Decision NR 2008-03, December 19, 2008

CEAA Reference No. 04-05-2996, NRCB Application No. 0602, AUC Application No. 1485454

Report of the Joint Review Panel

Glacier Power Ltd.
Dunvegan Hydroelectric Project
Fairview, Alberta

Joint Review Panel Established by:

Alberta

Canada

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EXECUTIVE SUMMARY

The Joint Review Panel (the Panel) was established by the Alberta Natural Resources Conservation Board (NRCB), the Alberta Utilities Commission (AUC) and the federal government (Canada) to conduct a review of the Dunvegan hydroelectric project (the Project) on the Peace River proposed by Glacier Power Ltd. (Glacier). The Terms of Reference were established by an agreement between the NRCB, AUC and Canada dated July 16, 2008.

A Notice of Hearing was published August 18, 2008 requiring that written submissions be filed on or before September 10, 2008. By letter dated August 27, 2008, the Panel extended the submission date to September 17, 2008. A public hearing was held in Fairview, Alberta beginning September 22, 2008 and ending September 26, 2008. Appendix B contains a listing of the parties who filed written submissions and a complete list of hearing participants, including witnesses and spokespersons.

The Panel has completed an assessment of the environmental and socio-economic effects of the Project and reached its conclusions regarding the public interest with the full benefit of extensive submissions from all participants. The Panel is confident that it has conducted this review with full regard for the Terms of Reference and relevant federal and provincial legislation. The Panel is satisfied that the environmental, economic and social impacts of the Project, with the conditions identified, are acceptable. A previous review of an application for a hydroelectric facility at the same site was completed by a EUB-NRCB Joint Review Panel resulting in a denial of the application in Review Decision 2003-20 released in March 2003. The current Panel benefited from considerable additional studies and work by Glacier done in relation to the Peace River ice regime and the fishery that were completed following the release of the previous decision.

Having regard for the many undertakings and commitments made by Glacier, the Panel concluded that the Project is in the public interest under the legislation governing the NRCB and AUC mandates. With regard to its responsibility under the *Canadian Environmental Assessment Act (CEAA)*, the Panel concluded that the Project is not likely to cause significant adverse effects. The Panel has made a number of recommendations to Canada, Alberta and Glacier that it believes, if adopted, would provide further benefits.

SECTION 1: BACKGROUND AND HISTORY

In May 2005, the Government of Alberta and the Government of Canada established a framework for conducting joint panels through the *Canada-Alberta Agreement on Environmental Assessment Cooperation* (2005).

On July 16, 2008, taking into consideration that the Alberta Utilities Commission (AUC) and Natural Resources Conservation Board (NRCB) had planned to hold a public hearing on the proposed Project, the federal government (Canada) entered into an agreement with Alberta to conduct a joint panel review. The NRCB, the AUC and the Federal Minister of the Environment established a Joint Review Panel (the Panel) and appointed three panel members to review the proposed Dunvegan hydroelectric project (the Project).

The same day, a Joint Panel Agreement was released after receiving public comments in early May 2008. Under the Joint Panel Agreement, the Panel must conduct its review in a manner that discharges the responsibilities of the NRCB under the *Natural Resources Conservation Board Act (NRCBA),* the AUC under the *Alberta Utilities Commission Act (AUCA)* and the *Hydro and Electric Energy Act (HEEA)*, as well as the requirements set out in the *Canadian Environmental Assessment Act (CEAA)* and in the Terms of Reference. The Joint Panel Agreement and the Terms of Reference describe the process for conducting the joint panel review and details on the scope of the environmental assessment. A copy of these documents can be found in the online registries at www.auc.ab.ca or www.ceaa.gc.ca.

This report sets out the Panel's decision, reasons, rationale, conclusions and recommendations with respect to its review of the Project under the *NRCBA*, the *AUCA*, the *HEEA* and the *CEAA*. This report also includes a discussion of recommended mitigation measures and follow-up programs, as well as a summary of comments received from the hearing participants.

SECTION 2: DESCRIPTION OF THE PROJECT

The scope of the Project assessed by the Panel is defined by the Joint Panel Agreement and the Terms of Reference.

Glacier Power Ltd. (Glacier) proposed construction and operation of a 100-megawatt (MW), low head, run-of-river hydroelectric project on the Peace River near Dunvegan, Alberta. The Project would be located on the Peace River approximately 2 km west of the Highway 2 bridge crossing at Dunvegan Historic Park. Dunvegan is located 80 km north of the City of Grande Prairie and 20 km south of the Town of Fairview.

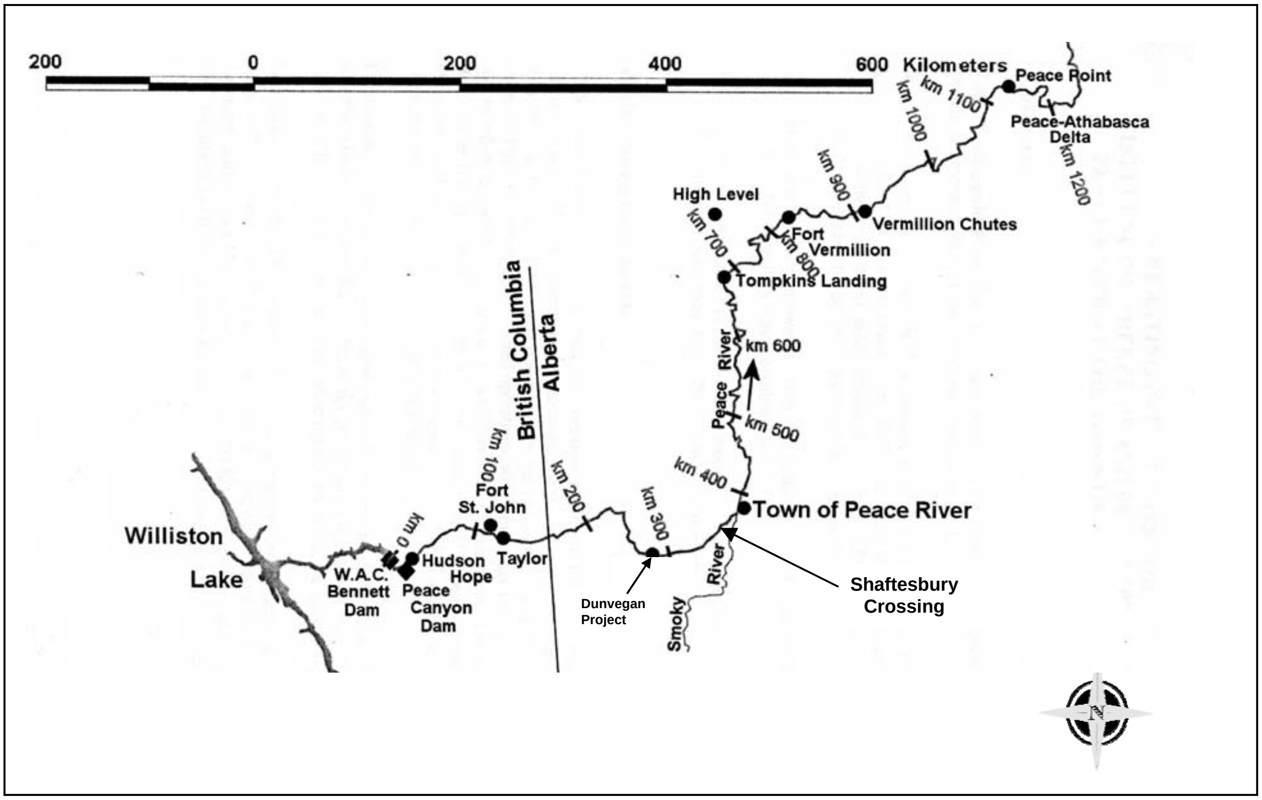

Figure 1: General Project Location Plan

The Project components, which are part of the scope of this assessment, include:

- A spillway and powerhouse across the Peace River to increase the water level in the river at the headworks by an average of 6.6 m. The headpond created by the headworks structure would extend up to approximately 26 km upstream of the powerhouse and spillway. The Project would be a run-of-river facility that produces power from the flow of the river without significant storage of water and therefore does not regulate the downstream flow regime. The powerhouse would consist of 40 turbine units, constructed side by side, extending into the main channel from both the north bank and the south bank for a total powerhouse length of 288 m. A crest-gated spillway would extend between the north and south sets of powerhouse units across the remaining 110 m of channel width to maintain water level differential across the structure.
- A boat lock for upstream and downstream passage of river traffic and a boat ramp upstream of the headworks to provide access to the headpond.
- Ramp fishways (fish ladders) placed on each bank to provide for upstream fish migration and ten fish sluices placed between groups of five powerhouse units for downstream fish migration.
- An approximately 4.3 km, 144 kV transmission line to the southeast of the Project, interconnecting at the existing ATCO 144 kV line.
- A plant substation, located adjacent to the hydro facility on the south bank of the river, connected via a 25 kV line to the turbines.

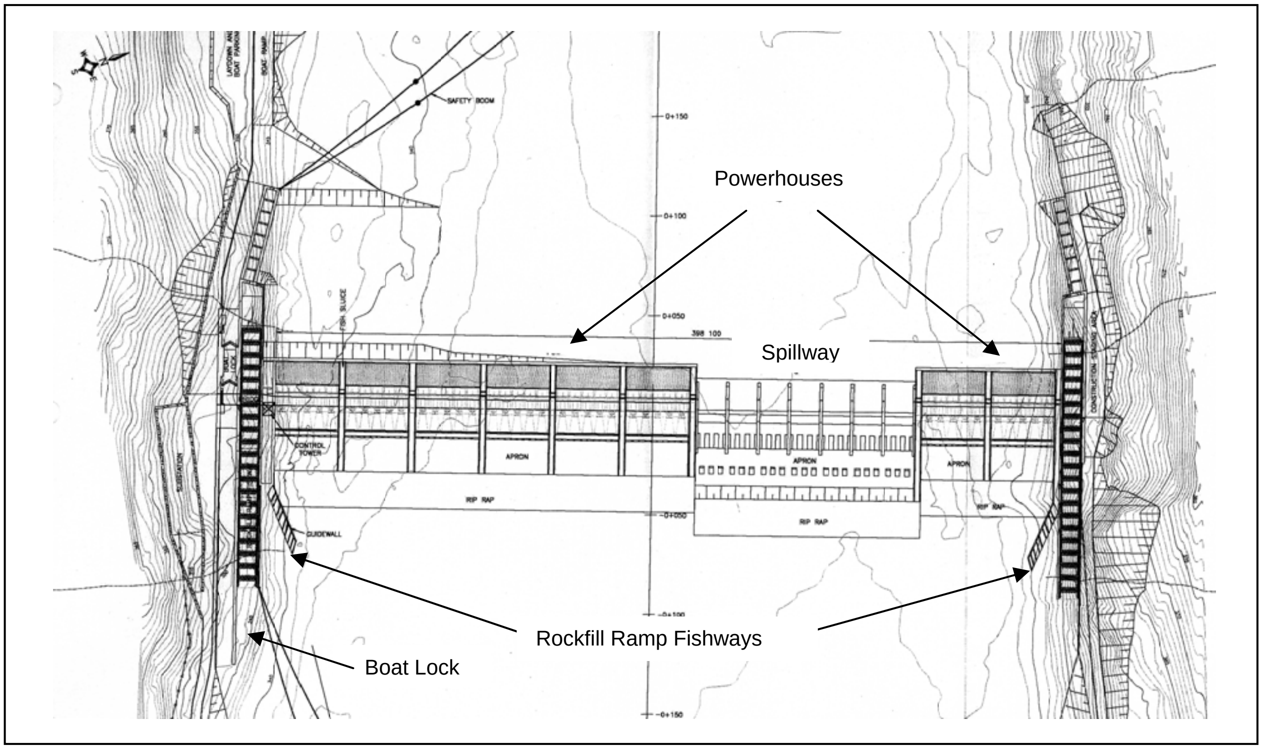

Figure 2: Project Components

SECTION 3: JURISDICTION OF REVIEW

3.1: GOVERNMENT OF ALBERTA

The Alberta Utilities Commission (AUC) has statutory responsibilities pursuant to the *Alberta Utilities Commission Act (AUCA)* and the *Hydro and Electric Energy Act* (*HEEA).* The Natural Resources Conservation Board (NRCB) has statutory responsibilities pursuant to the *Natural Resources Conservation Board Act (NRCBA).* An application (NR-0602) was filed with the NRCB pursuant to Section 5 of the *NRCBA* on October 27, 2006. On the same date, an application was filed with the AUC[1] (No.1485454) pursuant to Sections 9, 10, 14 and 15 of the *HEEA*.

Both the NRCB and the AUC have provisions that require an assessment of whether the Project is in the public interest. Section 2 of the *NRCBA* states: *"The purpose of the Act is to provide for an impartial process to review projects that will or may affect the natural resources of Alberta in order to determine whether, in the Board's opinion, the projects are in the public interest, having regard to the social and economic effects of the projects and the effect of the projects on the environment."*

[1] The separation of the Alberta Energy and Utilities Board into the Energy Resources Conservation Board and the Alberta Utilities Commission resulted in the Alberta Utilities Commission assuming responsibility for applications under the *Hydro and Electric Energy Act* on January 1, 2008.

Section 17 of the *AUCA* provides: *"Where the Commission conducts a hearing or other proceeding on an application to construct or operate a hydro development, power plant or transmission line under the Hydro and Electric Energy Act or a gas utility pipeline under the Gas Utilities Act, it shall, in addition to any other matters it may or must consider in conducting the hearing or other proceeding, give consideration to whether construction or operation of the proposed hydro development, power plant, transmission line or gas utility pipeline is in the public interest, having regard to the social and economic effects of the development, plant, line or pipeline and the effects of the development, plant, line or pipeline on the environment."*

The *HEEA* also provides the following purposes in Section 2:

(a) to provide for the economic, orderly and efficient development and operation, in the public interest, of hydro energy and the generation and transmission of electric energy in Alberta

(b) to secure the observance of safe and efficient practices in the public interest in the development of hydro energy and in the generation, transmission and distribution of electric energy in Alberta

(c) to assist the Government in controlling pollution and ensuring environment conservation in the development of hydro energy and in the generation, transmission and distribution of electric energy in Alberta

3.2: GOVERNMENT OF CANADA

The *Canadian Environmental Assessment Act (CEAA)* was triggered on May 12, 2004 as a result of the federal regulatory responsibilities under Subsection 35(2) of the *Fisheries Act* and Paragraph 5(1)(a) of the *Navigable Waters Protection Act*. Under Paragraph 5(1)(d) of the *CEAA*, regulatory decisions by the Department of Fisheries and Oceans Canada (DFO) and Transport Canada are subject to the federal environmental assessment process set out in the *CEAA*. DFO and Transport Canada are the responsible authorities for this environmental assessment under the *CEAA*. Transport Canada identified a comprehensive study list trigger in accordance with Paragraph 28(b) of the Comprehensive Study List Regulations.

On April 22, 2008, the Minister of DFO requested, in accordance with Section 25 of the *CEAA* and with the concurrence of Transport Canada, that the Minister of the Environment refer the Project to a review panel. On May 8, 2008, the Minister of the Environment referred the environmental assessment of the Project to a review panel in accordance with Paragraph 29(1)(a) of the *CEAA*. The Minister of the Environment also determined that a joint review panel should be established pursuant to Subsection 40(2) of the *CEAA*.

Under the *CEAA*, the Panel must:

- Submit a report to the Minister of the Environment providing the Panel's rationale, conclusions and recommendations relating to the environmental assessment of the project including any mitigation measures and follow-up programs.
- Assess the environmental effects of the project including the environmental effects of malfunctions or accidents that may occur in connection with the project and any cumulative environmental effects likely to result from the project in combination with other projects or activities that are in existence or planned.
- Determine the significance of the environmental effects of the project.
- Consider whether there are technically and economically feasible measures that would mitigate any significant adverse environmental effects of the project.

SECTION 4: CONSULTATION PROGRAM

Glacier began its consultation process in 1999 for the first application, continuing its discussions with various individuals and groups from that time to the present. Glacier provided documentation to the Panel outlining its efforts and identifying its communications approaches, messages and who was involved.

4.1: VIEWS OF THE APPLICANT

Glacier described its public consultation program as "robust and inclusive." It identified the objectives of its consultation program to "identify, contact, inform and obtain feedback from the general public, regulators, local stakeholders and Aboriginal groups." Glacier asked for suggestions or concerns about the Project and sought to work with each of the parties to deal with the matters raised.

Glacier stated that it expanded upon the consultation approaches used in its previous application in 2002. This involved contacting and meeting with individuals, regulators and groups with connections to the Peace River from the Bennett Dam area of BC, through Fairview, Dunvegan, the Town of Peace River and to the Peace Athabasca Delta (PAD) area in Alberta. Contacts included officials from towns and municipalities, provincial and federal government agencies, First Nations and Métis, the public, river users, landowners, water license holders, BC Hydro, interested parties and special interest groups.

Glacier stated that consultation activities from 2003 to 2008 involved formal public notices in local newspapers, open houses, newsletters, a Project-dedicated website, formal presentations, information sessions, joint workshops, one-on-one meetings, e-mails, telephone communications, availability of documents online and small group meetings to clarify or work on issues.

Glacier noted that it widely distributed its Environmental Impact Assessment (EIA), application materials and answers to Supplementary Information Requests (SIR) to individuals, groups, libraries and municipal and provincial buildings. Glacier also worked with a variety of stakeholders to acquire input on aspects of project design and a number of innovations that were incorporated, particularly around ice and fish studies.

Glacier asserted that it had studied the issues and concerns raised and that the results were incorporated throughout the EIA, the SIRs, supporting documentation and actions. Where unresolved aspects of issues or uncertainties remained, Glacier put processes in place to continue communicating and work on resolving them. Glacier noted it was also subject to further work that would be required by the various regulators and/or Panel conditions before finalization of design, monitoring plans, emergency response plans and necessary permits connected to construction and operations.

As examples of successful issue resolution, Glacier noted that it had reached an agreement with the Town of Peace River to provide funding and other flood-related considerations for the community. Subsequently, the Town of Peace River stated it supported the Project. Glacier also entered into written agreements with BC Hydro, which did not oppose the Project. The Duncan's First Nation (DFN), the closest First Nation to the Project (approximately 40 km from the Project site), signed a Memorandum of Understanding with Glacier and indicated support for the Project. Additionally, Glacier reached agreements with landowners in the vicinity of the proposed Project. No residents in the immediate project area objected to the Project by hearing commencement or appeared at the hearing.

Glacier submitted that it undertook substantial efforts with the Concerned Residents for Ongoing Service at Shaftesbury (CROSS) to further address particular concerns regarding possible effects of the Project on the ferry service and ice bridge at Shaftesbury Crossing. Glacier acknowledged that this was an important issue for the local residents and that Glacier took the issue seriously. Glacier entered into ongoing discussions with Alberta Transportation (AT) regarding the ferry and ice bridge. Glacier stated that negotiations would continue with AT, in good faith, to find a resolution and Glacier offered to pay up to 30 percent for a new ferry if that was determined an acceptable and workable solution.

Glacier submitted that, since 2003, it had met with CROSS and its representatives, arranged meetings between CROSS and AT, provided funding for CROSS to participate in the ice modelling workshops held from 2004 to 2006 and provided funding for CROSS to engage its own expert for the workshops and to review the EIA. Glacier also funded and shared a preliminary engineering study on ferries with CROSS and AT.

Glacier noted it also communicated with the Paddle Prairie Métis Settlement (Paddle Prairie), the Mikisew Cree First Nation (MCFN) and the Athabasca Chipewyan First Nation (ACFN) from Fort Chipewyan, Alberta. Glacier provided these parties with funding for technical reviews of the EIA. See Section 13 for a discussion of these consultations.

Glacier submitted that it attempted to meet with the Coalition (Alberta Wilderness Association, Canadian Parks and Wilderness Society Northern Alberta, Peace Parklands Naturalists and South Peace Environment Association) and reported that the Coalition did not avail itself of opportunities to consult. Glacier also attempted to share information with the Coalition after it was awarded Canadian Environmental Assessment Agency participant funding in 2008. Glacier reported that the Coalition did not meet with them.

4.2: VIEWS OF THE INTERVENERS

Alberta government departments did not participate in the hearing. The Government of Canada, which did attend the hearing, raised no objections regarding consultation. Local governments indicated support for the Project with favourable comments about how Glacier had conducted itself. The Town of Peace River, the Peace Region Economic Development Alliance, Birch Hills County, Northern Sunrise County, the Fairview & District Chamber of Commerce, the Town of Fairview, the Municipal District of Fairview, the City of Grande Prairie, Clear Hills County, the Municipal District of Peace No. 135 and Saddle Hills County all supported the Project. Adjacent local landowners had their issues resolved and had no objections to the Project.

CROSS

CROSS, in its final written submission, asked that the Project be denied. It asserted that Glacier continued to understate the potential negative effects of the Project on the area residents and users of Highway 740 that could involve reduced access across the Peace River. It also asserted Glacier failed to recognize the importance of residents' concerns, continued to consider the impacts of lengthy additional road travel as not significant and provided no meaningful information on outstanding issues and no reliable monitoring or mitigation program to assess impacts. CROSS was not satisfied with the discussions and negotiations between AT and Glacier.

CROSS commented that its concerns did not necessarily imply that Glacier "*has failed in the area of consultation*." CROSS acknowledged that funding and opportunities to participate in the ice modelling workshops were provided, that Glacier sought to discuss the crossing issues with AT and that there were many meetings, contacts and discussions between CROSS and Glacier. CROSS also expressed disappointment that AT chose not to participate in the hearing. CROSS participated in drafting questions for AT which were submitted for response after the hearing ended.

After reviewing AT's written responses to the Panel, CROSS asked that if there was an approval, it be conditioned so that a serviceable solution to the crossing issues be included before the Project would become operational.

The Coalition

The Coalition stated it had not met with Glacier and noted it had limited resources. It further indicated that when meetings were offered by Glacier, the Coalition decided it was in its best interest to use its available resources to prepare for the hearing. It did not respond to Glacier's request for a meeting, however, it did attend the pre-hearing meeting in January 2008 and made a pre-hearing submission.

