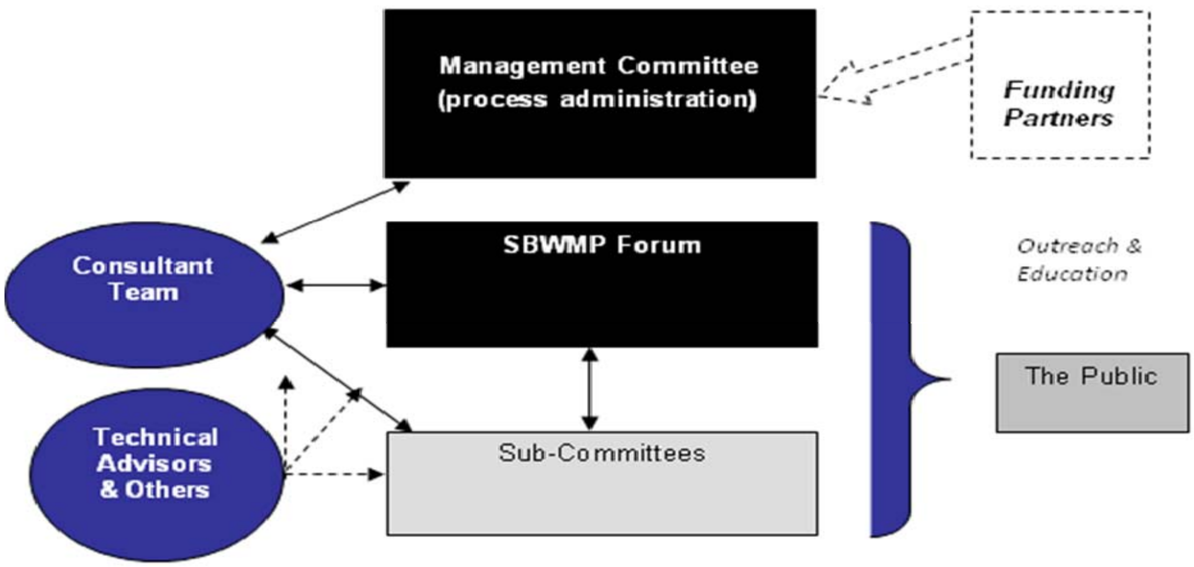

Figure 7 Current SBWMP process diagram

The current SBWMP process is shown in the diagram above prepared by Dan Ohlson who facilitated a number of the early meetings. In November 2009, Ted White of the Ministry of Environment in Victoria was asked to prepare some options to give the process some formal recognition and his discussion assessment is provided in Appendix A7. None of the formal options presented were pursued on account of the dam ownership issue. It will likely take a change in ownership of the dams (as envisaged in Stage 2) for a formal process to be initiated under Section 4 of the Water Act or under any new provisions if the Act is modernized.

[1] SBWMP Meeting Minutes, Port Alberni, June 29, 2010

Stage 4: Critical Infrastructure Upgrades at GCL and Sproat Lake

Critical infrastructure upgrades are necessary at Great Central Lake and Sproat Lake in order to develop long term water management capacity that is resilient in the face of climate change. Advancing these upgrades will require a sustained effort towards engineering and biological assessments.

Rationale:

Regardless of the future of micro-hydro at GCL, there is a need to implement infrastructure upgrades at both Great Central and Sproat lakes that will improve overall operations and build in the capacity for water temperature regulation in the rivers. (Background engineering and economic assessments are found in the Appendices.)

The main GCL dam currently has limited capability for safely adjusting flows at higher levels in order to balance lake level management with flood control considerations. The stop log controls need to be replaced with hydraulically-operated gates in seven bays, similar to what now exists in one bay now. Based on this upgrade alone, it seems likely the cost of fully modernizing the main GCL dam, possibly including a seismic upgrade, could range from $3-5M.

However, these upgrades should not take place until a total design concept has been developed that includes provision for micro hydro (if deemed feasible) and cold water infrastructure through the dam.

4. Conclusions

While there remains some uncertainty about the specific directions and accountabilities of a future Somass Basin Water Management Plan, a significant body of foundational technical work has been achieved in the last four to five years. This report describes some of this progress, but much remains to be done, as outlined in the specific actions and tasks of Section 2. Perhaps the important context for this and development of a community-based WMP is reinforced by an (October 6, 2010) email from Dr. Kim Hyatt of the Pacific Biological Station in Nanaimo. It reads as follows:

> *"As you know, I've been working with Howard Stiff over the past several months to dig deeper into the issue of climate variation impacts on migration delays and historic mortality events observed for Somass sockeye and Chinook salmon. Early results suggested there were reasons to be concerned about high temperatures slowing or stopping migration combined with the impact of degraded water quality conditions in Alberni Inlet on salmon forced to hold there.*
>
> *One issue that has always troubled me is the variable magnitude of salmon losses observed among years that at least superficially seemed very similar in terms of challenges posed for migrating fish. For example, the mass mortality event(s) during the summer of 1990 apparently have not been matched either before or after that year even though years of even higher thermal risk (e.g.*

1961, 1998 etc...) are on record. I'm happy to report that our most recent analyses have identified the combination of interacting factors that caused mortalities to occur in 1990 and to a lesser degree in a few other years.

This new analysis indicates that if current climate change trends persist or accelerate as projected by most GCMs, engineered cold water release facilities will be essential to the maintenance of sustainable sockeye and Chinook production in the Somass within 20 years or less. By contrast, there appears to be little to no hope that installing structures to increase oxygenation of mid-depth waters at the head end of the inlet is either feasible or likely to be effective. Given these results, a very compelling case can now be made for the need for cold water release infrastructure in the foreseeable future."

Before proceeding to the next level of detailed infrastructure design and costs, a compelling salmon conservation and economics case will need to be made with strong support from governments (including FN's) and NGO's. This is critical given the rough capital costs of Great Central Lake dam modernization, combined with cold water supplies at both Great Central and Sproat Lake outlets, are likely in the order of $9 – 12M.

In the meantime there are early lower-cost climate change and variation adaptation strategies that should be implemented as soon as possible as outlined in the recommended actions in Section 2 of this report – most notably pre-season harvest accords, passage improvements in the fishways, further restoration of the estuary, enhanced habitat protection in the watershed and identification / potential conservation of wild Chinook stocks.

APPENDICES:

Background Engineering, Economics and Regulatory Information

A1: Environmental, Engineering and Economic Assessments prior to the SBWMP

In 2004, Koers and Assoc. Engineering Ltd. assessed the status of the two GCL dams and their operation on behalf of DFO, following an offer by NorskeCanada to transfer ownership of both dams to the federal agency as a notional '$1 gift'. This was done recognizing the original purpose of the accompanying water licence had been converted from mill effluent dilution to fish conservation in May 2004.

As a part of the review of a potential dam ownership transfer, DFO had Edwin Blewitt and Assoc. Inc. conduct an analysis in January 2005 "of the economic and salmon management benefits" of dam ownership and operation. Blewitt concluded the present net economic benefits of dam ownership over 40 years, discounted at 3%, amounted to $71,099,264 based on Area 23 FN, commercial and sport fishery catches (before & after dam construction). Blewitt concluded that acquisition of the dams to support the salmon resource in Area 23 alone was "overwhelmingly economically justified."

In spite of this result, the Koers report identified a number of capital and operational cost issues and dam liability concerns that convinced DFO to ultimately reject NorskeCanada's offer. DFO did not seriously look at the potential for micro-hydro development at the site, as a means of offsetting some of the cost of a dam ownership transfer.

"Unless actions are taken to rebuild the saddle dam and to modernize the main GCL dam, there will be a continuing threat to downstream public safety" (TROW Assoc. 2008) and constraints on the surface water supply to DFO's Robertson Creek Hatchery, as well as on the opportunity to more effectively manage early winter lake levels to conserve wild fish populations.

Both Great Central Lake dams are in the "***High Consequence***" category from a dam safety perspective, and the saddle dam was considered to be in an "unsatisfactory" structural condition. The current access road to the Robertson Creek Hatchery and the main GCL dam is immediately downstream of the saddle dam. There were five overtopping or 'near overtopping' events of the saddle dam prior to 2007, and one in January of 2010.

The TROW report also indicated the main GCL dam has marginal capacity to pass flood flows with just three stop logs in place, and stresses how problematic it is to physically remove stop logs under high flow conditions. Since 2008, Catalyst has left limited stop logs in place after November 1st. Consequently, it cannot effectively control lake levels after that date for wild salmon conservation, or to provide an optimal gravity water supply to DFO's hatchery. Considering the significant downstream flood liability risk, Catalyst has little choice but to operate the dam very conservatively allowing natural fluctuations after each heavy rain so subsequent inflow peak events can be "cushioned" as much as possible.

The latter situation has contributed to reduced survival of juvenile Coho and fertilized sockeye eggs in affected lakeshore areas since 2008, and may continue to do so depending on how until main GCL dam is operated post saddle dam replacement in 2011. The availability of gravity-fed surface water from Boot Lagoon provides seasonal access to warmer surface water that has tangible benefits for fish growth as well as reducing lake water pumping costs for Robertson Creek Hatchery.

