RIVERS WITHOUT BORDERS
A TRANSBOUNDARY WATERSHED ALLIANCE

January 30, 2008

Tom Crafford, Mining Coordinator
ADNR / Office of Project Management and Permitting
550 West Seventh Ave., Suite 900D
Anchorage, AK 99501

Dear Tom:

Thank you for the opportunity to submit these comments on Redcorp Venture's proposal to access and service its Tulsequah Chief mine using a combination of hoverbarge, amphitrac and shallow draft tug. A central concern in our review and other comments we have read is the lack of data. Redcorp's proposal lacks data on the three vessels, their operations and impacts during different seasons and river conditions, the size and effects of surface and underwater wakes and maneuverability. These vessels have never been tested or used in the way Redcorp is proposing. Unsubstantiated assurances by the company and their consultants that everything will be fine do not hold up to even the mildest scientific and technical scrutiny. Given the importance of the Taku wild salmon fishery to working families in Juneau, extraordinary diligence and a precautionary approach are more than warranted in this permitting process.

Our comments are included below and consist of the following components:
--Summary of issues and concerns;
--Analysis of hoverbarge system's effects on the Taku, fish and fish habitat by Dr. Michel LaPointe;
--Analysis of Redcorp's project documents by fisheries biologist Adam Lewis of Ecofish Research Ltd.;
--Review of Redcorp's assessment methodology Bill Slater of Bill Slater Environmental Consulting;
--Analysis of previous uses of hoverbarges by Adam Lewis;
--Review of the hoverbarge landing facility and access road by Adam Lewis; and
--Bios for Dr. LaPointe, Adam Lewis and Bill Slater.

We would appreciate a response to these concerns and an explanation of how they will be addressed as the permitting process moves forward. Because Redcorp's submissions to date have been so flawed and incomplete, we look forward to submitting further comments as new information becomes available. Please feel free to contact me at 907/586-4905 or Zimmer@riverswithoutborders.org if you would like to discuss these comments.

Sincerely,

Chris Zimmer, US Coordinator

Rivers Without Borders Review of Redcorp Ventures' Proposed Air Cushion Barge Transportation System for the Tulsequah Chief Mine
January 30, 2008

Introduction

Rivers Without Borders (RWB) has completed a review of Redcorp Ventures' proposal for an Air Cushion Barge Transportation System (referred to in this Summary as "ACB" which denotes all three vessels) on the Taku River. The results of RWB's review suggest that the proposed ACB transportation system presents a significant risk of adverse ecological impacts to the Taku River ecosystem and adverse economic and social impacts to its users, including harm to salmon and salmon habitat, eulachon, wildlife, the existing commercial fisheries and the existing recreational and cultural uses of the Taku River. Many of these significant effects have been underestimated or ignored by Redcorp. This lack of technical information and analysis, when combined with Redcorp's failure to holistically consider combined ecological impacts from either the whole project or other projects/activities connected to the ACB system and Tulsequah Chief, leads to the conclusion that the documentation provided by Redcorp cannot support informed decision-making. Further decisions about the proposed transportation system should be postponed until there is a thorough understanding of all potential negative effects.

Although Redcorp has not provided detailed information on its proposal, there is enough information to raise substantial concerns that the ACB system will degrade important fish and wildlife habitats, harm adult and juvenile salmon and eulachon, adversely effect fishermen and boaters, disrupt wildlife feeding and migration patterns and disrupt water flow patterns. Redcorp has not provided information to demonstrate that it can avoid, minimize or mitigate these impacts. Its project description documents and permit applications are full of speculation, unsupported assumptions and conclusions made without data, studies or field experience. Redcorp certainly has not demonstrated that their proposal will not have significant adverse effects on the Taku and its users.

The hoverbarge proposal is inconsistent with the Alaska Coastal Management Program (ACMP) Transportation Routes and Facilities Standard (11 AAC 112.280) and the Habitats Standard (11 AAC 112.300).

- The Transportation Standard states that transportation routes must avoid, minimize or mitigate alterations to ground and surface water patterns and disruption of wildlife transit. The reports following this Summary demonstrate that changes in the ice cover from ACB passage are likely to disrupt migration and feeding patterns for moose, and possibly other wildlife. Redcorp provides few details on how the ACB system will operate on the ice and how it will avoid breaking the ice and disrupting the freezeup and breakup regimes. The ACB system will likely disrupt spawning by adult salmon and harm incubating salmon eggs and embryos and rearing juvenile salmon, and may disrupt the downstream migration of juvenile salmon. The ACB is likely to impact the spawning migration of eulachon. ACB passage may also change groundwater or surface water patterns at Canyon Island and possibly other areas. The ACB system may also impact upwellings that are critical for salmon spawning. Redcorp does not specify how it will mitigate. It simply provides baseless assurances that mitigation will take place based on observation by environmental monitors. Since there is no detail on how these monitors might detect problems that would be largely invisible despite their gravity, the entire mitigation regime is insufficient.

- The Habitats Standard covers offshore areas, wetlands, estuaries, tideflats, rivers, streams and lakes and the active floodplains and riparian management areas of those rivers, streams and lakes and important habitat. These areas must be managed to avoid conflicts from the proposed activity (the ACB) with existing uses such as commercial fishing. Adequate water flow and natural water circulation must be maintained. Adverse impacts to important habitat must be avoided, minimized or mitigated. The following reports provide specific evidence related to impacts to habitat, including erosion of river banks, suspension of sediments, channelization, damage to salmon spawning beds from wakes or physical contact with the vessels, and changes to the ice regime that could harm moose and incubating salmon eggs that need the ice for a thermal barrier. ACB passage, at Canyon Island in particular, could change water flow patterns and disrupt upwellings needed for salmon spawning. The ACB could impact existing commercial, sport and personal use fishing by causing reduced levels of salmon to return to the Taku. This past summer Redcorp's conventional barging operations repeatedly interfered with ADFG's research at Canyon Island and damaged the fish wheel. The ACB could also interfere with commercial and sport fishing operations and Taku River Lodge floatplane operations. Again, Redcorp relies on unspecified monitoring and mitigation plans.

DNR is also reviewing applications from Redfern for a Title 41 Fish Habitat Permit and a Title 38 Land Use permit. Redcorp has not met the requirements for either permit due to the reasons mentioned above and in addition because:

- The ACB system is likely to result in habitat alterations that could significantly decrease the productivity of the fish and wildlife habitats in the Taku. Redcorp has not provided adequate information to demonstrate that its proposal will not significantly degrade the Taku. Redcorp's permit applications deny that any channelization or bank alterations will occur, but there is clear evidence that this could occur.
- Redcorp has not provided a Spill Response Plan or other details as to how it will avoid releasing toxins such as oil, diesel fuel and cyanide into the Taku. Such a plan must be available for review before any permitting decision is made.
- Redcorp has not shown how it will avoid interference with commercial, sport or subsistence fishing nor has it shown with any detail, studies or data that its proposal will not reduce harvestable levels of salmon or moose.
- Redcorp has not provided adequate data on Taku fish and wildlife habitats nor on the depth and width of the Taku River channel in the areas it intends to implement its access plan.

For the reasons outlined above, we believe the ACB proposal is inconsistent with the ACMP standards. Thus, no permits should be issued for the ACB proposal until much more information is available and until such information demonstrates the ACB system will not harm fish, wildlife, habitat and existing uses of the Taku River for fishing, recreation and cultural activities.

Examples of information needed include, but are not limited to:
--identification of all salmon spawning, rearing and migration areas;
--identification of all eulachon spawning, rearing and migration pathways;
--comprehensive analysis of river depths and flows;
--data on wakes, currents and downblasts from the three vessels; and
--data on the ACB technology's maneuverability in high winds, heavy seas, shallow water, ice.

Redcorp also must provide detailed information on its testing procedures and criteria for the ACB technology, on its monitoring plans, and on mitigation plans. It is unclear how Redcorp's proposed testing will mimic conditions in the Taku and answer questions related to fish, wildlife, ice, etc. Detailed testing and other data should be made available before the ACB is allowed to operate in the Taku; the Taku should not be the testing ground. The Taku River is Southeast Alaska's most productive salmon river and is not the right place to experiment with unproven, new, and potentially harmful technology. Redcorp proposes monitoring as an apparent substitute for conducting a more detailed assessment, but doesn't provide details of how the monitoring would be conducted. For example, how can a one or two year monitoring program document impacts to juvenile king salmon, since the impacts would not be apparent until five or more years later when the adults return and the damage has already been done?

RWB completed its review with the assistance of independent experts and agency biologists.

- Dr. Michel Lapointe (Fluvial Geomorphologist and Scientific Director of The Centre Interuniversitaire de Recherche sur le Saumon Atlantique and Professor, Department of Geography, McGill University, Montreal, Canada) considered potential changes in the Taku River channel that may arise as a result of the proposed transportation system, and the effects of these changes on fish and fish habitat.
- Mr. Adam Lewis (Principle and Fisheries Biologist, Ecofish Research Ltd, Courtney, BC) reviewed the adequacy of Redcorp's proposal in identifying and evaluating potential effects on fish and fish habitat, prior use of the hoverbarge and potential effects of the hoverbarge landing site and access road.
- Mr. Bill Slater (Principle, Bill Slater Environmental Consulting, Whitehorse, Yukon) reviewed the adequacy of Redcorp's environmental assessment approach and methodology.
- Dr. Mark Lorang (Research Assistant Professor, Flathead Lake Biological Station, University of Montana, Polson, Montana) and Tom Bansak (Research Scientist, Flathead Station) contributed additional expertise related to the review of potential effects on the Taku River ecosystem and information about channel depths and widths.
- Alaska Department of Fish and Game biologists provided information about Taku salmon, eulachon and moose.

Mr. Bansak provided RWB with the following statement on January 17 after reviewing Dr. LaPointe's report: "I have just finished reading Michel LaPointe's report regarding the potential impacts of Redfern's proposed hoverbarge route and operations on the Taku River. I found the report to be very thorough, well researched, and well written. I share many of the concerns outlined by Dr. LaPointe about impacts of the barge on Taku River channel morphology, sedimentation, and juvenile fishes. I agree with his conclusions that Redfern has not adequately addressed many issues associated with the hoverbarge, particularly related to shallow water impacts and bank erosion. Given my time conducting research on the Taku, I think that Redfern's claim that the barge route will always be 3 feet deep or more is false. We have supplied depth data that shows shallow areas (<3 feet) along the barge route to the Taku River Tlingit First Nation to assist their assessment and comments on this proposal. Additionally, Redfern's claim that the hoverbarge will not have any impacts when water is more than 3 feet deep is entirely unsubstantiated. I am also concerned about the effects of the barge on the ice cover in the river, and the subsequent effects associated with the disturbance of the hoverbarge to ice formation, sediment suspension and erosion, and the fitness and survival of juvenile fishes. In my opinion, more research needs to be done into the potential effects described by Dr. Lapointe."

Summary of Issues, Concerns and Problems

This section summarizes specific concerns regarding Redcorp's project documents, assessment methodology and potential impacts to fish, wildlife, habitat and exiting uses of the river. These concerns are explored in detail in the reports following this Summary.

- Redcorp does not discuss underwater, wake related currents near the ACB system resulting from the displacements of water associated with the constantly advancing hulls of the three vessels. In shallow water, these currents could be significant, especially for the hoverbarge, for which the hull cross-section will represent a significant fraction of total wetted channel cross-section at some locations and water levels. The induced currents could lead to sediment entrainment and mobilization – both of which could adversely affect fish and fish habitat.
- Redcorp concludes that the effects of propeller wash and wakes will be "avoided and not significant" because the transportation system will utilize shallow draft equipment traveling in the thalweg (deepest part of the channel) for the majority of the route. Redcorp's conclusions here are partly based on data from the Mackenzie and Mississippi Rivers, the applicability of which is questionable given the Taku's smaller size and the bank composition – sand and gravel on the Taku River vs. much less erodable clay-till on the Mackenzie River. Despite specific evidence to the contrary and with no detailed information of their own, Redfern simply assumes there is a continuous deep channel and assumes that the ACB system will avoid churning up sediments, disturbing spawning salmon and harming incubating eggs and rearing juvenile salmon. No data about the effects of wakes, prop wash or downblast from the hoverbarge fans is provided and no channel depth and width data is provided for the area upstream of the Sand Flats.
- Redcorp claims the vessels can safely operate in depths of 3 feet or more without damage to habitat or salmon, but provides no data to support this claim. Preliminary analyses suggest that this may not be adequate for avoiding ecological effects. Travel through shallow water and over gravel bars could cause channelization and other habitat damage and disturb juvenile and adult salmon. No quantitative data are provided in relation to the underwater currents induced by the propulsion (amphitrac, tug) or lift (hoverbarge) systems. Regardless, Redcorp has not provided adequate water depth data to confirm the existence of a continuous 3 ft deep channel of sufficient width for ACB operation during proposed open water operating conditions, let alone a deeper channel if that proves necessary. Scientists carrying out research in this area have indicated that there are many areas where the water depths are 3 feet or less. Redcorp's analyses rely on mean monthly

flows which do not provide sufficient guidance for a system that proposes twice daily river transit. These issues become even more severe during transition periods.

- The Taku River mainstem includes salmon (confirmed sockeye and chum and possibly coho and pink) spawning areas which have not been adequately identified or characterized. Eiler's 1988 study identifies four sockeye salmon spawning areas along the proposed ACB system route, but only one of these is identified by Redcorp. Redcorp concludes that potential effects to spawning will be avoided, but does not map out salmon spawning areas. The proposed barge route passes directly over at least one known sockeye spawning area. The effects of this are not discussed or quantified, but could be significant from direct disturbance, redistribution of fine sediment, or vibration. Identification of such key habitat areas and understanding of possible effects are critical to completion of a rigorous impact assessment.
- The Taku River mainstem is heavily utilized by various salmonid species through a variety of life stages, including Chinook and sockeye salmon juveniles. Redcorp concludes that effects on juvenile fish will not be significant and that effects can be monitored, even though it acknowledges that the potential for the vessels to harm juvenile fish is not well understood. Redcorp's conclusions rely primarily on the ability of fish to avoid the ACB-induced currents. The swimming speeds of juvenile fish are lower than the travel speeds of the ACB system, making it impossible for these fish to avoid the vessels. Fish are at risk from being crushed or buried by displacement of channel materials caused by passage of the three ACB vessels. They are especially at risk in shallow water conditions, when the vessels are more likely to cause mobilization of channel materials.
- Redcorp acknowledges that the ACB transportation system is likely to affect spawning and reproductive success of eulachon, a critical component of the local marine food web. The critical habitat needs of eulachon and the locations of these habitats are not well understood and the potential effects have not been quantified. Redcorp proposes travel on gravel bars during critical spawning times, but many shallow depth crossings will still be required and are likely to affect eulachon eggs and embryos. One critical time for eulachon appears to be the transition period (days to weeks) between ice surface degradation and increased river flows – the same time period when the transportation system will experience technical challenges and will likely cause significant effects on channel conditions.
- The year-round, twice daily ACB traffic will disrupt ice cover formation in early winter – repeated breakup of the incipient ice cover will be unavoidable. This will lead to a delay in establishment of full ice cover. The disruption of ice formation may lead to thicker ice covers in areas downstream of fall ACB crossings, leading to changes in the succeeding spring breakup which is a key driver of any northern river ecosystem.
- Redcorp has split its ecological impact assessment into two main components, separated by the international border. Instead of holistically considering the combined effects of the whole project, the assessment evaluates effects on each side of the international border separately. As a result, the assessment approach fails to consider the overall effects associated with the ACB transportation system. The evaluation of effects of only some components of the project is not good environmental assessment practice and should not be considered adequate for meeting the requirements of any rigorous assessment process.