The Coalition was critical of Glacier's EIA and many of its conclusions. With respect to consultation, the Coalition indicated that it was not prepared to meet with Glacier before the hearing to discuss its concerns. In its pre-hearing submission, the Coalition did not indicate that consultation was one of its concerns. The Coalition also indicated its position that the Peace River should run free. In its closing arguments, the Coalition asserted that an intervener was not required to consult with Glacier.

First Nations and Métis

See Section 13 for First Nations and Métis views.

4.3: VIEWS OF THE PANEL

The Panel concludes that Glacier conducted a thorough consultation program with all affected and interested parties. The EUB-NRCB Joint Review Panel in 2003 indicated that it was "*satisfied with the consultation program undertaken by Glacier."* This Panel accepts that the current consultation program was satisfactory and can be considered outstanding in many respects. A number of participants and submissions lauded Glacier's efforts.

CROSS indicated that it was not pleased with certain aspects of its lengthy contacts with Glacier. The Panel is of the view, after reviewing the large file of exchanges between Glacier and CROSS, that CROSS's disappointment was primarily due to its issues remaining unresolved, rather than unsatisfactory consultation. It is the Panel's view that Glacier has conducted itself well in these discussions and is committed to continuing efforts to find an acceptable solution.

The Coalition also noted that it did not consult with Glacier but that was its choice, since in its view there should be no constructed facility in the Peace River that would impede fish movements. Again, the Panel does not see this as a failure of consultation but rather a different perspective about sharing information and working collaboratively to seek resolutions where possible.

SECTION 5: PROJECT NEED, PURPOSE, VIABILITY AND BENEFITS

5.1: VIEWS OF THE APPLICANT

Glacier submitted that project need should be considered from the perspective of the market (supply/demand and price), electric system benefits and overall government policy regarding renewable energy.

Glacier submitted that growth in the Alberta economy is dependent on a reliable source of competitively-priced electricity. It claimed that from 1960 to 1980, Alberta's consumption of electric energy per dollar of real GDP doubled by growing an average of seven percent per year. Further, it reported that Alberta generates approximately $1.85 million in real GDP (1992 dollars) for every GWh of electric energy consumed. It stated that Canada, and more specifically Alberta, have two of the most electric-intensive economies in the world as measured by electric energy per capita. Glacier also stated that at the end of 2004, Alberta's total gross installed generating capacity was approximately 13,000 MW, of which almost 25 percent will reach retirement age in the next 15 years and just under 40 percent will reach retirement age in the next 25 years. Glacier reported that Alberta's total electric energy sales have had an annual compound growth rate of 3.4 percent from 1987 to 2003 and are forecast to grow on a compounded basis by 2.7 percent per year from 2004 to 2018. It submitted that the growth rate in demand, coupled with projected retirements, would necessitate the need to develop almost 6000 MW of new gross-generating capacity over the next 15 years, which represents approximately 50 percent of current total capacity.

As reported by Glacier, the need for electric power generation in northwest Alberta is expected to increase by 2 percent per year through to 2016 (Alberta Electric System Operator 10-Year Transmission System Plan 2007-2016). Glacier also indicated that the Alberta Electric System Operator reported that approximately 57 percent of the northwest region's power comes from outside the region.

Glacier stated that the purpose of the Project is to address these needs by providing an emission-free source of renewable energy via the construction of a 100-MW, run-of-river hydroelectric generating facility that would generate power for the Alberta electricity grid. Glacier indicated that the Project aligns with current provincial and federal government support for increased energy production from renewable sources. Glacier noted that both the Alberta and federal government have made commitments to constrain or reduce greenhouse gas emissions and the Project would provide a significant reduction of greenhouse gas emissions in Alberta relative to non-renewable electricity development. It stated that approximately 500,000 tonnes of greenhouse gas reductions would be achieved annually compared to other thermal generation sources. It reported that Alberta government agencies, through Climate Change Central and Clean Air Strategic Alliance, are examples of government commitments to increase green energy production. Glacier also referenced the Government of Alberta's commitment to purchase 90 percent of the electricity used in government-owned facilities from green power sources.

Glacier suggested that the total construction expenditure for the Project would be an estimated $319 million in 2004 dollars or $344 million[2] in inflation-adjusted 2008 dollars. Glacier noted that the Project represents almost one-quarter of the expected major project expenditures for the region. Glacier stated that an estimated 10.6 percent of the total expenditure would likely accrue to the region and 41.6 percent of the total expenditure would accrue to Alberta. Glacier noted that the GDP and labour income effects of the Project would be $277 million and $186 million, respectively.

Glacier stated that, during the four-year construction period, the total onsite direct employment effect would be estimated at 500 person-years, with offsite employment comprising of professional and technical services estimated to be 383 person-years. Glacier noted the number of onsite workers during construction is expected to peak at 300. The managing contractor of the Project would hire locally where possible and it is expected that the regional construction force of 4,800 would be large enough to supply the majority of the workers required for the Project. However, Glacier noted that, depending on the availability of regional labour markets, a substantial number of workers employed at the Project might come from elsewhere in the province or beyond. Glacier completed an analysis of construction population effects that assumed all workers would come from outside the region to show a "maximum effect" scenario, showing that the peak workforce associated with the construction phase of the Project, in light of anticipated growth rates of the local population, would represent a temporary increase of about nine percent. Glacier pointed out that the population increase due to the construction phase would centre around the summer season, with the peak effect in July and August of year one and two of construction.

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[2] The JRP notes that this estimate was provided in Glacier's initial application and that estimates provided at the hearing projected a cost of $500 to $600 million. The increase in project expenditure is likely to alter the other numbers provided, however it is not expected that the increase in costs will impact the significance of the projections beyond a change in magnitude.

Glacier stated work camps might be used to limit the demand for short-term housing due to the Project. It anticipated that supervisory personnel may at times use local hotels, however, given the number of hotel rooms available it did not expect this to affect the supply and demand balance for hotel accommodations. Glacier noted that police, fire, rescue and emergency services are well developed and that any service demands associated with the Project would be easily accommodated using existing resources. In addition, Glacier stated the potential impact of health services to Peace County Health would likely be minimal but admittedly difficult to discern.

Glacier estimated that the ongoing operating costs of the Project would be $10 million per year, of which over one-third would be expected to accrue to the local region through taxes, employment wages and local procurement of materials and services. Glacier indicated that the Project would be expected to generate 19 direct, indirect and induced permanent employment opportunities in the local area following construction. Glacier stated its intention was to hire approximately six operators for the facility, following construction. It noted that the six operators would not require any specific skill set beyond being resourceful, mechanically minded and practical. It was stated by Glacier that these operators would receive training for operation of the facility. Glacier preliminarily estimated the municipal tax payment, using 2006 tax rates, to the MD of Fairview at $1.4 million per year.

Glacier estimated that the ongoing operations would require six on-site workers and four indirect positions for maintenance with a maximum population impact of 32 persons. If all positions were sourced from outside the community it stated that the impact on both the education and health system would be minimal, relative to the overall demand for those services from the existing population. Glacier noted that it used the maximum effect approach (all positions sourced outside of community) since population effects are difficult to predict and depend on factors such as personal preferences on commuting distance, schooling and proximity to community services.

5.2: VIEWS OF THE INTERVENERS

The Coalition

The Coalition stated that during the winter months the Project would provide only 3 percent of the estimated 1310 MW total electricity demand in the northwest region three years post-construction. It also submitted that this translates to only 0.4 percent of Alberta’s total demand as of 2014/15, as forecasted by the Alberta Electric System Operator. The Coalition felt that it was important for the Panel to weigh the contribution of electricity generated by the Project against the resulting full environmental impacts. It also reported that the three dams built in the Kananaskis Valley over the past 80 years only generate 0.12 percent of Alberta’s total power while being responsible for dramatically reducing the productivity of the river fishery and reducing the recreational potential of the river resource.

The Coalition also submitted that Glacier’s use of work camps and outside workers would reduce the economic benefits accruing to the local region.

The Town of Peace River

The Town of Peace River stated that it supported the Project largely because it would have minimal environmental impact and it would provide electricity from a renewable energy source. It noted that the Project would provide a source of power in northern Alberta, which is badly needed to attract natural resource-based, value-added industry and the associated population growth resulting from industrial developments.

The Municipal District of Fairview

The MD of Fairview stated that it supported the Project for a number of reasons, most notably the approximate 50 percent increase in tax base that would be provided. Additional benefits of the Project cited by the MD of Fairview were: green emission-free source of power, lower transmission line losses for the region, local economic activity generated through construction and ongoing operations, long-term employment and need for more locally based power generation. The MD of Fairview also reported that Glacier was proactive in its communications with municipalities and public consultations. It noted no outstanding issues with respect to the Project.

The Town of Fairview

The Town of Fairview submitted that the Project would be beneficial in that:

- It would provide power with virtually no greenhouse gas emissions.
- It would provide regional economic benefits associated with increased employment, increased retail and infrastructure development.
- The Project holds potential for diverse recreation opportunities.
- The Project would provide substantial tax benefits to the Town of Fairview's municipal partner, the Municipal District #136.

Written Submissions from Other Parties

Additional written submissions were provided in support of Glacier and the Project. The Panel received these submissions from the following parties:

- Peace River Economic Development Alliance
- Saddle Hills County
- Clear Hills County
- Birch Hills County
- City of Grande Prairie
- Fairview & District Chamber of Commerce
- MD of Peace No. 135
- Northern Sunrise County

These submissions varied from short to comprehensive, and all included comments on one or more of the following benefits: additional electricity generation in the region, source of green energy, local employment opportunities, increased tax revenue, improved commerce in the area, and positive impact on the quality of life and further monetary impacts.

5.3: VIEWS OF THE PANEL

The Panel finds that Glacier sufficiently demonstrated the need for the Project and concurs that a stable source of electric energy generation is appropriate. The Panel also agrees with Glacier's assessment that there is an increased demand for green power generation, which will likely grow in the future. This view is also supported by broad government public policy, which demonstrates a commitment to increase the supply and utilization of green power. Electricity generation that is dependent on fossil fuel feed stocks will increasingly be challenged due to greenhouse gas emissions and availability of the feed stock itself. Given Alberta's dependence on energy derived from fossil fuels, the Panel views green power generation, which emits minimal greenhouse gases, as increasingly important and in the public interest. Development of hydroelectric power as well as other renewable based electricity sources will be important to Alberta's long term need for a stable supply of electricity.

The Panel notes the substantial local municipal support for the Project, based on economic benefits derived from construction, long-term operations and on-going maintenance. The Project will require a substantial investment in infrastructure with construction spread over four to five years. Project expenditures are expected to represent approximately 25 percent of total investment in the region. The Panel concurs with Glacier and local municipalities that this investment will lead to significant positive economic impacts, particularly for the local area, with indirect benefits to the rest of the Province. Glacier has estimated that over 500 person years will be required on-site for construction and additionally over 380 person years off-site for professional and technical services. The Panel acknowledges that Glacier has committed to hire locally where possible for construction and ongoing operations. The Panel finds that this represents an opportunity for local residents to realize significant positive economic benefits.

SECTION 6: ASSESSMENT OF ALTERNATIVES

The Canadian Environmental Assessment Agency defines the *"alternatives to the project"* as the functionally different ways to meet the project need and achieve the project purpose[3]. For example, if a need for greater power generation has been identified, a proposed project might be to build a new power generation facility. An alternative to that project might be to increase the generation capacity of an existing facility.

"Alternative means of carrying out a project" are the various technically and economically feasible ways for the project to be implemented or carried out. This could include, for example, alternative locations, routes and methods of development, implementation and mitigation.

3 The Operational Policy Statement entitled *Addressing "Need for", "Purpose of", "Alternatives to" and "Alternative Means" under the Canadian Environmental Assessment Act* is available at http://www.ceaa-cee.gc.ca/013/0002/addressing_e.htm and the *Glossary of Terms commonly used in Federal Environmental Assessments* is available at http://www.ceaa acee.gc.ca/012/015/index_e.htm

6.1: ALTERNATIVES TO THE PROJECT

6.1.1: VIEWS OF THE APPLICANT

Glacier examined seven alternatives to the Project. Glacier concluded that "*every method of energy generation changes, impairs or endangers the environment.*" In its comparison of alternatives, Glacier considered the following variables:

- Efficiency
- Energy payback time
- Energy-harvesting factor
- CO_2 and GHG emissions
- NO_X and SO_X emissions
- Consumption of raw materials
- Space requirements
- Annual period of use

Glacier summarized the alternatives to the Project as follows:

- No Project

  Glacier concluded that no project development would result in northern Alberta's continued reliance on electric power generation from central and southern Alberta. It stated that forecasted energy demand in the study area would need to be met with out-of-region power sources, possibly resulting in upgraded and/or additional transmission lines.

- Large hydroelectric

  Glacier stated that the Peace River has high electricity generation potential and the Dunvegan site was studied for higher head dams. However, the bedrock was found unsuitable for large-scale dam projects. It also noted the environmental impact of high-head dams to be substantially larger than small run-of-river projects.

- Photovoltaic (solar power)

  Glacier reported that solar power technology has a potential for providing reliable power, in particular, for small-scale, stand-alone power demands such as homes in remote areas. It also stated that transmission losses associated with solar power are small when located at the demand source and are recognized for minimal environmental impact. Glacier estimated that a plant to produce 600,000 MWh per year of electricity would require roughly 450 ha and be three to five times more expensive compared to alternative energy technologies. It concluded that solar power, as an alternative to the Project, would be more expensive and less efficient.

- Wind

  Glacier stated that wind power is reliant on a relatively consistent and substantial wind resource and that Dunvegan ranks amongst the lowest potential areas in Alberta for wind-power energy generation. It reported that, according to Environment Canada's Wind Energy Atlas, the wind resource in the uplands near Dunvegan is less than 300 W/m^2 and ranges from 0 to 100 W/m^2 in the valley near the Project site, much less than the minimum wind energy required to generate 100 MW of power.

- Natural gas

  Glacier indicated that natural gas energy generation is the next most feasible type of available technology for the Peace region given the substantial oil and gas industry presence and available supply of gas. It reported that natural gas generation offers the lowest rate of GHG emissions, and other pollutants, compared to alternative fossil fuel sources and is viewed as a medium-term solution for new electricity supply. It noted the drawbacks of gas generation are dependence on highly fluctuating gas prices, shorter useful life of the plant, use of a non-renewable resource and generation of GHG emissions.

- Biomass and wood waste

  Glacier defined biomass and wood waste energy production as combustion of plant and animal waste material. It concluded that waste material in the region has largely been utilized in the Grande Prairie EcoPower Centre, which started operation in 2005. Glacier also stated that waste combustion generation is more expensive than either natural gas or hydroelectric options and has higher GHG emissions than the Project.

- Coal-fired thermal

  Glacier reported that Alberta generates low-cost electric energy from coal deposits in central and southern regions of the province. It noted that there are no known coal deposits in the study region and transportation of coal to the project area would likely make it uneconomical. Further, it stated that coal generation has the highest rate of GHG emission per unit of electricity produced and the highest emissions of common pollutants such as carbon monoxide, nitrogen oxides, sulphur oxides and particulates. Coal fired plants are also large consumptive users of water, as reported by Glacier.

Glacier stated its belief that a 100-MW, small-scale run-of-river project, when compared to the project alternatives it studied, is best suited to provide a stable electric energy supply for the Peace River region. Glacier summarized benefits of a small hydroelectric project as having no significant water storage with minimal flooding associated with the headpond (limited to pre-Bennett Dam levels), no air emissions post-construction, no regulation of downstream flows and no additional water diversion. Impacts, costs and benefits of the Project are discussed in great detail later in this report. Glacier also stated that the Project would provide substantial benefits to the local economy, stabilize the electricity grid and provide long-term investment with little or no burden to essential local services and minimal impact to the environment.

6.1.2: VIEWS OF THE INTERVENERS

The Coalition

The Coalition submitted that, while alternatives to the Project were included in the EIA, additional work needed to be done. While wind generation was evaluated, the Coalition submitted that the assessment should have included sites in addition to those chosen adjacent to the Project. It also stated that consideration should be given to the potential for cogeneration, energy recovery technology and energy conservation.

6.2: ALTERNATIVE MEANS OF CARRYING OUT THE PROJECT THAT ARE TECHNICALLY AND ECONOMICALLY FEASIBLE

6.2.1: VIEWS OF THE APPLICANT

Glacier has pursued the development of a low-head, run-of-river project since 1998 when it initiated feasibility studies. Following the EUB-NRCB Joint Review Panel's 2003 decision, which denied Glacier's application for an 80-MW project, Glacier increased the Project capacity to 100 MW.

To address the concerns raised in the EUB-NRCB Joint Review Panel's 2003 decision, Glacier submitted that it invested in environmental studies and design work for the Project. Specifically, Glacier undertook modelling studies to improve the design of fish passage facilities, such as the fishways for the upstream movement of fish and the sluiceways for the downstream movement. Glacier stated it also completed modelling for the fish exclusion racks to minimize the entrainment of fish through the turbines. Further details on these project design alternatives relating to fish passage are provided in Section 8 of this report.

Glacier indicated that it considered multiple locations for the Project and selected the proposed location for several reasons. These include the physical characteristics of the river channel and valley configurations, transportation networks and access to both sides of the river, proximity of an existing power line and availability of a nearby labour force, materials, supplies and services.

Glacier assessed three alternative sites within the local area:

- Downstream of the proposed site, approximately 500 m upstream of the Dunvegan Bridge.
- 3 km upstream from the proposed site.
- 80 km downstream of the proposed site in the Shaftesbury area.

Glacier rejected each of these sites for one or more of the following reasons:

- Proximity to the Dunvegan Historic Park and the Dunvegan Bridge.
- Lack of geotechnical suitability for abutments.
- Limited access to both sides of the river.
- Non-uniform river channel geometry.
- Proximity to multiple landowners.

Glacier indicated that the proposed location for the headworks represents the lowest impact and best fit into the existing landscape.

6.2.2: VIEWS OF THE INTERVENERS

Several interveners provided views on alternative means of carrying out the Project that focused on the fish passage systems and exclusion racks. The interveners' views on these issues are provided in Section 8.

6.3: VIEWS OF THE PANEL

The Panel supports the criteria used by Glacier to assess alternatives to the Project and site location. The Panel finds that the proposed run-of-river Project produces an excellent balance of reliable green hydroelectricity supply and minimum adverse impact to the environment when compared to alternatives. Other forms of power fuelled by fossil fuels for example, may supply dependable electricity but create greater adverse impacts in the form of GHG. Facilities like wind farms may be more environmentally benign but cannot be depended on for base generation. In terms of cost, hydro projects do incur substantial capital costs but are not subject to volatile prices of fossil fuels.

The Panel finds that extensive study and analysis went into the selection of the proposed site and finds that based on the selection criteria of: geotechnical stability, impact of the headpond, river channelling and access to transportation and transmission lines, the site is suitable. These criteria were applied to other possible sites but they did not match up as well.

SECTION 7: THE TRANSMISSION LINE FOR INTERCONNECTION TO THE ALBERTA INTERCONNECTED ELECTRIC SYSTEM

The application for approval to interconnect to the Alberta Interconnected Electric System was not filed by Glacier at the time of the hearing. Glacier had earlier submitted supplemental information outlining a plan to interconnect the Project to the Alberta Interconnected Electric System. Glacier's plan included a 4.3 km, 144-kV transmission line constructed on single wood poles connecting the plant substation to a switching substation at the interconnection point. Glacier had only completed the preliminary work to introduce the scope of the plan and stated that an application for the line and switching station would be made if the current application were approved.

Although Glacier did not apply for approval of the transmission line, the switching substation and interconnection to the Alberta Interconnected Electric System, the potential environmental effects of the proposed facilities must be considered under the *Canadian Environmental Assessment Act (CEAA)* subsection 16(1)(a) to (d) and 16(2) as outlined in Part II of the Agreement to Establish a Joint Panel for the Glacier Power Dunvegan Hydroelectric Project.

7.1: VIEWS OF THE APPLICANT

Glacier stated that an appropriate route for the 144-kV interconnection transmission line would start at the plant substation, on the south bank of the Peace River in the northeast quarter of Section 12, Township 80, Range 5, west of the 6th Meridian. The transmission line would follow the Peace River until it crosses Highway 2 and then would proceed roughly south along Highway 2 to a new switching substation in the northwest quarter of Section 31, Township 79, Range 4, west of the 6th Meridian. The switching substation would connect to the Alberta Interconnected Electric System via a T-Tap to the ATCO Electric Ltd.-owned 144-kV transmission line 7L73-1. Glacier stated that the route would be approximately 4.3 km.

Glacier indicated that the transmission line route would be mostly on existing right-of-ways with only a small amount of land expected to be cleared. Glacier specified that, for the most part, the transmission line would follow existing road allowances or cultivated land except where the line would follow the new south access road from the Project substation to the crossing of Dunvegan Creek. Glacier submitted that the preferred poles would be approximately 55 feet to 65 feet-high wood monopoles. Glacier further stated that only short portions of the Project would be visible from a limited number of vantage points along the highway.

7.2: VIEWS OF THE INTERVENERS

There were no intervener concerns with the transmission line, switching substation or the interconnection.

7.3: VIEWS OF THE PANEL

The Panel finds that the proposed location and facilities required for the Project's interconnection to the Alberta Interconnected Electric System do not create significant impacts. The transmission line, for example, will be mostly routed on existing right-of-ways or cultivated land and only short portions would be visible from the highway. The specific impacts associated with vegetation and forests, wildlife and historical and visual resources are more thoroughly dealt with in Sections 14, 15 and 17 of this report.

SECTION 8: EFFECTS ON THE PEACE RIVER FISHERY

The Project on a major northern Alberta river has the potential to impact fish habitat, populations, communities, migration and movement. Glacier has maintained that, with mitigation and adaptive management, no adverse impacts to the regional fish community would occur. Glacier adopted the concerns regarding the potential effects of the Project on the Peace River fishery, as previously discussed in the EUB-NRCB Joint Review Panel's

2003 decision, as a checklist for the 2006 application and Environmental Impact Assessment (EIA). Uncertainty regarding the performance and efficacy of various mitigative design features, as well as the absence of a clear baseline of information on the Peace River fishery, were information needs specifically addressed by Glacier.