A saddle dam failure (in a large flood event) would have damaged the paved road and hatchery infrastructure. Robertson Creek Hatchery staff has implemented an emergency preparedness plan that includes site evacuation during very large inflows to the lake.

Hence rebuilding the saddle dam was the key first step in pushing forward with a climate adaptation strategy to build ecological resilience, public trust and broader partnerships in implementing the SBWMP.

A2: Economic Opportunities for Upgraded GCL Dams with Micro-Hydro Power

As part of its long-term vision for GCL dam/water licence ownership, HFN has maintained a strong interest in developing micro-hydro at the site (Robert Duncan, CEO, HFN, pers.comm.). The objective would be to create an annual revenue stream to support dam maintenance and operations, as well as HFN's other business ventures and economic needs.

The concept of converting the existing old, low-head dam to power generation has been considered in the past. In 1999, Sigma Engineering Ltd. completed a "Pre-Feasibility Study for Hydroelectric Development" for Pacifica Papers, predecessor owners of the NorskeCanada, now Catalyst Paper Corp. mill in Port Alberni. The Sigma study concluded that development of a 2.7MW conventional plant with a design flow of 58cms, gross head of 6m, and net head of 5m was "technically viable but economically marginal based on the relatively high cost of development, moderate value of energy and relatively high operating costs."

Sigma did not consider detailed environmental impacts and mitigation/compensation costs of hydro-electric development, and particularly the high costs of screening fish (from adults to fry) from the penstock intake(s) during all operating periods. They did acknowledge there would be, on average, about three months a year when the plant was shut-down due to insufficient flows to meet both power and environmental needs. The report also did not consider the need to replace or significantly upgrade the Robertson Creek saddle dam, which in its state at the time was a structural liability and major constraint on operating GCL at a higher level under winter conditions, when power demand is at a peak. Sigma's very rough cost estimate for micro-hydro development was $5.8M in 1999.

More recently, there has been some interest in retrofitting the main GCL Dam with Very Low Head (VLH™) turbine technology available through Coastal Hydropower Corp. VLH turbines are designed to operate with 3.5m of head and a flow of 10cms each. Once installed, they can by hydraulically lifted clear of the water column, as required, to avoid large debris during floods or for routine maintenance.

However the proforma study conducted by nhc ltd and Compass Resource Management for micro hydro at the Great Central Lake location noted site conditions precluded the application of this technology. Their report states the following

"For a low head high-flow application, flexible efficient operation is required. Since this is a project which will effectively be operated similar to a run-of-river hydro facility, one of the requirements will be to perform at high efficiency over a range of flows. This can be achieved by either having several turbines of smaller capacity or having one turbine with the adjustability to maintain a high efficiency. The previous assessment conducted by Sigma Engineering (1999) opted for a fixed pitch propeller-type turbine that required multiple units to provide both capacity and efficiency over the range of operating flows (10 to +60 cms).

Listed below are some of the other factors regarding turbine selection at Great Central Lake Dam:

1. Since this is a relatively low capacity facility (2 to 5 MW) it has been considered more economically viable to select one versatile turbine with minimal civil works as opposed to several smaller units.

2. Installation on the existing dam was not an option due to structural and foundation issues and the costs of reconstruction, and loss of operational capacity of the dam during construction.

3. The turbine units would require a high degree of efficiency and reliability due to the low head and cost sensitivity to energy production.

4. Minimizing civil works and overall project size reduces construction costs. A more compact project site would enable a flexible layout providing better approach and tailrace hydraulics.

5. Great Central Lake levels vary considerably during the season and rise rapidly during large floods. The turbine and configuration must be able to shut-down quickly and accommodate varying headwater elevations. The unit must either be flood-proofed or allow overtopping.

6. The unit should be commercial availability, with design and support services, and a proven operational history.

Structural limitations of the existing structure and the design standards and reliability required for new works limit the use of the existing dam or pier in the construction of the hydro plant. The requirements to maintain hydraulic control and follow dam safety regulations and orders make utilization of the existing weir crest not feasible.

We excluded the *VLH* at GCL for several valid technical reasons primarily that the design head is greater than the rated maximum design capacity, and multiple units (8 to 10) would be required to provide similar power generation. That said, the VLH technology is highly suited for very low head applications, and has excellent fish protection characteristics.

Of the available turbines, a compact *Ecobulb* has been selected for the design basis, which is a propriety design of Andritz Hydro (Fig.8). For this application a 100 RPM

double regulated unit would be required. Although a detailed optimization analysis for turbine selection has not been carried out, it is believed that this turbine will provide the best efficiency for the capital cost including installation and all civil works. This turbine has also been selected since it is said to be “fish friendly”, as it provides a low incidence of injury or mortality for fish passage through to turbine.
Should this project proceed to detailed design, we recommended that a turbine and generator supplier be engaged to provide guaranteed efficiency curves and quote for a range of turbine configurations in order to be able to verify the turbine selection.

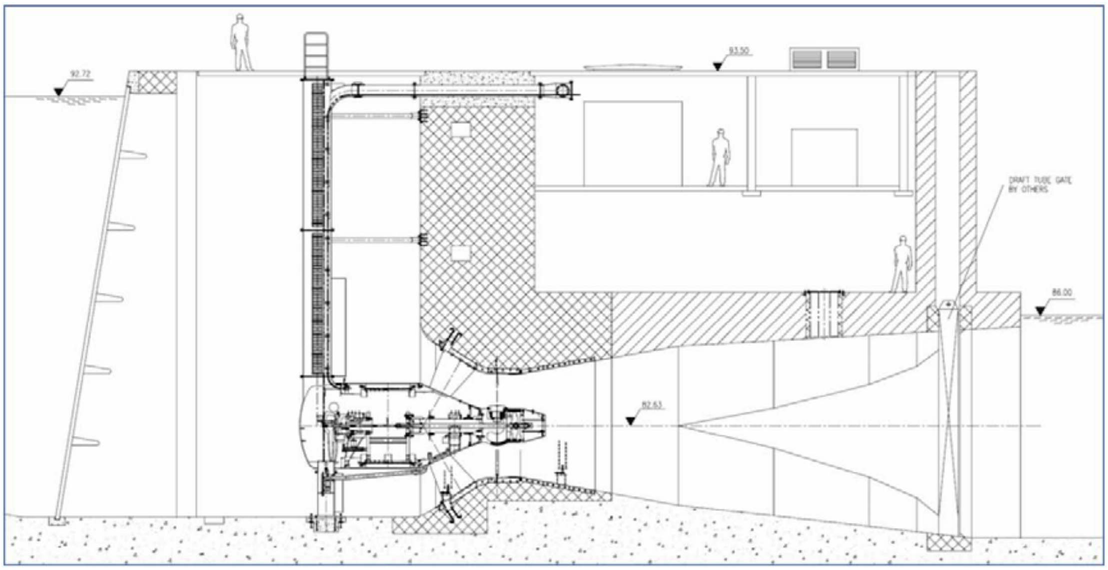

Fig. 8 above shows a low head installation using an Ecobulb turbine. (It is not scaled to the size of facility intended at Great Central Lake Dam, but provides a general arrangement.)

Fig. 9 below shows the location of the powerhouse relative to the existing dam.

The low head available at the site and large runner diameter require additional rock excavation to ensure sufficient submergence to avoid cavitation and vortexing. This basic physical constraint excludes the right abutment as a potential location for the power plant. The left abutment of the dam provides suitable access and the space to enable the coffering of the intake location for construction.

The plant would be constructed on the left abutment area adjacent to the existing dam. This location provides access and ability to isolate the work site without impeding operation and flows at the dam. Earthen cofferdams would isolate the upstream area. The power house is approximately 15 m wide, 15 m long and 10-15 m deep lying in a canal up to 75 m long. The power canal is constructed through overburden into existing bed rock. The deep cut is required to fully submerge the 4.2 m diameter turbine under all flow conditions.

The project layout will depend on the decisions made regarding fish passage and protection. As stated earlier, the design review and financial analyze examines the implications of both scenarios: full fish screening and no screens with fish friendly turbines and partial shut-down. If a full fish screen is required then the intake structure will be considerably different to a simple trash rack for debris only. A static, high or low speed screen will require a forebay structure and metalwork, debris handling and fish handling works and bypass flows. It will be significantly larger and more costly than a simple bar trash rack intake.

Structural allowances have not been made for the notional coldwater supply system as detailed in NHC (2010). However, control works for this system could be provided in the additional fishway constructed adjacent to the new powerhouse.

The plant would operate based on a combination of level sensor gauges measuring both headwater and tailwater levels. The powerhouse PLC will be set a target lake elevation which it will try to maintain by adjusting the flow through the turbine. During a flood, the plant may be shut down to avoid damage due to the entrainment of debris.

We have assumed that the minimum spin flow is within the capacity of the turbine, and all flows would preferentially discharge through the powerhouse to maximize energy production. As stated earlier, efficiencies at these lower flows are assumed and more detailed data is required to refine energy estimates.