- Concerns about holistic consideration of effects on ecological components are further exacerbated by Redcorp's approach to a cumulative effects assessment – a key component of a rigorous environmental impact assessment. Redcorp concludes that a cumulative impact assessment is not necessary "as there are no other known projects or proposals for projects including mining, forestry or development in the Taku River valley that would overlap with the Transportation System of the Tulsequah Chief Project spatially or temporally." Redcorp fails to recognize that cumulative effects assessment must focus on overlapping effects, regardless of whether projects overlap in either space or time. As a result, Redcorp did not identify a host of other activities and projects that needed to be considered in a cumulative effects assessment – i.e. mining of the Tulsequah Chief Mine and mine exploration and possible development at Big Bull and New Polaris.
- Redcorp is relying largely on monitoring to determine impacts, rather than conducting pro-active assessments. Many impacts may take years to show up.
- The conclusions in Redcorp's environmental assessment rely heavily on operational monitoring programs to determine whether effects are occurring and how to address these effects. An adaptive management approach of this type needs several inter-related components to be effective: (1) well-defined monitoring programs that are proven to be effective at identifying ecological changes and trends before the effects become significant, (2) relevant and measurable action thresholds/triggers that specifically describe the conditions that will lead to responses, (3) actions, mitigation and responses that are proven to be effective and can be implemented before ecological changes become significant, and (4) mechanisms to ensure that the monitoring, triggers and actions get carried out. Though Redcorp proposes such adaptive management as a key component of its management system, none of the above components are adequately defined.
- There is no specific, tested data on the vessels' maneuverability or assurances that the vessels can avoid collisions and interference with the commercial gillnet fleet, sport, subsistence and personal use fishermen, recreational boaters and with the ADFG Canyon Island fish wheels. Redcorp claims it will produce a Transportation Communications Plan prior to operation, but such plan should be available for review prior to permitting. Redcorp has provided no specific test results or data to demonstrate that the vessels can safely handle the natural hazards in the Taku of high winds, heavy seas and strong currents.
- Redcorp must not remove large woody debris from the Taku.
- Redcorp should not compare prior use of the hoverbarge in the Yukon River to the Taku as the hoverbarge in the Yukon was pulled back and forth across the river on a wire, the Yukon is a much larger, deeper river than the Taku and that area of the Yukon did not have the fish populations and habitat that the Taku has.
- Redcorp admits that juvenile salmon use the backwater channels where the Big Bull Slough barge landing site is, but provides no other detailed information or analysis of impacts.
- No data based on actual tests has been provided regarding the noise level of the ACB system.

Adverse impacts of proposed hoverbarge operation on fish ecosystem along lower Taku River

Michel Lapointe PhD,
Fluvial Geomorphologist and Scientific Director of CIRSA,
The Centre Interuniversitaire de Recherche sur le Saumon Atlantique
Professor, Department of Geography, McGill University
Montreal, Canada

Evaluation of Redcorp Ventures' Taku River hoverbarging proposal

I have reviewed the information in both volumes of Redcorp's September 2007 impact study (as well as its appendices), in the light of available information on Taku River fish habitat. I have also reviewed comments made in May and in December 2007 by Alaska Department of Fish and Game (ADFG) biologists and the October agency comments posted to the BC EAO website. I have conducted a helicopter reconnaissance trip over the entire proposed route of the hoverbarge (henceforth called Air Cushion Barge or ACB) including landings at key sites. I have also studied available videos of ACB operation at other sites. Finally, I have interviewed Adam Lewis (Ecofish Research Ltd) as well as salmon biologists at ADFG to discuss local fish habitat patterns. Based on this, I believe there are a number of potential adverse impacts of serious concern for fish reproductive and rearing habitats (as well as for overall wildlife use) along the river corridor. Although some of these concerns have been raised in Redcorp's impact studies, they have not been addressed with sufficient data and analysis, given their serious potential to cause harm to the Taku River fish ecosystem

Specifically, I concur with concerns expressed by ADFG fish biologists concerning potentially important impacts of daily barge traffic to a number of life-stages of key fish in this ecosystem, particularly during the low flow, late fall and early spring periods when ACB traffic along the main channel will occur in very shallow water. These impacts include ACB induced damage in early spring to eulachon embryo on the river bed surface, damage (in late fall and/or early spring) to salmon embryo incubating in redd substrate along the mainstem channel, as well as damage to free-swimming salmon juveniles. The proposed ACB operation will disturb the formation of the river ice cover in ways that will modify early winter river crossing patterns for terrestrial wildlife such as moose. These disturbances may also modify winter ice cover characteristic and this, in turn, has the potential to alter spring breakup timing and flood levels. Finally, any such changes to breakup flooding regime can have far-reaching, ecosystem level effects on fish and wildlife habitat. In what follows, I describe further each of these concerns.

Effects on aquatic habitat of ACB traffic at low river discharges

In their impact study, the proponents acknowledge that there is a potential for barge traffic to disturb both bed sediments and aquatic organisms, when the ACB navigates in depths under 3 feet (cf. Vol 2, pages 4.10- 4.11). However no quantitative data are given to support this particular threshold value. Specifically, no data are given on the power and underwater reach of air blasts issuing from the ACB skirt or on those of the wash from the amphitrac propulsion system or from that of the shallow draft tug. Neither are any data given on the ability of these boat-induced water currents to entrain, in various depths of water, various sediment fractions from the bed surface, or to violently displace juvenile fish in shallow water. Not only is the 3 feet threshold value used in the impact study not supported by any relevant data but I argue below that this value seriously underestimates the potential scope of the problem.

Occasional blasts of compressed air issuing from under the ACB skirt can be significant in shallow water, but are only one part of the potential problem. The study fails to mention (much less to quantify) the importance of wake-related currents on the channel bed near the barge that will be triggered by the speedy advance in shallow water of any large hull. As will be explained below, even if ACB air blast currents were non-existent, the rapid advance of any large hull in shallow depths will generate local currents under and along the sides of the craft that may scour fine sediments off the bed and possibly, if barge speed is sufficient, entrain gravels at bed surface.

The impact study does briefly discuss (and unduly minimizes) the potential for waves from the barge wake to erode fine textured channel banks. The waves caused by barge and tug traffic will cause more severe bank erosion problems on the Taku than they have along the Mackenzie River, both because of the relatively fine texture (sand rich gravel) of the Taku's alluvial bank materials and of the much narrower main channel dimensions along the Taku (compared to the Mackenzie or Mississippi). During low flow seasons along the Taku, the ACB will be forced to keep to the thalweg (deepest path along the channel), which passes quite close to the eroding banks in bends. Consequently, in many Taku bends with steep, undercut outer banks, wave energy from the close-passing barge will not dissipate appreciably before reaching the bank. This problem will be compounded by the removal by barge operators of any snags of large woody debris (LWD) along these banks. Not only are snags important on their own as juvenile fish habitat (on which, more later), they also constitute a natural buffer to accelerated bank erosion: produced by the undermining of the riparian forest at cut bank edge, these snags of fallen wood then help deflect high flow velocities away from the bank face, thus slowing down the rate of further bank retreat. With daily barge traffic and snag removal along Taku cut banks, the rate of bank erosion in bends will increase, meander cutoffs may consequently become more frequent, and channel morphology will be modified (in particular, flow may become shallower at river crossings (straight reaches between bends) as riffle bars build up due to the aggregate increase in annual sediment volumes in transport between eroding cut banks and downstream point bars).

However the impact study completely fails to discuss the potential erosive impacts on the channel bed of the underwater currents that are associated, in shallow channels, with the boat wake. Unlike the wake related waves, these underwater currents are largely invisible at the surface but form an integral part of the physical displacements of water associated with the constantly advancing water bulge at the bow and the forced, continuous rapid passage of this water behind the craft. (Note that these displacement currents are generated whether a hull is made of steel or of an air pressurized membrane, as long as displaced water cannot occupy the air space).

These boat-induced currents can become significant at the channel bed when a barge travels in shallow channels. Transient currents associated with boat passage are unavoidably created by the continuous displacement of very large volumes of water, pushed under and around the sides of an advancing barge of large cross-section as it progresses against the water. The strength and reach of these currents will depend on hull shape, water depth and the relative velocity of hull with respect to water: a large barge with blunt bow moving at 5 mph through still water in a very shallow pond will create appreciable currents of this type on the bed; if the barge were moving at 5 mph against a 5 mph current (for a 10 mph relative velocity), the induced wake currents on the bed would be much stronger. In hydrodynamic origin, if not in strength, these currents are not unlike the well known, bed scouring currents induced alongside a bridge pier around which river water is forcibly deflected.

Wake-related bed currents and surface waves will be generated by all craft used by Redcorp, whether tugs, the amphitrac or the ACB. In what follows, I focus my discussion on the currents associated with the ACB because, with the combination of deeper draft and widest beam this is the craft that potentially may create the strongest wake related currents. The underwater frontal area of the proposed ACB is very large (about 88 feet width by 2.7 feet draft) and this large hull section may advance at 5 to 10 mph with respect to river water in the upstream transit. (River current will vary with stage and location, but at low stages along the thalweg it should rarely decrease much below 3 ft/s or 2 mph). Thus, during very low flow conditions and in shallow depth river sections, the advancing ACB hull cross-section will represent a significant fraction of total wetted channel cross-section, thus potentially inducing significant near-bed currents and sediment entrainment. The impact study neglects to discuss the effects of these wake currents on the channel bed

As noted above, the proponent provides no data on main channel depths along the barge route upstream of the Sand Flats reach during the periods of lowest flows before ice formation or any other period. Significant, ongoing research along the Taku River on channel depths, flow velocity and salmon habitat is being conducted by researchers from the Flathead Lake Biological Station of the University of Montana. However these data, including depth classification maps, will not be available until March 2008 at the earliest. Preliminary analysis of the channel data collected in September 2007 (Tom Bansak, personal communication) nonetheless reveals at least 7 areas along the proposed barge route where the main channel's thalweg (deepest path along the channel) was less than or equal to 3 feet, at the flow levels encountered during the September 2007 surveys (between 17 000 and 22 000 cfs). Of course, as flow recession proceeds to well under 10 000 cfs before an ice cover is established in December, thalweg depths will become significantly less than this and reaches where barge grounding will occur will become more and more numerous along the barge route. The University of Montana data do suggest however that, as early in the flow recession as September, the ACB will essentially scrape bottom in a number of channel areas, all the while pushing water aside in its advance. In addition to skirt drag forces on bed sediments and air blast effects, the barge's advance in such shallow conditions will generate strong currents of displaced water which, as explained above, will also kick up various fine sediments fractions. Since shallow zones (mainly located in 'crossings' between bends) along the thalweg of alluvial channels are natural and get re-formed at any flows competent to move bed materials, dredging of a deep thalweg all along the route would need to be repeated at least annually (and probably much more frequently at intermediate discharges) to avoid daily bed disturbance by the barge.

Fig. 1 taken in mid-October 2007 near Jett Bar at km 89 from the river mouth in segment 3 of the ACB route and at a flow level of 11000 cfs (or about 300 cms) gives a further indication of the shallowness and narrowness of the main channel thalweg over which the barge will travel during late fall, before ice cover formation. Flow levels typically will recede much further than pictured in Fig. 1 (some years to less than 3500 cfs or 100 cms) before an ice cover is established in December. Again, note that the barge will have to travel upriver for many days or weeks when river stages are significantly lower than pictured in Fig 1.

In summary, to support their claim that ACB traffic will not appreciably disturb channel bed sediments, the proponent must quantify the strength of these wake-related bed currents, as these vary with boat speed and channel depth under the bottom of the barge skirt confining the compressed air volume. The following critical questions need to be answered by the proponent:

- What are the depths of the shallowest sections of the main channel thalweg, all along the barge route over which the ACB will be transiting, at the lowest flows that can be encountered before a solid ice cover is formed?
- What are the minimum water depths needed across the 90 ft width of the barge, when advancing at speed against the current, to avoid re-suspending fine sediments or disturbing bed gravels present on the bed (taking into account the wake displacement currents discussed here)?

Effects on incubating embryo in salmon redds

Although available data on salmonid reproductive habitat along the lower Taku appears to be patchy, there is evidence of important spawning zones that need to be protected along the barge route. A map in Eiler et al (1988; Fig 10) based on detailed spawner telemetry indicates that, within the extent of the barge route, there are at least 4 areas of sockeye spawning activity located along the mainstem system itself (rather than on its upland tributaries). Eiler reports that these 4 spawning areas are mainly located on Taku River side channels (such as the eastern branch at Canyon Island) and states that these side channel may also be used as spawning sites for Chum. My field visit to these sites in mid-October confirmed the presence of salmon redds and of spawning salmon in shallow water in these side channels. Such side channels are, at all but the low river stages, hydraulically connected to the main channel where the ACB will transit. However, the proponent fails to document critical flow levels and mean dates when back channels become hydraulically disconnected from the main channel. All four sectors are thus potentially subject to impacts from barge-related fine sediment suspension on the nearby main channel.

Note that of these 4 sectors, only the Canyon Island spawning zone is shown on the proponent's maps (Vol 2, Fig 3.6): none of the other important spawning sites identified by Eiler are mentioned in the impact study. Given that all 4 spawning sites are well documented in available literature, this is a critical omission on the part of the proponent.

In addition to the absence of references to existing, published data, the proponent failed to make adequate efforts to identify existing habitat. In a single day of field work, I was able to identify several habitats not identified by the proponent but potentially impacted by the barge operation. The project proponent cannot rule out that, in addition to these 4 sockeye spawning sectors, there may exist other spawning zones for various salmonids on Taku river channels along the barge route. ADFG aerial surveys in 1984 found chum spawning in several mainstem channel areas (personal communication from former ADFG biologist Paul Kissner). ADFG fish biologists suspect that pink salmon also spawn within the main, turbid channel, over which the ACB will transit, exposing these embryos directly to barge related redd disturbance.

Fig. 2 shows salmon redds observed during my mid-October 2007 field visit in the back-channel near Canyon Island. Numerous such redds where observed in a back-channel pool located within meters of the floodplain forest on Canyon Island. Given the local channel morphology, the proponent's proposed summer and fall barge route (running along the edge of this side–channel) will be forced to run over this pool and destroy these redds. Furthermore, compaction of channel sediments due to the repeated passages of the barge system may modify hyporheic and upwelling flow patterns in the substrate that are key to spawning habitat quality

Moreover it is important to realize that spawning habitat can be impacted even when the ACB is not transiting directly over redds, disturbing the bed sediments down to the level of the egg pockets and crushing the embryos. In general, salmonid reproductive success deteriorates whenever fine sediments settle on the bed around egg pockets where embryos are incubating. USGS suspended sediment data (cited in Vol 2 of Redcorp documents) confirms that, as in most glacier fed systems, natural suspended sediment loads along the Taku are generally very low during most of the redd incubation period (for many salmonids, this period extends from fall to spring). Indeed salmonid populations are known to adapt their reproductive timing and habitat selection to the natural flow and sediment regime of their ecosystem to minimise the impacts on redds of both scouring high flows and fines sedimentation during flow recession. On the Taku, while TSS can reach 300 mg/l at summertime high stages (Vol 2; table 3.5), concentrations typically decrease to 50 mg/l during fall recession and are extremely low (under 5 mg/l) by late fall and winter, especially once ice cover is established. In the natural regime in such glacier fed rivers, throughout the late summer flow recession period suspended sands settle and accumulate on the bed in low flow zones (notably along channel margins or in pools, where they mantle gravels and cobbles). Typically, these in-channel fine sediments are only re-suspended at the start of the next high flow period (in May on the Taku River).

Thus, over the whole late fall to early spring, salmon egg incubation period, fine suspended sediments loads in the river are naturally very low and are mainly made up of clay-sized particles that remain in suspension and do not tend to settle in quantity in spawning substrate. As discussed above, wake-related currents associated with ACB travel in shallow channel reaches may put back into suspension, twice a day, during very late fall or early spring, seasonally un-naturally high loads of sandy sediments that normally remain settled on the river bed at this time of year. Furthermore, these re-suspended fines will get flushed downstream by the river current and re-settle downstream, possibly on redds located along the main or connected back channels . It is thus not only important that substrate disturbance by the ACB, amphitrac or tug not take place directly over redds during the incubation period, but also that any ACB traffic induced sand re-suspension, repeated over many days in late fall or very early spring, be avoided upstream of any redd sites along the mainstem. Of course if the barge travels fast enough in very shallow zones, skirt contact or wake related near bed currents could also stir up gravel or cobbles and this could both crush incubating eggs and harm emerged juveniles, which often shelter in bed interstices during cold water months.

The proponent also failed to acknowledge the potential of vibrations, induced by the use of the amphitrac, ACB, and shallow draught tug, to cause damage to incubating eggs. These vibrations could cause mortality to the eggs through direct physical shock to the eggs or by causing movement of the gravel/cobble substrate which in turn could crush the eggs. These vibrations would be expected whenever there is contact with the substrate. The ability of physical shock and vibrations to cause mortality to salmonid eggs has been well documented (e.g. Jensen and Alderdice 1983, 1989; and Smirnov 1954, 1955). The period of egg sensitivity to mechanical shock has been demonstrated to extend until they reach the eyed stage. As development is largely temperature dependent the cold waters of the Taku River will result in an extended period of sensitivity. The limited mobility and long developmental time of salmonid eggs makes them particularly vulnerable to repeated exposures for an extended period of time. Research into the amount of vibrations produced around and under the amphitrac and ACB would be required to assess the potential impacts on incubating salmonid eggs. This is another critical weakness in the impact assessment by the proponent.