8.1: FISH POPULATIONS

8.1.1: VIEWS OF THE APPLICANT

Subsequent to the EUB-NRCB Joint Review Panel's 2003 decision, Glacier indicated that additional fisheries studies were undertaken between 2002 and 2005 to better understand the fish population in the Peace River in the vicinity of the Project. A baseline study conducted in 2003/04 revealed that there were minor differences from the results of the 1999 baseline study. Glacier noted that three sport fish species (rainbow trout, Arctic grayling and lake whitefish) and one species of non-sport fish (brook stickleback) were captured in 2003/04 but were not captured in 1999. One species of non-sport fish, fathead minnow, was captured in 1999 but not in 2003/04. The two baseline studies revealed the presence of ten sport fish species and 13 non-sport fish species in the study area. The ten sport fish species included, in decreasing order of abundance: mountain whitefish, burbot, walleye, goldeye, northern pike, bull trout, kokanee, Arctic grayling, lake whitefish and rainbow trout.

Glacier said the non-sport fish population was dominated by longnose sucker, lake chub, longnose dace and flathead chub with smaller numbers of white sucker, spottail shiner, fathead minnow, northern pikeminnow, redside shiner, trout-perch, brook stickleback, spoonhead sculpin and slimy sculpin.

Glacier indicated that relative abundance, as measured by catch-per-unit-effort, was similar in 1999 and 2003/04. Glacier concluded from the two studies that the relative abundance of non-sport fish species in the local study area (LSA) was low and relative abundance of sport fish very low compared to relative abundance indices from elsewhere on the Peace River. Glacier said there was a minor, but consistent, decrease in the relative number of walleye between 1999 and 2003/04. The relative abundance of lake chub was greater in 2003/04 than in 1999 and dominated the small fish community in both studies.

Although there was some variation in seasonal catches between studies, Glacier said the pattern of seasonal variation was consistent. Glacier reported that the catch rate for goldeye, burbot and flathead chub was generally highest in spring, followed by a continuous decline throughout the year. The catch rate for the longnose sucker was highest in summer, and that for mountain whitefish was highest in summer and fall. Glacier stated that the remainder of the large fish component of the population exhibited little seasonal variation in catch rate. Glacier observed that, in 1999, the catch rate for all species in the small fish community was highest in spring, whereas in 2003/04, it was highest in summer and was lowest in fall for all years.

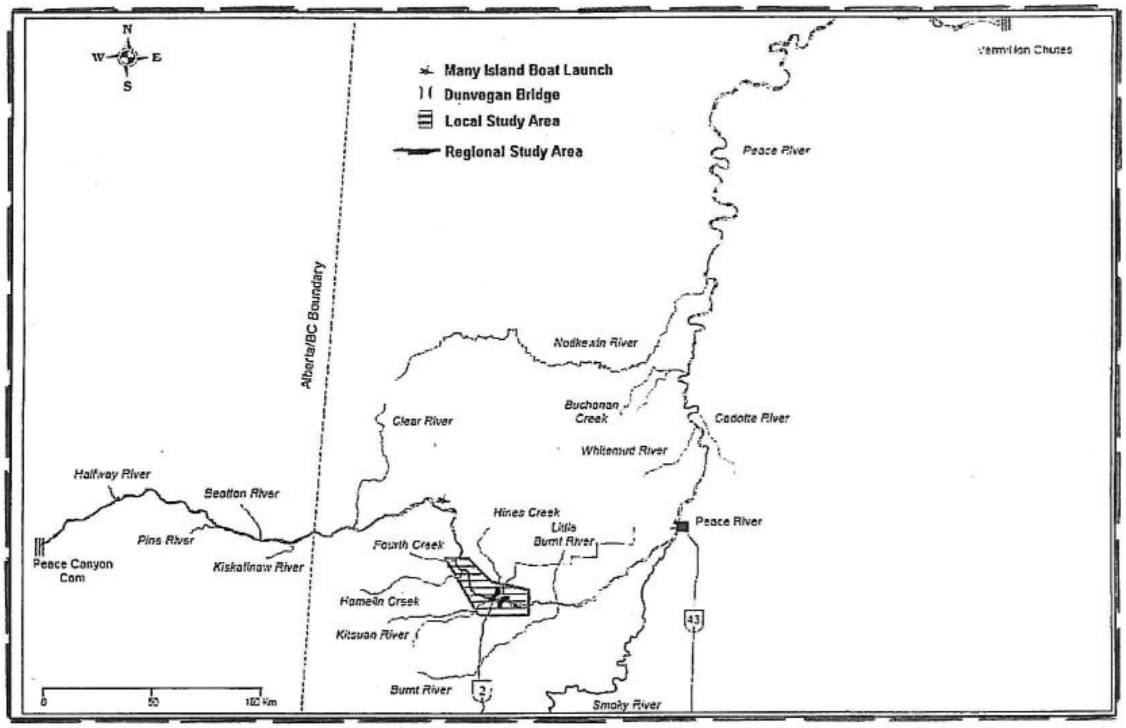


Figure 3: Spatial boundaries delineating the LSA and RSA for the Glacier Power Dunvegan Hydroelectric Project fisheries assessment

Glacier stated that young-of-the-year, juvenile and adult mountain whitefish, longnose sucker, white sucker and flathead chub were found in the study area. Juvenile and adult burbot and walleye were also found, however only the juvenile life stage of bull trout and the adult life stage of goldeye were captured. Glacier noted that the eggs of walleye were found at one location within the proposed headpond.

Glacier conducted fish movement studies using radio telemetry in 2002/03 and 2004/05 within core study areas and extended study areas. Glacier reported that the objectives of the studies were to describe the extent and timing of movements of target fish, to define movement corridors within the river channel so that initial predictions regarding movements could be confirmed, to provide information for design of proposed fish passage facilities and expand baseline data. Glacier said the target species for the movement studies included goldeye, walleye, longnose sucker and burbot. Glacier stated that a total of 115 fish were implanted with radio transmitters. Glacier indicated, however, that due to tag loss and malfunctions and presumed and known mortalities, 11 goldeye, 6 walleye, and 16 longnose suckers were available for tracking in 2002/03 and 11 goldeye, 16 walleye, 15 longnose suckers and 12 burbot were available for tracking in 2004/05. Glacier explained that a movement study using radio telemetry had been implemented in 2008 but the results were not available at the time of the hearing.

From the fish movement studies, Glacier concluded that:

- Goldeye were migratory. They travelled long distances within the extended LSA (i.e. BC/Alberta boundary to the confluence of Notikewin River and Peace River), though not all tagged fish moved past the Project site. The core upstream movement period occurred in May and June. The core downstream movement period was more protracted, extending from August to October.
- Tagged walleye moved relatively short distances, restricted to a 220 km section of river between the mouth of the Smoky River and the mouth of the Pouce Coupé River and were not deemed migratory. The majority of the tagged walleye moved past the Project site. Core upstream movement occurred from May to August. Core downstream movements occurred during two periods: October to December and May to June.
- Longnose suckers were non-migratory because of distance travelled (generally less than 10 km) and a total range of movement limited to a 200 km section between the Whitemud River and Fourth Creek. No distinct core movement periods were identified for longnose suckers. Relatively few of the tagged longnose suckers moved past the Project site.
- Burbot were non-migratory. The distances moved were limited and were confined to a section of river between the Shaftesbury area and the Many Islands area (126 km in length). Burbot exhibited two core movement periods: downstream movement commenced in November and peaked in December and January, and upstream movements were concentrated in February, March and April. A majority of the tagged burbot moved past the Project site.

Glacier reported that the movement corridor for all four species of fish tended to be located adjacent to the margins of the river channel. The maximum average distance from shore was 44 m for longnose sucker.

Glacier concluded that the project area was in a transition zone between coldwater and coolwater fish species. Glacier deemed goldeye and flathead chub to be migratory species, the latter because of the observed seasonal variation in catch. Glacier deemed bull trout and mountain whitefish to be transitory coldwater species. Arctic grayling, rainbow trout, kokanee and lake whitefish were categorized as incidental species because of their very low numbers. Glacier categorized the fathead minnow as a unique species because their capture was the first record of the species in the Peace River. Glacier designated the remaining species as resident, representing local fish populations that, having the requisite habitats available locally, completed their life cycles in the vicinity of the Project.

Glacier stated that the fish populations in the study area(s) have been adequately described as to relative abundance, species composition and distribution and life cycle phases and movements in order to identify potential impacts and develop effective mitigation for the potential adverse effects of the Project on fish populations. Glacier conducted a risk assessment for potential significant adverse effects for the construction, operations and decommissioning phases of the Project and for malfunctions or accidents. Glacier concluded that the potential for significant adverse effects was deemed nil or low in all cases for all species except for the local populations of walleye, mountain whitefish and burbot. The potential for significant adverse effects is moderate for walleye, high for mountain whitefish, and high for burbot during the operations phase. The potential for significant adverse effects is moderate for mountain whitefish during decommissioning and malfunctions or accidents. Glacier stated that the potential for significant adverse effect was ranked nil or low for regional populations of walleye, mountain whitefish and burbot.

Glacier reported it was committed to a fish population monitoring program during construction and operation phases of the Project, which would add to the current understanding of the fish community in the project area.

8.1.2: VIEWS OF THE INTERVENERS

The Coalition

The Coalition stated that Glacier's EIA failed to adequately assess and understand the current status and relationship of fish species movement, populations and sub-populations. The Coalition indicated that Glacier had not acknowledged the possible presence of three species (pygmy whitefish, large-scale sucker and prickly sculpin) that may occur in the Peace River in the project area.

The Coalition also contended that the use of only a catch-per-unit-effort to estimate and make decisions on relative population size was unwise. The Coalition presented a Chapman/Peterson mark/recapture population estimate for longnose suckers based on 2004 tagging and tracking data from Glacier. Unlike the estimated low numbers of longnose suckers based on a catch-per-unit effort method, the Coalition stated that its calculation of actual numbers for longnose suckers, using the Chapman/Peterson mark/recapture method, was notably higher (>170,000) in the study area. The Coalition maintained that all fish-capture methods are seriously inefficient in large, silty rivers.

Government of Canada

The Department of Fisheries and Oceans Canada (DFO) acknowledged that Glacier undertook and completed a number of studies to assess fish presence, species composition, and timing and pattern of fish movements, and agreed with the Glacier's classification of fish populations. DFO stated that some uncertainties remained with respect to fish movements, particularly for juvenile life stages, small bodied fish and adult burbot. DFO recommended that Glacier implement a monitoring program to improve its knowledge of the characteristics of the fish populations in the project area.

8.2: FISH HABITAT LOSSES AND GAINS

8.2.1: VIEWS OF THE APPLICANT

Glacier reported that it had inventoried instream and bank habitat using accepted, quantitative methods and concluded that the Peace River in the Project study area offered relatively low-quality habitat due to limited habitat complexity and fluctuating flow. Glacier concluded that the Project would not have any impacts on fish habitat downstream of the headworks, including the Peace Athabasca Delta (PAD). Glacier identified habitat loss associated with the instream footprint of the Project infrastructure and alteration of habitat in the Project headpond. Glacier emphasized that a conservative approach had been employed to habitat inventory, effects assessment and habitat loss/gain determination. Glacier applied a modified Habitat Suitability Matrix protocol to calculate habitat losses and gains in terms of weighted habitat units. Glacier stated that weighting factors applied to habitat type unit areas included a species/life stage-specific Habitat Suitability Index value and a species-specific importance value. Glacier noted that the indicator species used in the assessments included longnose sucker, goldeye, walleye, burbot, northern pike, mountain whitefish and bull trout. Glacier said the indicator species were selected because they constituted the most important large fish species in the project area and that habitat suitability criteria for the indicator species were available or could be developed. Glacier reported the results of the assessment were utilized to determine a habitat loss/gain balance and develop a habitat No Net Loss Plan to comply with the requirements of the DFO policy for the Management of Fish Habitat.

Glacier concluded that the footprint of the infrastructure (headworks structure, construction barge slip and bridge abutments) would cause a direct net habitat loss totalling 1.769 ha or 0.034 weighted habitat units. Glacier stated that the headpond would alter habitat, although the headpond would not result in any direct habitat losses. Glacier said the most significant harmful alteration of habitat in the headpond, resulting from formation of the headpond, would be the inundation of a known walleye spawning shoal, referred to as the Sawchuk shoal, which is located at kilometre 17 in the headpond. Glacier estimated that 10.58 ha of potential walleye spawning habitat would be inundated, with a net loss of 5.5 weighted habitat units. Glacier stated that the effect of the headpond on habitat would be positive overall (net gain of 384.3 weighted habitat units), largely due to the increase in area of available habitat due to the headpond and the value of some habitats, particularly over wintering habitat. Glacier acknowledged that while some fish species or life stages would benefit from the changes in headpond habitat, others would not.

8.2.2: VIEWS OF THE INTERVENERS

The Coalition

The Coalition questioned Glacier's prediction regarding headpond sedimentation and channel morphology and concluded that Glacier's interpretation of the habitat effects of the headpond were incorrect.

It was the Coalition's view that the nature of sediment deposition in the headpond and the evolution of river morphology post-Dunvegan, would result in an extension of Project effects on fish habitat beyond 26 km from the headworks. The Coalition maintained that Glacier should complete an assessment of fish habitats upstream from the upper end of the predicted headpond. The Coalition also submitted that Glacier provided very little assessment of the Project effects on fish habitat downstream of the headworks. The Coalition stated that this missing assessment information was required to develop a valid fish habitat compensation plan.

Government of Canada

DFO did not agree with Glacier's conclusion that the headpond would result in a net gain in fish habitat productivity largely due to the uncertainty attached to species and life stage use of the altered habitat in the headpond. DFO recommended that Glacier implement a post-construction monitoring program to verify effects of the headpond on fish and fish habitat. Should monitoring reveal negative effects, DFO stated that additional habitat compensation would be required.

8.3: HABITAT COMPENSATION PLAN

8.3.1: VIEWS OF THE APPLICANT

Because of the potential loss of the Sawchuk shoal as a walleye spawning habitat, Glacier stated that efforts to compensate for the alteration of the shoal had concentrated initially on the creation of walleye spawning habitat. Glacier said that potentially suitable sites for creating walleye spawning habitat in the vicinity of the Project had been sought out and four sites had been selected for detailed evaluation. Glacier established that none of the four sites was acceptable, largely due to a lack of adequate gradient. Glacier concluded that creation of instream walleye spawning habitat was not feasible in the Peace River in the vicinity of the Project. However, Glacier reported that creation of northern pike spawning/rearing habitat might be feasible at one or more of the sites with low gradients assessed for walleye spawning habitat. Glacier identified two potential sites and targeted a site within the headpond zone that would yield approximately 11 ha of northern pike spawning and rearing habitat.

Glacier stated that a habitat compensation plan had been submitted to DFO and Alberta Sustainable Resource Development (ASRD) that included creation of northern pike spawning and rearing habitat in the headpond zone and a radio telemetry study of walleye in the Little Smoky River. Glacier also reported that a fish monitoring plan had been prepared, the components of which would be used to verify predicted habitat effects of the headpond and should monitoring reveal unanticipated effects, inform additional habitat compensation and adaptive management strategies.

8.3.2: VIEWS OF THE INTERVENERS

The Coalition

The Coalition maintained that Glacier could not achieve the habitat objective of no net loss. The Coalition also took the position that a study of walleye movements in the Little Smoky River did not constitute equivalent compensation for habitat losses or changes caused by the Project on the Peace River.

Government of Canada

DFO stated that the direct habitat losses due to the Project infrastructure footprint and habitat alteration due to inundation of the Sawchuk shoal in the headpond area could be compensated with the proposed compensation plan provided that the proposed pike spawning habitat creation was established and confirmed as successful.

8.4: UPSTREAM MOVEMENT OF FISH

8.4.1: VIEWS OF THE APPLICANT

Subsequent to the EUB-NRCB Joint Review Panel's 2003 decision, Glacier reported that a number of hydraulic modelling studies had been undertaken, with the advice and cooperation of DFO and ASRD, to improve and refine the design and effectiveness of the proposed upstream fish passage facilities. Glacier said that field studies using radio telemetry to characterize fish movements and identify fish travel corridors within the river channel had also been implemented and completed. Glacier proposed to construct two upstream fishways located adjacent to the north and south banks, each consisting of a step-pool ramp section and a submerged orifice section. Glacier noted that the submerged orifice section provided for some flow control in the fishway. The design operating flow for the fishways was 1.8 m^3/s, but could be operated at flows ranging from 0.9 to 5.6 m^3/s. Glacier indicated that attraction flows at the downstream end of the ramp section could be manipulated using an auxiliary water supply system and attraction flows could be further enhanced using a guide wall structure adjacent to the fishways to direct a portion of tail-water flow towards the fishway entrance.

Glacier concluded that, given the results of fish movement corridor study, fish would likely find the entrance to the fishways located on each bank. Glacier believed that the upstream fishway facility offered great flexibility in operation allowing for maximum adaptive management and it was confident that the fishways would allow any fish greater than 150 mm in length to pass upstream. Glacier indicated that fish specimens greater than 150 mm in length had been captured for 14 of the 23 fish species found in the study area. Glacier also noted that the conservative approach used for hydraulic modelling and the use of large rock rip-rap along the margins of the rock ramp portion of the fishway would probably allow fish smaller than 150 mm in length to pass upstream through the facility. Glacier acknowledged that the upstream fish passage facilities would operate only during the open water season and that burbot would be unable to pass the facility for a portion of their core upstream movement period.

Glacier commissioned a hydraulic modelling study of flows at and around the coffer dams that would be in place during the construction phase of the Project. Glacier noted that during construction years two and three, and for a portion of construction year four, the channel of the river would be constricted by coffer dams such that a potential water velocity barrier could occur. Glacier reported that a solution had been developed which incorporated the pre-cast concrete triangular trash rack pier elements and temporary pre-cast concrete trash rack bay covers. Glacier stated that manipulation of the size and location of trash rack pier wall ports would produce optimal fish passage velocities. While it believed that this design would mitigate any potential adverse effects on fish passage during construction, Glacier said a contingency fish capture and transfer program was developed to deal with any unforeseen upstream fish passage issues during construction.

8.4.2: VIEWS OF THE INTERVENERS

The Coalition

The Coalition stated that upstream fish passage success was unlikely to be 100 percent and that the effect of fish passage inefficiency would be a consistent removal of a proportion of spawners that would lead in the long term to an ever decreasing population. The Coalition also noted that, as the fishways were not designed for flathead chub, a species designated by Glacier as migratory, flathead chub would not be able to complete their migration. The Coalition also expressed the opinion that as the fishway would not pass fish less than 150 mm long, local sub-populations of small-bodied fish would not be able to access critical habitats and would also decline.

Government of Canada

DFO concurred with Glacier’s position that open water upstream fish passage during the operational phase of the Project had been adequately modelled and that through monitoring and adaptive management, open water upstream fish passage was achievable. However, DFO stated that it remained concerned about the absence of upstream fish passage during winter, particularly for burbot. DFO recommended that Glacier develop and implement a monitoring program to verify predictions related to burbot migration and impacts, implement a burbot study to gain a better understanding of the impacts that inhibited upstream passage in winter might have on the resident burbot population, prepare an adaptive management strategy to address potential fish passage blockage and implement the strategy if necessary.

DFO indicated that upstream fish passage issues during construction had been addressed but would need to be verified by monitoring. DFO recommended that Glacier implement an ongoing monitoring program aimed at verification of predictions related to fish migration through the construction area and implement an adaptive management program should monitoring reveal any problems with fish passage during construction.

8.5: DOWNSTREAM MOVEMENT OF FISH

Glacier stated that the objective of mitigation measures to ensure the safe downstream passage of fish was focused on protection of the adult cohort of the fish population. Based on a review of the literature, Glacier concluded that no new state-of-the-art technologies were available that could be widely adopted as mitigative measures for the safe downstream passage of fish species of interest in this Project. However, Glacier stated that the following established mitigative measures for the downstream movement of fish have been integrated into the new design of the planned Dunvegan hydroelectric plant headworks:

- 10 fish passage sluiceways
- 8 fish exclusion racks
- 40 "fish-friendly" turbines
- 110 m long fixed ogee shaped spillway

8.5.1: VIEWS OF THE APPLICANT

8.5.1.1: FISH PASSAGE SLUICEWAYS

Glacier said that one sluiceway is positioned between each set of five turbine units. Two sluiceways are placed between the powerhouse and spillway and one sluiceway is located next to each fish passageway on the north and south banks of the river. Glacier explained that each of the 5.25 m (width) by 48.3 m (length) sluiceway structures, coarsely screened by a metal-bar support frame (i.e. grizzly), consists of an upper (400 mm) and lower (600 mm) gated conduit which regulates flows and conveys fish from the headpond to the downstream tailrace area. Glacier noted that the fish sluice at the south abutment does not have an upper-gated conduit. Glacier said that guidewalls extend approximately 20 m downstream from the end of the sluiceways to guide the fish exiting the structures away from the turbulent tailrace zone to further assist the downstream passage of fish,

Glacier stated that the flows designed for the upper and lower gated conduits are 0.75 m^3/s and 20 m^3/s, respectively. However, if required by river flow and headpond conditions, Glacier said the discharge capacity of the lower gated conduit, positioned near the base of the headworks wall, could be increased from 20 m^3/s to 50 m^3/s. Glacier stated that during the core downstream fish migration season (i.e. August 1 to October 31), flows of up to 60 m^3/s would be provided to the fish sluices. Consequently, Glacier reported that at peak conduit flow capacity, only three sluices could operate at any given time. Alternatively, Glacier said it would be possible to operate all the fish sluices at the same time with a flow of 6 m^3/s per sluiceway. Glacier indicated that the operation of the fish sluices would occur on a rotational basis to optimize any preferences exhibited by fish as to passage locations along the face of the headworks structure.

Glacier stated that the low river flows, normally occurring during August 1 to October 31, would prevent simultaneous operation of all 40 turbines. Glacier said flow conditions allowed flexibility as to which and how many turbines to shut down at any given time to enhance guidance flows to the sluiceways. Glacier concluded that during plant operation, the distribution of flows between the fish sluices would vary depending on the presence of fish and river flow volumes. In this regard, Glacier reported that hydraulic modelling was conducted to develop plant operational criteria and adaptive measures. Glacier indicated that the latter protocols would be field-verified and refined based on monitoring of fish passage during operations. Glacier denied the possibility of sacrificing water flow through the fish passage to increase electricity generation and profits.