The operation of the plant was assumed to be independent of the dam, even though lake storage and elevations sustained by adding or removing stop logs or operating the sluice gate could affect power production. We have assumed no additional infrastructure is constructed with the powerhouse and intake, other than the works required for fish passage and protection. As detailed in the financial *proforma*, a sensitivity analysis was included to reflect additional capital funding to repair the existing dam, assuming it requires replacement before the hydro plant.”

Regulatory Considerations

Proponents of clean energy projects in BC must meet technical, commercial, and permitting requirements to develop a project as described in *Clean Energy Production in BC: An Inter-agency Guidebook for Proponents* (Province of BC, 2011). As a general overall guide to proponents, the guidebook provides a thorough description of the interplay between these requirements.

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In terms of the permitting aspects and overall regulatory requirements, a typical project must undertake a series of steps to obtain regulatory approvals, during each of the design, construction and commissioning/operating phases. Key legislation which most waterpower projects must comply, provincially and federally, include:

Applicable Legislation.

Provincial:

- Land Act
- Clean Energy Act
- Water Act
- Forest Act
- Forest and Range Practices Act
- Highway Act
- Environmental Assessment Act
- Water Protection Act
- Wildlife Act
- Fish Protection Act
- Parks Act
- Heritage Conservation Act

Federal:

- Fisheries Act
- Navigable Waters Protection Act
- Canadian Environmental Assessment Act
- Species at Risk Act
- National Energy Board Act
- Migratory Birds Convention Act

“An operational model was developed to estimate daily power generation and project optimization techniques were used to determine a notional plant capacity for the detailed financial *proforma* model. Preliminary quantity take-offs and scaling was used to estimate construction and equipment costs to a Class D level. Further optimization of the plant size would likely take place during detailed design.

Capital costs associated with construction of a project are relatively high ranging from \$5.8M to \$3.8M per MW installed. Conceptual costs to provide fish protection with permanent screens, additional fish passage with fishways and fish barrier at the tailrace add to the already high capital costs. This assessment also considered scenarios where no fish screens were installed at the intake, but plant operations are curtailed to protect downstream smolt migration.

The optimum plant size identified was approximately 4.2 MW at a flow of 70 m3/s, and utilizing the sixteen year historical hydrological data string, the proposed plant produces an average of 21.6 GWh per year (±3.4 GWh = 1-STDEV) not including any mandated shutdown period. The estimated construction cost was \$36.1 million with fish screens installed, or \$23 million with fish screens excluded, plus approximately \$1 million in net additional costs for interest during construction and reserve account funding. Excluding fish screen costs and shutting down during the smolt migration period (assumed to be all of April) was identified as the most attractive approach given the high cost of fish screens.

A detailed financial *proforma* of the operation of potential hydroelectric plant at Great Central Lake was undertaken, developing rates of return and cash flows. Variables and outputs in the financial analyses included:

- Capital costs and assumptions
- Financing terms
- Electricity revenue
- Capital structure and equity IRR

Sensitivities to several financial variables were examined. Using the optimized design described above, assuming no fish screen installation and a shutdown for the month of April, the total project budget would be $24.1 million. With the highest acceptable leverage, the project would require an $18.8 million loan and a $5.3 million equity investment. The equity provider would earn a return of 7.2%, which is considered below the target return range of 10% - 15% for projects of this type.

A similar proforma was developed for the Elsie Lake Dam Hollow Cone Valve instream flow release opportunity, based on the same financing and revenue assumptions. This project would generate 3,000 MWh per year with total costs of $5.2 million. The equity provider would earn a return of 5.8%, which is considerably below the target return range. "

While the Elsie Lake option is expected to be much simpler to implement from a regulatory perspective, it has limited projected surplus cash flow that could be applied by a new dam owner for operations and maintenance of the Great Central Lake facilities.

A3: Basic Upgrade for Flow Management and Safety at GCL Dam

Throughout much of its history, the main GCL dam was operated at a higher minimum level in winter (i.e., 372.5 to 373 ft. MB datum)), largely to protect incubating sockeye eggs on perched beaches around the lake's perimeter. The higher minimum, water level also appears to have been provided in response to requests relating to hatchery water supply intake elevations. Larry Cross, Catalyst Paper, says he "has found a 1990 internal memo specifically stating this requirement. I am not sure when the awareness of the sockeye spawn habitat became part of this management. I have found 2000 vintage emails re balancing minimum levels for water intakes versus sockeye stranding AND DAM SAFETY."

This changed in 2008 following release of the TROW report on saddle dam safety. Increased threat of winter floods in the Pacific North West, as a result of climate change, (http://cses.washington.edu/cig/pnwc/pnwwater.shtml), alerted dam owners to the need for greater caution in managing reservoir levels and the need for flood "buffers". Hence, drawing down GCL by November 1st to approx. 370 ft MB datum may remain the preferred course, and could become the dam owner's standard operating practice in future (even after the new and higher saddle dam was built).

This has obvious consequences for both wild fish production and the potential for micro-hydro development at the site. The fall lake drawdown regime will continue to expose creek mouth benches and strand rearing Coho fry for a number of years before channels re-grade ("down-cut") through natural fluvial process. The loss of several thousand Coho fry to seasonal stranding is unfortunate, but of little biological consequence in a watershed where tens of thousands of adult Coho spawners return annually.

Of more concern is the potential loss of significant numbers of shore-spawning Sockeye redds (up to 10% of annual escapement; K. Hyatt, DFO, pers. comm.), when adults spawn on temporarily wetted beaches following early November storms. Previously discussed flood protection concerns (downstream) will inevitably result in dam operating trade-offs, where moderate floods may be passed at the dam (if practical), but larger inflows partially retained to reduce the threat to public safety and urban infrastructure.

As a minimum, upgrading the main GCL dam will require replacement of stop log controls with hydraulically-operated gates in seven bays, similar to what now exists in bay #2. Bay #1 includes DFO's vertical slot fishway and "attraction water" supply system (Fig. 10).

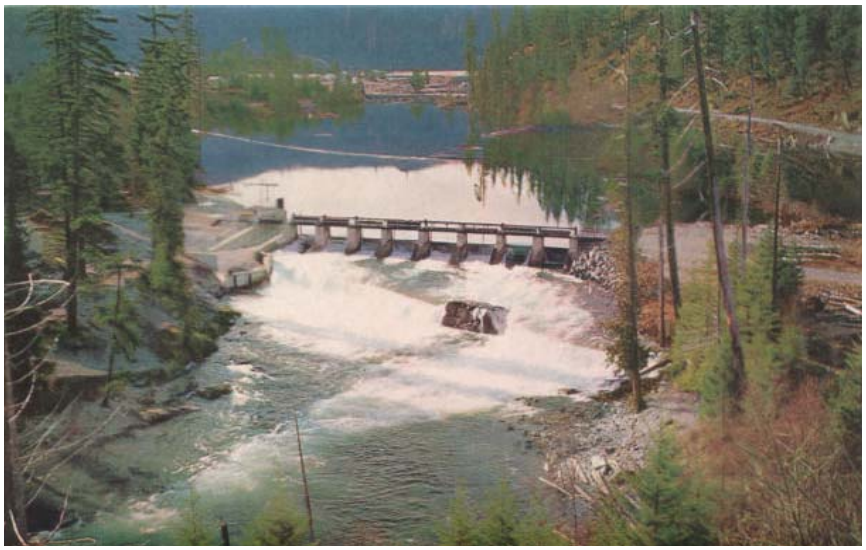


Fig. 10 Stamp River (GCL) dam, circa 1958. Fishway is adjacent to the abutment on left side of photo.

In 2004, Koers & Assoc. Engineering Ltd. conservatively estimated the cost of new automatic gates in seven bays at $1.5M, including a computer control system. Based on this upgrade alone, it seems likely the cost of fully modernizing the main GCL dam, possibly including a seismic upgrade, could range from $3-5M. Annual operating costs could approach $200K, even following control gate automation. From a regulatory perspective, it is likely GCL dam upgrades would result in a "streamlined" CEAA review process given obvious benefits to public safety, flood control and wild fish conservation.

However, these upgrades should not take place until a total design concept has been developed that includes provision for micro hydro (if deemed feasible) and cold water infrastructure through the dam.

A4: Provision for Cold Water Supply Infrastructure at Great Central and Sproat Lakes

NHC Ltd., under contract to BCCF/Living Rivers – Georgia Basin / Vancouver Island, has been responsible for modelling thermal conditions in the river corridor used annually by migrating sockeye and Chinook salmon (as well as other species). From an enhanced array of data loggers, results indicate that air temperatures "drive" daily and seasonal water temperatures and that water temps can vary widely (3-4°C) over 24 hours. In summer, thermally stratified lakes combined with shallow outlets can increase water temperatures to well above 20°C, presenting physiological and freshwater disease threats to adult sockeye, in particular.

With a history of previous sockeye "warm water" mortalities, migration delays and reproduction failures in the watershed (likely in at least 30% of all return years; Hyatt 2005), there are compelling reasons for investigating engineering options for strategically cooling river water at the height of sockeye migration.