Effects on juvenile fish

ADFG data shows that 40-50% of juvenile salmon rear below the Tulsequah River confluence, with the majority of juvenile Chinook rearing in the lower Taku River and largely in the main channel. During transitional late fall and early spring periods when the ACB navigates over shallow waters, free swimming salmonid life stages will also thus be threatened by the barge related currents (whether these locally enhanced currents are caused by air cushion blast or wake water displacement). Lorenz et al (1991) found that 0+ juveniles of various salmonid species rear in high numbers in the various branches of the lower Taku River along the barge route, with Chinook and Sockeye juveniles more common along the main channel over which the ACB will transit.

On this point, the proponent's impact statement relies largely on the ability of free-swimming fish to avoid ACB-induced currents. Here again, things are not so simple. As water temperatures and fish metabolism are very low during the early spring and fall transitional periods, many juveniles save energy by sheltering at the bed surface in available interstices of the gravel and cobbles (as well as near woody snags, if present). Because the swimming activity of juveniles is reduced in these cold water periods, they are at higher risk of being either crushed by barge induced displacement of surface gravels, or buried under any re-depositing sands put into suspension upstream by the barge. Finally, the systematic removal of mid-channel snags that will be required along the barge route will also destroy important juvenile resting habitat in these cold water, spring and fall periods, especially for the juvenile chinook and sockeye, most common along the main channel according to Lorenz (1991).

Water depths along the barge route during low discharge, open water periods.

In this section, I give further reasons to believe that shallow thalweg depths may not be confined to a few reaches (as indicated by the September 2007, University of Montana data) but may be a general feature of the main channel in the period October-December. As discussed above, it is imperative that daily ACB operation not disturb either vulnerable salmon juveniles or the salmon embryo incubation process. Contrary to impact study claims, this will pose real challenges here, especially during the early spring and late fall 'transitional' seasons (the low discharge seasons when the ACB has to travel at least partially on open but shallow water, as the ice cover is non-existent or still too weak to support the barge and its propulsion vehicles).

Note first that the scope of this transitional season is poorly defined by the proponent. The proponent provides no data on ice strength or on mean start and end dates (and inter-annual variations) for the period of safe ACB transit wholly on solid ice. Rather, the impact statement simply assumes that, in all years, and for the whole of fall and spring periods without a solid ice cover, minimum 3 ft channel depths exist over the entire route upriver. This key claim is left totally unsubstantiated in the impact study.

Recall also that no data were provided in the first place to support the claim of a 3 feet threshold as being the correct 'safe depth.' On the contrary, it appears unlikely that a 2.5 foot draft barge, cruising at a 5-10 mph speed (relative to water) in a 3 foot deep channel (i.e., with about 6 inches of free water below the 90 foot wide skirt), would fail to stir up fine sediments or even mobilize fine gravel on the bed all along its route. The safe water depth when the barge travels at cruising speed over sand-rich, gravel bed substrate (a bed composition that is generalized along the barge route) remains to be substantiated by the proponent, but may well be in the 5 or 6 feet range at least (taking into account wake currents on the bed and also that, as a boat increases its speed against the current, its draft increases as the hull sinks somewhat deeper between bow and stern waves).

Secondly, recall that for the majority of the travel route (the entire route upstream from the Sand Flats), no low flow bathymetric data are provided to back the claim that a consistent, 3 foot deep barge channel is available during the entire transitional period. As noted earlier, preliminary bathymetric data collected in September 2007 by the University of Montana appears to disprove this claim.

Here, I present further evidence that, contrary to the proponent's claim, there may well be periods of many weeks during transitional seasons when the ACB will be forced to repeatedly travel over zones of quite shallow water, with significant impacts on substrate re-suspension, juvenile dislodgement and redd habitat deterioration. This conclusion is based on perusal of the historical flow records and inspection of barge route air photos supplied in the proponent's reports. Although conditions will vary from year to year, in general, mean flow levels appear to fall below 7 000 cfs (or 200 cms) in early November (some years earlier) while a full and strong ice cover allowing safe ACB transit completely out of water apparently only exists weeks later, sometime in December. Similarly, in spring, there could be many days or weeks between the date when the ACB stops traveling on weakening ice and the date (mid-April, on average) when flow levels rise above 7 000 cfs. Thalweg depths will be quite shallow at such flow levels, of the order of a foot less than pictured in Fig. 1 (a photo taken at 11 000 cfs). Historical flow statistics indicate that average flow levels continue to fall below 7 000 cfs and many years reach below 3 500 cfs (100 cms) between mid December and early April, when even lower channel depths must occur, at times when the barge may not be able to travel safely on ice.

As noted earlier, to back their key claim of safe, open water navigability, the proponents need to provide data on channel depths over the bulk of the barge route (upstream of the Sand Flats) at these very low discharges (7 000-3 500 cfs or lower). In the meantime, and in the absence of hard data from the impact study, back of the envelope calculations (based on typical channel width to depth ratios), suggest that this claim of sufficient depths is suspect. For barge traffic to avoid any possibility of re-suspending bed sediments, let's assume (with some factor of safety) that there must exist a continuous navigation route of at least 3 times the barge width (i.e. about 80 m or 250 feet width) over which depths need to be everywhere greater than 6 ft (1.8 m). Based on the barge route imagery provided, the wetted width of much of the main channel where the barge will travel was approximately 150 m (500 ft) on May 15, 2006 (the date of most satellite imagery covering the downstream part of route atlas). At that date, discharge was 7 000 cfs (about 200 cms, USGS data). No photos in the route atlas (or other data) were available to assess flow widths at lower discharges (such as 3 500 cfs). Upstream of the international border, where widths and depths may be smaller, barge route atlas photos were taken at higher flows, around 13 000 cfs (360 cms). Wetted widths of the main channel at 13 000 cfs were also approximately 150 m, implying even narrower main channel widths at 7 000 cfs in the upper part of the route.

An approximate range of likely mean depth values can next be estimated by applying to the widths measured on the route atlas the expected channel 'width to depth ratios' for typical braid channels ('anabranches') at low flow levels. Field data will need to be collected by the proponent on this point, since only rough guesses are possible from theory. Braided river anabranches are known to have quite variable cross-sectional geometry and varied patterns of width and depth changes with stage (relations described as 'at a station hydraulic geometry'). Perusal of published data sets on braid 'width to depth ratios' <u>at annual low flows (i.e. lower baseflows)</u> yields ranges of ratios of 60:1 up to 100:1 in some cases, depending on braid morphology and severity of the low flow level measured. This suggests that <u>mean</u> channel depths (including depths in pools) at 7 000 cfs may be as low as 1.5 m or 5 feet (150 m divided by 100), with possibly lower depths upstream of the border. Furthermore, alluvial channels are normally significantly shallower than these reach average values at riffles or 'crossings' between bends (how much shallower depends on the relative annual bed material transport load through the channel reach).

This rough calculation suggests that <u>mean</u> channel depths could be as low as 1.5 m (5 feet) at 7000 cfs, (and even lower, as flow recedes towards 3500 cfs before freezeup). In this context, it would appear unreasonable to believe that an 80 m wide boat channel (fully half the 150m channel width) will consistently be deeper than 1.8 m (6 feet) all though late fall or early spring. Indeed, at riffle zones (or 'crossings') thalweg depths should be significantly lower than these reach mean values. The proponent's implied claim that safe depths are maintained over wide channel swaths and along the entire barge route at 3500 cfs (100 cms) during entire transitional periods every year is thus not only unsubstantiated in the impact study, it appears also highly dubious, based on first principles.

Finally, it is important to realize that even at the lowest river stages, it is impossible, in practice, for the ACB to ever travel purely along bar margins (avoiding all shallow water crossings). Non-vegetated portions of gravel bars (the surfaces that could be used for dryland ACB travel) are by their nature fragmentary so that their distribution continuously alternates sides along alluvial channels. Even if the ACB skirted water by traveling on bars during low flow transitional periods, approximately 10-15 water crossings from bar to bar would be required between the upper part of the Sand Flats and the mouth of the Tulsequah River. To compound this problem, the shortest crossing route from bar to bar coincides with riffle locations, the shallowest channel zones.

Effects of barge traffic in early spring on eulachon.

Because of the shallowness of the channel in early spring, another major concern is erosion and destruction by ACB traffic of eulachon eggs or embryos incubating on the bed surface. Eulachon are a critical, rich food source for many animals in the Taku ecosystem including gulls, Stellar sea lions, harbor seals, bald eagles and other birds and mammals (Marston et al. 2002) with high importance to First Nations. Note that ADFG believes that dead eulachons are a food source for juvenile salmon.

The impact study only addresses this important concern for the Sand Flats reach, where the proposed mitigation strategy is at best partial. For reasons explained in the previous section, even if the ACB maximizes travel over channel bars, repeated channel crossings and potential disturbance of shallow substrate are unavoidable, along any part of the floodplain route. Furthermore, the assumption made in the impact study that eulachon reproduction is limited to the Sand Flats section of the estuary is, again, both unsubstantiated and doubtful. Eulachon embryo can develop attached to the surface of river bed gravels as well as sand substrate (Willson et al 2006) and ADFG and Taku River Tlingit First Nation biologists suspect eulachon spawn at least as far upriver as Canyon Island. In any case, suitable eulachon sandy gravel spawning substrate extends well beyond Canyon Island on the Taku River.

The timing of eulachon reproduction as well as the nature of its spawning habitat and swimming capability makes the species susceptible to ACB impacts in spring time. Eulachon spawning runs generally coincide with the period of early spring, low flows, during which the ice is disintegrating. It was noted above that during the days or weeks after ice cover degradation (which occurs usually in late April) but before strong discharge rise (in May), the ACB will be forced to travel daily over shallow depth zones. Unlike incubating salmon embryo which are buried a few decimeters below the bed surface, eulachon embryo are present directly on the bed surface, where they are attached to relatively small sand or gravel particles that can easily be dislodged by ACB-induced bed currents. This habitat arrangement implies potentially large increases of reproductive mortality of Eulachon along the barge route in early spring. Moreover, once hatched, eulachon larvae are small (5 mm, or 0.20 inches in standard length, Hay and McCarter 2000) and thus slow swimming, increasing the risk that they will not be able to avoid the path and induced currents of the ACB , as the proponent has suggested that free-swimming fish will be able to do. Even assuming the conservatively fast specific swimming speed of salmonids of 10 body lengths per second (Webb 1975) results in a specific swimming speed of only 2 inches per second, equivalent to just 0.11 mile per hour. Even if eulachon larvae could detect an approaching barge and respond with evasive action, they would be unable to escape in time. The impacts of the pressure and currents created by the barge on eulachon larvae are unknown.

Effects of barge traffic on the river ice regime

Recall that it is impossible to tailor a barge route up-valley that relies solely on dry river bars and avoids frequent water crossings. It follows that at the start of river ice formation in early December, ACB traffic is bound to repeatedly break up the incipient ice cover. Indeed, over the period of initial ice formation, the ACB will trigger break up of newly formed, thin ice twice daily, at all sites where the ACB crosses water. This process may recur for many days or weeks, until air temperatures are cold enough for the ice cover that forms in one night to be sufficiently thick to resist the next day's ACB loads. Inevitably the onset of a full, solid ice cover over the whole river will be delayed to some extent, if daily ACB traffic is maintained throughout the ice formation period. The only practical way for the proponent to avoid interfering in this way with the ice formation process would be to interrupt ACB operation over this entire, early winter period and until a solid ice cover has formed all along the route.

Thus, uninterrupted ACB traffic will maintain open water at these crossing sites for days or weeks longer than normal in any given year, depending on the severity of the early winter cold and ACB on-ice loads. This important disturbance to ice cover formation is not discussed sufficiently in the impact study. The proponent needs to analyze climatic data and ACB-amphitrac stress levels on ice to assess the typical duration of this period of ice cover disruption. Not only will this disturbance affect channel crossings by terrestrial wildlife in this early winter period, it can also potentially alter the very characteristics of the final, winter ice cover. In theory at least, as explained below, these changes to the thickness and strength of the winter ice cover could also have spin-off effects on the timing and intensity of the succeeding spring breakup, an event that is a key driver of any northern river ecosystem.

In general, river ice forms progressively in early winter as ice flocs of supercooled water (called 'frazil') form when open water interacts with cold, night air (mainly below -10C). These flocs are then carried downstream, gradually collecting into ice pans in slower flowing, pool sections, where these pans progressively fuse into a full ice cover (Fig 3). As the incipient ice cover starts insulating the water from direct contact with the cold air, production of supercooled frazil flocs is reduced. However, heat conduction through the thin ice still allows it to thicken, up to a mid-winter, equilibrium thickness which will depend on local climate and river flow conditions.

However, areas of faster river water (such as riffles, rapids, falls, etc.) usually remain open longer than the slower, pool-like reaches. Until they close, these fast areas can continue to supply fresh, frazil flocs that are carried by the flow and serve to further build up the existing ice cover over the slower flowing areas lying just downstream. In certain hydraulic conditions, frazil flocs produced at rapids and other areas that stay open well into winter accrete underneath the downstream ice cover and appreciably thicken it. In very cold climates, for example, the intense frazil production at turbulent rapids sections that remain open can lead to the buildup of 'frazil ice dams' under downstream ice covers. In some cases, 'freezup ice jams' can even occur around these 'frazil dams' and this, in turn, can lead to scouring of the bed (and potentially of any salmon redds) located near the ice jams. Note that such mid-winter, ice dam related scour events occur at a time when river discharge is low and normal winter time flow velocities and sediment transport is weak over other sections of the river.

Potential ACB impacts on winter ice cover and breakup conditions.

The repeated breaking up of incipient ice cover at barge crossings over the early winter weeks will thus lengthen, by days or weeks, the period of frazil production over these zones. Depending on the severity of the cold and the extra length of time of open water at barge crossings, this enhanced frazil production (at multiple points along the channel) as well as the daily re-freezing of ice pieces broken by the ACB may well thicken and roughen the final ice cover in the sections located downstream from all barge crossings. In turn, this enhanced ice thickness at many reaches along the river may, in theory, entail some delay in mean spring date of ice disintegration. If ice disintegration is thus significantly delayed in spring, the snowmelt driven rise in river discharge may possibly occur before significant ice weakening, leading to an increase in ice jamming potential and in spring breakup flood levels. Finally any such modification to the timing and character of spring breakup along a Nordic river can have important ecosystem level impacts on channel morphology and spring time river habitat conditions for many plants and animals. In Nordic river ecosystems, changes to spring breakup energy, flood levels and timing are known to have wide-ranging effects on overall sediment transport patterns, channel dimensions and sediment sizes (especially along back channels that are formed by flood flows), as well as on replenishment of floodplain ponds by nutrients and water, scouring of fish spawning habitat, propagule dispersion of riparian plants, etc.

Insufficient data are provided in the impact study to assess precisely the changes to ice cover that will occur on the Taku. The severity of the winter cold and the timing of spring warming along the Taku may or may not be sufficient to trigger freezup jams or delayed spring breakup. However localised modifications to the normal winter ice cover is likely, as open channel crossings and open water frazil production persist for longer periods than normal.

Conclusion

In summary, the necessary information has not been produced in the impact study to rule out that, in many years, there may be periods of many weeks or months during transitional seasons when the ACB will be forced to cross repeatedly zones with quite shallow water, with potential significant impacts on substrate re-suspension, juvenile dislodgement, redd habitat deterioration and winter time ice cover characteristics.

Figures

Fig. 1. Example of shallow depth of barge route at 11 000 cfs, in mid-October 2007 (near Jet Bar).

Fig. 2. Salmon redds (lower right) in pool at upstream end of Canyon Island back channel, mid-October 2007.

Fig. 3. Frazil and river ice formation processes.

References

Eiler, JH, Nelson, BD et al., 1988. Distribution, stock composition, and location and habitat type of spawning areas used by Sockeye Salmon on the Taku River, Auke Bay Laboratory. Alaska Fisheries Science Center National Marine Fisheries Service National Oceanic and Atmospheric Administration 11305 Glacier Hwy. Juneau, AK 99801-8626

Hay, D.E. and P.B. McCarter. 2000. Status of the eulachon Thaleichthys pacificus in Canada. Department of Fisheries and Oceans Canada, Canadian Stock Assessment Secretariat, Research Document 2000-145. Ottawa. 92 p.

Jensen, J.O.T, and D.F. Alderdice 1983. Changes in the mechanical shock sensitivity of coho salmon (Oncorhynchus kisutch) eggs during incubation. Aquaculture 32: 303-312

Jensen, J.O.T, and D.F. Alderdice 1989. Comparison of mechanical shock sensitivity of eggs of five Pacific salmon (Oncorhynchus) species and steelhead trout (Salmo gairdneri). Aquaculture 78: 163-181.