8.5.1.2: FISH EXCLUSION RACKS

Glacier reported that eight exclusion racks, one in front of each set of five turbine units, would be installed across the entire upstream face of the headworks. The fish exclusion or trash racks were designed to minimize entrainment of fish through the turbine inlets and to provide guidance flows towards the sluices. Glacier planned to deploy exclusion racks of two different spacings. Glacier stated that the racks, each with a framework of 25 mm spaced steel or plastic bars inclined at 35 degree to the horizontal, would be installed during the core downstream migration period to physically exclude adult fish, particularly goldeye and walleye species. Glacier explained that the period of August 1 to November 15, coincided with low river flows, which carry the least amount of debris and suspended sediments, enabling the use of the overlay of fine bar racks without undue maintenance and cleaning.

Glacier said that, following the core migration period, the exclusion racks with 25 mm spacings would be removed, leaving the coarse debris racks with 100 mm spacings. Glacier indicated the coarse debris racks would be removed just prior to freeze-up of the river (i.e. frazil ice formation), which generally occurs around November 30, and would be re-installed after ice break-up in late March or April. Glacier said the rack supports would remain in place all year round. Glacier stated that flexible measures, based on adaptive management, would be developed and implemented to ensure that the appropriately sized exclusion racks would be in place as early as possible and kept in place as late as possible each year. As an example, Glacier suggested that the reinstallation of the 25 mm bar rack after the initial generation of frazil ice and the formation of solid ice cover on the headpond in early winter might be investigated if warranted to protect the downstream passage of burbot in winter.

Glacier reported that extensive physical and numerical modelling was completed to examine the hydraulic velocities near the two trash rack designs under different simulated river flow conditions. Glacier concluded that the water flow velocity in front of the trash racks was lower than that in the headpond and slightly above 1 m/s, a flow velocity that allowed fish to swim away from the screen. Based on the results of tests using physical models, Glacier believed that the pattern and direction of water flows near the trash racks designed for the Project would guide fish to the sluiceways. Glacier committed to implement a follow-up program to monitor and evaluate the effectiveness of the exclusion racks and associated management measures in mitigating the effects of the operation on the downstream passage of fish.

Glacier stated that in recent years, very few studies had evaluated the effectiveness of downstream passage technologies in diverting riverine fishes away from hydroelectric turbines. Glacier noted that, while downstream protection or passage facilities for non-game and game fish species were planned or installed for many projects in the US, no information or data were reported for most of the fish species of concern at the Project site. Glacier reported, however, that the few studies that were conducted with narrow-spaced bar racks supported the use of this approach for preventing entrainment simply because the bars act as a physical barrier, as well as a behavioural barrier, for some fish species.

Glacier acknowledged that, while it had experience with the management of trash racks as a mitigative measure for the downstream passage of fish at ten of its operating hydroelectric plants in Canada, none of these facilities used exclusions racks similar to that designed for the Project. Glacier indicated that the high angle of incline (i.e. 35^{o}) of the racks and the bar spacings were features unique to the Project.

8.5.1.3: TURBINES

Glacier described the propeller-type turbines proposed for the Project as fish-friendly and the best technology available today for low-head application. Each turbine, with a generating capacity of 2.5 MW, consists of four fixed-pitch blades and a runner diameter of 2.6 m. The turbine blade rotates at 170 rpm and creates a peripheral runner speed of 23.3 m/s, which is 94 percent greater than the optimal value for a fish-friendly turbine (12.2 m/s). This value for the Project turbine blade, however, is at the lower end of the range of peripheral runner speeds for turbines operating at comparable hydroelectric facilities (19.0 to 40.9 m/s). Glacier reported that the clearance between the runner and fixed housing components is 6 mm, which exceeds the optimal fish friendly criteria of 2 mm or less. Clearances values for turbines operating at comparable hydroelectric facilities range from four to ten mm. Glacier stated that the turbine operation efficiency is 91 percent, which meets the optimal criteria for fish friendly turbines (i.e. 90 percent or greater). Glacier did not compare the specifications of the Project turbine with that of fish-friendly turbines or that of turbines at comparable hydroelectric facilities for additional criteria such as minimum pressure drop, rate of change of pressure and shear stress indicator.

Glacier reported that in the event of low river flow conditions, some turbines would be shut down entirely to allow all the remaining turbines to operate at their full capacity and peak efficiency. Glacier indicated that water flow through the turbine would account for 84.9 percent (second half of June) to 99.3 percent (first half of December) of total available river flow.

Glacier stated that fish entrained through the turbines could sustain injuries. Glacier explained that the rate of injury and subsequent rate of survival would depend on the size of fish and the characteristics of the turbine. Glacier reported that, in general, smaller fish experience lower injury rates than larger fish because the smaller fish pass through the available gaps and openings in the turbine system more easily. Glacier indicated that turbine characteristics affect the injury rates of fish by influencing the rate of physical strikes and by inducing rapid pressure change (cavitation) and shear force stress. Based on the literature, Glacier said the probability of fish experiencing a strike from a turbine blade is a function of fish length, flow, number of runner blades, blade angle and revolutions per minute. Strike rates are directly correlated with flow rate, number of blades and revolutions. Glacier concluded from a review of the literature that mechanical-related injury to fish is the dominant cause of fish mortality at low-head (< 30 m) projects.

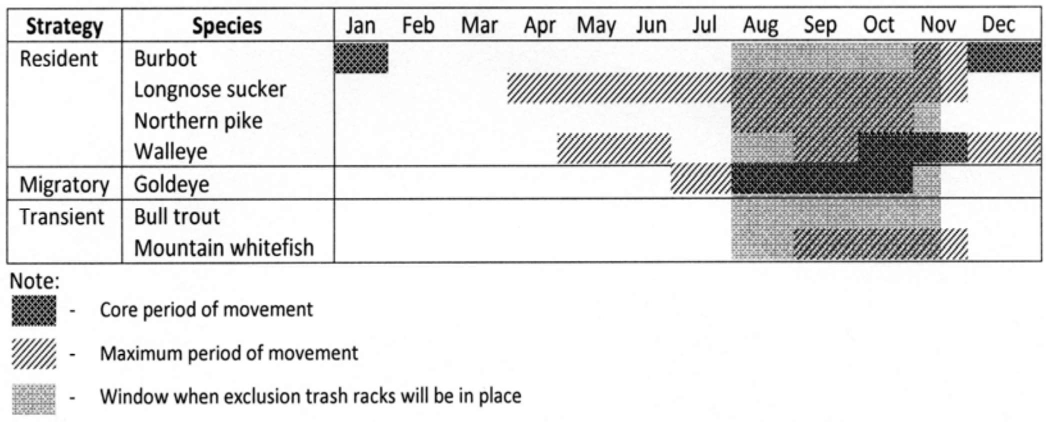
Based on the results developed and reported in the published literature, Glacier estimated the following survival rates for fish passing through its Project turbine:

- 95 percent survival of fish <100 mm in length
- 90 percent survival of fish 100-199 mm in length
- 88 percent survival of fish 200-299 mm in length
- 83 percent survival of fish equal to or greater than 300 mm

Glacier reported that the average survival rate of fish entrained and passing through a turbine at the Project is estimated to be > 90 percent.

Glacier emphasized that the mitigation strategy to protect fish from turbine entrainment was designed to physically exclude all adult fish of large-sized fish species populations during the period August to November. Small-sized fish species populations and non-adults of large-sized fish species would be able to pass through the turbines year round. Glacier indicated that the potential adverse effects of turbine operation on fish health and survival would depend on the portion of the population that passes through the turbines and the survival rate of the fish during turbine passage. Glacier presented Table 1 as a summary of the expected timing of downstream movements by adult fish of large-sized species populations compared to the period of exclusion by trash racks.

Table 1: Fish Movement Timing Downstream Past the Project Area and Window for Fish Exclusion Trash Racks



Based on results in Table 1, Glacier noted that:

- Migratory adult goldeye would be excluded from turbine passage during the core period of downstream movement. However, goldeye that move outside the core period in July would be entrained.
- Resident burbot and walleye species exhibit core movement periods. No adult burbot of this species population would be excluded from turbine passage. Adult walleye moving downstream in May, June and December would not be excluded from turbine passage.
- Longnose suckers are susceptible to turbine entrainment as they demonstrate an extended period of downstream movement (April to November).

Glacier emphasized that a predicted significant adverse effect caused by the Project is limited to the local fish community. At the regional fish community level, the potential for the Project to cause a significant adverse effect is low to nil.

8.5.1.4: SPILLWAY

Glacier reported that the spillway would be a gated fixed crest Ogee-shaped design used to provide flood discharge capacity for flows in excess of 2,150 m^3/s. Glacier said the downstream lip of the spillway was designed to direct the discharge horizontally to prevent the spillway flow from plunging to depth. Energy dissipaters would be installed at the base of the spillway in the tailrace zone. Glacier indicated that each of seven spillway chutes would contain five energy dissipaters: two in the front and three in the rear of the tailrace.

Glacier indicated that the spillway, when flowing, would offer an alternative downstream passage route available to fish. During an average flow year, spillway operations were expected to occur from the second half of April to the second half of June. Glacier anticipated that the average percentage of river flow through the spillway would range from 2-12 percent, with peak flows occurring during the first half of June.

Glacier reported that, although fish could pass over a spillway uninjured, there were a number of potential sources for injury of fish during passage:

- abrasion or impact against the spillway base or energy dissipater structures
- turbulence
- rapid changes in pressure
- rapid deceleration
- shear stress
- impacts associated with free fall

Glacier explained that the Ogee-shaped spillway design and the low head (6.6 m) of the spillway structure substantially reduce the probability of injury to fish from these sources. The spillway design would allow water to adhere largely to the structure surface, preventing free fall against the tailrace and rapid pressure change. The low head would minimize shear stress and rapid deceleration of the spillway water. Glacier indicated that the depth of the water in the tailrace zone would be greater than 4.9 m during a spill event, which would reduce the probability of fish injury due to impact against the floor of the tailrace. Glacier concluded that the probability of fish passing over the spillway, and subsequently being injured, would be dependent primarily on the percentage of available flow that was spilled and the timing of the spill relative to downstream movement of fish.

8.5.2: VIEWS OF THE INTERVENERS

8.5.2.1: FISH PASSAGE SLUICEWAYS

The Coalition

The Coalition questioned the feasibility and sustainability of the adaptive management plan proposed by Glacier for the downstream movement of fish. The Coalition said effective implementation of the proposed adaptive management plan, involving the selective shut down of turbines to influence the guidance of river flow towards the fish sluices during the core downstream fish movement period, required an informed, timely and discretionary onsite decision by knowledgeable individuals. In this regard, the Coalition noted that required observations such as fish movements, headpond levels and river flows would have to be made by an on-duty staff of three. This complement of individuals was scheduled to work on a shift basis to manage the headworks operations 24 hours per day, 365 days a year.

The Coalition maintained that debris or ice transported by the river could lodge in the fish passage sluiceways to block the flow of water, hindering the attraction of fish to the sluiceways and the direct passage of fish downstream. The Coalition questioned the feasibility of Glacier's plan to employ routine maintenance equipment and procedures, designed to remove accumulated debris from the trash racks installed in front of the turbines, to clear debris lodged in the sluiceways.

Government of Canada

DFO acknowledged the physical and numerical modelling and design work conducted by Glacier to investigate the downstream passage of fish. DFO stated that, provided adaptive management would be carried out, the downstream fish passage concerns were addressed by Glacier for open water. However, in view of uncertainties related to the operation and performance of the downstream passage systems under ice-covered and high-debris conditions, DFO recommended that Glacier continue to work with DFO and ASRD to finalize a comprehensive monitoring program for downstream fish passage systems to inform adaptive management strategies and achieve effective fish passage.

8.5.2.2: FISH EXCLUSION RACKS

The Coalition

The Coalition believed that several important aspects of the operation of the exclusion racks remained open to considerable uncertainty:

- Feasibility of timing of the installation and removal of the fine and coarsely spaced racks to ensure optimum and effective protection of fish species of interest from entrainment
- Effectiveness of the installed racks to protect the downstream passage of various fish species of interest, specifically thin-bodied adult fish such as goldeye, fry and juvenile life stages of fish species and all small fish species
- Behaviour of fish species of interest, which was untested with respect to the exclusion racks, and the subsequent effectiveness of the exclusion racks to guide the fish to the sluiceways
- Timing of the maintenance procedures to remove debris from the exclusion racks and the subsequent effects on fish migrating downstream

Government of Canada

DFO indicated that the fine bar racks would not be in place during December to January, the core time period during which burbot move downstream under ice cover to access spawning habitat. Subsequently, DFO stated that the estimated turbine mortality of the adult burbot migrating downstream was a concern. To address this concern, DFO presented the following recommendations:

- Glacier develop and implement an ongoing monitoring program aimed at verification of prediction related to burbot migration and impacts through the project area
- Glacier develop a burbot study to gain a better understanding of the impacts that a lack of winter movements may have on the resident burbot population
- Glacier prepare an adaptive management strategy to address potential fish passage blockages and/or turbine mortality issues for burbot and, should monitoring indicate a negative effect, implement this strategy to the satisfaction of DFO

DFO stated that a better understanding was needed regarding the hydraulic flows that would occur immediately adjacent to the upstream face of the designed trash racks. In this regard, DFO recommended that Glacier conduct a near-field modelling study of the exclusion racks to assess the nature of guidance flows for fish and to fine-tune the design of the racks, if necessary.

DFO confirmed that Glacier had accepted all of its recommendations related to the use of exclusion racks as a mitigative measure for the downstream passage of fish.

8.5.2.3: TURBINES

Coalition

The Coalition questioned the extent to which Glacier would be able to adaptively manage and effectively resolve the issue of adult fish mortalities due to turbine entrainment. The Coalition stated that it was unclear what mitigative measures may be feasible if, for example, monitoring showed too many burbot were being injured or killed by turbine entrainment.

Government of Canada

DFO stated that it was concerned with the potential for turbine mortality of burbot moving downstream during the winter months to access downstream spawning habitat. DFO said the potential effects of turbine mortality on the burbot population were unknown. DFO presented recommendations to address its concerns (Section 8.5.2.2).

8.5.2.4: SPILLWAY

Government of Canada

For the types of fish inhabiting the Peace River, DFO stated that there are limited data and experience regarding the mortalities and injuries associated with fish passage over an Ogee-shaped spillway and through a tailrace installed with dissipaters. DFO presented recommendations to address its concern (Section 8.5.2.1)

8.6: VIEWS OF THE PANEL

The Panel has regard for the concerns that were expressed about the lack of information and understanding of the fish populations in this region. Matters of abundance and mortality related to fish movements upstream and downstream of the proposed Project site are two particular concerns. Other concerns outlined by interveners include: habitat loss, proposed adaptive management, mitigation measures, compensation strategies and the design and efficacy of the various proposed fishway and trash rack structures.

In March 2003, the EUB-NRCB Joint Review Panel recommended that Glacier's application for the Project be denied. Part of the reason for denial of the application was related to a number of identified, significant uncertainties and unresolved issues with respect to Peace River fisheries. The Panel finds Glacier has attempted to meet each fishery concern raised in the 2003 decision. Glacier has produced a better fish-friendly design of the headworks, conducted additional fish studies and developed specific monitoring, adaptation, mitigation and compensation strategies. In undertaking this work, Glacier has worked collaboratively with DFO and ASRD on both fish modelling and alterations to the facilities design to enhance fish survival and movement both upstream and downstream.

ASRD indicated that it would not participate in the hearing and that its questions had been answered. DFO participated in the hearing and was satisfied with much of Glacier's work and commitments. DFO, however, had a number of ongoing concerns and made recommendations that have been accepted by Glacier. The Panel notes that DFO will still need to issue a number of approvals and will further review Glacier's activities during construction and operations. Additional conditions and requirements may still be added by DFO.

The Panel recognizes that there may be negative consequences in regards to the fisheries in the LSA, particularly for some species, but finds that cumulative effect on the regional fishery will be low to nil. The Panel is of the view the capacity of the fishery as a renewable resource to meet the needs of the present and those of the future is not likely to be significantly impacted. The Panel is cognizant that all predictions and models have a level of uncertainty and that there are some risks to fisheries, both during construction and operations. The Panel recognizes that there will be a need for a follow-up program to carefully monitor both the fish communities and the performance of the mitigative facilities. The Panel expects the dedicated and active involvement of DFO and ASRD in order to ensure that appropriate and timely adaptive responses come into play if negative outcomes are detected. Negative outcomes for fisheries that cannot be satisfactorily dealt with through adaptive management may require additional mitigation and perhaps additional habitat compensation.

Characteristics of the Fish Populations

The Panel finds that extensive additional work has been completed since 2003 to meet the deficiencies in understanding the nature and movement of fish populations, particularly in the Dunvegan stretch of the Peace River. The Panel rejects the Coalition's general conclusion that little improvement in understanding has been gained with the additional work completed by Glacier. In particular, the Panel finds that the two years of completed site-specific baseline fish community studies, as well as the three completed years of fish tagging and telemetry studies has provided a major improvement in the understanding of the characteristics of the fish populations in the LSA. Despite the considerable knowledge acquired about the timing and extent of fish movement through the project area and the species diversity, structure, abundance and communities of fish populations, the Panel appreciates that some uncertainties regarding the characteristics of the fish populations still remain and will require resolution. While Glacier will initiate and complete further studies, monitoring and assessments, the Panel recommends that directly accountable resource management agencies, such as ASRD and DFO, share this responsibility.

The Coalition argued that the real characteristics of the local fish community remain unclear because Glacier has underestimated the actual abundance of fish populations in the LSA and the amount of movement exhibited by the overall fish metapopulations. The Panel finds the Coalition's position largely unsupported given the extensive work conducted by Glacier as noted above. The Panel finds relevant the fact that there were no provincially listed endangered fish species found in the LSA and that the LSA fishery is characterized by a low abundance in sportfish species and dominated by non-sportfish and small fish species. In view of the nature of the LSA fishery, the Panel also finds that the fishery provides low recreational value and low usage as a source of food to the local citizens and Duncan's First Nations people.

The Panel finds that the characteristics of the fish population are adequately understood but recognizes that there is a need to further validate the key conclusions presented by Glacier regarding fish populations and migration. This will be accomplished largely by Glacier's commitment to complete a third year of study on baseline fish communities prior to start-up of the Project. The Panel recommends that DFO incorporate, in any future permits or authorizations, the recommendations related to follow-up and monitoring programs filed in this proceeding. The Panel strongly encourages collaborative studies that will add to the current understanding of the interrelationship of resident non-sportfish and small fish species to the regional fish populations, as well as the importance of fish movement through the Dunvegan area, particularly for juvenile and adult life stages of fish such as the mountain whitefish, bull trout and goldeye. The Panel notes that Glacier has committed to an adaptive management approach for dealing with any impacts detected on local fish populations.

Upstream Movement of Fish

The Panel finds that the potentially adverse effects of the Project on the upstream movement of migrating and transitory groups of fish can be successfully mitigated through the installation and operation of the two upstream fish passageway systems designed for the Dunvegan site. The Panel finds the flexibility in operation of the fish passageway system that includes fishway flow controls, guidewalls and passageway attraction flows, will enable implementation of the adaptive management strategies which are planned to ensure successful performance of the upstream fish passageways during varying river flow conditions. In this regard, the Panel particularly notes Glacier's commitment to provide, at any given time, no less than 60 m^3/s of river water flow for the fish passage structure operations. The Panel finds that the three-year program of hydraulic modelling and evaluation studies undertaken by Glacier with the advice and cooperation of DFO and ASRD has resulted in a unique, custom-designed, fish-friendly structure.

In particular, because of the hydraulic modelling studies, examination of water flows and velocities around the coffer dams with and without mitigative structures during the construction phase of the Project, the Panel finds the proposed mitigation strategy for upstream fish movement reasonable and acceptable. The Panel concurs with the view of DFO that the upstream fish passage issues, particularly during the third and fourth year of the Project construction, have been adequately addressed. The Panel recommends, as advocated by DFO, that Glacier implement an ongoing follow-up program to verify modelling predictions and implement an adaptive management program, should monitoring reveal any problems with fish passage during construction. The Panel notes that Glacier has committed to a fish capture and transfer contingency program during construction, if warranted by unpredicted upstream fish passage issues.

The Panel remains concerned about the absence of upstream fish passage during the winter months that will adversely impact the resident burbot migration particularly. The Panel recommends, as advocated by DFO, that Glacier monitor, study and adaptively manage the impacts on resident populations and implement an ongoing monitoring program to verify its predictions related to fish migration and fish population impacts for mountain whitefish, bull trout and burbot within the project area.

During the period of open water and operation of the upstream fish passageway, the Panel notes that there is some uncertainty whether fish less that 150 mm long will be able to use the system to pass the headworks. The Panel finds the longer-term impact on fish populations of this limitation of the fish passageway to the movement of small-bodied fish, particularly migratory species such as flathead chub, is not clearly understood. The Panel recommends, as advocated by DFO, that Glacier monitor and adaptively manage this issue, post-construction.

Fish Habitat Compensation Plan

The Panel finds that Glacier conducted an assessment of fish habitat losses and gains for the Project, according to an accepted protocol and submitted a habitat compensation plan to DFO and ASRD. The Panel recognizes that DFO is directly responsible for implementing the federal "Policy for the Management of Fish Habitat" and ensuring that Glacier adopts an appropriate hierarchy of preferences to develop its no net loss fish habitat compensation strategy. Consequently, the Panel finds the habitat compensation plan that includes creation of northern pike spawning and rearing habitat in the headpond zone and a radio telemetry study of walleye in the Little Smoky River, to be a satisfactory option for mitigating the Project related fish habitat losses in the LSA.

The Panel finds that, with a few exceptions such as Sawchuk shoal located 17 km from the headpond, the existing fish habitats in the LSA are generally characterized by low complexity and quality. Based on the evidence, the Panel disagrees with the Coalition's conclusion that fish habitat greater than 26 km upstream from the headworks will be adversely affected and require assessment. The Panel finds that there will be no adverse effect to fish habitat at the regional level and accepts Glacier's commitment that it will mitigate habitat losses in the LSA via an approved DFO no net loss action or habitat compensation plan.