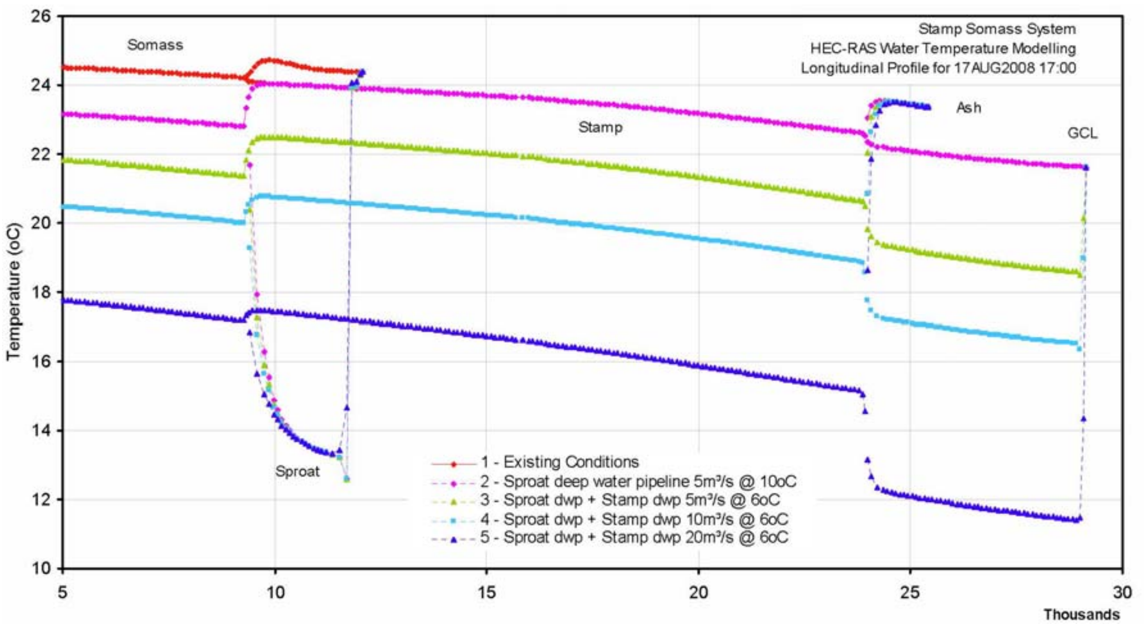


Fig. 11 HEC-RAS Water Temperature Modelling Longitudinal Profile for Somass River for 1700 hours August 17, 2008

The modelling work undertaken by nhc ltd established that it is feasible to reduce Somass River water temperatures albeit with some re warming below the dams after introduction of cold water on the hottest days/ (Fig.11) Nhc Ltd. evaluated four test conditions against the base case (current conditions) model, including:

a) 5cms cold water release from Sproat Lake outlet;
b) 5cms cold water release from GCL dam;
c) 10cms cold water release from GCL dam; and
d) Flow control and cold water release from both Sproat and GCL (cold water only; minimize/eliminate typical surface spill).

Cold water (6-10°C) typically lies below the thermocline (at 18-20m depth) in both large lakes from late May to October, annually. Engineers have focused on several methods and infrastructure concepts for "capturing" sufficient volumes of cold water to affect an overall temperature reduction (**to <20°C**) along the entire river corridor from GCL to Paper Mill Dam on the lower Somass River (approx. 28km).

The preferred concept at GCL requires installation of a twin pipeline (1.6m dia. polyethylene pipe) extending 1km from 30m depth in the lake to the dam site, and using the dam's head difference (4m) to hydraulically "drive" 11cms through the twin pipes terminating in Bay#1 (DFO's fishway; Fig. 13). Class D[2] costs for cold water supply are estimated at $5-5.5Million.

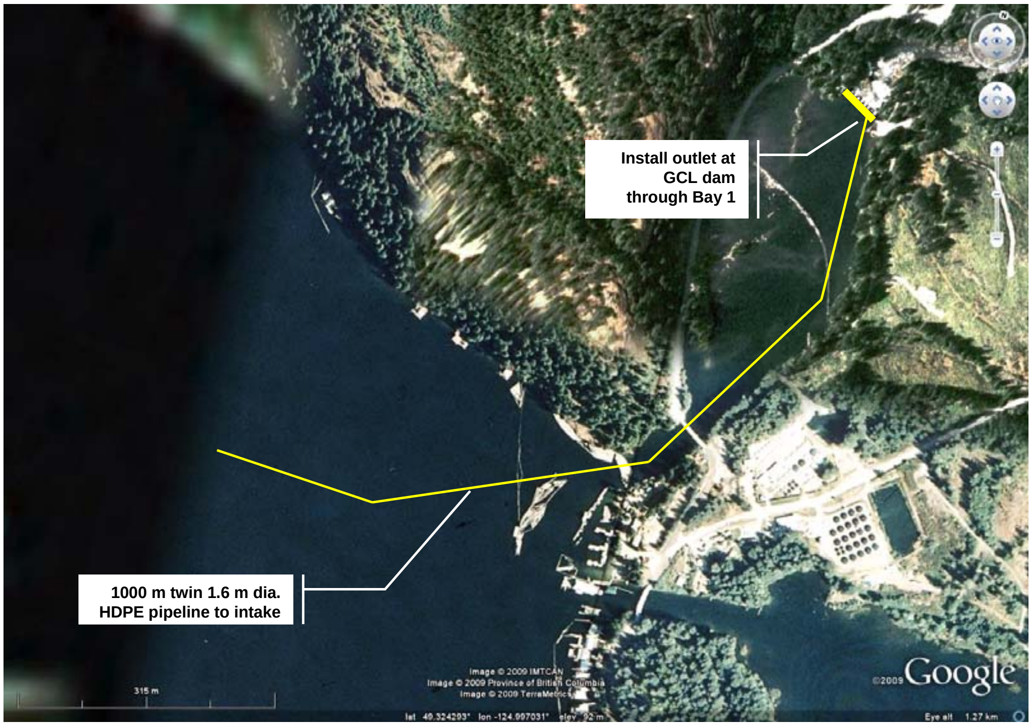


Fig. 12 Approximate location of GCL cold water twin pipeline (nhc Ltd. 2010).

At Sproat Lake, the preferred concept is to use a large hypolimnetic air lift pump mounted on a raft which can pull 5cms of cold water from 25m depth and direct it through a floating pipeline for 0.7km to the Catalyst weir in the lake outlet. (Figs. 13 and 14) Class D costs for cold water supply are estimated at $0.8-1.2M for Sproat Lake but could reach approximately $2 Million with a rebuild of the Sproat Lake weir an other ancillary requirements..

[2] This is a preliminary cost estimate which, due to little or no site information, indicates the approximate magnitude of cost based on the client's broad requirements. This overall cost estimate may be derived from lump sum or unit costs as identified in the construction cost manual for a similar project. It may be used to obtain approval in principle and for discussion purposes.

Fig. 13 Example of hypolimnetic air lift pump from St. Mary Lake (Saltspring Island) that is envisioned for a Sproat Lake application.

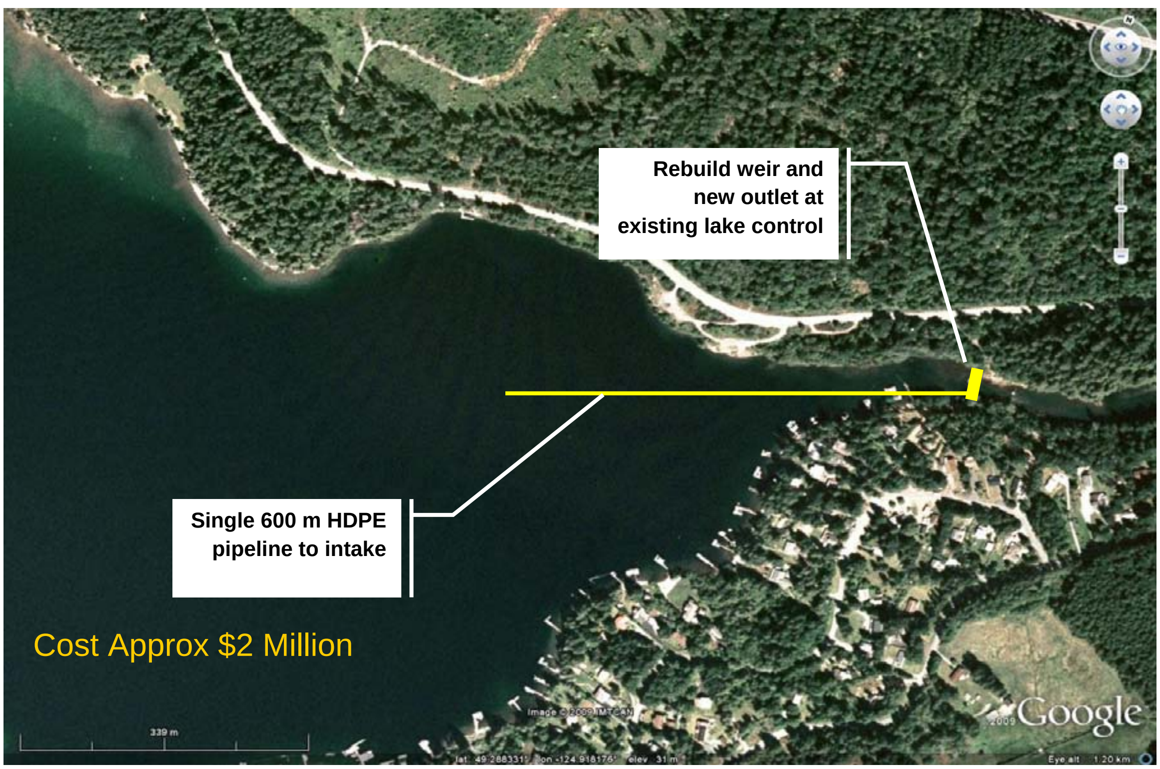
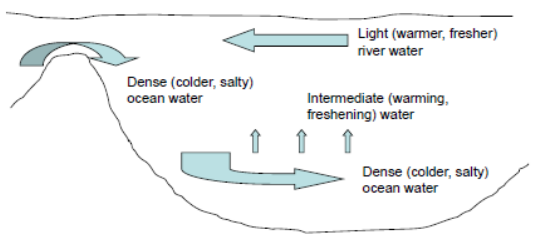