Lorenz, JM, Murphy, LM et al., 1991**.** Distribution and abundance of juvenile salmon in two main channel habitats of the Taku River of Alaska and British Columbia. Auke Bay Laboratory. Alaska Fisheries Science Center National Marine Fisheries Service National Oceanic and Atmospheric Administration 11305 Glacier Hwy. Juneau, AK 99801-862

Marston, B.H., M.F.Willson, and S.M.Gende. 2002. Predator aggregations during eulachon *Thaleichthys pacificus* spawning runs. Mar.Ecol.Prog.Ser.Vol.231:229-236.

Smirnov, A.I. 1954. The effects of mechanical agitation on developing eggs of the pink salmon (Oncorhynchus gorbuscha) (Walbaum). Salmonidae. Doklady Akedemii Nauk. SSSR 97(2): 365-368. Translated from Russian, 1959: Fisheries Research Board of Canada Translation Series 231.

Smirnov, A.I. 1955. The effects of mechanical agitation at different periods of development on eggs of autumn chum salmon (Oncorhynchus keta infrasp. Autumnalis Berg, Salmonidae). Doklady Akedemii Nauk. SSSR 105(4): 873-876. Translated from Russian, 1959: Fisheries Research Board of Canada Translation Series 230.

Webb, P.W. 1975. Swimming speeds. Chapter 3 in Hydrodynamics and energetics of fish propulsion. Bull. Fish Res. Bd. Can. 190, 159 p.

Willson, M.F., R.H. Armstrong, M.C. Hermans, and K. Koski. 2006. Eulachon: A Review of Biology and an Annotated Bibliography. National Marine Fisheries Service, National Oceanic and Atmospheric Administration. Juneau, AK.

Ecofish

Ecofish Research Ltd.
Suite F, 450 8th Street
Courtenay, B.C.
V9N 1N5

Phone: (250) 334-3042
Fax: (250) 334-3097
Email: ecofish@telus.net

December 18, 2007

Reference:

Rivers Without Borders
419 6th Street,
Room 221,
Juneau, AK
99801

Attention: Chris Zimmer

Dear Sir:

Re: Review of Volumes 1 and 2, the Air Cushion Barge Transportation System: Taku River Operations Plan and agency/TRTFN comments on Redfern Resources Ltd.'s Hoverbarge Comments

As per your request this letter provides a review of the background information and impact assessment of the referenced project. We have provided detailed comments on a number of issues that have been integrated into a letter prepared by Michel Lapointe. To facilitate the integration of more general comments with those of ADFG October 19, 2007 Memo, we have synchronized our comments with theirs: ADFG comments are in bold italics and our relevant comments follow.

The potential for adverse impacts related to the use of this new technology raises serious concern for fish and wildlife habitat along the river corridor, as well as for the various user groups of the Taku River. The daily passage of the Air Cushioned Barge (ACB) and/or the shallow draught tug or amphitrac could cause significant disruption to user groups on the river, cause channelization within the river, damage sensitive spawning and rearing habitat, and disrupt normal ice formation and breakup. The lack of information on this new technology causes specific concerns with regards to maneuverability of the ACB in high flows, noise generation (above and below the water), and overall safe operation. The lack of fish habitat data within this section of the Taku River leads to serious concerns on assessing the impact of the ACB route on fish habitat. Although some of these concerns have been discussed by the proponent, they have not been addressed with sufficient data and analysis, given their serious potential to cause harm to the Taku River fish ecosystem. These concerns are discussed in more detail below.

Project description does not discuss a plan for avoiding or mitigating impact to U.S. and Canadian commercial fishers as well as personal use and sport fishers in the river and upper Taku Inlet.

We agree with this concern. The proponent plans to mitigate disturbance to commercial activities through the use of an extensive communication plan. They suggest that commercial fishing activities in Canadian waters (immediately upstream of the border) will be disrupted for a period of 10 min twice daily. During this time commercial fishing will have to be ceased to allow passage of the vessel. The proponent provides no information on discussions or input from commercial fishers and this apparent lack of input demonstrates that this issue may not have received the appropriate amount of attention required. If barge traffic is permitted it seems more plausible that it be restricted during commercial fishing activities.

One of the most important concerns from a commercial fisheries perspective is the potential threat to the Taku River stock assessment program. The west route around Canyon Island is the most direct and the preferred route. However, the fish wheels are located in this stretch and there is concern that the wheels might be damaged or completely destroyed if the barge wanders even a little off track through this narrow and fast flowing section of the river. The river is only slightly wider than the barge at Canyon Island. The Canyon Island fish wheel stock assessment project is funded through the Pacific Salmon Treaty and has been instrumental for Taku River salmon stock assessment for the past 25 years.

The alternate or east route around Canyon Island also raises potential concerns. This is an area where many sockeye and coho stage and spawn in and around Fish Creek. Changes to the river caused by the Amphitrac tug or air cushion barge negatively impact these fish and their immediate spawning habitat. There is also the question of potential impact to the river bed itself…after months or year of travel around the east route there is the potential for redirecting much of the main flow to this channel due to scouring. That would lead to some significant changes that are not favourable to the fish. The department recommends that another route that avoids the Canyon Island area altogether be investigated.

During the open-water season the proponent plans to avoid the western route area completely and use a route on the eastern side of Canyon Island. In winter season the proponent plans on using the western route to avoid the open leads on the eastern route.

The concern regarding fish habitat along the eastern route has already been discussed by Michel Lapointe. The proponent offers no data on the cumulative effects of the amphitrac and ACB to cause significant scouring. The potential for channelization in the eastern route is also of concern. The cumulative effect of scouring of gravel at the top end of the route by the twice daily travel of the ACB and amphitrac over an extended period could lead to a significant change in water flow patterns through this section, which would greatly impact fisheries habitat.

Noise from the vessel in this area may also be of particular concern. The proponent suggests that noise will not be a significant issue, but provides no specific data on noise transmission into the water. In certain applications noise is used to scare fish out of an area, as is common during blasting operations. The potential for the twice daily noise exposures in the shallow, narrow channel to cause avoidance of this area by fish has not been discussed.

The Amphitrac tug (and to a lesser degree the hover barge) is unproven in the application being proposed. The department has many concerns about obvious and significant habitat damage and other negative impacts this equipment will have on the environment and particularly to the salmon resources of the lower Taku River. For example, the following four aspects of this project would likely lead to channelization (a bad thing for salmon habitat): 1) continuous passage up and down river of a very large craft or object, 2) snag and debris removal, 3) changes in bank topography due to waves or water surges, and 4) changes in bank topography in transition zones from land to water routes. The department does not agree that this critical habitat area of the lower Taku River watershed should be the testing ground for the unproven application of this technology.

We agree with this concern. Many of these items have already been discussed in Michel Lapointe's comments. The proponent offers no real data that can be used to predict changes in channelization, and bank topography. Changes in bank topography in transition zones are likely and have not been thoroughly assessed.

We further agree that a high value habitat such as the lower Taku River watershed should not be the testing ground for the unproven application of this technology.

This proposal by Redfern Corp. will damage valuable salmon spawning and rearing habitat which will lead to reduced numbers of salmon returning to the Taku River and the coastal waters near Juneau. Over the life of the proposed Tulsequah project the negative impacts could be very significant and the economy of the commercial fishery could suffer.

The lack of data available on the amphitrac, and ACB in this application precludes conclusive statements regarding lack of impact, accordingly there is a risk of damage to valuable salmon spawning and rearing habitat as stated by the ADFG. We judge the risk of impact to be high, based on the analysis provided by Michel Lapointe.

The displacement of 450+ tons moving 4-5 knots over shallow water will likely have negative effects on the environment and the fish and wildlife that inhabit that environment. Department biologists believe that the hoverbarge and amphitrac tug will cause significant harm to adult and juvenile fish and the habitats that they depend upon. One of many concerns is what effect the air cushion barge and amphitrac have on salmon eggs laid in the gravel? These eggs go through several stages of development that are extremely sensitive to any type of disturbance. The first very sensitive period is the first hour after fertilization. Then, 12-36 hours after fertilization cell division begins and if the eggs are so much as rolled over, they can and likely would be killed.

We agree with this concern and it is addressed in detail in Michel Lapointe's comments.

The department does not believe that the barge will be safely maneuverable during downstream transits especially when the river flow is at its maximum. The barge "can move at speeds up to 12 to 15 km/h (6 to 7 knots)…average speed will be 10 km/h." The river itself will be running at speeds as fast as or faster than the top running speed of the hoverbarge so control of the barge will be questionable if not impossible. This is unacceptable.

The proponent does not offer any information with regards to maneuverability of the ACB during downstream travel when flows may be faster than the top running speed of the amphitrac. In their operations plan the proponent states that at flows at or below 9 knots, that the shallow draught tug has ample power to maneuver the ACB upstream and downstream. If flows are higher than 9 knots they say these areas will be avoided and if needed additional power (amphitrac or second tug) will be used.

Noise emissions from four 500 hp diesel engines on the barge and three 1200 hp engines on the amphitrac tug will be significant and potentially detrimental to wildlife, residents, and tourists on the river.

The proponent provides some information on the level of noise that will be emitted (70 decibels at 100 feet); however, there is not enough information given to properly address this issue. There is also no information given on transmission of noise into the water column, other than that the proponent states that the ACB will not likely generate significant underwater noise. More information is needed with regards to noise transmission into the water column to assess this issue.

Proposal for snag removal and route maintenance: the department does not agree that this is desirable or will be beneficial. Snags, root wads, and debris in the river provide valuable habitat to fish and to birds.

We agree with this concern and it is addressed in detail in Michel Lapointe's comments.

The low water route overland near the toe of the glaciers during low water periods may have a lesser impact to sensitive areas. However, there have been numerous studies and more are planned for mapping the important "critical estuarine and inter-tidal habitat" areas for Taku River fry and smolt. The department will reserve an official opinion on this route until ongoing and future habitat studies can be completed.

Before any route is chosen it should be ensured that it will not disrupt any critical habitat areas for any species. The issue of lack of information (or review of available information) for spawning habitat was also made apparent in Michel Lapointe's comments.

In the winter, ice and snow cover provide a buffer to salmon presmolt and fry against the severity of extreme cold temperatures. There is potential for the air barge and amphitrac tug to disrupt normal ice formation and snow coverage in the lower river which would negatively impact presmolt and fry survival.

We agree with the concern that normal ice formation and breakup may be disrupted and the negative effects this could have on fishes and it is addressed in detail in Michel Lapointe's comments. The proponent states that they will allow ice to form under natural conditions. It is unclear, however, how this will actually be achieved with the ACB and related tugs traveling the river daily. The only way to ensure ice would form naturally would be to restrict ACB and related traffic during the period of ice formation. Given interannual variability in the timing and location of ice formation as well as the ice strength, prediction of the appropriate safe time for travel will be difficult, and errors in these predictions will increase the risk of impacts to ice formation and fish habitat.

The proponent also states that a winter road will not be constructed and only minor compaction of snow will be required. It is unclear what is meant by "minor compaction" and how this could affect the timing of ice breakup.

Tulsequah floods occur annually and can be triggered quickly. Safe hoverbarge operations would be nearly impossible during these annual events that can last for a week or two.

We agree with this comment.

There are no contingency plans discussed for anticipated or non-anticipated problems and/or accidents. If the barge is stopped or breaks down over an embankment, will the barge itself be strong enough to support its payload? Is there a chance that the barge might break apart under uneven weight and stress loading?

In the operations plan the proponent states that a comprehensive spill prevention plan and contingency plan will be developed prior to commencement of operations. This spill prevention plan will also need to be reviewed, prior to commencement of operations. They do not offer information as to the stability or the structural integrity of the ACB if it has to stop or breaks down on an embankment or is subject to an uneven weight or stress loading. There is no quantitative risk assessment of the these events: how probable are accidents, and what will be the consequences to fish and habitat?

In summary, the lack of relevant information on the use of this new technology in sensitive fish habitats, such as the Taku River, makes determination of impacts difficult without prior field testing. As is stated in the ADFG's December 05, 2007 memo, the use of monitoring to identify impacts post operation raised instead of conducting a meaningful proactive assessment is of particular concern. We agree that although monitoring will undoubtedly be needed, this monitoring should not replace the need to review pertinent information to predict and assess potential impacts to the environment and fisheries. The proponent also fails to identify the specific details of the monitoring plan that would allow for impacts to be detected or quantified.

Yours truly,

Ecofish Research Ltd.

Adam Lewis
Fisheries Biologist/Principal

Review of Assessment Methodology and Approach

Tulsequah Chief Mine
Proposed Air Cushion Barge Transportation System

December 19, 2007

Prepared for:
Rivers Without Borders
Whitehorse, Yukon
Juneau, Alaska

Prepared by:
Bill Slater Environmental Consulting
Whitehorse, Yukon

Table of Contents

1.0 Introduction

Bill Slater Environmental Consulting has reviewed Redfern Resources Ltd's (RRL) "Tulsequah Chief Mine, Air Cushion Barge Transportation System, Volume 1: Project Description" (the 'Project Description'), "Tulsequah Chief Mine Air Cushion Barge Transportation System, Volume 2: Supporting Information for the BC Project Approval Certificate Amendment and the Alaska Coastal Zone Consistency Review" (the 'Assessment Report'). Bill Slater completed this review on behalf of Rivers Without Borders, to evaluate the adequacy of the environmental assessment for the proposed Air Cushion Barge (ACB) transportation system. Several other documents were also reviewed and considered to support completion of this report:

- Tulsequah Chief Mine, Air Cushion Barge Transportation System: Operations Plan. Gartner Lee Ltd. October 2007.
- Letters provided to the BC Environmental Assessment Office at the conclusion of the public comment period for RRL's application including letters from Taku River Tlingit First Nation (October 12, 2007), Alaska Department of Natural Resources (October 10, 2007), US Department of the Interior (October 5, 2007), Fisheries and Oceans Canada (October 5, 2007) and various local residents.
- Memo to Jackie Timothy, Alaska Department of Natural Resources, from Kevin Monagle, Alaska Department of Fish and Game re: Tulsequah Chief Mine Air Cushion Barge, 2007.
- Memo to Jackie Timothy, Alaska Department of Natural Resources, from Brian Glynn, Alaska Department of Fish and Game re: Tulsequah Chief Mine Air Cushion Barge, 2007.
- News Release, Redcorp Announces Redfern's Tulsequah Project Feasibility Study Results, January 29, 2007. Redcorp Ventures Ltd.
- Various documents and materials contained on the websites of Redcorp Ventures Ltd., and Hovertrans Inc.

This report focuses on the adequacy of RRL's project documents and the methodology and requirements of the British Columbia environmental review process and Canadian federal environmental review. Other reviewers are considering detailed technical aspects of the project including the effects on fish and fish habitat and the effects on river geomorphology. Rivers Without Borders has internal expertise related to Alaskan and United States permitting and review processes.

Qualifications and experience of Bill Slater Environmental Consulting are described in Attachment 1.

2.0 Summary of Findings

In general, the environmental assessment approach and the information and analyses provided in the project documentation are not, in my opinion, sufficient to support governments' needs to reach environmental assessment conclusions about the proposed ACB transportation system.

The overall assessment approach is flawed in three key areas. First, the assessment is based, in part, on a comparison to the previously proposed road access; an inappropriate baseline for comparison. Second, RRL splits the project into two components separated by the international border and fails to holistically describe the effects of the entire project. Third, RRL concludes that a cumulative effects assessment for this project is not required because the project does not overlap spatially or temporally with the proposed project; failing to recognize that the cumulative effects assessment needs to consider potential overlapping effects, not overlapping projects.

Aside from the fundamental concerns about the assessment approach, there are also several areas where RRL has not provided sufficient information and analyses to support its environmental assessment conclusions.

The combined results of the above concerns mean that the information provided by RRL does not adequately identify, describe, analyze or interpret potential environmental effects associated with the ACB transportation system. With the information provided, it is not possible to reach a conclusion about the significance of effects associated with the proposed project.

3.0 Background

3.1 Tulsequah Project

RRL's Tulsequah Chief Project is located approximately 160 km south of Atlin B.C. and 65 km northeast of Juneau, Alaska adjacent to the Tulsequah River, the largest tributary of the Taku River. RRL proposes to mine a volcanogenic massive sulphide deposit containing copper, lead, zinc, gold and silver. A feasibility study prepared for RRL identifies a probable reserve of over 5,000,000 tonnes. The company proposes a mining rate of approximately 2000 tonnes per day with a mine life estimated as approximately eight years.