Downstream Movement of Fish

The Panel finds that the specific features of the headworks designed to facilitate the safe passage of fish downstream during open water (e.g. gated fish sluiceways, 25 mm bar spacing exclusion racks, Ogee-shaped spillway, hydraulic energy dissipaters) will satisfactorily mitigate the impact of the Project on the local and regional fish community. The Panel acknowledges that Glacier conducted numerical and physical modelling studies in cooperation with DFO and ASRD to assess and improve the design and the subsequent performance of the sluiceways and fish exclusion racks. When the plant is not operating at full capacity, the Panel finds that Glacier can, as an innovative adaptive management strategy, selectively shut down turbines adjacent to the sluices for congregating fish to enhance the guidance flows of water toward the sluices.

Glacier's mitigation strategy to protect fish from the turbines is the physical exclusion of all adult fish of large-sized fish species populations during the period August to November. The Panel understands, however, during periods of high debris and ice flow, as well as, throughout the winter months, that the fish exclusion racks will not be in place. Consequently, there is a concern that adult fish species such as burbot, walleye, goldeye, whitefish and longnose suckers moving downstream will become entrained in the turbines and suffer mortalities despite the use of fish friendly turbines. In view of the mitigative design features for downstream fish passage and Glacier's commitment to provide adaptive management responses if and when any unpredicted losses occur, the Panel finds that the expected fish mortalities are not a significant adverse effect. However, the Panel strongly recommends, as advocated by DFO, that Glacier follow up to verify its predictions regarding impacts to fish movement, migration and fish populations, including small-sized fish species and non-adults of large-sized fish species.

The Panel finds Glacier has adequately addressed the issue of potential fish mortality associated with the spillway operation. Considering the Ogee-shaped design of the spillway and the expected short two-month period of flow over the spillway, the Panel finds that the potential adverse effect on fish health/survival caused by the spillway operation is expected to be negligible for most fish species populations. In addition, the Panel considered the views of Glacier and the interveners with regard to potential gains in fish habitat productivity and expects Glacier to work closely with DFO and other stakeholders to maximize any measures to enhance beneficial environmental effects. However, the Panel recommends, as advocated by DFO, that Glacier finalize a comprehensive follow-up program that includes studying the downstream passage route for fish.

SECTION 9: ICE FORMATION AND BREAK-UP

Ice formation and break-up issues were considered as a prominent area of concern for this application, as was the case during the previous application in 2002/03. This arose because of uncertainties associated with complex river ice processes during both formation and break-up on the Peace River. Interactions with the Project and naturally occurring processes complicated analysis of the potential impacts of the Project on the ice regime of the Peace River and in particular, impacts on the ice regime near the Town of Peace River, at Shaftesbury Crossing, Taylor, BC and Fairview. Ice formation and break-up, the ice regime on the Peace River and associated changes in human and environmental risk were identified as the most susceptible to potential impacts as a result of the Project. Notably, the ice regime would change from a one-front ice cover to a two-front ice cover as a result of the Project.

Currently the ice regime and processes on the Peace River are monitored by the Alberta-British Columbia Joint Task Force on Peace River Ice (JTF). The JTF, formed in 1975 as a result of flow regulation of the Peace River by the Bennett Dam and Peace Canyon Dam, is comprised of Alberta Environment, the British Columbia Ministry of the Environment and BC Hydro. The JTF monitors ice processes during ice formation and break-up, specifically processes that have the potential to cause flooding at the Town of Peace River. JTF decisions influence BC Hydro's operational procedures so as to reduce the flooding risks at the Town of Peace River. The JTF does not have any enforcement capabilities, but relies on cooperation, agreement and consensus among its members.

9.1: VIEWS OF THE APPLICANT

Glacier stated that, in order to further address issues associated with the impact of the Project on the ice regime of the Peace River, it conducted studies on ice behaviour for three years after the issuance of the EUB-NRCB Joint Review Panel's 2003 decision.

To examine the ice formation and break-up, Glacier used an area along the Peace River from the Bennett Dam to Fort Vermillion (approximately 860 km) as the spatial boundary and a temporal boundary that extended from 1958 to 2111 (the earliest dates of river discharge records to projected Project decommissioning). Glacier stated that administrative boundaries included meteorological and hydrometric station locations within the spatial boundaries and had technical boundaries defined by the quality of the meteorological, hydrometric and channel morphologic information used.

9.1.1: EXISTING CONDITIONS

Glacier stated that currently the ice regime for the Peace River is dependent on the climate in the region. Cold winters promote rapid development of the ice cover as far upstream as Taylor, BC, while warm winters delay the formation of an ice cover and limit the upstream progression. At break-up, relatively warmer spring temperatures contribute to the weakening, melting and downstream recession of ice cover on the Peace River as does increasing run-off in tributaries, particularly the Smoky River.

Glacier explained that river water temperatures are also influenced by outflow water discharge and temperature from the reservoir created by the Bennett Dam. When the air temperature is lower than river water temperature, the water cools as it flows downstream. After it reaches zero degrees Celsius, the water continues to supercool (water temperature falls below freezing point), and it begins to nucleate and forms frazil ice.

Newly-formed frazil ice consists of small crystals which are primarily disc shaped and approximately 0.1 to 6 mm in diameter. They grow in number and size within the full water column. Frazil ice can stick to the river bottom, forming anchor ice, or can float to the surface to form surface ice that continues to move down the river. Frazil ice can also stay in the water column and travel downstream in suspension before it eventually becomes permanently or temporarily deposited under an existing ice cover downstream. Glacier's evidence showed that the amount of frazil ice in suspension versus the amount deposited depends primarily on its size and water velocity. As surface frazil ice moves downstream, it coalesces and freezes into pans that grow in size and thickness, as a function of time of exposure to cold air. Eventually surface frazil ice reaches a surface concentration of 100 percent at which time no additional suspended frazil is produced in the water column. Shore ice growth also occurs during this time.

Glacier submitted that in those places where the river current slows, shore ice grows, pans become concentrated and an intact ice cover begins to form. On the Peace River, this typically begins near Fort Vermillion, (usually at Vermillion Chutes). Depending on the air temperatures and the amount of open water, as additional surface ice pans are transported down the river, their progress is arrested at the intact ice cover front. If the current is weak, the pans would juxtapose, accumulating against the downstream ice and the intact cover would rapidly grow upstream with the thickness of one pan layer. However, if the current is stronger, as is common in the Peace River, the pans thicken into a multi-layer (primary consolidated), typically 0.8 to 1.2 m in thickness that moves more slowly up the river because the ice cover accumulation is thicker.

Glacier stated that this new accumulation would develop an ice crust at the water surface, binding the pans together. Over time, this crust would thermally thicken and the cover would therefore gain more and more strength. In some cases the new accumulation can collapse through a secondary consolidation. Glacier asserted that this is particularly true when the new accumulation growth occurs quickly upstream and when the thermal crust of the accumulation is thin. When secondary consolidation occurs, large volumes of water are released and a wave of ice and water moves downstream that results in thickening of the ice cover downstream causing water levels to rise sharply and rapidly.

The location of the ice cover front in the river at any given time depends on how much ice is produced, how thick the ice cover accumulation is and climatic conditions. The amount of ice produced depends on the available river surface area, the initial water temperature and discharge released at the Bennett Dam and meteorological conditions such as air temperature. Glacier provided typical pre-Project ice cover durations at various points of interest along the Peace River under current conditions (Table 2). In warm winters, the ice front reaches within 300 km of

Bennett Dam, near Dunvegan, while in cold winters the ice front typically reaches within 100 km of Bennett Dam, near Taylor, BC.

TABLE 2: TYPICAL ICE COVER DURATION ALONG THE PEACE RIVER	
Location	**Ice Cover Duration (weeks)**
Taylor	0-3
Dunvegan	0-14
Town of Peace River	6-20
Fort Vermillion	16-25

Glacier outlined how the break-up of the ice cover occurs in the spring. As the air temperature increases and the hours of sunlight increase, the ice cover temperature increases, resulting in weakening of the ice cover. In the open water portions of the river, water temperatures increase above zero. When this water meets the ice cover front, it further warms the ice, partially melting it. The cover would eventually be unable to withstand external forces (such as water, wind and ice shear, and pressure) and it would fail in one of two ways – by thermal or mechanical break-up. According to Glacier, upstream of the Town of Peace River the ice cover near the front gradually gets eroded by the warm water typically at 5-10 km/day. This process is called thermal break-up.

Glacier submitted that break-up could also be “mechanical” (also known as “dynamic”), particularly on the Smoky River or on the Peace River downstream of the Town of Peace River, during some years. Mechanical break-up occurs when strong external forces, usually created by rapid increases in discharge, break-up ice cover and transport it downstream. Many kilometres of ice cover could be destroyed in a relatively short period of time (within a few hours). When break-up is mechanical, or dynamic, the broken ice eventually ends up forming an “ice jam” somewhere downstream where the cover is strong enough to resist the external forces. When an ice jam occurs, water levels can rise to significant levels within hours.

Glacier stated that regulation of river flow by the Bennett Dam has generally altered the ice regime in the Peace River in two ways: by delaying the onset of freeze-up upstream of Fort Vermillion (because of higher winter discharge and warmer water temperature released from the reservoir) and by creating a milder break-up upstream of the Smoky River through the regulation of upstream spring runoff and providing warmer water that favours thermal break-up.

Glacier indicated that at the Town of Peace River, the effects of flow regulation were more complex. Regulation delayed freeze-up at the Town of Peace River between one week and two months, increased water levels during freeze-up at the Town of Peace River by 2 to 3 m and increased ice thickness due to formation of mainly consolidated ice covers. These effects were principally due to higher winter flow rates that favour consolidated covers rather than juxtaposed covers and the longer presence of open water that increases frazil production and the resulting thickness of frazil deposition under the consolidated cover.

Glacier submitted that in the spring, the regulation resulted in an earlier break-up due to increased thermal input and reduced the probability of jamming at the Town of Peace River because the cover was already thermally weakened by the time the Smoky River break-up ice reaches the Town of Peace River. Glacier concluded break-up severity has likely been reduced.

9.1.2: POTENTIAL EFFECTS OF THE PROJECT ON ICE REGIME

Glacier initially identified and considered a number of potential effects the Project may have on the ice regime in the Peace River and, in particular, the impact of the ice cover formation becoming a two-front system post-Project. The first ice front would continue to develop from downstream of Fort Vermillion, near Vermillion Chutes, as it did pre-Project and move upstream, albeit at a reduced rate upstream due to reduced frazil ice transport. Glacier indicated that a second ice front would develop at the Project and move upstream from there.

9.1.3: ICE MODELLING

Glacier recounted that the initial assessment of the Project's effects on the Peace River ice regime was prepared during the 2000 EIA and application, and presented at the 2002 public hearing. At that time, two models were applied to the Peace River, the Trillium Engineering ICE Model of the Peace River (TRICEP) and the River ICE (RICE) Model. Glacier stated that RICE was computationally more sophisticated than TRICEP but not as well calibrated to historical observations and measurements on the Peace River. RICE was generally used to check the results of TRICEP. Glacier noted that the two models did not necessarily correlate well with one another as RICE was developed for the St. Lawrence and Niagara Rivers. Glacier observed that the uncertainty cited from the EUB-NRCB Joint Review Panel's 2003 decision may have arisen due to differences in the two ice model outputs.

Glacier utilized a new model, the Peace River ICE (PRICE) Model developed by Dr. Hung Tao Shen of Clarkson University (Potsdam, New York), to model the ice regime of the Peace River for the current application. The PRICE Model was developed from 2003 to 2006 using the RICE (which had been in development for ten years also by Dr. Shen) computational framework, but with more refined advancements in how it simulated ice processes on the Peace River. Glacier stated that PRICE was calibrated with detailed, documented observations and measurements of ice processes on the Peace River. It stated that PRICE was developed with a particular focus on the frazil transport and deposition algorithms which were refined and tested at considerable length.

Glacier argued that the PRICE model contains the combined strengths of each of the two previous models and that PRICE simulated important ice formation and break-up processes but it was not used to simulate ice jam formation, secondary consolidations and mechanical break-up. Glacier applied PRICE to simulate the ice regime along the study area from Fort Vermillion to Peace Canyon. Glacier concluded that PRICE is the state of the art in simulating unsteady ice processes in rivers and represents the most current model available.

Glacier presented evidence showing that calibration of the PRICE model was a collaborative process, including 18 months of multi-stakeholder review and input. PRICE was investigated by several ice experts, government agency representatives and stakeholders through five technical workshops with the goal to gain consensus on the ability of the PRICE model to simulate pre- and post-Project ice conditions. Glacier submitted that there was agreement among all workshop participants, including experts representing Glacier, CROSS, Alberta Environment, Alberta Transportation and BC Hydro, that the ice modelling work represented an excellent application of the best technology available today.

Glacier showed that calibration of PRICE was based on real ice measurements and conditions observed during the winters of 2002/2003 and 2003/2004. By employing the correct values of key parameters, the model simulated individual ice processes such as thermal ice crust thickening, frazil ice generation and ice pan thickening, but not secondary consolidations or mechanical break-up.

Once the PRICE model was calibrated, Glacier said that it used 23 years of records between 1980 and 2004 for model verification. Historic daily fluctuations of water discharge released from the Bennett Dam, the water temperature when available and air temperature were input into PRICE for simulation of the ice cover evolution each winter. For periods when water temperatures were not available, daily median water temperature values were used instead.

Glacier submitted that the modelled variability was sufficient to generate a range of events that were then analyzed statistically. Glacier stated that the model did a reasonable job of simulating the position of the ice front over the winter period, but in cases where secondary consolidation occurred, or the model misrepresented a day of juxtaposition, the position of the ice front was not precisely reproduced. The model was also assessed for the performance of predicting ice-related water levels. Glacier stated that the model reproduced the rise and fall of water levels associated with changing flows and accumulation thickness reasonably well, but because PRICE did not explicitly address secondary consolidations, the peak freeze-up levels associated with these events were not well represented.

Glacier stated that PRICE was able to:

- Simulate base freeze-up levels related to juxtaposition and primary consolidations and the subsequent thickening (or thinning) of the ice cover due to frazil deposition (or hydraulic erosion) underneath.
- Simulate penetration of the thermal crust thickness into the ice cover.
- Simulate the ice cover front advance upstream and location of the ice cover front as the winter advances.
- Simulate the downstream recession of the ice cover front location.

Glacier rated the accuracy of the model in a coarse fashion by comparing measured and calculated ice front locations for each year during the 23-year period investigated and calculated the statistical characteristics of the deviations. For the 23 years simulated, the average error in ice front position simulations was 4 km, with a standard deviation of 24 km and average errors ranging from -14.7 km to +27 km (standard deviations ranging from 11.7 to 42.9 km) for individual years. From a statistical perspective, Glacier presented that the ice front would be simulated within plus or minus 24 km of its actual location, 68 percent of the time and within plus or minus 48 km, 95 percent of the time. Glacier expressed a high degree of confidence in the validation of the PRICE model, the model's results and the predicted effects of the Project on the ice regime in the Peace River.

As indicated earlier, Glacier stated that the PRICE model could not predict secondary consolidation events (including flood events in 1992 and 1997), but Glacier emphasized that reliable conclusions made about secondary consolidations were based on the assessment of conditions that PRICE was designed to predict that precede secondary consolidations. Based on an ice cover strength parameter (corresponding to the length of the cover divided by thermal ice cover thickness), Glacier made determinations about how the pre- and post-Project secondary ice conditions may change as a result of the Project.

Glacier acknowledged PRICE:

- Was not able to effectively predict mechanical break-up and/or secondary consolidation or the redistribution of frazil ice under ice cover.
- Did not consider anchor ice (as it was deemed not to be substantial).
- Used equal width shore (border) ice growth.

Glacier stated that frazil ice processes are not very well simulated due to a scarcity of data on frazil ice movement. Glacier added that even if these processes were adequately modelled, the conclusions would likely remain unchanged.

When questioned about another river ice model, CRISSP, Glacier submitted that the PRICE and CRISSP models fundamentally have the same engine, simulating similar processes from freeze-up to break-up. Glacier understood that the CRISSP model was more flexible in manipulating the data and results. It was Glacier's view that, regardless of which model and predicted processes were used, fundamentally they would show the similar conditions and results as Glacier's modelling evidence. Glacier acknowledged that notwithstanding the same model and inputs, in complicated systems like the Peace River, interpretations of the output may be different.

The interpretation of the importance of various processes, as well as the calibration of these processes within the model, could also influence model results and conclusions. Glacier stated that the modeller could influence the outcome of the model and that two different models could give substantially different results as could the same model applied by different people. Glacier noted that any particular model could be applied, and that the reliability of the model would increase if the produced results and interpretations were similar to those from a different model, provided both models were scientifically sound and good judgment was applied.

9.1.4: EFFECTS OF THE PROJECT

Glacier stated that it ran the PRICE model for the 23-year period with and without the Project, to simulate the ice regime on the Peace River given the same climatic conditions for each scenario. A typical normal year, warm year and cold year were each presented for comparison between pre- and post-Project conditions in the EIA. On average, the timing of freeze-up did not change appreciably downstream from Notikewin River, located approximately 271 km downstream from Dunvegan. Glacier showed that in the reach between the Notikewin River and Dunvegan, the rate at which the ice front advanced was reduced considerably post-Project due to interception of ice at the Project headpond, where a second ice front forms. Glacier stated that the formation of the ice cover was delayed at the Town of Peace River and Shaftesbury. In the most severe cold winters, the model predicted that the first ice front advanced within approximately 20 km of the Project. Freeze-up of the second ice front in the headpond would be much earlier, while break-up would occur later, substantially lengthening the ice season upstream of the Project. Glacier noted that there was no significant difference in the timing of ice cover break-up downstream of the Project.

Glacier reviewed the potential environmental and socio-economic effects of the changing ice regime in five areas – the headpond, downstream of the headworks, the Town of Peace River, Shaftesbury Crossing, and upstream of the headpond at Taylor, BC. Glacier stated that two concerns regarding ice formation and break-up may require mitigation: a predicted 0.5 m increase in base freeze-up water levels at the Town of Peace River, increasing the potential for groundwater seepage, and a potential two to three week average delay in the formation of an ice bridge at Shaftesbury.

In the Headpond

Glacier used the two dimensional DYNARICE model to predict and examine aspects of ice lodgement in the headpond, which would occur as soon as ice appeared in the headpond. While the model simulated velocities in both the downstream direction and secondary (lateral) direction (i.e. two-dimensional model), flow in the headpond would essentially be downstream (i.e. one-dimensional). Glacier stated that although the lodgement process could be treated as a one dimensional process without a significant loss in simulation accuracy, the two dimensional model was used for added rigour.

Glacier modelled two-dimensional lodgement to develop an understanding of how ice could accumulate in the headpond, which was considered more important for Glacier's initial proposed 40-MW-project in the EUB-NRCB Joint Review Panel's 2002 proceedings, when "free" lodgement and significant capacity for ice transport over the structure was possible. Glacier said that under the proposed 100-MW Project, little to no ice transport would occur over the structure making two-dimensional modelling relatively less important. It asserted that ice cover would be forced to lodge against the structure and the ice front would advance upstream from there, in a one-dimensional fashion. Glacier submitted that, relative to pre-Project, the ice cover in the proposed headpond area would form much earlier: late

November in a normal year, early November in a cold year or as late as late December in a warm year, post-Project (Table 3).

TABLE 3: ICE COVER FORMATION CHANGE IN THE PROPOSED HEADPOND AREA	
Type of Year	**Amount of Time Earlier (weeks)**
Cold and Normal	6-8
Warm	8-10

Glacier stated that at a typical winter river flow, the thickness and accumulation of ice was predicted to be approximately 1.0 m next to the headworks' structure and 1.4 m at a point 500 m upstream from the structure. The ice thickness reached pre-Project thickness (3.0 m) 12 km upstream from the structure. Glacier explained that once the headpond storage capacity for frazil ice was reached (approximately 40 days after cover formation) frazil slush would move through the powerhouse and be transported downstream.

Glacier addressed the potential creation of a water surge generated by a secondary consolidation upstream from the Project and the impact of such a surge on ice cover newly forming at the Town of Peace River. Glacier asserted that model simulations, using separate hydraulic routing models, showed that, depending on winter severity, the upstream ice front would be 20-100 km upstream from the Project when the downstream ice front was at the Town of Peace River. Based on data from observations of a similar event elsewhere on the Peace River, Glacier simulated a water wave caused by a 20 km secondary consolidation travelling under a 75 km ice cover, through a 25 km long headpond, and down a 100 km open water reach to reach the Town of Peace River. Glacier submitted that although a large increase in the water level was initially created, the water level or wave attenuated as it travelled downstream and by the time it reached the Town of Peace River, the water level increase was approximately 0.06 m. Glacier submitted that this level of increase did not have the potential to destabilize the ice at the Town of Peace River.

Glacier stated that there would be a thermal break-up in the headpond and upstream in late March or April every year, as opposed to a mechanical break-up because of the lack of significant tributaries flowing into this stretch of the Peace River. It noted that observed ice-scoured bars and banks, ice-push ridges and ice-scarred trees were consistent with freeze-up and water levels that are experienced during freeze-up, particularly in the event consolidations. Glacier contended that ice processes, formation and break-up, and model interpretations would not be significantly affected due to changes in sedimentation, shoaling or river morphology that would likely occur over time in the headpond area.

Downstream from the Headworks

Glacier stated that after the Project, the downstream (i.e. first) ice front would migrate less quickly upstream during freeze-up. In warmer years, the ice front would advance to within approximately 60 km from the Project, just past Shaftesbury Crossing, to within approximately 40 km of the Project in normal years, and to within approximately 20 km of the Project in colder than average years. Backwater effects that may reduce power production were predicted to be apparent at the tailrace when the ice front advances within 15 km of the Project.

Glacier submitted that water coming out of the headpond would be essentially ice free (particularly during the first 40 days of ice cover formation) and this would lead to an active frazil ice generating zone downstream from the Project. According to Glacier, 30 km downstream of the Project, where the Town of Fairview water intake is located, suspended and surface ice concentrations would be low and would not negatively impact the water intake structure by clogging it up because the intake pipe is near the river bottom. Glacier determined that anchor ice would not be a factor in ice processes downstream from the Project.