Fig. 14 Approximate location of Sproat cold water pipeline and weir (nhc ltd. 2010)

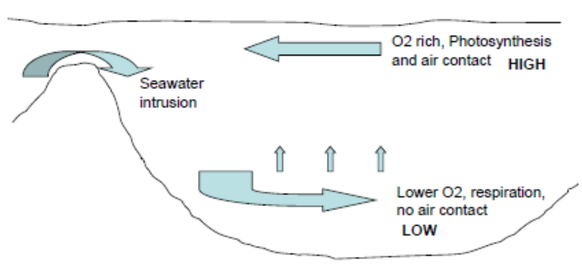
A5: Estuary Monitoring and Oxygenation

Alberni Inlet – a natural glacial fiord

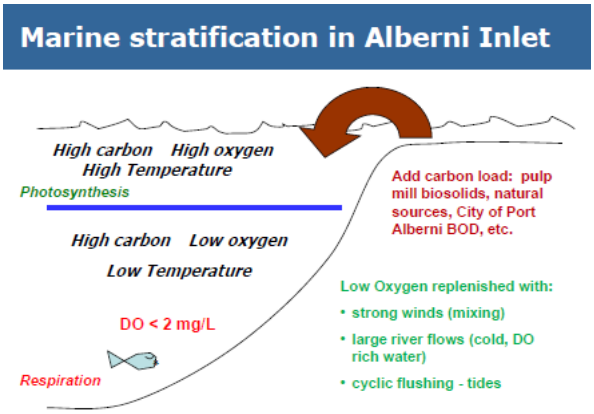


In Alberni Inlet oceanographic features play a large part in the low DO availability for salmon. As shown above, there is a natural glacial fjord at the entrance to the Inlet which creates a low layer of cold water, low in DO. This layer is below the fresh, oxygen-rich river water that “floats” on top on its way out of the Inlet. These two distinct layers are called stratification in the water column (see Illustration below). In order to mix the two layers and so ensure that oxygen gets to the lower cool areas, the water column must receive strong winds, tidal flushing and/or cold fresh run-off from the rivers.

Alberni Inlet – a natural glacial fiord



In addition, the top layer of the water column is where photosynthesis occurs, usually in phytoplankton (plant plankton). The planktons feed on the carbon in the air and produce oxygen and then when they die, fall to the bottom layer where bacteria consume them, using the minimal amounts of oxygen at the lower layers to do that. In the Alberni Inlet (see below) humans have added a high carbon load to the water in the form of pulp mill and waste water effluents and bio-solids which ultimately results in very low DO in the cooler water where Sockeye salmon will spend their time waiting for cooler river temperatures so they can migrate upstream to hold in Sproat and Great Central lakes and eventually spawn.

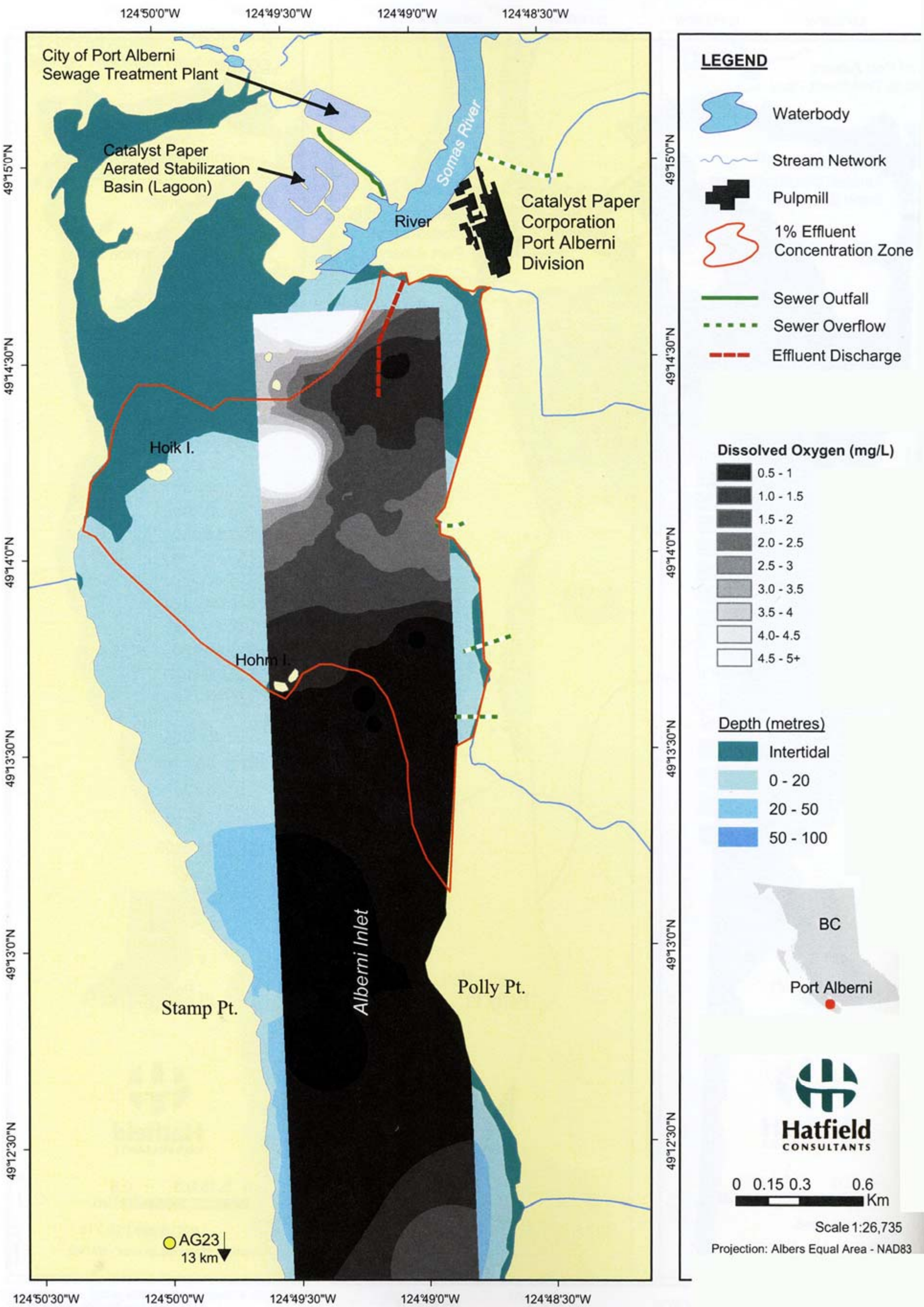


A fibre mat near the pulp mill outfall built up over many years as a result of historic operations of previous owners of the pulp and paper mill. It has been recognized as a longstanding threat for DO decline. The fibre mat is consumed by bacteria, using the oxygen in the lower levels. Because of this, the pulp and paper mill are required to conduct regular sampling of water quality, marine plants and animals, and DO in the Inlet.

It was decided to use the historic data collected through this sampling program, and data from an increased sampling schedule in 2009, in order to model the DO "sinks" in the area of concern for salmon migration and holding. To study this more closely, sampling for DO and salinity levels was conducted at a couple of key locations, chosen for their proximity to the Catalyst outfall, and the sewage outfalls and overflow. At each location measurements were taken in the top part of the water column (1.5 metres from surface) and down deep (1.0 metre from bottom). Results showed a high salinity rate in the deeper measurements and a corresponding low DO reading. In the upper water column results were the opposite - salinity readings were lower and DO readings higher.

A study of the actual fibre mat showed that the size of the mat has been reduced by sediments gradually covering it. As a result, the mat size has decreased from 1.03km^{2}to 0.3-0.6 km^2. This means that the threat of low DO has also been reduced. Though the study did determine a reduction in the threat, there is still a current oxygen use by the matt, estimated at 252-2500 kg/day. (See Figure 4.8 below from the report prepared by Hatfield Consultants.)