In its initial proposal, RRL proposed construction of an access road from Atlin B.C. This road was the subject of significant controversy. Despite concerns about possible environmental effects associated with the mine and the road, RRL received a Project Approval Certificate from the BC Government in 2002. In 2005, the Canadian government determined, under the *Canadian Environmental Assessment Act*, that the project was not likely to have significant adverse environmental effects.

On the basis of a feasibility study, RRL put its plans for mine development on hold in May 2006 for economic reasons. The cost for the road was one of the large drivers in this decision.

In January 2007, RRL announced plans to move ahead with its mine development plans without the road access. Instead, it proposed to rely on use of ACBs for transport of materials to and from the mine site. The proposed ACBs are to have a capacity of approximately 450 tonnes and a draft of approximately 0.75 m (2.4 ft) when fully loaded and on hover.

RRL proposes to move the ACBs using a combination of ocean tugs, shallow draft tugs and "amphitracs." The amphitrac is a conceptual vehicle that is to be developed specifically for this project. It is currently in the design phase. The amphitracs are to be modified Rolligon vehicles that have amphibious capability with Archimedes screws for propulsion in water and rubber and steel wheels for travel over land and ice.

During mine production, RRL proposes to navigate the Taku River with the ACBs approximately once per day in each direction to transport concentrate to Juneau Alaska for trans-shipment via ocean barge to Skagway Alaska. At Skagway, the concentrate would be transferred to ocean-carriers for shipment to smelters.

Because the ACBs are unable to operate on the Tulsequah River due to channel conditions and debris, the proposed scheme will require construction of a landing site and an access road 8-12 km in length from the Taku River landing site to the mine site.

3.2 Taku and Tulsequah Rivers

The Taku River drains a large (approximately 18,000 km^2) un-roaded watershed that spans the BC/Alaska border. It drains into Stephens Passage just south of Juneau, Alaska. First Nation people from both the Taku River Tlingit First Nation and the Douglas Indian Association consider the Taku River watershed to be an important part of their home and they recognize a responsibility for stewardship in this area.

The Taku River supports large subsistence, commercial and sport salmon fisheries. A report prepared by The McDowell Group, "The Taku River Economy: An economic profile of the Taku River Area" (referenced in the Monagle 2007 memo) estimates that the Taku River commercial and sport fisheries jointly generate approximately US$8 million in annual economic activity. The mouth of the Taku provides important habitat for hump-back whales and sea lions as well as other marine mammals. The watershed spans several ecological zones and, as a result, provides rich habitat for a variety of terrestrial species including grizzly bear, caribou, black bear, moose, mountain goat, sheep and others.

3.3 Rivers Without Borders

Rivers Without Borders is an environmental non-government organization focused on maintaining and protecting the diversity and abundance of fish and wildlife species and their habitat in the transboundary watersheds of Canada and Southeast Alaska. The organization was founded in 1999 as the Transboundary Watershed Alliance. Protecting the Taku River watershed from adverse effects associated with mining activities has been a key component of Rivers Without Borders' work since its inception.

4.0 Adequacy of Environmental Assessment

This section of the report describes issues and concerns related to the methodology that RRL has used for the environmental assessment of its activities in Canada and the application of environmental assessment processes by Canadian agencies. RRL intended that the resulting environmental assessment would support assessment under all Canadian assessment processes. The Assessment Report (Section 4.3.1) acknowledges that a Section 35(2) fisheries authorization under the federal *Fisheries Act* will be required for construction of the barge landing facility that includes infilling of a side channel on the Taku River. As a result, there are two Canadian assessment processes that must be completed: one under the BC *Environmental Assessment Act* and one under the *Canadian Environmental Assessment Act* (CEAA).

The BC environmental assessment process generally includes the following steps prior to public review of an application:

- Preparation of a "Procedural Order" that establishes the framework for the assessment.
- On the basis of this framework, the proponent and the Environmental Assessment Office conduct issue scoping through consultation with various groups and agencies.
- The results of this consultation are used to finalize a terms of reference for an application package.
- The terms of reference guides the proponent in preparing the application.
- Once the application is submitted and declared to be adequate, it is circulated for public review.

In this case, the application appears to have proceeded directly to the public review stage. Most of the preceding steps appear to have been sidestepped, likely on the basis that the ACB transportation system is considered to be an amendment of the existing project certificate. In a May 30 2007 letter to the Tulsequah Working Group, the Environmental Assessment Office (EAO) indicates that it has received the application and will be contacting the working group about it. The EAO Project Information Centre website shows no further correspondence on this application until the September 5, 2007 notice of the public comment period establishing a comment period that ended on October 17. Several individuals and agencies submitted comments during the public comment period and many of these raised concerns about the adequacy of the information provided.

The BC *Environmental Assessment Act* provides little guidance about information requirements for applications. In the absence of a project specific terms of reference that is part of the standard BC assessment process described above, the process has failed to provide project specific guidance about the information requirements for the proposed transportation system. As a result, the process lacks rigour for completing an effective assessment, especially for a proposal that incorporates a unique transportation system operating in an environment as challenging as the Taku River. With a Terms of Reference, the EAO, technical agencies and affected local parties could have provided RRL with specific guidance about valued ecological components, local conditions and environmental issues that needed to be addressed in preparing an environmental assessment submission. The failure to adequately consider environmental values and issues is evidenced by the submissions to the EAO requesting substantial additional study and information.

Unlike the BC *Environmental Assessment Act*, CEAA establishes some clear requirements for completion of an assessment. These requirements have been further refined through various cabinet directives, operational policy statements, procedural guidance documents and court decisions. Federal agencies with responsibility for assessment and decision making will need to ensure that the assessment process meets their obligations under CEAA. In my opinion, the assessment completed by RRL does not provide sufficient information to allow a federal agency to reach an assessment determination. This view appears to be supported by federal agency comments submitted to the EAO.

Overall, RRL has taken an assessment approach that appears fundamentally flawed in three areas. At least in part, these issues could have been addressed by the EAO providing more specific guidance to RRL about preparation of its project proposal and environmental assessment.

First, RRL establishes a context for the assessment that compares the performance of the proposed ACB Transportation System with the previously proposed road. This is not an appropriate "baseline" for completion of the environmental assessment and the discussion is misleading because the two transportation systems would have effects on different ecological components under different conditions. The concerns related to this comparison are further exacerbated by the second flaw in the assessment approach, that of splitting the project.

RRL splits the overall project into two separate components – one on each side of the international border. As a result, RRL proposes a project scope for the Canadian assessments (both BC and federal) that fails to consider the project and its effects holistically. From a CEAA perspective, the assessment does not include all components of the project that could affect areas of federal jurisdiction. Instead of considering the combined effects of the whole project, the assessment evaluates effects on each side of the international border separately. As a result, the assessment approach fails to consider the overall effects associated with the ACB transportation system. While the EAO appears to have accepted this narrow scoping, the evaluation of effects of only some components of the project is not good environmental assessment practice and should not be considered adequate for meeting the requirements of any rigorous assessment process.

Third, RRL fails to carry out any cumulative effects assessment at all, arguing that no other overlapping projects are occurring. CEAA requires consideration of combined effects for projects and activities. There are several activities, including some proposed by RRL that could affect the same ecological components as the ACB transportation system. These cannot be ignored and CEAA requires that they be addressed in a cumulative effects assessment.

Aside from the above flaws, there are several areas where the application does not provide sufficient information to allow assessment and evaluation of potential environmental effects.

Project splitting, cumulative effects assessment and the adequacy of assessment information are discussed in more detail below.

4.1 Overall Assessment Methodology

4.1.1 Scope of Project

Section 1.4 of (the "Assessment Report"), describes the scope of the project considered in the assessment of environmental effects for the proposed ACB transportation system. Not surprisingly, the document proposes a project scope that is limited to the ACB transportation system and does not include the mine activities. This focus on new or changed project elements is standard methodology for proposed changes to major development proposals and, in itself, does not warrant concern. However, RRL has chosen to divide the project further into two components, one on each side of the international border. The resulting assessment fails to take a holistic view of potential environmental effects even though the ecological values clearly do not recognize the boundary.

RRL references the methodology in Section 1.2 as part of its description of the document:

> "Chapter 4 … provides a strategic, issues driven effects assessment of the proposed transportation system in Canada. This assessment is presented as an amendment to the access component of the current Project Approval Certificate."

RRL describes (Sections 1.4.1 and 4.2) a Canadian project scope that includes: (1) upgrading 8.5 km of road, (2) construction of an ACB landing and loading facility, and (3) year-round ACB operation on 10 km of the Taku River between the ACB landing site and the US/Canada border. The assessment takes a similar approach for US activities, where the scope of the project considered is only that portion that occurs in the US. Chapter 4 describes some possible environmental effects of the proposed Canadian activities, but these effects are only addressed to the extent that they happen in Canada. Chapter 5 describes effects that may occur in Alaska, but only in the context of Alaskan approval and review processes.

The approach presented in the Assessment Report splits the project into two components and considers their effects separately, thereby suggesting that Canadian and US officials complete separate reviews, neither one of which will be a comprehensive review of overall project effects. The EAO appears to be proceeding on the basis of concurrence with this approach. RRL identifies the issue of transboundary effects in Section 4.3.1 where it states that the BCEAO has suggested that it will "defer to the Alaska State review process and findings to satisfy the need to address potential transboundary effects." This still does not address the need for at least one agency to consider the effects in combination. If the BCEAO follows this approach, each agency will only consider the effects within their own jurisdiction.

The possible impacts of utilizing this flawed assessment approach are best explained by example. Sections 4.4.4 and 5.7 identify effects on fish and fish habitat occurring on each side of the border. In both cases, RRL concludes that the effects will not be problematic. However, the combination of these effects is not addressed. Both nations recognize the shared interest in conservation of fish and fish habitat. They established the Pacific Salmon Commission and the Boundary Waters Treaty that both provide vehicles for holistic consideration of the effects of human activities. It is critical that assessments consider all of the effects together because the combination of more than one insignificant or negligible effect could be significant. In the field of cumulative effects assessment, this issue is often referred to as the "nibbling" effect. In this case, RRL's decision to split its own project into two components has raised the issue of the nibbling effect for a single project.

RRL acknowledges that an authorization will be required under the *Fisheries Act* for activities associated with the ACB transportation system. This authorization will trigger an assessment under the *Canadian Environmental Assessment Act* (CEAA). One of the purposes of CEAA, as stated in paragraph 4(1)(c) is "to ensure that projects that are to be carried out in Canada … do not cause significant adverse environmental effects outside the jurisdictions in which the projects are carried out." This seems to support consideration of the overall project and its effects, regardless of the international boundary.

In 2005 the Canadian federal cabinet issued the "Cabinet Directive On Implementing The Canadian Environmental Assessment Act" (www.ceaa.gc.ca/013/010/directives_e.htm) that applies to Fisheries and Oceans Canada and includes guidance about determining the scope of major projects under the CEAA. The Directive supports project scopes that are sufficiently broad to allow consideration of effects on all areas of federal jurisdiction. Based on the Directive, the Environmental Assessment Projects Committee prepared the "Interim Approach for Determining Scope of Project for Major Development Proposals with Specific Regulatory Triggers under the *Canadian Environmental Assessment Act"* (www.ceaa.gc.ca/012/016/index_e.htm). Under this approach, the scope of project is to include:

- any component of the development proposal directly related to a regulatory trigger(s) (in this case, the Fisheries Authorization); and
- any other components of the development proposal that should be included in the scope of the project in consideration of their potential to cause adverse environmental effects related to matters within federal jurisdiction.

The approach proposes a broad interpretation of federal jurisdiction suggesting, as an example, that project components that might affect wetlands should be included because they may lead to effects on migratory birds – an area of federal jurisdiction. The Directive addresses conditions where a federal assessment is coordinated with that of another jurisdiction (in this case BC) and notes that project scopes should be complimentary but need not be the same.

Overall, the CEAA and its guidance materials indicate that the federal environmental assessment should be carried out for a project that includes activities and facilities on both sides of the international border. If the BC process does not consider effects on both sides of the border and those in all areas of federal jurisdiction, it seems unlikely that Fisheries and Oceans Canada will be able to rely solely on the BC assessment process. The documentation provided by RRL does not support a holistic approach to the assessment and, in my opinion, RRL will need to complete additional assessment work to meet federal requirements.

4.1.2 Cumulative Effects Assessment

Concerns about holistic consideration of effects on ecological components are further exacerbated by RRL's approach to a cumulative effects assessment – one of the key requirements of assessment under the CEAA (CEAA Section 16). Section 4.10 of the Assessment Report describes RRL's cumulative effects assessment – or lack thereof. RRL decided that a cumulative impact assessment is not necessary "as there are no other known projects or proposals for projects including mining, forestry or development in the Taku River valley that would overlap with the Transportation System of the Tulsequah Chief Project spatially or temporally." This statement appears to misinterpret the requirements of CEAA, considering the potential overlap of projects instead of the potential overlap of effects. It also fails to recognize several important activities and projects including RRL's own exploration and potential development activities at Big Bull and Canarc Resources Ltd's exploration and potential development activities at New Polaris.

CEAA requires consideration of the combined <u>effects</u> of the project with those of other projects and activities that have been or will be carried out. In order to address this requirement and determine the extent of cumulative effects for the ACB proposal, the assessment needs to: (1) identify projects and activities that are being carried out in the area, (2) evaluate interactions between all the projects/activities and ecological values (i.e. could these other projects/activities affect ecological values), (3) identify activities that may affect the same ecological values as the ACB transportation system (overlapping effects), and (4) evaluate the significance of the combined effects. In my opinion, RRL erred in its completion of the first step – it has not effectively identified projects and activities that are occurring within the vicinity of the ACB transportation system.

A cursory evaluation of potential cumulative effects on fish and fish habitat using the above four steps raises serious concerns about RRL's decision to ignore the issue of potential cumulative effects.

Step 1: There are many activities that are ongoing along the transportation corridor. Some of these include commercial fishing, sport fishing, recreational boating, hunting, commercial shipping, commercial recreation, cabin construction/use and mine exploration.
Step 2: All of these activities could have effects on fish and fish habitat in the lower Taku River.

Step 3: The ACB transportation system could also affect fish and fish habitat in the lower Taku River.
Step 4: The effects of the various projects and activities need to be quantified so that the overall combined effects can be evaluated.

While RRL has not attempted to complete anything except the first step, the above example illustrates the need for a comprehensive cumulative effects assessment. Even if the effects of a single activity are insignificant, they could combine into an overall significant effect.

In addition to the projects and activities identified above, the cumulative effects assessment also needs to consider the effects of the ACB transportation system in combination with the effects of the Tulsequah Chief Mine (TCM). Even though the ACB transportation system will service the TCM, the overall mine is not included in the scope of the project for the purposes of the assessment. Therefore, it needs to be considered in the cumulative effects assessment. Otherwise, there will be no consideration of combined effects.

Finally, in Section 4.10, RRL suggests that effects of development at Big Bull would not be considered as cumulative effects – but rather as an extension to the project. This type of project is precisely what could lead to cumulative effects. The Big Bull development must be considered in one of two ways: either as part of the project or part of the cumulative effects assessment. In fact, this rule applies to all activities that may lead to overlapping effects – they must be addressed either as part of the project scope, or as part of the cumulative effects assessment.

Table 1 provides preliminary overview of potential cumulative effects associated with a variety of ongoing activities on the Taku River and illustrates the importance of a more comprehensive cumulative effects assessment for this project. In Table 1, the shaded boxes represent possible interactions between ecological components and various activities. If more than one activity could interact with the same ecological component, then cumulative effects are possible. In each of these cases, RRL needs to provide a specific rationale about the effects or their scope that addresses potential cumulative effects.

The projects/activities and ecological values identified in Table 1 are for illustrative purposes only, but they demonstrate the degree to which projects and activities may have overlapping environmental effects with the proposed ACB transportation system. Additional proposed projects and ecological values need to be included, which further increases the need to complete the cumulative effects assessment.

In the absence of a systematic methodology for the identification of potential cumulative effects, followed by a thorough analysis of any potential effects identified, the environmental assessment fails to adequately consider some key effects that may arise from the proposed project. The lack of attention to these important potential effects, in my opinion, leads to a deficient environmental assessment that should not be considered adequate for assessment agencies to fully understand potential environmental effects. In the case of CEAA the environmental assessment does not appear to meet the basic requirements of the legislation, which obligates Canadian federal agencies to consider the effects of the proposed project in combination with other projects and activities. Federal agencies could accept RRL's documentation in its current form, but if they did, they would be obligated to conduct a cumulative effects assessment on their own.