At the Town of Peace River

Glacier submitted that the PRICE modelling determined that on average the Project would delay freeze-up at the Town of Peace River by ten days (5 to 10 days in cold winters and 10 to 15 days in warm winters) due to a reduced supply of frazil ice because of lodgement in head pond. This would result in thicker ice accumulations because the ice front would advance at a slower rate. An ice thickness increase of 0 to 1 m is expected. Glacier predicted that this would result in an average post freeze-up water level 0.2 m higher than pre-Project levels for a range of river flows. However, Glacier stated that it used a higher value of 0.5 metre as a conservative estimate, in describing the impacts that the higher water levels would have on the Town of Peace River.

Glacier submitted that an increase in these base freeze-up levels may have an impact on the potential for basement flooding in Lower West Peace because of the connectivity between river levels and groundwater levels. Glacier described groundwater seepage as something that could occur when high freeze-up water levels at the town persisted more than a few days. High water levels lead to elevated groundwater levels, which increase the potential for groundwater seepage into basements in low-lying parts of town. Glacier observed that this is currently experienced and has been experienced two of the last three winters. Glacier pointed to efforts set out in a formal contract with the Town of Peace River to mitigate any incremental effect the Project may have on groundwater seepage due to higher freeze-up levels and general mitigation of the risk of flooding at the Town.

Glacier also asserted that it was unlikely that the average water level increase at freeze-up would significantly increase the risks of the Town of Peace River dike overtopping because overtopping was usually related to increased water levels due to mechanical break-up or secondary consolidation. It argued that the increase in base water levels caused by the Project would not increase the existing risk of mechanical break-up and there would be a reduced likelihood of secondary consolidations. Glacier concluded that there would be an overall decrease in the flood risk at the Town of Peace River because of the reduced likelihood of secondary consolidations.

Glacier acknowledged that many of the processes and mechanisms that control secondary consolidation events remain poorly understood. It concluded that the risk of secondary consolidations would remain similar or be reduced because of the conditions that may be present prior to, and during, a secondary consolidation. Glacier explained that due to interception of frazil ice at and upstream of the headpond, ice forming in this reach would not contribute to ice formation downstream from the Project. This would reduce the rate at which ice was supplied to downstream ice front formation and reduce the rapidity of its advance (or celerity) upstream. It was expected that the post-Project celerity would be 2-6 km/day, a 50 percent reduction in current low flow advance rates (when secondary consolidations are unlikely to occur) and a 65 percent reduction in celerity at higher river flow advance rates (when secondary consolidations are more likely to occur).

Glacier submitted that the tendency for a secondary consolidation to form would increase at higher ice cover advance rates because a longer ice cover would result in a larger increase in hydraulic forces than a shorter cover. It further stated that secondary consolidations would be greater if the thermal ice crust thickness of that advance was thinner. Glacier stated that PRICE simulations showed that the advance rate to crust thickness ratio was reduced post-Project. It therefore argued that the likelihood of secondary consolidations post-Project would be less than pre-Project. Glacier estimated that there would be an approximately 2 m reduction in extreme secondary consolidation events due to the reduction in frequency and amplitude of secondary consolidations post-Project. Therefore, Glacier concluded that the overall effect of the Project on water levels at the Town of Peace River was neutral to positive.

Glacier submitted that predicted ice cover duration at the Town of Peace River would be one to two weeks shorter post-Project as compared to pre-Project.

Glacier submitted that break-up at the Town of Peace River occurs either thermally, when the ice front recedes downstream from the town before the Smoky River breaks up, or mechanically, when the Smoky River breaks up first. Glacier explained that the mechanical break-up of the ice cover at the Town of Peace River occurs approximately 80 to 100 percent of the time because of break-up in the Smoky River, which may or may not lead to an ice jam. It stated that, generally, the potential for a mechanical break-up increases the longer it takes the receding ice front passes the Town of Peace River.

Glacier's model predictions estimated that the receding rate of the ice front would be approximately 5-10 km/day pre-Project and would vary from 5-10 km/day, to half of that, 2-5 km/day, some years post-Project. As the starting point of the ice front would be closer to town when break-up is initiated and the rate of thermal recession becomes significant, the front arrival at the Town of Peace River would not be delayed. Glacier concluded that the risk of Peace River mechanical break-up related to Smoky River break-up was no greater than currently exists pre-Project and that the Project would be neutral with respect to the likelihood of ice-related flooding during break-up at the Town of Peace River.

Glacier stated that ice jam break-up water levels were not modelled at the Town of Peace River. Glacier looked at the mechanism by which these events occur and what contribution the Project would have in increasing or decreasing the likelihood of ice jams occurring. Glacier noted that there would be no change to the date of thermal break-up at the Town of Peace River.

Ice Conditions at Shaftesbury Crossing

Ice formation and break-up issues relating to the Shaftesbury Crossing are addressed in Section 10.

Effects Upstream at Taylor and downstream of the Town of Peace River

Glacier submitted that there would be no change in the potential for secondary consolidation events upstream of the headpond, specifically at Taylor, BC, or downstream from the Town of Peace River.

Glacier stated that access to water supply wells in the Peace River was the main ice related concern at Taylor. Although the presence of an ice cover would not affect well performance, it would reduce access to the wells, affecting maintenance. Glacier said that accessibility issues could be mitigated by more systematic maintenance of the wells prior to ice cover.

9.1.5: EFFECTS OF CLIMATE CHANGE

Glacier attempted to assess the potential effects of climate change on the ice regime pre- and post-Project using the PRICE model, based primarily on air temperature changes. It was assumed that climate change would result in warming. Glacier believed the main impacts on the ice regime would be to change the rate at which the ice front advances and recedes and the rate of thermal ice growth, and its ultimate thickness, before break-up. Glacier did not believe the overall ice cover thickness would change as it is primarily the result of the local channel geometry and the flow in the river, neither of which is expected to change regardless of climate change.

Based on general climate model predictions, Glacier evaluated the effects of climate change by transforming the pre- and post-Project ice regime, as evaluated for the current climate, into 21st century scenarios using the PRICE model. The model indicated that the duration of a pre-Project ice cover at the Town of Peace River and Shaftesbury would be shorter by approximately 30 days in a warm year, 60 days in a normal year, and 90-100 days in a cold year. The ice cover would only advance into BC once every ten years and it was predicted that the ice cover was unlikely to advance to Taylor.

Glacier concluded that post-Project effects of climate change on the ice regime would be less noticeable. Glacier noted that, generally, the difference in ice front location for the three climate scenarios (warm, normal and cold years) was not as large post-Project and that there would be little difference in the overall ice regime for cold winters regardless of what climate scenario was adopted. Glacier said that it was difficult to quantify the effects of the Project on ice-related flood risk at the Town of Peace River as a result of a warmer climate. It believed that the potential for flooding would not change as a direct result of the Project. Glacier stated that under warming climate change conditions, it is unlikely that a competent ice cover would form at Shaftesbury except for cold years, with or without the Project, although the Project would further shorten the ice season at Shaftesbury.

9.1.6: PROPOSED MONITORING

Glacier stated that ongoing monitoring of ice conditions and processes would be completed throughout the lifetime of the Project. The monitoring program would include ice thickness measurements at a number of different locations, one of which could be Shaftesbury Crossing. Glacier stated that measurements and monitoring would be conducted in collaboration with the JTF.

9.2: VIEWS OF THE INTERVENERS

CROSS

The views of CROSS on ice formation and break-up related issues are addressed in Section 10.

The Coalition

The Coalition, representing the Alberta Wilderness Association, Canadian Parks and Wilderness Society Northern Alberta, the Peace Parklands Naturalists, and the South Peace Environment Association, submitted that the ice modelling exercises and development of the PRICE model was impressive and unusually thorough. However, the Coalition asserted that the assessment of the ice regime in the headpond and upstream of it, appeared to represent estimates based on the current morphology and hydraulics of the river and did not consider future changes to sedimentation in these areas and the effects this may have on the ice regime. It argued that a more complete assessment should be done to systematically examine the ice regime in light of the changes in channel geometry created by the sedimentation at several stages through the expected life of the Project.

The Coalition submitted that there is some evidence that mechanical break-up events upstream from the proposed headpond may be present pre-Project. It noted that ice-push ridges, ice-scoured bars and banks and ice-scarred trees at elevations of up to 6 m above field datum were observed upstream of the proposed headpond area and suggested that mechanical break-up has occurred along this reach of the Peace River. The Coalition conceded that the presence of the headpond and an established ice cover is apt to substantially reduce the probability for such events post-Project. The Coalition also questioned whether extensive shoaling of the channel in the headpond might incrementally affect ice cover conditions and processes, including occurrence and water level, affecting model predictions.

BC Hydro

BC Hydro submitted that during the open water period, the water flow velocity in the Peace River tends to be higher at the top of the water column and decreases with depth due to friction with the bottom. When an ice cover forms, a lower water flow velocity area develops on top and the bottom of the water column due to friction. Since the water discharge in the Peace River is fairly constant and the overall water flow velocity is reduced under ice cover conditions (due to friction with the ice cover and river bottom), the water depth can increase up to 92 percent of the ice thickness. BC Hydro presented some basics of river ice formation and break-up and associated processes typically found on the Peace River. BC Hydro stated that with Alberta Environment and Glacier, data on ice was collected and it presented data on some past ice-related events.

BC Hydro submitted that the Project would thicken ice cover at the Town of Peace River, increasing winter water levels. The increased water levels would cause a reduction in the freeboard to the top of the dikes surrounding the Town of Peace River and increase the likelihood of groundwater seepage into basements in the Lower West Main of the Town of Peace River. BC Hydro initially expressed concern that this result may require increased flow controls directed by the JTF, which may impact BC Hydro financially. BC Hydro submitted its concerns were adequately addressed in a formal agreement with Glacier as entered in evidence.

BC Hydro explained that it used the CRISSP model, which had been developed with other hydro companies and Dr. Shen from Clarkson University, since 2002. BC Hydro spoke to Glacier about development of the CRISSP model, but the finish date for the CRISSP model was deemed too late by Glacier, as it was beyond the time that Glacier wanted to re-apply for the Project. As a result, Glacier hired Dr. Shen to develop the PRICE model, which was similar to the CRISSP model but did not have the ability to simulate as many ice processes.

BC Hydro pointed out that both models were developed closely together, ensuring both models had the full benefit of available data and experience from the Peace River. BC Hydro submitted that the results from the CRISSP model were similar to the PRICE model and both were viewed to produce accurate and reliable predictions with respect to ice processes. BC Hydro stated that although CRISSP showed some of the effects of the Project, specifically higher base freeze-up water levels with ice cover, the values used by Glacier to represent increased base freeze-up water levels due to the proposed Project at the Town of Peace River were an appropriate estimate for design purposes given the potential modelling uncertainty. BC Hydro stated that working with a two dimensional model such as CRISSP to simulate the entire Peace River from the Bennett Dam to several hundred kilometres downstream may be impractical and required significant computational power.

BC Hydro outlined the nature of the Joint Task Force, identified its members and described its function. The JTF consists of Alberta Environment, the BC Ministry of the Environment, BC Hydro and the Town of Peace River. Its purpose is to balance hydropower production and the ice jam flood risk, primarily at the Town of Peace River, during both break-up and freeze-up. BC Hydro stated that management of river flows during times of flood risk requires flow control operational measures by BC Hydro at the Bennett Dam. Any change in discharge of water over the dam takes approximately two days to reach the Town of Peace River. BC Hydro explained that a constant discharge of 1,600 m^3/s is attempted during ice formation at the Town of Peace River and is typically implemented two days prior to the ice front reaching a point 16 km downstream from the Town of Peace River. The flow control is lifted 10 to 14 days after the ice front has arrived at Dunvegan. BC Hydro submitted that new, scientifically based criteria would have to be developed, that included safety factors, with the addition of the Project because of the Project’s effects on the ice regime downstream from Dunvegan. BC Hydro agreed with Glacier that the possibility of an ice collapse due to secondary consolidation at or close to the Town of Peace River would possibly be less post-Project than pre-Project.

With respect to ice break-up in the spring, BC Hydro stated that two to three weeks prior to anticipated break-up, BC Hydro and the JTF monitor river levels, discharges, and tributary inflows if the water level in the Peace River is above 314 m. Particularly relevant is whether there is above normal snow pack in the Smoky River basin upstream from the Town of

Peace River. BC Hydro explained that it would reduce flows from the Bennett Dam if forecasted flows at the Town of Peace River were greater than 3,200 m^3/s. BC Hydro explained that flow restrictions are rarely implemented in response to the risk of a mechanical break-up. BC Hydro stated that based on current information and modelling, ice cover thermal break-up near the Town of Peace River would not be delayed and would not increase the risk of a Smoky River ice jamming situation induced by the Smoky River in the Town of Peace River.

BC Hydro confirmed that the JTF does not currently take into consideration flow regulation and effects on the operation or construction of the ice bridge at Shaftesbury.

The Town of Peace River

The Town of Peace River did not file ice-related evidence but indicated by a brief submission and delivered oral evidence that it supported the Project. It discussed ice conditions and the Town's experience with flooding and groundwater seepage. The Town of Peace River explained that depending on weather conditions and the occurrence of a winter consolidation or spring break-up, 24-hour river watch coverage was conducted by the Town of Peace River at considerable cost and resources of the Town. It pointed out that there had been considerable flooding at the Town of Peace River, with three, "one in one hundred" year flood events since 1982, the most recent in 1997. In addition, there had been ongoing issues with groundwater seepage primarily in Lower West Peace with the potential of over 120 homes being affected. The probability of groundwater seepage was expressed as a one in ten-year possibility.

Further, the Town of Peace River stated that approximately 70 percent of homes in the Town are located on the east side of the river of which 30 percent could be at risk should the dikes, which are designed for a one in one hundred-year flood event, be overtopped.

The Town of Peace River stated that it accepted the results of the modelling activities that appeared to show a reduced risk for flooding issues to occur at the Town of Peace River. It also testified that the Town of Peace River had entered into an agreement with Glacier, which set out certain rights and obligations of the two parties with a view to mitigating the groundwater seepage issue.

9.3: PARTICIPATION OF DR. FAYE HICKS

The Panel issued a Notice to Attend to Dr. Faye Hicks because it wanted the benefit of her knowledge and expertise. Dr. Hicks is a professor at the University of Alberta in Civil and Environmental Engineering and has studied the dynamics of ice for over 20 years.

Dr. Hicks had been retained by Alberta Environment in both the 2002 application and the present application to advise the department on ice issues. She also advised AT on ice issues in the present application. Dr. Hicks participated in the PRICE ice modelling workshops and provided input to the departments regarding the Supplemental Information Request process as well as provided her view to the departments on the completeness of the ice related work conducted by Glacier for the EIA. Dr. Hicks submitted that she had no communication with the two departments since December of 2007 and gave evidence on her own behalf, not on behalf of Alberta Environment or Transportation.

9.3.1: VIEWS OF DR. HICKS

Dr. Hicks delivered a presentation that demonstrated ice development on rivers. She explained that there are various processes occurring in the middle of the river channel, making the understanding of the cover or formation processes complicated. She said that a rigorous approach must be employed to model these processes.

Dr. Hicks described the process of ice formation on the Peace River. She pointed out that while surface concentrations of ice and ice pans could be measured and quantified, frazil ice concentrations and dynamics below the surface of the river could not. Dr. Hicks highlighted the situation where ice gets pushed together in a jumbled mass resulting in a hummocky or consolidated ice cover. It is the consolidated state of ice formation, she stated, that if extremely severe, can lead to high water levels and possibly flooding because consolidated ice covers, both primary and secondary, are typically thick with rough undersides causing water levels to rise.

Dr. Hicks described ice break-up as a process that could be complicated or quite simple. If the ice simply melted away in a thermal break-up, the consequences could be quite innocuous. However, she testified that break-up could be dynamic and dangerous if large quantities of big rough pieces of ice pushed up together clogging the channel and causing high water levels. This situation is termed dynamic or mechanical break-up and the process can unfold quickly.

Dr. Hicks spoke of her own research and model development attempts to quantify and predict both thermal and dynamic or mechanical processes. The physics of her thermalized process modelling are essentially identical to the physics of the PRICE model and other models that are developed for thermalized ice processes, although different numerical approaches are employed for each model. She testified that the Peace River is amenable to thermalized process modelling.

With respect to the PRICE model developed and used by Glacier, Dr. Hicks stated that the PRICE model was developed from the RICE model, both of which had more sophisticated hydraulics modelling capabilities than TRICEP. She stated that the PRICE model is the RICE model implemented specifically for the Peace River (i.e. the RICE model with a “P” in front). She said that a considerable amount of effort was put into obtaining data for the PRICE calibration and a very rigorous approach was incorporated into the calibration process.

Dr. Hicks stated that she attended the last four of five modelling workshops hosted by Glacier, including development and calibration of the PRICE model and that consensus was reached that the PRICE model “represented a good analog” of the behaviour of the thermal ice processes on the Peace River. She explained that although this type of model could not determine or predict specifics on a small scale, it could be used on a larger scale to predict conditions used to assess before and after cases. Dr. Hicks said that this is as good as could be done with today’s knowledge and that PRICE, on average, could predict what is expected to happen, with some reliability.

With respect to potential risk of flooding at the Town of Peace River caused by a delay in the recession of the ice front located near the Town at the same time as the break-up of the Smoky River, Dr. Hicks stated that the PRICE model used for the timing of break-up relative to ice front location was an appropriate approach to use. She agreed that the conclusions reached by Glacier were reasonable.

With respect to a thermalized process model's ability to predict secondary consolidations, Dr. Hicks acknowledged that it may be possible to try scenarios and detect antecedent conditions that exist which may lead to secondary consolidations. She testified that Glacier's approach to predict secondary consolidations at the Town of Peace River was a reasonable attempt to address this issue because the causative factors outlined by Glacier were consistent with what is believed to cause secondary consolidations. Dr. Hicks cautioned, though, that one could not say with a high degree of confidence that there would never be a risk.

Dr. Hicks observed that the likelihood of a potential consolidation of the ice cover upstream of the Project, releasing a water wave that may reach the Town of Peace River causing flooding, would be no different than it is today.

Dr. Hicks stated that development of her model is designed to predict both thermal and mechanical or dynamic ice processes and secondary consolidations. She referred to her model as very new, one that had been validated for known measured ice consolidation events although not tested in real world applications. She believed that the CRISSP model was similar to her own but stated that the PRICE model was running right up behind the leading edge and Glacier was using the most modern tool available. She recommended that there would be great value in continuing the validation of the PRICE model post-Project and that the use of CRISSP or her own model could be used to assess the potential impacts or changes related to the risk of secondary consolidations and dynamic break-up on a go-forward basis, exploring the physics of the ice/water interaction, potential stability of the ice cover during changing flows and managing the river ice.

Dr. Hicks acknowledged that Glacier obtained probably the most experienced person in modelling the Peace River, Mr. Dave Andres, whose knowledge and experience with respect to ice processes on the Peace River is well respected. Dr. Hicks believed that Glacier applied good, sound techniques and reasonable judgment in coming up with conclusions based on modelling efforts.

Dr. Hicks agreed that the ice modelling work and associated analysis provided sufficient information to assess the potential impacts of the Project.

Dr. Hicks expressed concern that the evaluation of ice river processes was incredibly complex and was difficult to model. She testified that although some changes were made to the proposed Project (particularly the fact that the Project proposal would not allow ice to overtop the structure) and increased field data and measurements were obtained, no significant improvement in modelling was made regarding the likelihood of secondary consolidations or mechanical break-up as compared to the 2002 hearing. Dr. Hicks stated that it was not possible to say that dynamic events would not occur as a result of the Project, or that secondary consolidations would occur more or less frequently than is presently experienced. Dr. Hicks believed that arguments put forth by Glacier were compelling, but would not agree or guarantee that the predictions would be true.

9.4: VIEWS OF THE PANEL

Existing Conditions

The Panel acknowledges that the ice regime for the Peace River is dependent on the regional climate. Cold winters promote rapid ice cover development as far upstream as Taylor, BC, while warm winters delay ice cover formation, limiting or slowing upstream progression. At break-up, relatively warmer temperatures contribute to the weakening, melting and downstream recession of ice cover on the Peace River, as does increasing run-off in tributaries, particularly the Smoky River near the Town of Peace River.

The location of the ice cover front in the Peace River at any given time depends on several factors, including ice production and thickness of the ice cover accumulation. The amount of ice produced is dependent on river surface area, the initial water temperature, discharge released at the Bennett Dam and meteorological conditions such as air temperature.

The Panel understands that regulation of river flow by the Bennett Dam has generally altered the ice regime in the Peace River in two ways: by delaying the onset of freeze-up upstream of Fort Vermillion, AB (due to higher winter discharge and warmer water released from the reservoir) and by creating a milder break-up upstream of the Smoky River (by regulating upstream spring runoff and providing warmer water that favours thermal break-up).

Ice Modelling

The Panel acknowledges that potential Project impacts to the ice regime were a significant issue in the 2002 application. In its application to the 2003 EUB/NRCB Joint Review Panel, Glacier used the TRICEP and RICE models to simulate Project impacts on the ice regime in the Peace River. The Peace River ice modelling conducted using these models was found by the 2003 EUB-NRCB Joint Review Panel to be inconclusive as the models produced different predictive results, particularly with respect to ice conditions downstream of the Project to the Town of Peace River.

The Panel understands that Glacier conducted additional studies on the ice regime on the Peace River to address issues brought forward from the previous decision and developed the PRICE model to predict effects of the Project on the ice regime. The PRICE model was specifically developed to simulate ice formation and break-up on the Peace River. An acknowledged international river ice-modelling expert, Dr. Shen of Clarkson University, and other modelling experts were retained by Glacier to develop the PRICE model, which was based on the RICE model. The Panel notes that important components of the PRICE model development were model calibrations using ice measurements and conditions observed on the Peace River during the winters of 2002/2003 and 2003/2004. The Panel acknowledges that the calibration was a collaborative process which included multi-stakeholders' (ice experts from CROSS, Alberta Environment, AT and BC Hydro) review and input. The Panel also notes that model verification was conducted using 23 years of record (based on discharges from the Bennett Dam, water and air temperatures) between 1980 and 2004.

The Panel accepts that the soundness, reliability and predictive accuracy and precision of any model that attempts to simulate and predict natural processes, such as ice formation and break-up, will be subject to inherent weaknesses and uncertainties because of incomplete understanding of complex natural systems. The Panel was presented with evidence from river ice experts who had academic, professional and operational expertise related to ice processes on the Peace River. These experts agreed that the PRICE model was sound and reliable for predicting certain specific ice conditions on the Peace River. Caution was expressed by some of the experts related to the challenge and difficulty of modelling very complex river ice processes. In particular, Dr. Hicks stated that it was not possible for her to say that dynamic events would occur more or less frequently as a result of the Project or that secondary consolidations would occur more or less frequently than is presently experienced.