Figure 4.8 Spatial distribution of near-bottom dissolved oxygen in the Alberni Harbour water column, Port Alberni EEM Cycle Five, August 2009.



A6: Results of 2010 Pit tagging study

The study objectives were:

1. Calculate length of sockeye salmon migration time between ocean and paper mill dam tagging sites and passage through the three fishways on the map below where detectors were installed by BCCF staff.
2. Investigate the correlation of sockeye migration behaviour (i.e., migratory speed, stops/starts, passage through the fishways) with environmental conditions in order to facilitate design of future climate adaptation strategies.

PIT tags were applied into the body cavity of sockeye at the ocean test fishery boat *Argent 1* that operated at five different locations at the mouth of Alberni Canal where it enters Barkley Sound. A total of 1,487 tags were applied there between June 14 and July 19, 2010. An additional 1,322 tags were also applied after beach seining at Paper Mill dam in the lower Somass River between June 28 and August 9, 2010. Each individual tag carries a unique code so it possible to track the migration timing of individual fish as long as they are subsequently detected.

A total of 596 tags were detected at Sproat fishway (21%) of which 258 were ocean tags and 338 had been tagged at Paper Mill dam. Detections were 316 at Stamp Falls fishway (10%) but 94 of these were not subsequently detected at Great Central Lake fishway although 24 appeared to have migrated back downstream from Stamp into Sproat. There were also 26 tags (<1%) recovered from harvest fish sampling, but it was not expected to recover many tags from fisheries.

There was a very large Somass sockeye run in 2010 (Total estimate $1.743 Million) that had very favourable migration conditions and relatively low harvest rates early in the run, but higher water temperatures and harvest rates were encountered later on after escapement targets had largely been met. DFO estimated the total catch to be 938 thousand with a total overall exploitation rate of 54% which compares to 68% of the tags that were not recovered. The difference can be accounted for by natural or tagging induced mortality; tagging of non-Somass stock (i.e. Henderson), tag loss and missed detections at arrays. .

Conclusions: PIT tagging is a very feasible way to track salmon migration timing into and through the Somass system. Analysis of the results in terms of guiding future designs for cold water facilities is complex and does require more than one year of tagging under a variety of river and harvest conditions. Lessons learned from this study will be applied to the next round of tagging.

Some of the most notable findings were as follows:

1. Sockeye took significantly longer on average to navigate through the Sproat fishway array (35 minutes) than the Stamp fishway array (11 minutes).
2. Ninety five percent of the Sockeye tagged took up to 60 minutes to transit through the 27-meter Sproat fishway array but the same percentile of Great Central Lake bound fish transmitted through the 18-meter Stamp Falls fishway array within 30 minutes.
3. The migration timing through the Sproat fishway array varied from 54 seconds to over seven hours. (The time taken is very important if Sockeye are exposed to high water temperatures while waiting to pass through.)
4. Even though Sockeye were able to migrate through the Sproat fishway array at water temperatures up to 23.9 degrees C, a number of mortalities were observed above the fishway and below the lake (e.g. approx. 500 dead of 6-800 observed on July 28, 2010).
5. Average travel speed above Stamp Falls was three times faster than below it.
6. As expected, travel speed was inversely correlated with Somass water temperature. GCL-bound ocean-tagged fish travelled approximately twice as fast at 16 degrees C than at 20 degrees C.

Above: Application of PIT tags   Below: An Antennae Array Installed in Sproat Fishway

The information obtained from tagging at Paper Mill dam is much harder to interpret on account of active fisheries taking place in the area which influenced both timing and tag recoveries.

Recommendations

Recommendations arising out of the 2010 Somass Sockeye PIT tag study include: improvements in the experimental design of future PIT tag studies; and maintenance, or addition, of data monitoring activities to facilitate study of Sockeye migration behaviour in the Somass system.

Experimental Design

1. Randomize river tag releases in future PIT tag studies to obtain statistically testable information on the environmental impacts of freshwater migration timing and travel rates.
2. Due to a weak effect on migration time associated with ocean tagging location, it is important to accurately specify exact time and location of tag releases to control for differences in distance travelled up the inlet.
3. Conduct field study to assess short-term and delayed mortality due to PIT tagging to improve estimates of en route mortality and overall survival.
4. Target PIT tag studies for Sockeye return years that are forecast to be characterized by extreme environmental conditions and low adult returns, to maximize the frequency of environmental effects, and to avoid the confounding effects of high harvest rates on migration timing.
5. **Investigate impacts of fishway access and navigability for a range of water temperatures, water levels, and migrant densities, especially for the Sproat fishway, in future field studies**.
6. **Initiate field research to assess the biological condition and fecundity of Sproat Sockeye before and after ascending the Sproat River to quantify the potential impacts of exposure to reduced water quality and quantity on reproductive capacity.**

Tag Detection and Environmental Data Monitoring

1. Maintain water temperature data recorder in Somass, Stamp and Sproat rivers.
2. Maintain water level logger in Stamp River, and **incorporate new water level data logger in Sproat River** to circumvent delays in availability of WSC discharge data.
3. Implement double antenna array at GCL fishway to ensure high tag detection efficiency. This would obviate the need for a similar array at the Stamp fishway (though the Stamp fishway array could be rationalized by the need for further information regarding: en-route GCL-bound fish mortality rates; diversion rate of Stamp enumerations to the Sproat system; and fish travel time differences above versus below Stamp Falls,
4. **Install a full stream array in the Somass** as near as possible to the mouth to determine when, and under what conditions, migrants enter the Somass River.
5. **Install a full stream array in the Sproat** above, but as close to the confluence with the Stamp to determine when, and under what conditions, migrants enter the Sproat River.
6. **Install an array at the Henderson counting fence** to determine the number of Henderson bound fish that are tagged. This will provide greater insight into recovery rates at Somass and also be of importance to management of this stock.

A7: British Columbia Regional Adaptation Collaborative: *Preparing for Climate Change: Securing BC's Water Future*

In order to prepare effectively for climate change and its impacts, decision-makers need regionally relevant tools and knowledge to work closely with local stakeholders and resource managers. The British Columbia Regional Adaptation Collaborative (BC RAC), entitled *Preparing for BC's Water Future,* was designed to advance adaptation decision-making in such a manner.

The $6.9-million BC RAC (2010-2012) aimed to improve the ability of British Columbians to prepare for climate change and its impacts on water through four interrelated initiatives. It integrated climate change adaptation into a variety of existing planning and decision-making processes. Its activities will include consultation, risk assessment and knowledge transfer. The BC RAC program involved extensive collaboration and $3.3 million over three years from Natural Resources Canada, as well as matching or in-kind funding from 18 regional partners. It was one of six regional adaptation collaborative projects planned under Natural Resources Canada's Regional Adaptation Collaborative funding program.

The Somass Basin Watershed Plan was one of four pilot watershed plans in the BC Conservation Foundation's BC RAC initiative. Funding support was first available in Jan-Mar 2010 and continued until Jan-Mar 2012.

During that period a total of $367,377 was contributed to SBWMP that were eligible costs under the RAC (not including any construction). BCCF applied to the RAC for $100,151 of that amount and the balance was paid by Catalyst Paper for design and EIA work associated with the Robertson Creek saddle dam replacement ($185,630) and by the BC Living Rivers Trust Fund to BCCF ($81.595). The costs of construction and all costs prior and after the RAC period have been borne by others.

The major projects supported at least in part by direct RAC funding included facilitation and support for the SBWMP management committee and forum, cold water release feasibility engineering assessments; Speece cone feasibility; the 2010 PIT tag study and subsequent data assembly and the micro-hydro proforma.

A8: Somass Basin Water Management Plan – Discussion of Implementation Options

by Ted White, Ministry of Environment, November 2009

Purpose

This document has been prepared in response to discussions which occurred at the November 3, 2009 meeting of the SBWMP Management Committee meeting regarding options for implementing a plan. The purpose of this document is to:

- describe possible options for the planning committee to pursue and
- serve as a tool to facilitate discussion among the members of the Management Committee.

Context

The following understanding of the interests of the SBWMP comes from the views expressed during the November 3 Management Committee meeting.

Interests of SBWMP:

- Regulation of Great Central Lake Dam and potentially the weir at the outlet of Sproat Lake to provide conservation-based flows for fish at appropriate temperature regimes.
- There is interest in evaluating the feasibility of installing a low head power generator at Great Central Lake Dam, following transfer of ownership and water licence to the HFN from Catalyst Paper Corp.
- Potentially, modifications may be considered to the operation of BC Hydro's Elsie Lake Dam if it is determined to be important to achievement of the planning team's objectives. This would only involve the timing of the annual maintenance shutdown of the GCL powerhouse and re-routing of Elsie Lake storage releases to the Ash River.
- Local government is interested in participating in planning for the management of water (future interest in water supply and understanding of how healthy fish populations benefit community), however, is currently not interested in expanding the scope of this committee to include regulation of land based activities due to legal complexities and funding constraints.
- Management Committee members are interested in receiving assurances that their efforts in developing the plan will be applied by the provincial statutory decision maker (Comptroller of Water Rights).