Table 1: Possible Cumulative Effects

ECOLOGICAL VALUE / ACTIVITY OR PROJECT	Possible Cumulative Effects?	**Proposed Project** ACB Transportation System Operation	Mining – Tulsequah Chief Mine	Mine Exploration – Big Bull, New Polaris	Commercial and Sport Fisheries	Existing Residential and Cottage Development	Recreational Activities
AQUATIC							
Surface Water Quality	y	X	X	X		X	X
River Ice Conditions	n	X					
Fish Populations	y	X	X	X	X	X	X
Fish Habitat	y	X			X	X	
Spawning Areas	y	X				X	
Shoreline Stability	y	X			X	X	
TERRESTRIAL							
Vegetation	y	X	X	X		X	
Moose	y	X	X	X		X	X
Bear	y	X	X	X		X	X
Furbearers	y	X	X	X		X	X
EXISTING LAND/RESOURCE USE							
Residents holders		X			X	X	X
Recreational Uses (including aesthetic values)		X	X			X	
Traditional uses by First Nations		X	X	X	X	X	X
PHYSICAL/CULTURAL HERITAGE		X	X	X		X	X

4.2 Adequacy of Information for Assessing Effects

In several areas, RRL's project description and supporting information do not provide adequate information and analyses to support a thorough understanding and evaluation of potential environmental effects. Information inadequacies arise in all areas of the assessment including the project description, ecological context and environmental effects descriptions. A thorough understanding of each of these components is needed to support a robust environmental assessment.

For its assessment of aquatic effects, RRL's submissions do not demonstrate application of a methodical approach to the identification of potential environment-project interactions. It appears that RRL applied a more systematic methodology for identification of potential terrestrial effects, but it has not provided a rationale for the differences between the two approaches. The juxtaposition is perplexing especially since the less systematic approach was applied to the environmental components of greatest perceived value and with the greatest risk for effects. Ultimately, it appears that RRL has not identified all potentially important environment-project interactions. In addition, the documentation indicates that RRL may have underestimated the importance of some effects that are discussed. Many of the specific technical concerns are to be addressed by other members of the review team. However, some significant shortfalls relate to the understanding of ecological relationships, performance of the conceptual amphitrac vehicles and reliance on past uses of the ACB to interpret expected performance for the proposed use. It is my understanding that other technical concerns will be addressed in greater detail by other reviewers.

4.2.1 Understanding of Ecological Context

For some key ecological values, the existing ecology is not well understood which leads to a risk that unexpected effects may occur. For example, information on use of the lower Taku River for key life stages of eulachon is very limited. As a result, the environmental assessment fails to thoroughly consider this key ecological species which may lead to unexpected effects on this species and others. Similar issues arise in relation to salmon spawning areas on the Taku River as well as wildlife and bird use of the area. Effects on fish and fish habitat are to be addressed in greater detail by other reviewers.

4.2.2 Effects of Amphitrac

RRL proposes use of an "Amphitrac" for moving the ACB in winter river conditions. RRL describes the Amphitrac as "essentially a Rolligon that has been converted to an amphibious vessel, so that it can operate on land, using soft tires, or in water, using Archimedes screws" (Project Description, Section 3.4). RRL proposes adding several components to the Rolligons to make a functional vehicle that will be able to travel on land, ice and water and make transitions between these. Added components include:

marine pontoons, retractable rear metal wheels for traction on snow and ice, two retractable Archimedes screws for propulsion, and retractable rubber tires.

This vehicle has not been constructed. As a result, its practicality, feasibility and functionality have not been demonstrated. Vehicles propelled by Archimedes screws have been used in the past for moving over varied terrain and water. In the 1960s the Soviet Union utilized amphibious vehicles to reach cosmonauts after they landed in Siberia. In 2002, a British Team successfully crossed the Bering Strait, a distance of approximately 90 km, in a modified Bombardier tracked vehicle. This vehicle was modified to make an amphibious vehicle powered, in part, by Archimedes screws. A 2001 attempt was thwarted when a predecessor vehicle failed. The successful vehicle also experienced technical difficulties prior to completing the voyage. The vehicle used for the Bering Straight crossing was much smaller than the proposed amphitrac, was not required to tow other vehicles and was only required to carry a very light load.

I am not aware of any precedents for construction or operation of a vehicle of this type or size for an operation of the scale of the ACB transportation system. The proposed system will require vehicles that are capable of towing the ACBs and maneuvering barges in locations that may often be constrained. At some times of the year, especially during transition seasons, the travel conditions will be very challenging. The previous vehicles have all been light vehicles used for transporting people in locations without major spatial limitations. Their use has also been infrequent or one-time, while the amphitracs will be required to operate on a daily basis.

Overall, RRL's assessment provides little information about potential effects of the proposed amphitracs even though they are a critical component of the transportation system. Generally, RRL has assumed that the effects from the amphitracs will be minimal, but has not provided evidence to support this conclusion. As a result, the information provided is not adequate to determine what types of effects may occur and whether they will be significant.

4.2.3 Use of ACB

There are several areas in which the information provided does not demonstrate the likely performance of the ACBs and the potential environmental effects.

RRL cites several previous examples of uses of ACBs including:

- ACBs used to cross the Yukon River during the construction of the Trans-Alaska pipeline in 1976.
- ACBs used as drilling platforms in swamps in Suriname.

Neither of these is analogous to the conditions for the ACB transportation system on the Taku River. The ACBs used to cross the Yukon River were propelled by a cable/winch system. This provides substantially easier operating conditions than those that will be experienced on the Taku River. No confirmation is provided about whether the ACBs continued to operate throughout the break-up and freeze-up periods. In the Project

Description (Section 3.1), RRL states that there were no reported environmental issues identified with the use of the ACB for the Yukon River crossing. At the time, environmental concerns likely did not receive significant scrutiny for this activity.

Because of the operating system used on the Yukon River, potential effects on the Yukon River were limited to the area of a single river crossing. In the case of RRL's proposal, effects could occur over approximately 37 miles along the Taku River, leading to a much greater risk for effects on the aquatic ecosystem including fish and fish habitat.

In Suriname, the ACB was used as a drilling platform – with less frequent requirements for transport, probably over smaller distances. Most of the travel was within a swamp and it was not in frozen conditions or break-up/freeze-up conditions. Any slopes were likely short – probably less than the length of the barge – and gentle – allowing the slope changes to be taken up by the skirts. Because the operations were carried out in a swampy area, the currents were likely very low. This will not be the case on the Taku River.

In addition to the above examples, Hovertrans, the ACB supplier, has also provided an ACB for use as a supply vehicle for an island located 178 km off Abu Dhabi. This vehicle operated in open seas where precise maneuverability in strong currents was not likely an issue.

None of the above examples provide documentation that the ACB can be effectively maneuvered through the conditions of the Taku River in all seasons. The other cited uses have not included requirements for precise maneuverability on a daily basis over long distances and for lengthy durations. The operation on the Yukon River offers the only example where river currents exist, but the barge travel was controlled in this case by fixed cables.

RRL has proposed that the ACB will be equipped with a Rolligon-type wheel that can be lowered to act as a keel to control side slippage when traversing sloping ground. None of the other cited uses of the ACB demonstrates the operability on sloping ground – especially when traversing sloping ground. Traverses of sloping ground on the river bank will likely be necessary for this proposed project, notably on the east side of Canyon Island. As acknowledged by RRL, it is unlikely that the ACB would remain on sloping ground without a stabilizing mechanism in direct contact with the ground.

On a 2% (1.15˚) slope, the force component along (down) the slope for a 750 tonne barge would be approximately 15 tonnes. If the barge routing traverses (i.e. travels along) a slope, there is negligible friction offered by the air cushion, and we can assume that a side force of 15 tonnes would be required to hold the barge on the preferred course on a 2% slope. The forces would be higher for steeper slopes. Side forces of this magnitude could be applied by structures attached to the barge, but it is not clear that the concept proposed by RRL would work and, even if it does, it seems likely to cause some environmental effects that have not been addressed.

- A single wheel-type mechanism is not likely to be effective for retaining the ACB on its planned route. The ACB would likely rotate around a single mechanism – rotation and direction would depend on the balance of forces applied by transport vehicles and gravity.
- RRL states that the average pressure exerted by the ACB is 1 psi. This is correct and it is worth noting that the ACB exerts the same average pressure whether it is sitting directly on the ground or on hover. Of course, the air cushion allows the standard deviation of point pressures that make up the average to be much smaller because the "flexibility" of the cushion creates a more even pressure distribution. Adding wheel-type mechanisms to act as a keel will create locations where the pressure exerted by the barge is substantially higher than the 1 psi average stated in the project submissions.
- Operation of the retractable keel-wheels will likely be challenging as these mechanisms will need to carry some weight so that they can exert the necessary side forces, but placing excess weight on these mechanisms may create excessive point forces on the barge or mechanisms themselves.
- Given the need to exert substantial side forces to maintain lines of travel for the ACB, the keel-wheels will lead to direct disturbance of channel materials whenever the ACB is traversing sloping ground. Such direct disturbance has not been considered or addressed in the information provided.

In evaluating the potential for effects from wakes and waves, the Assessment Report cites studies on the Mackenzie and Mississippi Rivers. The study referenced on the Mackenzie River assessed the potential for erosion and scour of clay-till material that made up the riverbed and banks. Clay-till material is significantly less erodable than the sandy material that may be present along the Taku River. Also, the ACB will be operating close to, and in some cases on, the banks and beds of the river. During these conditions, the sand could be dry and subject to mobilization by air. It is my understanding that the potential for shoreline erosion will be addressed in greater detail by other reviews. However, the specific characteristics of the ACB system operating in the environment of the Taku River do not appear to have been evaluated, leading to a lack of adequate information to assess the potential environmental effects.

On its website (http://www.hovertrans.com/previous_projects.htm), Hovertrans promotes the ice breaking capability of ACBs. However, the Assessment Report (Section 4.4.2.3) suggests that the ACB will not be used for ice breaking, in order to maintain the natural break-up/freeze-up cycle of the Taku River. The description of ice-breaking capability on the website suggests that this will be difficult to control.

> "The Hovertrans air cushion platform's icebreaking technique is very simple, being relative to its air cushion pressure capacity. As the platform moves over the ice, the air cushion pressure from the platform creates a thin gap between the bottom of the ice and the water. The water is forced away, leaving the ice suspended on a cantilever. As it becomes heavier the ice snaps off and sinks below the hover platform."

From this description, it appears that the ice-breaking capability will occur if the ACB is moved over a water/ice transition. Because the ACB transportation system will traverse from open water to ice during each winter trip, it appears that it would be difficult to maintain natural break-up and freeze-up conditions. RRL's assertions that it will not affect break-up/freeze-up timing or conditions by use of the ACB are not supported by adequate descriptions of how this will be done. As a result, it is not possible to effectively predict the possible environmental effects. It is my understanding that this issue will be addressed in greater detail by other reviewers.

Overall, the information provided to illustrate the performance of ACBs is not directly relevant to the operating conditions proposed for this project. This project will require precise maneuverability in challenging flow, channel, ice and weather conditions. The ACBs will need to traverse slopes as well move effectively up and down them. The proposed operations will include lengthy daily trips with heavy loads. Performance of ACBs under these types of operating scenarios and conditions does not appear to be confirmed by the examples cited. Without this information, it is difficult to complete an effective environmental assessment about the potential effects of ACB operation.

5.0 Closing

This report identifies key issues related to environmental assessment methodology and adequacy of information submitted by RRL in support of its ACB transportation system proposal. I have not addressed all of the issues identified during my review. However, in my opinion, the above concerns about assessment methodology and the adequacy of key assessment information do not support further consideration of RRL's ACB transportation system at this time. RRL needs to complete additional work to gain a better understanding of the ecology of the Taku River and to demonstrate that the proposed system can operate effectively without causing unacceptable effects on key environmental values in the Taku River watershed.

I believe that this information is necessary before a conclusion can be reached about the significance of potential environmental effects. In the absence of additional information, it would be difficult for Canadian federal officials to fulfill their obligations under the CEAA. This is particularly important because the project has potential to affect international resources on which both Canada and the US have placed significant value.

Ecofish

Ecofish Research Ltd.
Suite F, 450 8th Street
Courtenay, B.C.
V9N 1N5

Phone: (250) 334-3042
Fax: (250) 334-3097
Email: ecofish@telus.net

December 21, 2007

Reference: 1032

Rivers Without Borders
419 6th Street, Room 221,
Juneau, AK
99801

Attention: Chris Zimmer

Dear Sir:

Re: Analysis of previous use of the hoverbarge

Hoverbarges have been used in a number of locations to transport materials. These precedents provide no information to support a conclusion that the use of a hoverbarge on the Taku River will not cause significant environmental impacts. In the following analysis, the undersigned and Sean Faulkner of Ecofish Research Ltd. have examined previous examples of hoverbarge use and demonstrate how they greatly differ from the proposed application in physical and biological conditions, precluding their use as precedents.

The example of the Yukon River was given as a precedent for use of the hoverbarge. The hoverbarge website states: "The Trans Alaskan pipeline was in danger of slowing down because at the centre of its 1280 km route was the mile wide Yukon River - forming a hazardous natural barrier. With the road bridge behind schedule, the river frozen over part of the year and a strong, fast flowing river the remainder of the year, there was no solution for a continuous trucking service across the river." (available on the internet at http://www.hovertrans.com/previous_projects.htm). For this application two hoverbarges with payloads of 160 tons were used to transport construction material across the river. A cable system was used to pull the hoverbarges across the one and a half mile wide river crossing (depicted and described in the video available at the website mentioned above). In total, they suggest more than 3000 tons of material could be transported daily, which would relate to 19 return hoverbarge trips daily. This hoverbarge crossing was in place until the pipeline bridge across the Yukon was built 1974-1975. No information has been provided on the evaluation of environmental concerns for the Yukon River crossing, and it is likely that the standards of evaluation at the time of this application were less rigorous than those that would be applied today.

Even if it is assumed that this hoverbarge application did not cause any negative environmental impacts, this example does not provide any certainty that impacts will not accrue on the Taku River, as the proposed application of the hoverbarge on the Taku River differs greatly from that mentioned above for the Yukon River. For the Yukon River application, hoverbarges were used to provide a means of transporting construction materials and equipment across the river. As such, the impacts are largely limited to the area around the 1.5 mile wide crossing. The proposed application on the Taku River is to transport material over 37 miles of the lower and upper Taku River. Impacts could be expected to potentially occur along this entire river section. The cable system used to cross the Yukon did not introduce any additional environmental impacts. The shallow draught tug and amphitrac proposed to be used may also cause negative impacts. The large differences in river size between the Taku and Yukon River may also be cause for concern, as the impacts of hoverbarge use will be dependent on river size: the larger the relative size of the hoverbarge, the greater the effect on river currents, substrate, and ultimately on fish habitat and fish. Fish spawning, rearing, and incubation habitat will much located at shallower depths on the Taku River than on the Yukon River and therefore more likely to be impacted by barge traffic.

It is clear that the hoverbarge example on the Yukon River is in a much larger river, as Figure 1 shows a wide channel many times wider than the hoverbarge, whereas maps of the Taku River provided by the proponent show the hoverbarge taking up a large portion of the channel. In addition to being wider, the Yukon River is a relatively deeper river than the Taku.

The Yukon River near the Alyeska pipeline crossing site has an average discharge of 121,179 cfs (USGS 15453500 Yukon R near Stevens Village, average discharge 1977 to 2006), which is 8.9 times larger than the Taku River near Juneau (USGS 15041200, average discharge from 1988 to 2006 was 13,751 cfs) and 12.7 times larger than the Taku River near Tulsequah, average discharge from 1961 to 1982 was 9,568 cfs). A plot of the annual time series of available discharge data illustrates the difference in river size (Figure 2). The depths of these rivers can be compared by examining information collected by the USGS at the respective gauging sites in each river. Based on site measurements between 2000 and 2007 on each river, we have plotted the depth and corresponding flow in both rivers in Figure 3. The dashed lines show the estimated depth at mean annual flow levels, illustrating that the depth of the Yukon River is at least 2 times greater than the depth of the Taku River at Juneau. Given this, we conclude that using the historic use of hoverbarges in the Yukon River to justify their use in the Taku is flawed, considering that the Yukon River is at least 2 times deeper at the gauging site and therefore would be less likely to suffer sediment disturbance and subsequent disruption to fish habitat than would the Taku River. This general comparison would apply throughout the river. A comparison of the satellite images from 34.3 km above the earth also illustrates the vast difference in the width of these two rivers (Figure 4).