The Panel finds that the PRICE model is reasonably suited for simulating base freeze-up water levels, thickening (or thinning) of the ice cover due to frazil ice deposition (or hydraulic erosion), penetration of the thermal crust thickness into the ice cover, ice cover front advance upstream and location, and downstream recession of the ice front location. The Panel also acknowledges that the model is not able to effectively predict mechanical break-up, the redistribution of frazil ice under the ice cover and/or secondary consolidation. The Panel agrees that although the PRICE model does not directly predict secondary consolidation events, the model can predict conditions that are generally agreed on to precede secondary consolidations. That Panel finds that through expert assessment and interpretation of these conditions, the likelihood of secondary consolidations can possibly be forecasted. The Panel notes that the model is not able to simulate frazil ice transport and mechanical break-up due to limited scientific information and difficulties in measuring and determining these types of processes.

The Panel understands that PRICE and CRISSP, another river ice model applied on the Peace River, fundamentally have the same computational framework and simulate similar processes from freeze-up to break-up. The Panel understands that the CRISSP model is more flexible in manipulating the data and results and accepts that, regardless of the model and predicted process, fundamentally each would provide similar output results and present similar conditions, leading to the same conclusions. The Panel acknowledges that even with the same model and inputs, in complicated systems like the Peace River, interpretations of the output may be different.

In summary, the Panel finds that Glacier's modelling approach, development, application and associated analysis are sound, providing sufficient information to assess the potential impacts of the Project on the ice regime of the Peace River. In addition, the Panel finds that proper expertise, judgement and experience, with respect to ice processes on the Peace River were utilized to assess and interpret the model's output.

Potential Effects on the Ice Regime

The Panel appreciates that the Project will result in the creation of two ice fronts, one upstream of the Project's headworks and one downstream of the headworks. Post-Project, the downstream ice front will advance at a significantly slower rate. The Panel finds that because of the slower advance of the downstream ice front cover, the ice front cover will be located within the following approximate distances from the Project: 60 km in warmer years, 40 km in normal years, and 20 km in colder than average years. A significant difference in the timing of ice cover break-up is not expected. The upstream ice front will start forming in the headpond area significantly earlier than before, about six to ten weeks, advance further upstream, and last longer in post-Project conditions.

The Panel concludes that an important potential impact of the Project is the potential for the creation of a water surge generated by a secondary consolidation upstream of the Project. Glacier modelled a water surge produced by a secondary consolidation upstream of the Project and the impact of this surge on an ice cover at the Town of Peace River. Glacier submitted that a wave generated by a secondary consolidation upstream of the Project would attenuate quickly as it moved downstream and that it would be approximately 0.06 m at the Town of Peace River. The Panel accepts that this increase in the water level at Peace River would not likely destabilize the ice cover, result in jamming or cause flooding at the Town of Peace River. The Panel also finds that the potential for consolidations upstream of Project would be no different from current conditions.

The Panel accepts that break-up would be predominantly thermal in the headpond and upstream of the headpond, as opposed to mechanical, because of the lack of relatively large tributaries in this stretch of the Peace River.

Potential Effects of the Project

The Panel's views, reasons and findings related to the Shaftesbury Crossing are addressed in Section 10.

The Panel finds that the post-Project ice front originating from the headworks has the potential to reach Taylor, BC more frequently, approximately 35 percent of the years, and remain near Taylor on average for approximately 25 days, preventing access to the District of Taylor water supply wells. The District of Taylor did not file written material in support or objection, nor did it appear at the hearing. The Panel has considered this issue and believes that no significant inconvenience or impact is realized by the District of Taylor as a result of the Project. The Panel acknowledges that the ice cover does not impair water supply during freeze-up and that maintenance schedules can be adjusted to compensate for any lack of access to the wells.

The Panel acknowledges that the Town of Fairview filed a letter in support of the Project, attended the hearing and gave evidence. It did not raise issues regarding negative impacts on its water intake structure in the Peace River as a result of the Project's effect on the ice regime. The Panel accepts that suspended and surface ice concentrations would be low and would not likely reduce performance of the intake structure because it is positioned near the river bottom.

The Panel accepts that post-Project the ice cover front will arrive at the Town of Peace River on average 10 days later than at present. This will result in a thicker ice cover causing base freeze-up water levels at the Town to rise, conservatively predicted at 0.5 metre. The Panel heard that in recent years the Town of Peace River has experienced basement flooding caused by groundwater seepage attributed to relatively high river levels on the Peace River. The Panel concludes that post-Project the risk of flooding by groundwater seepage will increase due to the increased base freeze-up water level.

The Panel confirms that a contract between Glacier and the Town of Peace River was entered in evidence on a confidential basis to the Panel. The agreement details mitigative action for Project effects on groundwater seepage and other matters related to flooding at the Town of Peace River and generally mitigating the risk of flood to the Town. Glacier also stated that it is committed to funding and constructing the works, which will mitigate the impacts of groundwater seepage. The Panel finds that the mitigation agreed to by Glacier through this contract, provides for substantial mitigation for Project effects on flooding at the Town of Peace River. Glacier's commitment to provide funding for the Town of Peace River to proceed with engineering and construction of the capital works to mitigate Project impacts played a key role in the Panel's determination that the elevated flood risk to the TPR would be effectively mitigated.

BC Hydro expressed concern that higher base freeze-up water levels under post-Project conditions would reduce the amount of freeboard available on the dikes at the Town of Peace River and increase the risk of overtopping and flooding under ice jam conditions. BC Hydro asserted that this scenario would likely require more frequent and longer periods of mitigating action by BC Hydro at the Bennett Dam. The Panel understands that under these conditions BC Hydro could suffer a consequential loss of power generation and associated revenue. However, the Panel has considered evidence that Glacier and BC Hydro have negotiated an indemnity agreement that provides financial compensation to BC Hydro in these situations. The Panel concludes that these Project effects have been adequately dealt with by the agreement between Glacier and BC Hydro.

The Panel reviewed evidence on whether the Project reduces the likelihood of secondary consolidations upstream from the Town of Peace River. The Panel heard from all ice experts that secondary consolidations are not entirely understood and have not been incorporated into the models used by Glacier. There was general agreement that secondary consolidations occur when the ice front advances at a rapid rate while the thermal ice thickness is relatively thin. The Panel believes that post-Project conditions upstream from the Town of Peace River, namely a reduced ice front advance rate to crust thickness ratio, would lower the risk of extreme secondary consolidation events. The Panel does take note that Dr. Hicks did not believe it was possible to conclude with certainty that secondary consolidations would occur with more, less, or the same frequency. The Panel concludes that the Project may reduce the incidence and severity of secondary consolidations upstream and at the Town of Peace River. The Panel finds that this would represent a neutral to beneficial impact on the Town.

The Panel accepts that ice cover break-up at the Town of Peace River under post-Project conditions will occur at the same time or one to two weeks earlier than under pre-Project conditions. The Panel notes that there would be no change in the risk of an ice jamming situation induced by Smoky River ice break-up at the Town of Peace River because the ice front will have receded past the Town at the time of break-up within the Smoky River. The Panel therefore determines that the Project would be neutral with respect to the likelihood of ice related flooding during ice break-up at the Town of Peace River.

Effects of Climate Change

The Panel finds that it is difficult to quantify the effects of the Project on ice-related flood risk at the Town of Peace River as a result of climate change, but believes that the potential for flooding would not change as a direct result of the Project. The Panel agrees that under warming climate change conditions, it is unlikely that a competent ice cover will form at Shaftesbury Crossing, except for cold years, with or without the Project, though the Project would further shorten the ice season.

Proposed Monitoring

The Panel supports Glacier in its commitment to ongoing monitoring of ice conditions and processes throughout the lifetime of the Project. The monitoring program should include secondary freeze-up levels at the Town of Peace River, ice thickness at a number of different locations (possibly including Shaftesbury Crossing), and ice conditions at the Town of Fairview water intake. Measurements and monitoring should be conducted in collaboration with the JTF.

Conclusion

The Panel concludes that overall there will be no ice-related effects related to the Project which cannot be satisfactorily mitigated. The Panel concludes that changes to the ice regime, most notably the change from a one-front river ice cover growth to a two-front system and an expected increase in base freeze-up levels of 0.5 m at the Town of Peace River, can be mitigated and are not significant.

The Panel recognizes that monitoring by Glacier can contribute to the overall management of the Peace River and continue to share information with the JTF.

SECTION 10: SHAFTESBURY CROSSING

The Shaftesbury Crossing is the site where local residents cross the Peace River by way of a ferry in the summer and an ice bridge in the winter when available. Crossings at this site have occurred since 1951 during both the summer and winter months. The potential impacts that the Project may have on the use of the Crossing were an issue during the hearings in both 2002 and 2008. The Concerned Residents for Ongoing Service at Shaftesbury (CROSS) is a local community group representing the interests of users of Secondary Highway 740 that will be affected by impacts of the Project on the current river crossing at Shaftesbury. CROSS was an intervener at the 2002 hearing and has remained involved in Glacier's public consultation process leading up to this hearing. Its primary concerns relate to the Project impacts on the length of time that an ice bridge is functional and increased frequency in the number of years when no ice bridge can be constructed. Alberta Transportation (AT) was also involved in the public consultation process leading up to the 2002 and 2008 hearings. While AT has a mandate for maintenance of the Shaftesbury Crossing, it did not attend the 2008 hearing but was requested to provide answers to a number of questions that arose at the hearing which were deemed important for the Panel in assessing impacts at Shaftesbury. In response to this request, AT submitted written response and CROSS was given the opportunity to respond after the oral hearing in Fairview, AB.

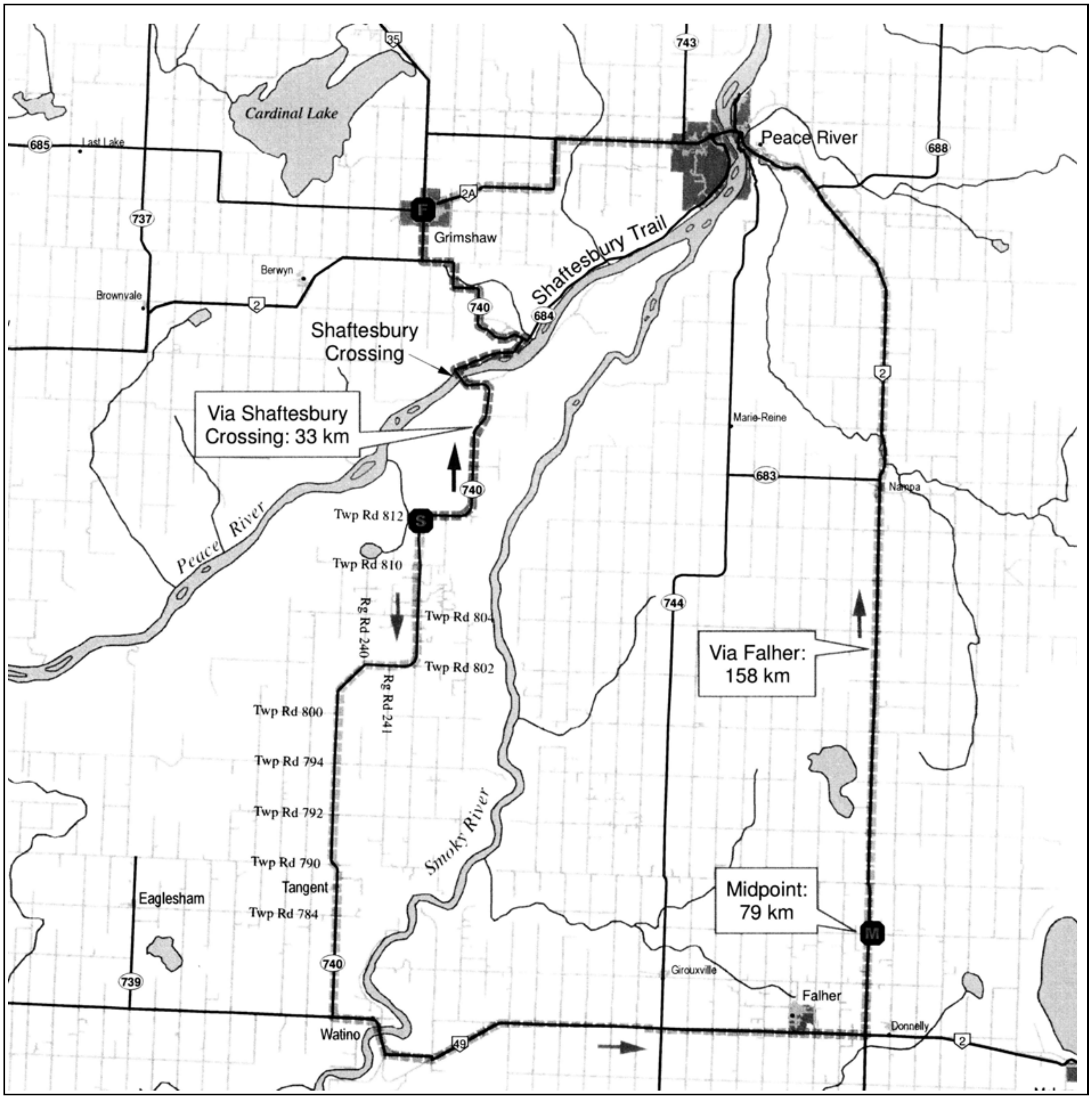


Figure 4: Location of Shaftesbury Crossing and Alternative Travel Route

10.1: ICE CONDITIONS AND ICE BRIDGE AT SHAFTESBURY CROSSING

10.1.1: VIEWS OF THE APPLICANT

Glacier used the PRICE model to simulate freeze-up and break-up dates at the Shaftesbury Crossing for the 23 years (between 1980 and 2004) of simulated pre- and post-Project conditions. Glacier stated that based on PRICE model predictions, post-Project ice cover break-up dates at Shaftesbury Crossing would not change significantly from pre-Project conditions. It also submitted that post-Project freeze-up, including the arrival of the ice front, would be delayed due to the increased time for the development of downstream ice front cover formation. Glacier noted that in the 23-year time period simulated, there were two years when ice duration was less than 30 days at the Shaftesbury Crossing and that post-Project there would be two years that the ice front did not advance to Shaftesbury Crossing. The delay in freeze-up would be approximately 10 days in a cold winter, 20 days in a normal year, and 30 days during a warm winter, for an average of approximately 20 days.

Glacier presented ice durations at Shaftesbury Crossing pre- and post-Project (Table 4).

TABLE 4: ICE DURATION AT SHAFTESBURY CROSSING

	Ice Duration (days)		
Condition	**10% of years**	**50% of years**	**90% of years**
Pre-Project	120 or more	86 or more	50 or more
Post-Project	108 or more	65 or more	23 or more

In cross-examination Glacier was asked if it was aware of criteria used by AT in determining the ice front distance from Shaftesbury Crossing as a means of beginning construction and/or operation of the ice bridge. In response, Glacier indicated that the ice front distance was an analogue to ice thickness and not a criterion. Glacier further submitted that it had, on a number of occasions, requested ice bridge construction criteria from AT and had never been provided with an ice front distance criterion. Glacier also stated that while a 40 km ice front may have been used in the past, there was no reason that 40 km would be used in a post-construction regime and that the analogue, were it to be applied post-Project, would likely be a 5 to 6 km ice front.

10.1.2: VIEWS OF THE INTERVENERS

Concerned Residents for Ongoing Service at Shaftesbury (CROSS)

CROSS is a local community representing the interests of users of Secondary Highway 740 that would be affected by impacts of the Project, particularly upon the current river crossing at Shaftesbury.

CROSS asked the Panel to compel the attendance of AT to respond to questions concerning Shaftesbury Crossing.

CROSS indicated that funding from Glacier had allowed it to retain an ice expert and for representatives of CROSS to attend ice modelling workshops in order to gain an understanding of Project impacts at the Shaftesbury Crossing.

CROSS submitted that ice-related assessments done by Glacier were done with the highest standards that are possible within the current "*state-of-the-art*" modelling in river ice engineering. CROSS stated that PRICE is on par or superior to any known model of its type. CROSS stated that a collaborative approach was fostered at the workshops and consensus was reached by those involved in the ice modelling workshops. CROSS indicated that it generally agreed with model results presented.

CROSS submitted that there were alternative models such as the BC Hydro model that had led to somewhat different results compared to those developed by Glacier. It went on to state that ice modelling was not infallible and could not lead to fully conclusive results. In its view, ice modelling was relatively new, relied on leading-edge science and therefore was largely unproven.

CROSS stated the duration of ice crossings over the last 27 years averaged 72 days, or approximately ten weeks, as indicated by personal diaries of a CROSS resident. CROSS stated that the Project was expected to delay the construction of the ice bridge by two to three weeks. It felt that this reduction was incremental, tangible, and was in addition to the normal variation in bridge duration. CROSS's view was that a delay in the formation of solid ice post-Project had the potential to double the number of years in which no ice crossing would be available. It believed that in over half the years post-Project, the ice front would not reach 40 km upstream of Shaftesbury. CROSS indicated the 40 km ice front was used by AT to commence construction of the ice bridge.

CROSS stated that it would be impacted the most directly by the Project in comparison to other interveners and the impacts had an associated risk of uncertainty related to ice modelling results. CROSS also indicated that it did not agree with Glacier's conclusion that the Project impacts would not be significant on CROSS residents.

CROSS submitted that the reduction in average use of the ice bridge would be compounded by the 'buffer' distance of the ice front required by AT. It stated one of the criteria used by AT for beginning construction of the ice bridge is the formation of an ice front 40 km upstream from Shaftesbury. CROSS stated that in normal and warmer than normal years, the ice front would not reach 40 km upstream of Shaftesbury as presented in the ice model, and that the proximity of open water due to the change in the ice regime would make it unsafe to construct an ice crossing. CROSS noted that for normal and warmer than normal years it believed that the Project impact at Shaftesbury would be more than the two to three week delay stated by Glacier. CROSS stated that in its opinion, AT had not been clear about the importance of the ice front location when making its decision on when construction of the ice bridge could commence. CROSS further stated that anecdotal evidence showed that AT did in fact wait until the ice front had reached approximately 40 km upstream from Shaftesbury to construct the ice bridge.

CROSS believed that the Environmental Impact Assessment (EIA) was deficient in assessing the cumulative environmental effects likely to result from the Project in combination with other existing, approved and proposed projects in the region as they pertain to ice processes in the river. CROSS submitted that the EIA should have used pre-Bennett Dam river conditions as the base case to evaluate the cumulative effects at the Shaftesbury Crossing site. It argued this more rigorous approach would be more in line with other major projects and EIAs in Canada. CROSS stated that by not including BC Hydro Site C, the cumulative effects assessment in the EIA was not consistent with the Canadian Environmental Assessment Agency guidelines. CROSS presented the cumulative effect issues as significant because the Bennett Dam had a relatively large impact on the Shaftesbury ice bridge (a 40 percent reduction in the duration of ice cover). When the Bennett Dam impacts were considered in combination with the Project, a reduction in the duration for an ice bridge would exceed 60 percent over natural river conditions. It also submitted that if potential impacts from Site C were included the impacts on the Shaftesbury Crossing would be larger again.

CROSS further stated that, based on information presented by Glacier, within the next 50 years, the delay in ice formation at Shaftesbury may increase to four or five weeks based on the combined effects of the Project and global climate change predictions.

Alberta Transportation

AT stated that the primary criterion used to begin construction of an ice bridge is ice thickness. AT stated that it did not have a criterion that the ice front needed to be 40 km upstream of the Shaftesbury site before it was safe to commence construction of the ice bridge. AT submitted that its Maintenance Contractor Inspector typically begins checking ice thickness at the Shaftesbury Crossing between five to seven days after the ice consolidates at the Crossing.

AT noted that a Workplace Health and Safety Bulletin titled "*Travelling, Standing and Working on Ice Requires Caution*" recommended 60 to 90 mm of effective ice thickness for one person or a group of people to begin working on ice. It also noted that the pamphlet recommended an ice thickness of 230 mm for carrying a light truck weighing 2500 kg. AT indicated that as a further precaution and in addition to other secondary measures, it had recently considered the distance of the ice front as a secondary measure, but confirmed that AT did not have a minimum distance requirement.

10.2: SOCIO-ECONOMIC IMPACTS

10.2.1: VIEWS OF THE APPLICANT

Glacier stated that the predicted two to three week increase in time that the Shaftesbury Crossing was unavailable would have an effect on residents on both sides of the river who use the Crossing. Glacier also noted that there were relatively few residents on the north side of the river who relied on the Crossing due to a low number of services on the south side of the Crossing. Glacier stated that commercial establishments north of the river would be affected through a decline in patronage during the additional period for which the Crossing was unavailable. Glacier noted this impact would likely be offset due to a larger than normal access of business services once the Crossing resumed operation. Glacier also indicated that the potential negative impact to business on the north side of the Crossing would be offset to some degree by an increase in business revenue to producers of goods and services elsewhere.

Glacier stated that the increase in the time for which the Crossing was unavailable was not expected to have an effect on the overall transportation system in the region due to the limited number of vehicle crossings at Shaftesbury in comparison with the bridges at Peace River and Dunvegan. Glacier stated that although there would likely be increased traffic on Highway 2 during periods for which the Crossing was unavailable, that increase was expected to average less than one percent. Glacier concluded that Project effects on CROSS members would not be significant.

10.2.2: VIEWS OF THE INTERVENERS

CROSS

CROSS stated that members of the Tangent community travelled across the Peace River for commerce, employment, recreation, education, veterinary and health services in addition to relying on the Crossing for emergency services. CROSS noted that when the Crossing was unavailable, residents of the community faced an additional distance of 100 km one way to access similar services and added that residents would likely travel to Grande Prairie rather than Grimshaw or Peace River to reduce the distance travelled. CROSS stated that under the current ice regime, residents planned appointments with businesses on the north side of the Peace River around the availability of the Crossing. In addition, CROSS stated that residents on the south side of the Crossing relied on Grimshaw for access to fresh products and perishables, and when the Crossing was unavailable their diets changed to food items that could be stored.