Potential activities that could result from the SBWMP:

- Upgrade of works;
- Regulation of works;
- New works/change of purpose; and,
- New water governance arrangements at the local/regional level.

Other considerations and background:

- Three separate licensees may be involved in the recommendations of the plan;
- Future community water supply is being considered from GCL;
- The influence of Treaty process on this plan and future decisions needs to be considered;
- Population growth is expected in the region;
- Climate change forecasts for the Pacific Northwest indicate increasing frequency of severe drought and flood events for coastal regions, similar to that experienced in recent years (i.e., 2006/07); and
- The combined value of Somass Basin fish resources is worth several million dollars a year to the Alberni Valley, and is increasingly important to the community's tourism and small business-based economy.

Implementation Options

Options for implementing the SBWMP that were discussed at the November 3 meeting included:

- Establish an Advisory Board to the Regional Water Manager (e.g., current model of Cowichan Basin Water Management Plan);
- Order regulating works and require monitoring and related studies (e.g., BC Hydro Water Use Planning);
- Develop a Water Allocation Plan;
- Participate in regional/local government planning initiatives (RGS, OCP, zoning);
- Undertake a *Water Act* Part 4 Water Management Plan

The flow chart and discussion guide on the following pages provides a structured means for evaluating the planning options.

From discussion of interests at the meeting there are two main options for implementing the SBWMP, including:

1. WUP model regulation via *Water Act* Section 18 and 88 order and in the long-term pursuit of a Water Allocation Plan; or
2. Part 4 *Water Act* Order.

The province recommends the planning team explore the first option, that is regulatory orders using Sections 18 & 88, and over the long-term pursue an official water allocation plan. An annotated version of the flow chart showing my reasoning for recommending option 1 is attached.

Further discussion with local government may indicate that a Part 4 WMP may be an effective tool to address long-term plans. However, planning tools available to local government including Regional Growth Strategies and Official Community Plans may serve the same function.

Discussion Guide to Water Planning Options

This guide has been developed to provide an overview of the water planning tools available to address current or potential water conflicts. The guide is structured to facilitate discussion among planning partners, stakeholders, First Nations and regulatory agencies.

This guide speaks to the options for addressing water conflicts through operational plans, rather than strategic plans.

- It does not dictate the process by which the plan is to be developed (e.g., a structured decision making process or MCA may be employed for the development of a Section 18 & 88 orders or a Part 4 WMP).
- Additionally, any statutory decision will be subject to an appropriate level of First Nation consultation. A planning process does not relieve the Crown of its duty to consult with First Nations.

The guide is structured in two sections:

1. Flow chart and discussion guide for identifying planning options.

   This section has been developed to facilitate a discussion of the water planning alternatives that exist.

2. Comparison of different aspects of Sections 18 & 88 orders, Water Allocation Plans and Part 4 Water Management Plans.

   This section provides detail regarding:
   i. The scope of regulatory authority for the options noted and
   ii. An overview of the life cycle of the planning processes.

As water plans will be initiated to address different issues and respond to the local context, a more detailed analysis of roles and responsibilities will be required for each plan.

Water Planning Options Flow Chart

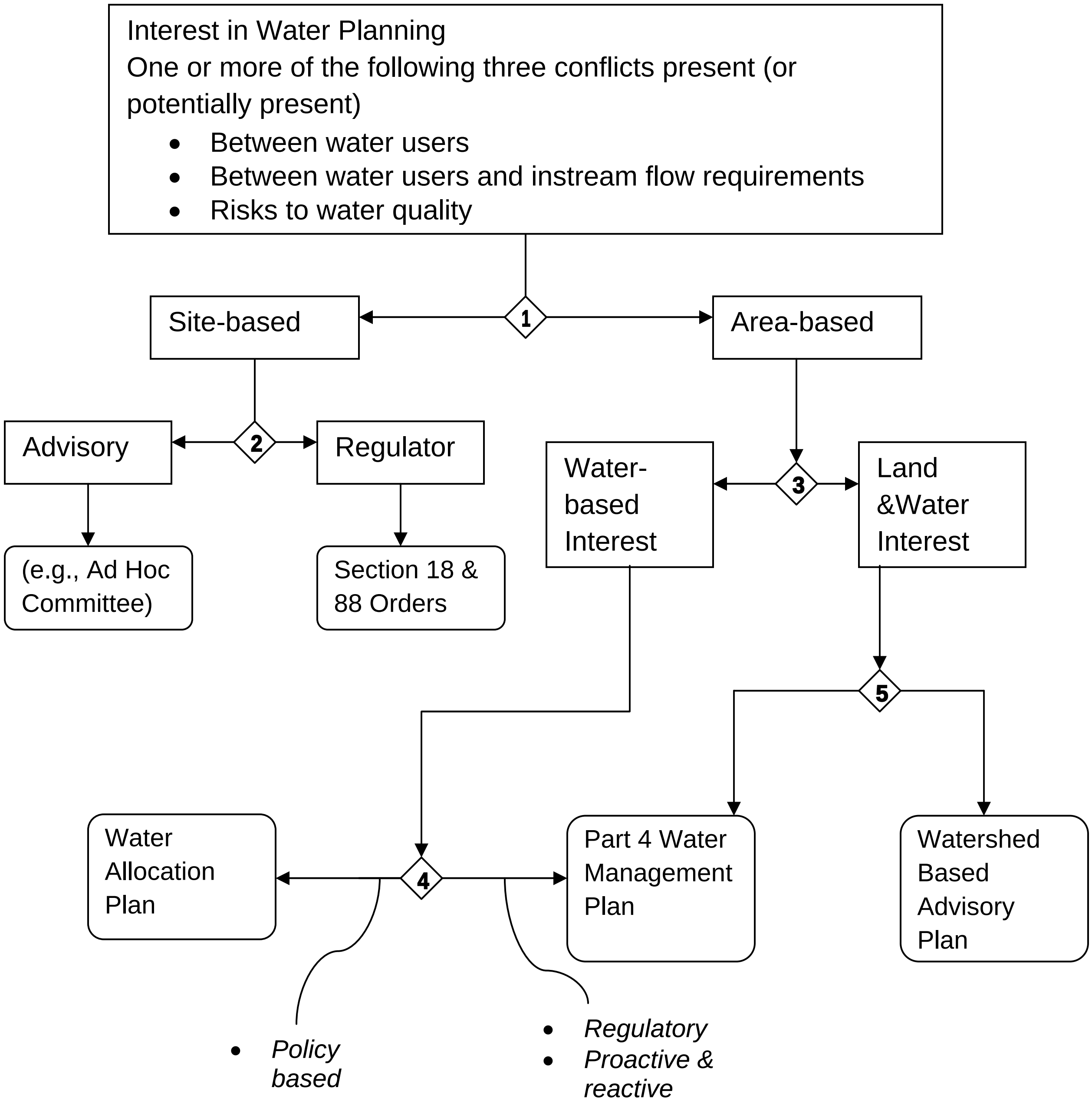
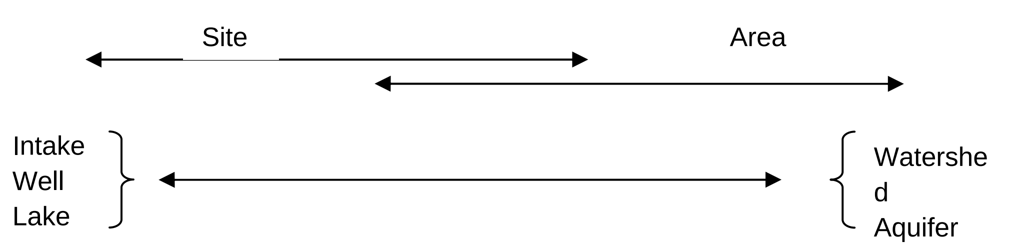


Table 1 Water **Planning Options Flow Chart Discussion Guide**

Decision Point	**Discussion Guide**
Water Conflicts	There are three conflicts referenced in Part 4 of the *Water Act:* between users; between users and instream flow needs; and risks to water quality. There is a number of water planning options that exist to seek resolution to these conflicts. Prior to proceeding to the selection of a planning option the problem should be examined to identify the water conflict present, the technical ability to resolve the conflict and then this guide be used to facilitate actions of the planning team in selection of an appropriate implementation tool.
1 – Site-based or Area-based	For the purpose of this discussion, plans are separated into site and area based. In reality the distinction will not always be as clear. If it seems that there is a mix of site and area-based issues that are being addressed it may be an indication that the appropriate response will include a suite of responses. Site-based refers to situations where the water planning focuses on one, or a group of, localized works. BC Hydro's WUP process was a site-based plan as they regulate specific works (e.g., for BC Hydro's Coquitlam WUP there are two dams, a diversion tunnel, and two powerhouses regulated by the order). Site-based may also include a well, intake or a lake Area-based refers to situations where the interest is dispersed across a wider landscape where many water licensees, groundwater users, and land based activities may be included in the plan. The distinction between site and area based is somewhat subjective, as illustrated below, and needs to be considered in terms of the water conflict present and what activities the planning process will influence. 