The extensive proposed route along the Taku River makes comparisons of river substrate and bank stability encountered by the hoverbarge between the two rivers difficult. Along the Yukon River, the substrate encountered by the hoverbarge is limited to the shallow banks of the river. From the video supplied at the above mentioned website it appears that the bank substrate was composed of shallow sloping compacted sand and gravel. Although sections of the Taku River may be composed of similar material, there are large differences in substrate type and bank stability along the 37 mile proposed route along the Taku River, with sections of fine sediment and large bed material, arranged in complex bar patterns. Predicting the impacts of barge operation on these is difficult, and direct comparison to the historic use on the Yukon River does not provide a precedent that supports a conclusion of no negative effect on the Taku River.

Other examples of hoverbarge use are from Abu Dhabi, Suriname, the Dead Sea, US Coast Guard and George Wimpy (available on the internet at http://www.hovertrans.com/previous_projects.htm). In Abu Dhabi a hoverbarge with a 250 ton payload was used to transport a section of a liquification plant to Das Island 178 km off of Abu Dhabi. The use of the hoverbarge is this application replaced the need for building docking structures at both locations. The marine application of this is obviously different physically and ecologically than the proposed application along the Taku River. In Suriname, a hoverbarge with a 330 ton payload was used as a drilling platform in remote swamps. In the Dead Sea, a hoverbarge with a 50 ton payload was used over shallow water, soft sands, and salt mushrooms to drill. A Rollogon soft tire tractor was used to maneuver the hoverbarge. The US Coast Guard has also used hoverbarges as icebreakers. They have been used to effectively clear slush ice up to 10 feet thick and "plate ice of up to 15" thick was broken with ease". A hoverbarge has also been used to take core samples over tidal mudflats off the English Norfolk Coast. The physical environment, fish habitat, and ecology is radically different in these other examples than in the proposed application, precluding any use of these as a precedent to justify a finding of no negative effect on the Taku River.

In summary, we have examined previous examples of hoverbarge use and shown how large differences in the physical and ecological conditions preclude their use as precedents to justify a finding of no negative effect for the proposed application of this technology on the Taku River.

Yours truly,
Ecofish Research Ltd.

Adam Lewis, M.Sc., R.P.Bio.
Fisheries Biologist/Principal

Figure 1: The hoverbarge on the Yukon River.

Figure 2: Mean annual discharge in the Yukon River and in the Taku River by year.

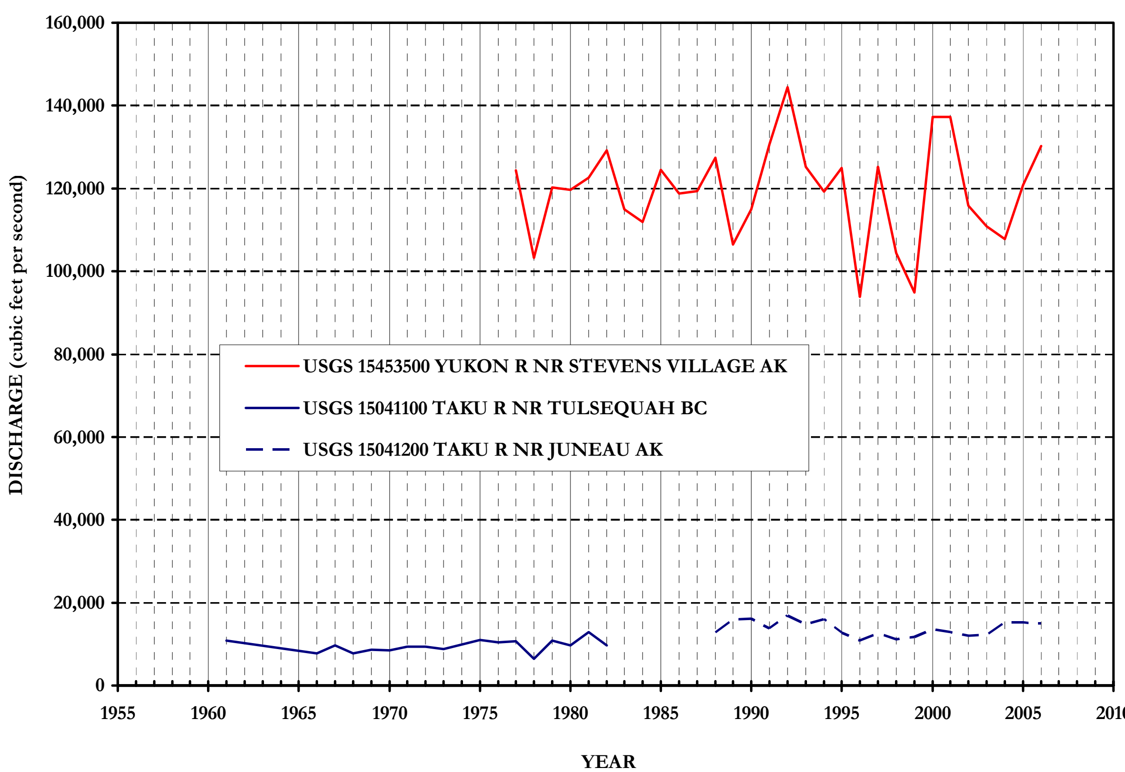


Figure 3: Depth and discharge relationships in the Yukon River and in the Taku River by year.

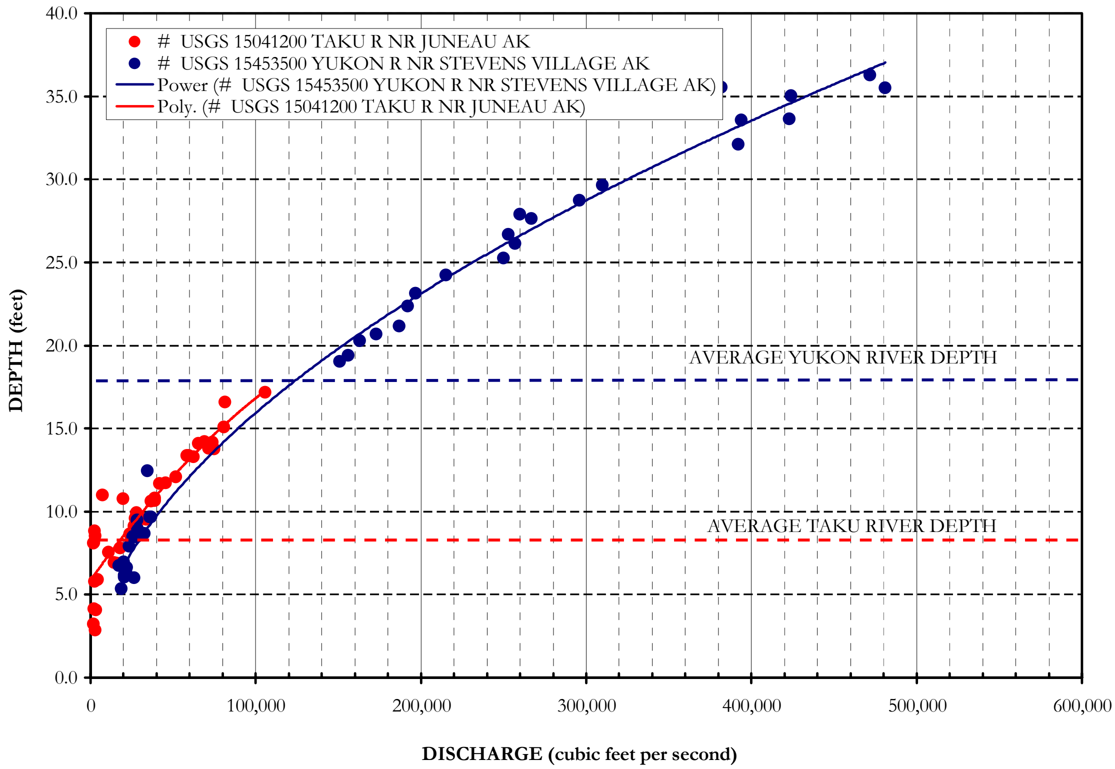
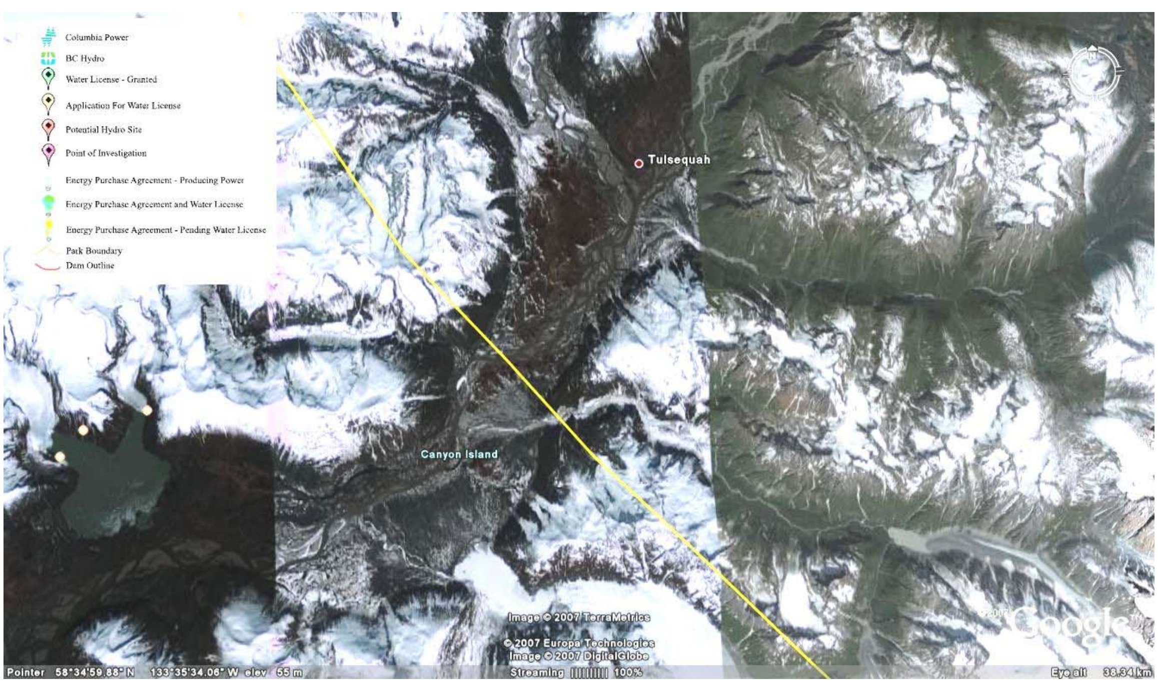


Figure 4a: Satellite image of the Yukon River near the hover barge working area taken at an altitude of 38.3 km.

Figure 4b: Satellite image of the Taku River near the hover barge working area taken at an altitude of 38.3 km.



Ecofish

Ecofish Research Ltd.
Suite F, 450 8th Street
Courtenay, B.C.
V9N 1N5

Phone: (250) 334-3042
Fax: (250) 334-3097
Email: ecofish@telus.net

December 21, 2007

Reference: 1032

Rivers Without Borders
419 6th Street, Room 221,
Juneau, AK
99801

Attention: Chris Zimmer

Dear Sir:

Re: Review of Barge Landing and Access Road

To evaluate baseline information and impact assessment on the access road from the Tulsequah Chief Mine to the Air Cushioned Barge (ACB) landing site, the undersigned and Sean Faulkner of Ecofish Research Ltd. have examined the available information prepared by the proponent. Information on these was summarized from the Tulsequah Chief Mine Air Cushion Barge Transportation System Volume 1 and Tulsequah Chief Mine Air Cushion Barge Transportation System Volume 2 (hereafter referred to as Volume 1 and Volume 2).

Access Road to ACB Landing Site

<u>Information summarized from Volume 1 and 2</u>

To facilitate transport of material to and from the air cushioned barge landing site and the Tulsequah Chief Mine site, a 12.5 km road will be required. The proposed road would utilize the previously approved 4 km section of road between the mine site and the limestone quarry, and the 8.5 km exploration road that would need to be upgraded to an all-weather haul road to transport the shipping containers to and from the ACB landing site for the life of the mine. The proposed access road alignment is shown on Figure 5-1 (from Volume 1, attached below). Only the 8.5 km section of the road south of the limestone quarry is included in the scope of the proponents impact assessment report (shown in Figure 3-8 from Volume 2, attached below), as the remaining 4 km section of the road was included in the original scope of the Tulsequah Chief project and previously approved in the Project Approval Certificate. In addition to this access road a spur road is required to additional storage space located at Paddy's Flat (Figure 5-1 Volume 1).

The proponent states that "Overall, the proposed road extension to the barge landing site will generally be constructed, operated and decommissioned to a standard similar to the originally proposed and reviewed 160 km mine access road to Atlin. The design and operating parameters for the Atlin mine access road are described in: Chapter 6.12 and Chapter 10 of the *Tulsequah Chief Project Report, Volume II, Project Description* (Rescan Environmental Services Ltd. 1997); and

The Tulsequah Chief Project Application for Special Use Permit & Mining Right of Way Act Authorization (Redfern Resources Ltd. 1998)".

In the area included for the proponent's assessment of this haul road, which includes the section of road located to the south of the limestone quarry, there are a total of six stream crossings.

According to Volume 2 of the EIA "Redfern commissioned stream crossing assessments along this segment of road which confirmed that all the crossings exist above significant fish passage barriers. At the vicinity of the road crossings all streams have a steep, greater than 20%, gradient. All crossings are above the upper extent of fish use in these creeks."

According to Volume 1 of the EIA "All of these crossings are located upstream of the portion of the streams utilized by fish. Therefore, fish passage structures are not required on any of these stream crossings. All stream crossings and culverts installed along the exploration road are designed and built to accommodate the heavy construction equipment, and to withstand the 1 in 100 year floods. As such, these structures are adequate to meet the needs of the year-round haul road. Upgrading of these stream crossing structures is not required, therefore, and no work associated with the stream crossings is proposed as part of the barge landing access road upgrade."

The proponent offers discussion on the issues that operation effects may cause sediment-laden waters to enter into fish bearing waters and spills of deleterious substances.

The proposed mitigation for these included:

- "Volume 1 describes the upgrades that will be carried out, including increased number of turn outs, reducing road grades from 10% to 8%, installing truck run-away lanes, etc. Any construction activities that are adjacent to the Tulsequah River riparian zone or within the riparian zone of the streams that are crossed will be carried out with the proper care and attention for the protection of water quality and nearby fish habitat.
- Measures implemented will include having environmental monitors on site, erosion and sediment control, construction will take place under favourable weather conditions, vegetation clearing will be kept to a minimum and grubbing will not take place within the riparian zones. Construction activities required to upgrade the haul road are not expected to have any significant environmental effects on fish or fish habitat.
- Roads will include suitable ditching and culverts to contain and divert surface runoff away from fish bearing waters or stream sections that are immediately upstream of fish barriers.
- Redfern will develop and maintain detailed spill response plans appropriate to the type and quantity of deleterious materials that will be transported along the haul road."

They go on to conclude that "Construction activities required to upgrade the haul road are not expected to have any significant environmental effects on fish or fish habitat and operations of the haul road are not expected to cause any significant environmental effect."

Comments

No actual data is given on the streams or stream crossings other than that the proponent states that they are non fish-bearing and have a gradient greater than 20% at the location of the crossing. Although this section of road has previously been approved for an exploration road further assessment may be needed to confirm that appropriate mitigation and or compensation has been planned for the upgrading of this to a haul road. Presentation of data on the location of the fish passage barriers with relation to the road crossings and methods used to assess the barriers is critical information to assess potential impacts of the upgrade, such as the clearing of a 20 m wide right-of-way.

Moreover, an assessment of the quantity and quality of fish habitat downstream of the road in each tributary is required to determine the importance of sensitivity of these habitats to potential disturbance during road construction. Despite the application of best management practises under an environmental management plan, it is probable that impacts will accrue to fish habitats at each stream crossing, and given that there are six crossings the probability of accidental impacts is increased. Should high quality, critical habitat be located downstream of the stream crossings, special measures may be required including road realignment. The tendency of salmonids in this region to spawn in tributary streams emphasizes the potential importance of fish habitat downstream of each bridge.