<table>
<tr><td></td><td>Examples of Site vs. Area<table><tr><th>Site</th><th>Area</th></tr><tr><td>• Intake
• Well (Well Protection Plan)
• Lake
• Municipal Well Capture Zone
• Springs (Community Spring Protection Area)</td><td>• Watershed (Community Watershed, Drinking Water Protection Plan)
• Aquifer</td></tr></table></td></tr>
<tr><td>2 –Site-based – Advisory v. Regulatory</td><td>If the plan is site-based the plan can proceed on an advisory basis or seek regulatory authority through orders under Sections 18 & 88 of the Water Act. See table 2 for more information regarding orders under Section 18 & 88.
• Advisory based plans may be helpful when:
o The licensee is willing to collaborate with planning partners to develop and implement plan
o The plan is likely to result in changes to water use efficiency that are considered one time changes (e.g., upgrade irrigation works or change to new irrigation schedule)
o The plan is to advise on a future decision of the RWM (for new applications at a site or in a limited area such as a lake or stream reach)
o There is little likelihood of objection to the plan and therefore reduced need for procedural rigour.
o Appropriate where the recommendations of the plan may be beyond the authority of the RWM to implement. The plan becomes a communication tool to influence behaviour and operational choices.

• Regulatory – Sections 18 & 88 orders may be an option when:
o The scope of the plan is focused on the operation, maintenance or improvement of authorized works
o The plan may recommend monitoring and reporting of water diversion, storage and use or effectiveness monitoring
o The licensee is a willing participant in the planning process and willing to accept the implementation order.
o The order requires the licensee to operate within rule bands and includes ongoing discussion with other regulating agencies (e.g., provincial and federal fish agencies)</td></tr>
<tr><td>3– Area-based – water based & land & water based</td><td>If the plan is to be area-based, it must be determined if the interests are primarily water-based or both land and water based. This distinction will help direct the planning options which are pursued.</td></tr>
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<table>
<tr><td>4 – Area-based – Policy v. Regulatory</td><td>If the plan is area-based and dominated by water interests, the primary options that exist are a Water Allocation Plan or a Part 4 Water Management Plan.
Water Allocation plans are brought into effect through regional policy. As such they guide future decisions and are therefore primarily a proactive management tool.
Part 4 Water Management Plans are brought into force through regulation. They are legally enforceable and may integrate land based issues.
See table 2 for more information regarding the regulatory basis and life cycle of Water Allocation Plans and Part 4 Water Management Plans.</td></tr>
<tr><td>5 – Area Based. Land & Water Interests – Advisory v. Part 4 Plan</td><td>Land and Water based plans can proceed on an advisory basis or through the regulatory based Part 4 Water Management Plan option.
Advisory based plans can be very effective for developing relationships among sectors, identifying issues and raising public awareness. Effective advisory committees can seek commitment from members to bring about change as well as bringing a coordinated message to other official planning processes.
Regulatory intervention may be required to achieve the objectives of the area-based plan. Where it can be established that regulatory tools are required and will provide an opportunity to achieve the planning objectives a Part 4 WMP should be considered. The WMP may affect decisions made under the authority of a broad range of statutes, with the exception of the Forest and Range Practices Act.</td></tr>
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Table 2 Comparison of Section 18 & 88 orders, Water Allocation Plan, and Part 4 Water Management Plan – Authority and Life Cycle

	Section 18 & 88 orders – Site-based (specific to authorized works)	**Water Allocation Plan – area based**	**Part 4 Water Management Plan – Area Based**
Scope of Regulatory Authority	Section 18 provides the Comptroller or Regional Water Manager with the authority to amend or substitute licences and approvals. http://www.qp.gov.bc.ca/statreg/stat/W/96483_01.htm#section18 Section 88 provides engineers and officers with the authority to regulate works constructed under a water licence. Refer to the *Water Act* for specific language. http://www.qp.gov.bc.ca/statreg/stat/W/96483_01.htm#section88	Water Allocation Plans are regional policy which the decision-maker considers when exercising their authority under the *Water Act*. The Vancouver Island Region has implemented water allocation plans to provide guidance to decision-makers and inform the public how applications will be addressed for the specified watersheds. The plans have • Made information regarding Water Management's position on water allocation decisions available to future applicants and the public. • Reduced application response time. • Eliminated the need for individual studies and reports on	Part 4 of the *Water Act* provides an opportunity to develop a plan that addresses water conflicts within a defined water management plan area. The plan is initiated at the direction of the Minister of Environment and follows a planning process as set out in that order. A Part 4 WMP is implemented via regulation issued by the Lieutenant Governor in Council. The scope of the regulation which may be considered includes: • require that persons making decisions must consider the plan in making those decisions; • restrict the issuance or amendment of licences,

		each application. • Improved the consistency of Water Management's approach and decisions. • Defined specific allocation directions and decisions. • Reduced the need for referrals on individual applications. A Water Allocation Plan typically includes sections addressing: - General watershed information; - Hydrology of the area; - Instream flow requirements; - Water Demand; and - Conclusions and recommendations http://www.env.gov.bc.ca/wsd/water_rights/wap/index.html	approvals, permits or other authorizations; • restrict the exercise of a power The Plan Implementation Regulation may establish requirements that must be imposed in issuing or amending a licence, approval, permit or other authorization under an enactment. The Plan Implementation Regulation may restrict or prohibit the drilling of wells; the alteration of wells; the installation of well pumps; the conduct of flow tests. **See Foot Note 1 for discussion of plan governance** http://www.qp.gov.bc.ca/statreg/stat/W/96483_01.htm#part4
Life cycle of planning	Pre-planning – A letter from the licensee	Pre-planning – The RWM initiates a water	Pre-planning

process	notifying the regional water manager of their intent to develop a plan and submit it with a request to be implemented – RWM replies setting out minimum expectations of process prior to considering a plan Planning – Licensee leads development of plan Submission – plan submitted to RWM with supporting consultation documentation. RWM considers request and adjudicates per Water Act requirements, considering the plan and information submitted. Implementation – RWM considers plan and issues implementation order.	allocation plan when a business case is established that establishing a plan will provide efficiencies to core WSD business Planning – WSD leads the planning process Submission – Plan submitted to RWM Implementation – RWM signs plan, which becomes regional policy Review – At a specified review date or when directed by RWM	– Letter to RWM requesting the development of a Part 4 WMP – Assessment of preparedness among stakeholders, First Nation and province (**See Foot Note 2 for discussion of readiness assessment)** Planning – Planning is initiated when The Minister issues an order – Partners develop plan and undertake consultation in accordance with the order. Submission – When completed the plan is submitted to the Minister for acceptance. – Cabinet review of recommendations and Implementation – Implementation regulation issued by LGIC Review

	Review – At a review date or in response to conditions set out in the order the plan is reviewed. A new order may result.		– The Minister may direct the review of the plan or any part of the plan

Footnotes to Planning Option Comparison Table

1. Governance/establishment of self-funding organization as an outcome of a *Water Act* Part 4 Water Management Plan

Many parties interested in initiating a Part 4 Water Management Plan have expressed a desire that the implementation of a plan include a self-funding agency to support the implementation of the plan and any new governance arrangements which may result.

Section 65 of the *Water Act* describes how a plan may be implemented with respect to statutory decisions. Section 65 focuses on effecting how decision-makers exercise their authority under existing enactments, not creating new powers for those decision-makers or new management bodies. Of the face of it, Section 65 does not provide the authority to require a new self-funded management body.

Further review of Section 65 shows that the implementation regulation may require specific requirements to be met prior to the decision-maker exercising powers. This potentially could include a requirement that an improvement district or local service area, or other entity, be established prior to the exercising that power. This provision appears to open the door to the creation of self-funding bodies. The scope of the authority may be limited by 65(4) which states that requirements imposed under 65(3) are deemed to be imposed under the enactment which the authorization or permit is issued or amended.

Legal advice has not been provided for this interpretation of implementing a WMP. The mechanisms available for implementation of plans will become clearer as scenarios are developed for different plans and evaluated through debate among stakeholders and further informed through legal advice.

2. Assessment of readiness for a Part 4 WMP

There are no policies in place for when a Part 4 Water Management Plan is to be recommended to the minister. In recognition of the absence of policy, the following evaluation criteria and business case requirements are being used to guide the discussion of when to employ a Part 4 Water Management Plan.

Criteria	Evaluation of Criterion
Water conflict	• Conflicts between users • Conflicts between users and the environment • Risks to water quality
Area-based or site based	• A WMP is an Area-based tool. • Resolution of site specific conflicts is more appropriate through existing *Water Act* tools.
Ability for WMP to affect issue (technical and regulatory ability)	Is there a technical ability to resolve, using the powers of Part 4 of the *Water Act*?
Capacity to undertake plan	- local capacity to undertake plan and implement - WSD regional capacity to undertake
Availability of funding	Is there sufficient funding to support the studies and planning activities

If the screening shows that a Water Management Plan may be an appropriate tool a detailed business case for the plan will be required prior to recommending to the Minister that an order be issued. At a minimum, the business case would be required to include:

- Budget
- Communications Plan
- Stakeholder analysis
- Risk assessment
- Information Needs Analysis
- Timeline
- Project Plan
- Capacity statement