Barge Landing Site

Information summarized from Volume 1 and 2

The proposed barge landing site is located on the Taku River near its confluence with the Tulsequah River. A conceptual layout of the landing site is shown on Figure 3-7 (Volume 2), and 5.2 (Volume 1; attached below). The landing site is located in a side channel known as the Big Bull slough, about 400 m upstream of the river confluence. The landing site will be located on District Lot 6302 that is owned by Redfern. The barge landing site will consist of: a cleared and surface area approximately 1.8 ha in size for landing the barges and setting them down off hover; two earth-filled, log crib loading ramps, approximately 1.2 m high; two sets of docking winches for pulling the ACBs on shore; and space for four days of container storage (concentrate empty and full, supplies empty and full) in the adjacent landing yard. A marshalling yard that will support a small camp for overnight accommodation of the river crew, as well as provide storage for up to one week's production of concentrate containers will also be established just north of the barge landing site (shown in Figure 5-2; Volume 1). The camp will be equipped with a potable water supply from an on-site well and an in-ground septic system. Both utilities are already being permitted through the Northern Health Authority.

The barge landing area is part of a large flat area created by river deposition at the confluence of the Taku and Tulsequah Rivers. The general area includes relic channels and channels that carry water only during high water conditions during the summer. These backwater channels would be used by juvenile salmonids for rearing when there is sufficient water. The layout of the landing yard has been designed to minimize impact to channels that appear to carry water (based on observation of the freshet flood flows in June 2007). Note that it is constrained by a pond outlet creek to the south and a backwater channel to the north. The actual footprint will not be known until final design and there is a possibility that the backwater channel will need to be filled in to accommodate the ACB landing yard. The infilling would impact no more than 100 m of the channel that is 10 m wide for an estimated impact of up to 1,000 m^2 of backwater habitat. The likely compensation for this impact would be to reconstruct a channel around the landing area to maintain the connection with the remaining channel during high water conditions.

Comments

The proponent offers no detailed information on fish use of this area or any fisheries habitat data that is located in the area of this potential landing. The do suggest that "these backwater channels would be used by juvenile salmonids", but they do not provide any discussion on potential impacts from the construction of this barge landing. In addition, no discussion of the removal of riparian vegetation along this area is given. No fisheries data is given on the backwater channel that may need to be filled (depending on final design). A thorough impact assessment cannot be completed without these baseline fisheries data. The fish habitat quality and quantity, and the timing and extent of use by salmonids should be described to permit a thorough evaluation of the importance of the habitat and potential sensitivity to development.

Please contact me if you have any questions or require further information.

Yours truly,
Ecofish Research Ltd.

Adam Lewis, M.Sc., R.P.Bio.
Fisheries Biologist/Principal

CURRICULUM VITAE

MICHEL F. LAPOINTE

McGill University
Department of Geography
805 Sherbrooke St. West.
Montreal (Que). H3A 2K6

Main Research Areas:

Fluvial geomorphology, river hydraulics and sediment transport mechanics, river landscapes and salmonid habitat organisation.

Education

1990	Ph.D. in Geography. University of British Colombia .Vancouver, B.C.
1983	McGill University, Montréal. M.Sc. in Geography
1975	McGill University, Montréal, B.Sc Honours in Mathematics.

Professional Experience

2005-	Scientific Director of CIRSA (Centre Interuniversitaire de Recherche sur le Saumon Atlantique, http://www.bio.ulaval.ca/cirsa)
1996-	Associate Professor, McGill University, Department of Geography.
1996-1997	Visiting Professor, INRS-Eau, Quebec City.
1990-1995	Assistant Professor, McGill University, Department of Geography.
1988-1990	University Lecturer, McGill University, Geography. Part-time appointment with Centre St.-Laurent, Environment Canada, Montreal.
1982-1986	Physical Scientist, Northern Hydrology Section, National Hydrology Research Institute, Environment Canada.

PUBLICATIONS SINCE 2000

Students I have supervised appear in ***bold.***

1. Davey, C. and Lapointe, M., 2007. Sedimentary links and the spatial organization of Atlantic salmon (*Salmo salar*) spawning habitat in a Canadian Shield river. Geomorphology: 83: 82-96

2. Levasseur,M., Bergeron, N.E., Lapointe, M. and F. Bérubé, 2006. Effects of silt and very fine sand dynamics in Atlantic salmon (*Salmo salar*) redds on embryo hatching success. Can. J. Fish. Aquat. Sci. **63**: 1450–145

3. P. M. Biron, **T. W. Haltigin**, R.J. Hardy and M.F. Lapointe, 2007. Assessing different methods of generating a three-dimensional numerical model mesh for a complex stream bed topography. International Journal of Computational Fluid Dynamics, 21(1): 37–47

4. Haltigin, T. W., Biron, P.M. and Lapointe, M. In Press (October 2007) Three-dimensional numerical simulation of flow around stream deflectors: The effect of obstruction angle and length. Journal of Hydraulic Research (IAHR),

5. Burge, L.M. and Lapointe M.F. 2005. Understanding the temporal dynamics of the wandering Renous River, New Brunswick, Canada. Earth Surface Processes and Landforms, 30, 1227-1250.

6. **Burge, L.M**. 2005. Wandering Miramichi rivers, New Brunswick, Canada. Geomorphology, 69: 253-274

7. **Burge, L.** 2005 Testing links between river patterns and in-channel characteristics using MRPP and ANOVA. Geomorphology , 63: 115-130

8. **Zimmerman, A, Coulombe-Pontbriand, M.** and M. Lapointe, 2005. Biases of submerged bulk and freeze core alluvial sediment samples. Earth Surface Processes and Landforms, 30 (11):1405-1417

9. Zimmerman, A. and Lapointe, M. 2005 Intergranular flow velocity through salmonid redds: sensitivity to fines infiltration during low intensity sediment transport events. Rivers Research and Applications, 21: 865-881

10. Zimmerman, A. and Lapointe, M. 2005. Sediment infiltration traps: their use and potential misuse to monitor salmonid spawning habitat . Hydrological Processes, 19: 4161-4177

11. Biron, P.M., **Robson, C.**, Lapointe, M.F. and Gaskin, S.J. 2005 Three-dimensional flow dynamics around deflectors. River Research and Applications, 21: 961-975

12. Biron, P.M., **Robson, C.**, Lapointe, M.F. and Gaskin, S.J. 2004. Comparing different

methods of bed shear stress estimates in simple and complex flow fields. Earth Surface Processes and Landforms, 29, 1403-1415.

13. Biron, P.M., **Robson, C***.,* Lapointe, M.F. and Gaskin, S.J., 2004. Deflector designs for fish habitat restoration. Environmental Management: 33 (1): 25-35

14. Lapointe, M. F., Bergeron, N. et Bérubé, F., M-A Pouliot and P. Johnston, 2004 . Interactive effects of substrate sand and silt contents, redd-scale hydraulic gradients and intersticial velocities on egg to emergent survival of Atlantic salmon (Salmo salar). Can J. Fish. Aquat. Sci.: 61(12): 2271-2277

15. **Coulombe-Pontbriand, M***.* and M. Lapointe. 2004. Landscape controls on boulder-rich, winter habitat availability and their effects on Atlantic salmon (Salmo salar) parr abundance in two fifth-order mountain streams Can J. Fish. Aquat. Sci, 61:648-658

16. **Coulombe-Pontbriand, M***.* and M. Lapointe. 2004. Geomorphic controls, riffle substrate quality and spawning site selection in two semi-alluvial salmon rivers in the Gaspé Peninsula, Canada. Rivers Research and Applications , 20: 577-590

17. Guay, J.C, D. Boisclair, M. Lapointe, 2003. Assessment of the transferability of biological habitat models for Atlantic salmon parr (Salmo salar) Can J. Fish. Aquat. Sci., 60: 1398-1408

18. **Talbot, T***,* et M. Lapointe, 2002. The modes of response of a gravel bed river to meander straightening : the case of the Sainte-Marguerite River. Water Resources Research; Vol 38 (no 6) pp 9-1 to 9-7

19. **Talbot, T***,* et M. Lapointe, 2002. Numerical modeling of a gravel bed river's response to meander straightening: the coupling between the evolutions of the bed pavement and long profile. Water Resources Research Vol 38 (no 6) pp. 10-1 to 10-10

20. Guay, J.C., D. Boisclair, M. Leclerc, M. Lapointe, et P. Legendre. 2001. Science on the edge of spatial scales : a reply to the comments of Williams (2001). Can. J. Fish. Aquat. Sci, .:58: 2108-2111

21. **Eaton, B.** et M. Lapointe. 2002. Effects of large floods on sediment transport and reach morphology in the cobble-bed Sainte-Marguerite River. Geomorphology, 40 : 291-309

22. **Latulippe, C.***,* Lapointe, M. and **Talbot T.** 2001. Visual characterisation technique for gravel-cobble river bed surface sediments : validation and environmental applications. Earth Surface Processes and Landforms, 26/3: 307-318

23. Guay, J.C., Boisclair, D., Rioux, D., Leclerc, M., Lapointe, M. and Legendre, P., 2000. Development and validation of numerical habitat models for juveniles of atlantic salmon (S*almo salar).* Can J. Fish Aquat. Sci. 57 : 2065-2075.

24. Lapointe, M., **Eaton, B., Driscoll, S. and Latulippe C.**, 2000. Modeling the probability of salmonid egg pocket scour due to floods. Can J. Fish Aquat. Sci., vol 57, pp 1120-1130

PROFESSIONAL SUMMARY

Adam Lewis, M.Sc., R.P.Bio.
Fisheries Biologist

Mr. Lewis has a Master's degree in fisheries biology and is a Registered Professional Biologist (BC) with over 20 years experience in environmental consulting on fisheries issues. He focuses on the assessment and management of impacts from industrial developments. He has managed environmental assessments of dozens of development projects including hydroelectric projects, mines, forestry, pipelines and transmission lines, urban development, and marine foreshore projects. During these projects impacts to the aquatic and marine environments including water quality, primary production, invertebrates and fish were assessed. For many of these projects Mr. Lewis liaised with government, industry, the public, and First Nations as part of regulatory review process.

Lewis quantifies impacts to fisheries resources from industrial developments, designing and implanting mitigation and compensation as required. He has worked on environmental assessments of the proposed Prosperity Gold-Copper Project near Taseko Lake BC, and the proposed Pebble Project near Lake Illiamna, Alaska, and the Tulsequah Chief Mine near Atlin BC. He has participated in environmental reviews of numerous hydroelectric projects and provided expert testimony in habitat and water use hearings and trials.

Mr. Lewis specializes in aquatic habitat assessment. He has conducted instream flow assessments for over a dozen projects, including instream flow modeling and impact prediction. In 1993, Mr. Lewis assessed the effectiveness of flow releases from hydroelectric projects in a world-wide survey on behalf of the Canadian Electrical Association. This review of case histories and key factors influencing effectiveness was published in the primary literature. From 2002 to 2004 he was part of a team of a consultants that development instream flow standards for the Ministry of Sustainable Resource Management, and the lead consultant developing methods for instream flow assessment. These methods are proposed for use for all instream flow assessments in BC. From 2001 to 2004 he was the environmental coordinator on four water use plans for BC Hydro.

Mr. Lewis is a member of the American Fisheries Society, and a former Director of the Steelhead Society of British Columbia and the Eulachon Conservation Society. Mr. Lewis has published two books on Pacific salmon in the popular literature.

Company Profile and Project List
Bill Slater Environmental Consulting
September 2007

Bill Slater Environmental Consulting provides technical, regulatory and policy consulting services in environmental management, environmental impact assessment, water management, mining and infrastructure development. Clients include government agencies (federal, First Nation, territorial and municipal), independent resource management agencies, non-government organizations and private companies. Bill Slater Environmental Consulting has worked collaboratively with other consultants on a variety of projects.

Prior to starting his consulting business, Bill had over ten years of experience working in Yukon for the federal and territorial governments in the fields of environmental assessment, water management and First Nation land claim implementation. On behalf of governments, he led technical reviews of large mine development proposals as well as mine closure plans. Bill is very familiar with Yukon's project permitting and environmental assessment regimes and has advised both governments and First Nations extensively on the development and implementation of Yukon's environmental and socio-economic assessment legislation: the *Yukon Environmental and Socio-economic Assessment Act*.

Bill graduated with distinction from the University of Guelph in 1988, receiving an honours degree in Agricultural Engineering and the Association of Professional Engineers Gold Medal for highest academic standing.

The following is a partial list of projects undertaken by Bill Slater Environmental Consulting:

- Technical Manager for the Faro Mine Closure Planning Office – April 2005 to present: In partnership with Brodie Consulting (Vancouver), guiding the technical aspects of closure planning for the Faro Mine Complex.
- Senior advisor to the Council of Yukon First Nations on the 5-year review of the Yukon Environmental and Socio-Economic Assessment Process.
- Technical consultant to Selkirk FN on the Minto Mine project: providing technical advice and review on closure plans and changes to mining plans.
- Technical consultant to Kwanlin Dun First Nation on renewal of a water licence for the Fish Lake Hydro Project, Whitehorse. 2007.
- Technical consultant to Little Salmon Carmacks First Nation on the proposed development of a copper heap leach mine by Western Silver at William Creek: providing technical advice related to project planning, environmental assessment, socio-economic assessment and regulatory processes.
- Technical consultant to the Tr'ondek Hwech'in First Nation on the proposed Yukon River Bridge at Dawson City: providing technical evaluation, advice and recommendations related to proposals for regulatory approvals. Assisted by Mr. Martin Jasek, P.Eng.
- Technical consultant to Environment Canada on the closure planning for the Brewery Creek Mine – May to August 2004: work included the review and evaluation of closure plans/designs; identification of outstanding issues; proposals for mitigation; development of Environment Canada recommendations for water licencing; collection and analysis of

water quality data; representing Environment Canada at multi-agency meetings; and, participation as a technical expert during water licencing processes including Yukon Water Board hearings.

- Technical consultant to Government of Yukon's Abandoned Mines Office – April 2004 to Present: work includes review and evaluation of technical/research/design reports for the Faro Mine closure planning; options paper for regulatory authorization of interim care-and-maintenance activities; preparation of environmental assessment screening report for Government of Yukon's activities at United Keno Hill Mine; participation at technical meetings/workshops; review and advice on closure planning studies for the Mt. Nansen Mine; and, advice on development of mine closure objectives.
- Technical consultant to Teslin Tlingit Council on a variety of projects proposed in their traditional territory.
- Technical consultant to Council of Yukon First Nations (CYFN) on the development and implementation of the *Yukon Environmental and Socio-economic Assessment Act* (YESAA) – November 2003 to present: work includes review of proposals for regulations; representing CYFN on multi-agency working group; developing proposals for regulations; advising and consulting with First Nation caucuses; and, advising CYFN staff and leadership.
- Developed template assessment documents for First Nations decision making legislation for environmental and socio-economic assessments in Yukon.
- Preparation and facilitation of two 2-day workshops (January 2005 and October 2005 – 70 and 130 participants respectively) on coordination of assessment and decision making processes under YESAA. Assisted by JC Environmental (Jillian Chown) and R White Consulting.
- In cooperation with Brodie Consulting and Steve Wilbur Consulting, researching the participation of First Nations in closure planning for mines across northern Canada (Yukon, NWT and Nunavut), as part of a report prepared for DIAND – January to April 2004.
- In cooperation with R. White Consulting, development and delivery of training courses on YESAA for First Nations and government agencies – February 2004 to December 2006.
- Ongoing development and delivery of YESAA training programs for various clients (all levels of government, NGOs).
- In cooperation with R. White Consulting, development and delivery of training courses on YESAA, environmental assessment methodology and socio-economic assessment methodology for the YESA Board – July 2004 to December 2004.
- Technical review and evaluation of proposal for large nickel mining project: as a subcontractor to Materials Efficiency Research Group, on behalf of Noranda/Falconbridge, completed the technical aspects of a third party review of the company's Koniambo Project Proposal (a nickel mine proposal in New Caledonia) – February 2004.
- Review and analysis of proposed regulatory and environmental assessment changes for placer mining projects: reports prepared for Yukon Conservation Society – November 2003, October 2004, and August 2005.
- Preparation of environmental assessment report for Kwanlin Dun Cultural Centre – September to November 2004: worked with Touch the North (a Whitehorse based project management company) as part of a team developing an application for federal funding for

development of a cultural centre on the Whitehorse waterfront. Project proponent is Kwanlin Dun First Nation.

- In cooperation with Laberge Environmental Services, preparation of environmental assessment report for the Hamilton Boulevard Extension, Whitehorse – 2005: working as part of a larger project team that is providing design and environmental assessment services to the Government of Yukon.
- Peer reviewer for research papers prepared as part of the Mine Environmental Neutral Drainage (MEND) program administered by Natural Resources Canada – work completed on behalf of Mining Watch Canada, September 2004.
- Specialist advisor for YESA Board on some specific aspects related to rule development for the YESAA assessment process – September/October 2004.