CROSS stated that the proposed changes in the availability of the Crossing would result in increased travel time and increased isolation and there would be a negative impact on property values in the Tangent area. CROSS expressed concern that the increased isolation and increased travel time could cause populations in the Tangent community to dwindle.

CROSS submitted that the ice bridge and ferry crossing at Shaftesbury remained important components of local cultural heritage. The first ferry was built by a local farmer Everett Blakley and began operation in 1951. CROSS stated that the Crossing was privately run and maintained until 1978 at which point AT built a regulation ferry and took over operations. CROSS submitted that the long standing heritage of the Shaftesbury Crossing was important and needed to be continued.

10.3: OPERATION OF SHAFTESBURY FERRY

10.3.1: VIEWS OF THE APPLICANT

Glacier stated that the Project would have no impact on when the ferry was put into service in the spring, as timing of break-up of the ice bridge would remain the same pre- and post-Project. It indicated that potentially the main effects of the Project on ferry operations could be during freeze-up when protracted periods of running ice occur in the river. Glacier stated that ice floe concentrations in the river can increase from 1 to 20 percent in a few days and that a 20 percent ice floe concentration is a conservative estimate of when the ferry becomes inoperable. Glacier asserted that there will not be a difference between pre- or post-Project conditions in the timing of when 20 percent ice concentration is achieved during freeze-up. It therefore concluded that, since there is no difference in the timing of breakup pre- and post-Project and no difference in when the 20 percent ice floe concentration is reached, the Project should not have any effect on duration of ferry operations.

Glacier stated that although the ferry would be removed more or less at the same date, it would take longer post-Project for a solid ice cover to form. Glacier acknowledged that this freeze-up period has the greatest affect on being able to cross the river. To evaluate the delay in ice bridge construction, Glacier assumed that ice bridge construction could commence when an ice thickness of 0.1 m is achieved by natural growth. It stated that when the ice thickness reaches 0.1 m, the time to achieve safe travel on the ice would be about the same length of time pre- and post-Project. Glacier used reported information on first crossing dates and simulated dates when an ice thickness of 0.1 is achieved to determine that the post-construction delay in formation of an ice bridge would be delayed by about two to three weeks.

10.3.2: VIEWS OF THE INTERVENERS

CROSS

CROSS expressed concern that the Project would delay the construction of an ice bridge which cannot be offset by extending the time which the current ferry operates. CROSS believed that the delay in the formation of stable ice would result in longer periods of flowing ice conditions which would not allow for extended use of the ferry to offset the shortened ice bridge season.

10.4: MITIGATION OPTIONS

10.4.1: VIEWS OF THE APPLICANT

Glacier stated that three options had been considered to address the effects of delay in ice bridge formation: travel cost compensation, a community compensation fund or advocacy and support for upgrading the ferry. Glacier stated that evaluation of the options suggested that the ferry upgrade option is equivalent or superior to all other options based on all criteria.

Glacier noted that frazil ice traveling in the river can create unmanageable and unsafe ferry conditions. As temperatures drop, the frazil ice can become lodged in the ferry pontoons, reducing its mobility and ability to steer. Glacier stated that replacement of the ferry with an improved design better able to withstand flowing ice and improvements to the ferry docking infrastructure to ease the removal and replacement of the ferry have the potential to more than offset the delay in ice bridge construction. Glacier stated it proposed to fund one-third of the cost of a replacement ferry. Glacier noted that although it is assisting with this initiative, ultimately the responsibility for owning and operating any ferry or infrastructure rests with AT.

Glacier stated it was waiting for CROSS to accept the ferry as reasonable mitigation before moving ahead with more detailed engineering and design studies.

10.4.2: VIEWS OF THE INTERVENERS

CROSS

CROSS expressed concern regarding the lack of an agreement for the replacement of the ferry. CROSS stated that without detailed design plans, it was unable to comment on the potential of the replacement ferry to offset the delay in ice bridge construction. CROSS requested to be included in the design and planning of the replacement ferry.

CROSS requested that approval of the Project should be deferred until there is a plan in place for all parties to evaluate. Failing that, and should the Project be approved, CROSS requested a condition be placed on the approval that outlines the implementation of a replacement ferry that is specifically designed to operate in the post-Dunvegan ice condition, along with a monitoring plan that would be established to evaluate the performance of this ferry to ensure that the operating season is actually extended. It also requested that a monitoring plan be developed to assess the effects of the Project on ice bridge formation and an action plan be developed to deal with any unexpected impacts of the Project on the ice bridge.

Alberta Transportation

AT submitted that the replacement of the Shaftesbury ferry is not within AT's current three-year plan, as the ferry is believed to have some serviceable life left. AT stated, however, that it is committed to negotiate in good faith with Glacier to determine if a cost share arrangement to prematurely replace the ferry can be reached.

Regarding the participation of the public with respect to the design of equipment, AT stated that its normal process is not to involve public groups in the detailed design process, nor does it share information with third parties which are not party to the agreement.

10.5: VIEWS OF THE PANEL

The Panel declined CROSS's request to compel the attendance of AT. However, the Panel did require that AT respond in writing to a number of questions that were developed at the hearing with the input of hearing participants. The written responses of AT were provided to all hearing participants following the close of the oral proceeding. Participants were afforded the opportunity to supplement final argument based on this additional evidence.

Having regard for the submissions presented during the course of the review, the Panel accepts that the Project will shorten the winter crossing season by delaying the construction of the ice bridge. There was general agreement between CROSS and Glacier that the Project will delay the formation of the ice bridge by two to three weeks. The Panel concurs with this conclusion and has considered this expected delay in formation of the ice bridge in assessing the impacts. In addition, the Panel finds that there will also be an increase from the current average of one in ten years to an average of one in five years when the ice bridge cannot be established. The Panel recognizes that CROSS did not agree with Glacier about the frequency and manner of ice bridge construction.

The Panel understands that for those days where crossings cannot be made at Shaftesbury the option is either to postpone travel to destinations that require a Peace River crossing or to make a much longer drive to cross at either Peace River or the Dunvegan Bridge. While the added distance and associated travel time will vary depending on the particular circumstances of the traveller, the Panel accepts that this may in the more extreme examples amount to an increase of 1.5 hours of travel time each way. The effect of crossing day losses on any individual will be greater, the closer they reside to the Crossing. As the time of service disruption is during the winter months, it is also reasonable to assume that road conditions may lengthen travel times and increase safety concerns. The Panel finds that the impact of the Project on Shaftesbury Crossing is incremental to the existing situation since under the current ice regime, there are years when no ice bridge can be built and there are years, depending on the severity of the winter, when considerably fewer crossing days are available than in other years.

The Panel finds that full reliance on the ferry and ice bridge for emergencies is not practical. Pre-Project conditions are unpredictable as demonstrated by the fact that no ice bridge was available during the winters of 2002/03 and 2005/06. While the Panel understands that in some circumstances use of Shaftesbury Crossing for emergencies may be the best option, the Panel does not believe that residents can fully rely on the Crossing for emergency situations. While there was some oral evidence submitted at the hearing, the Panel does not find that evidence would support the view that the Crossing is or has been the first best choice for emergencies.

The Panel finds that Glacier's previous actions and continuing commitment to contribute to the design and construction of a new ferry capable of extending operations during periods of surface ice floe conditions represents a reasonable and measurable mitigation of the Project's impact on Shaftesbury Crossing. However, the acquisition of a replacement ferry is entirely within the mandate of AT. AT has committed to negotiate in good faith with Glacier a cost sharing arrangement, which would accelerate the replacement of the current ferry ahead of its projected service life with one that is more capable of navigating during periods of initial ice floe conditions.

The Panel also considered the relationship between the ice front and ice bridge construction. CROSS challenged the evidence of Alberta Transportation related to the ice front distance requirement for bridge construction. The Panel accepts that there is currently no specific ice front criterion for construction of the ice bridge. The Panel acknowledges that past practices may have informally used some upstream distance for the ice front before construction of the ice bridge began. However, the Panel has not placed significant weight on this anecdotal evidence. In the Panel's view, this becomes less of an issue as the evidence shows that the post-Project ice front formation is forecasted to advance at a slower rate but have greater thickness and integrity as it forms. The Panel finds that as the ice front passes the Shaftesbury site it will require less upstream front to establish safe conditions to commence ice bridge construction. The result is that there will not be an additional delay in the construction of the ice bridge caused by the time required for the ice front to travel a further 40 km upstream. The Panel understands Alberta Transportation's submissions that current criteria used to initiate ice bridge construction are primarily based on ice thickness and will accommodate any changes they may observe in the establishment of the ice front as a result of the Project.

The challenge to the Panel is weighing the proposed Glacier mitigation and determining what residual effects to account for in deciding whether the Project is in the public interest. Having regard for the Project's effects on Shaftesbury Crossing and the Glacier commitment to financially participate with AT for the study and replacement of the ferry, the Panel is satisfied that Glacier has taken a responsible approach to project impact mitigation. However, without certainty that a new ferry will be commissioned to coincide with completion of the Project, the Panel must assess the Project based on the conservative assumption that a new ferry will not be considered until such time as the existing ferry is retired from service based on AT's current replacement policy.

The Panel acknowledges that the EUB-NRCB Joint Review Panel's 2003 decision concluded that the Project would result in negative impacts to regional residents who accessed the Shaftesbury Crossing. Given the substantial improvements in ice modelling presented at the 2008 hearing and the evidence provided by Glacier, the Panel concludes that the impacts at Shaftesbury Crossing are well understood. The Panel finds that the adverse effect of the Project is an incremental loss of crossing days and, while important to the Shaftesbury users, is not sufficiently significant so as to cause the Panel to deny the Project. Having regard for the extent of the effect on CROSS members and other users of the Crossing the Panel concludes that these adverse effects created by the Project are potentially mitigated by Glacier's commitment at the hearing to contribute 30 percent of the costs toward the ferry replacement and commitments made by AT to negotiate an upgrade to the existing ferry. The Panel encourages AT to proceed with the commissioning of a new ferry on a timely basis. The Panel finds that an upgraded ferry has the potential to substantially alleviate the incremental impacts of the Project on the Shaftesbury Crossing. The Panel recommends AT move forward with the consideration of a new ferry in a timely way.

SECTION 11: GEOTECHNICAL ISSUES

11.1: SLOPE STABILITY

11.1.1: VIEWS OF THE APPLICANT

11.1.1.1: DEEP-SEATED LAND SLIDES

Glacier asserted that deep-seated slope instability and extensive major landslides are common along much of the Peace River valley in northwest Alberta. It said that deep-seated landslides occur preferentially in areas where the position of the Peace River valley coincides with two special geologic settings.

Glacier said that one setting occurs where the river valley is incised into unconsolidated sediments, such as clay and till, that were deposited by glaciers into very deep valleys of a pre-glacial drainage systems consisting of the ancestral Peace River and its tributaries. It said the second setting is where the present valley is cut into thick, structurally weak, marine shale bedrock sediments of the Kaskapau and Shaftesbury formations.

Glacier provided examples of such major landslide occurrences along the Peace River valley. One area is located upstream of the proposed headpond and between the confluence of the Montagneuse and Peace rivers and about 18 km east of the British Columbia border. A second is located downstream of the headworks between Dunvegan and Hines creeks and Dunvegan Settlement. A third extensive area of large landslides is located along the Peace River between the 6th Meridian and the town of Peace River.

Glacier explained that the entire length of the Peace River valley from the headworks to the uppermost extent of the headpond does not have the geologic settings that are required for deep-seated landslides to occur. It said the geologic setting along the expected extent of the headpond was different for two reasons.

First, the deep pre-glacial or ancestral Peace River valley is not present along the anticipated headpond and the thick and unstable unconsolidated sediments associated with infilling of the pre-glacial valley are therefore absent. Second, the present Peace River valley is cut into primarily sandstones, siltstones, and shales of the Dunvegan Formation, which is inherently geotechnically stable and not prone to the development of deep-seated landslides.

Glacier further explained that along the section of the Peace River where the headpond is anticipated to form, the unconsolidated clayey sediments and marine shale of the Kaskapau Formation are thin and overlie the geotechnically competent Dunvegan Formation. It clarified that the slide-prone shales of the Shaftesbury Formation do not crop out along the anticipated headpond, but are situated beneath the bottom of the Dunvegan Formation and at considerable depth (30 to 40 m) below the river bed.

Glacier concluded that the geological conditions encountered along the proposed headpond do not promote the initiation of large deep-seated landslides into the headpond, and that the likelihood of large landslides originating in the bedrock along the proposed headpond is low.

11.1.1.2: SLOPE STABILITY IN THE PROJECT AREA

Glacier provided an analysis of historical and anticipated future slope stability processes that have affected, and may affect, the sediment and debris delivery into the headpond. It explained that erosion and slope stability are affected by numerous factors, such as climate, parent materials, relief, aspect, biota, and time.

Glacier assessed slope stability along the entire proposed headpond by reviewing existing literature and aerial photographs and conducting a field assessment. It identified four slope processes or types along the proposed headpond. It described the slope types as follows:

- Type 1: Bluff Slopes

Glacier described bluff slopes as consisting of intact exposures of interbedded sandstone and shale of the Dunvegan Formation, with minimal flood plain or debris protecting the toe of the slope. It said this slope type is found primarily along the lower 3.5 to 6.5 km of the north slope of the Peace River and accounts for about 12.3 percent of slopes along the proposed headpond.

Glacier indicated that sliding on the bluff slopes consists primarily of movement of a 0.3 m thick weathered layer. It said water flowing over the upper slope and erosion of the toe of the slopes contributes to sliding of the weathered layer.

- Type 2: Valley Slopes

Glacier described valley slopes as being characterized by a small terrace or fan below the toe of outcropping sandstone beds of the Dunvegan Formation. Slopes above the weathered Dunvegan Formation consist of thin deposits of Kaskapau shale and surficial sediments. Glacier indicated that about 60 percent of headpond slopes are of the valley slope type.

- Type 3: Large Gullies with Gently Sloping Colluvium

Glacier indicated that large gullies containing fans of slide debris extending from near the crest of the valley to the river are present at various locations along the proposed headpond. The slide debris consists of earth-flow materials that have infilled existing gullies that were cut through the Dunvegan Formation by meltwater. The occurrence of this slope type is minor and accounts for about three percent of slopes along the proposed headpond.

- Type 4: Steep Gullies with Shallow Colluvium

Glacier identified steep gullies with shallow colluvium at numerous locations along the north slope of the Peace River valley. It said the colluvium consists of reworked and weathered shales and loose clay and till. The gullies deposit relatively small volumes of colluvium into the Peace River. Glacier indicated that about 20 percent of valley slopes along the headpond consist of this type.

11.1.1.3: EFFECTS OF INCREASED WATER LEVELS

Glacier indicated that, in general, rising of the Peace River water level in the proposed headpond would reduce flow velocities along the river edge, which would in turn reduce lateral erosion acting on the valley toe. However, Glacier said that in specific areas it expects lateral erosion to increase due to deflection of river flow by aggradation of existing sand and gravel bars. Glacier expected that this increased lateral erosion would result in only a slight increase in localized sliding and slumping along the valley walls over the initial few years of operations. Glacier said that in general there would be an overall decrease in toe erosion along the majority of the headpond compared to current conditions.

Glacier indicated that increased headpond water levels would not increase rates of sliding and slumping along the tributaries of Hamelin and Fourth creeks because increases in water levels are expected to only be about one metre at Hamelin Creek and near zero at Fourth Creek. However, Glacier said that an increase of 6.6 m is expected at Ksituan River (located about 2.2 km upstream of the headworks) and this may affect stability of its valley walls under certain conditions.

Glacier said increased water levels along the lower 1000 m of the Ksituan River would have the positive effect of reducing flow rates and the associated erosion along the toe of the slope. However, Glacier indicated that the increased water levels would soften the lower portions of the slope and would lead to increased slope failures in the unlikely event of a sudden drawdown in water levels of the headpond caused by a complete headworks failure.

Glacier indicated that a further mechanism that would increase erosion along the headpond would be waves generated by boats. However, Glacier said that the amount of such wave-induced erosion would be small enough to be immeasurable.

Glacier presented an analysis comparing water levels in the proposed headpond that existed under pre-Bennett Dam unregulated conditions with post-Dunvegan regulated conditions. It concluded that the headpond could be divided into two zones.

The first zone is from the headworks to about 15 km above the headpond. Glacier said that this zone would experience higher average annual flow levels and 1:50 year flood levels than those prior to regulation by the Bennett Dam. The second zone extends from about 15 km to about 26 km above the headworks. Glacier explained that this zone would have average annual flow levels in the upper half of the pre-Bennett range of flow levels and the 1:50 year flood levels.

Glacier explained that in the first zone, the post-Project flow would not be confined to within the banks of the pre-Bennett Dam channel and flow is expected to act on slopes that have not historically been subjected to prolonged flows or higher flood events. Glacier said that slopes that would be most affected are isolated shallow gullies containing shallow colluvium within the lower 7 km of the headpond. It predicted that the main effects on slope stability would be the submerging and softening of weathered bedrock and slope debris currently above water level. Glacier said the effects of wave erosion are expected to be negligible within this zone.

Glacier explained that flood waters in the second zone would be acting on previously inundated slopes and effects would be confined to reworking and redistribution of fine silty fluvial terraces at the base of the majority of the slopes. It said that the section along the left bank, between 2 to 17 km above the headworks where numerous steep gullies with shallow colluvium terminate at the river edge, also has a high potential for erosion due to flooding (1:50 year or less).

Glacier indicated that overall, shoreline erosion in the anticipated headpond is not expected to affect the headpond sediment balance in any noticeable way.

Glacier indicated that its studies and evaluations of slope stability along the proposed headpond were complete and comprehensive and that additional, detailed, studies are not warranted.

11.1.2: VIEWS OF THE INTERVENERS

The Coalition

The Coalition commended Glacier for the very high level of professional competence exhibited by its consultants in all aspects of the Project impact assessments. It acknowledged that Glacier's consultants have high reputations and their work was conducted to the expected standards for such investigations. However, the Coalition submitted that a number of aspects of the work were not pursued far enough to provide the most comprehensive feasible environmental assessment of the Project.

The Coalition submitted that additional work may be warranted to obtain appraisal of the likely magnitude of lateral sediment delivery to the headpond from hill slopes and gullies.

The Coalition agreed with Glacier that sediment delivery by the process of wave attack would be quantitatively insignificant. However, it believed that it may create persistently high suspended sediment concentration in the shore zone. The Coalition stated that the process most likely to create significant wave attack is boat passage at high speed. It believed that because Glacier has proposed to construct a boat launch in the headpond, recreational boat traffic and shoreline wave attack would both increase. The Coalition suggested that provision be made to monitor the process to determine if it would become significant and if operational remedies would be required.

The Coalition believed that there is considerable evidence, such as the growth of fans at tributary mouths, that sediment delivery from tributaries and into the headpond may be significant. It believed that although it would be difficult, Glacier should attempt to quantify sediment delivery from tributaries and to forecast the effect of 100 years of sedimentation. The Coalition stated that initially sediment would infill the back-flooded zones at the mouths of tributaries, but later it would prograde into a shoaling reservoir. It said that there may be a possibility for one or more of the tributaries to significantly bar the river and raise upstream water levels after decades of sedimentation. The Coalition stated that some form of monitoring would be required for some years, if the Project proceeds.

The Coalition indicated that Glacier may have underestimated the significance of sediment delivery to the headpond by debris flow from gullies. It said that debris flow is episodic and infrequent for any one gully. However, individual flows may range from insignificant (thousands of cubic metres) to significant (100,000 cubic metres). The Coalition said there may be some chance to establish an approximate history of past debris flow events by examining preserved stratigraphy at the mouths of some gullies. It said this would be the most efficient way to gain knowledge of the phenomenon.

The Coalition did not disagree with Glacier's assertion that significant deep-seated landslides are not likely to occur along the proposed headpond because of the presence of competent Dunvegan Formation under the lower valley slopes. Similarly, it did not disagree with Glacier that shallow landslides would occur on upper slopes underlying by Kaskapau shales and unconsolidated clayey sediment. The Coalition noted, however, that there is abundant evidence that former slumping and block sliding has occurred in sediments overlying the Dunvegan Formation and it appears that the river banks have not been extensively disturbed in recent times.

The Coalition's view was that future changes (including climate change) over the 100 year lifespan of the Project may create one or more significant events. It said that only one really major event needs to occur to create a significant problem. The Coalition suggested that a regional investigation of slope instabilities should be conducted in areas of similar geology beyond the currently projected reservoir limit to increase the sample of potentially significant events, and to establish firmer probabilities for the likelihood of a major event to impact the reservoir.

Government of Canada

The DFO agreed that slope stability and landslides have played a role in the development of the valley of the Peace River in the area. It agreed that the Peace River follows outcropping Dunvegan bedrock in the area covered by the headpond and headworks of the Project, making it less susceptible to landslides than elsewhere.

11.2: SEDIMENTATION AND CHANNEL MORPHOLOGY

11.2.1: VIEWS OF THE APPLICANT

11.2.1.1: SEASONAL VARIATION IN SUSPENDED SEDIMENT TRANSPORT

Glacier cited several studies that assessed suspended sediment data and calculations of annual suspended sediment loads of the Peace River. All of those data were collected after the construction and operation of the Bennett Dam.

Glacier reported that the peak sediment concentration at Dunvegan occurs in the spring and early summer due to inflow from unregulated tributary streams. Glacier indicated that construction of the Bennett Dam is not expected to have significantly reduced the sediment availability in the downstream river, because most of the sediment comes from tributaries downstream of that dam.

11.2.1.2: ANNUAL SEDIMENT LOADS

Glacier provided sediment transport data from the Peace River near Dunvegan and the Town of Peace River, which indicated that very high-suspended sediment concentrations occur periodically and remain elevated throughout the open-water period. It said 10 to 47 percent of the average annual sediment load could occur in one day.

Glacier estimated the annual suspended sediment load in the Peace River ranges from 3.6 to 39.8 Mt per year with an average of 15.6 Mt per year. It indicated that flows in May and June typically carried the greatest concentration of suspended sediment. Glacier also provided estimates of gravel bed load as well as the finer bed material load.

Glacier reported that the channel in the vicinity of the proposed facility had a gravel bed with a surface armour layer and finer, more poorly sorted subsurface materials.

Glacier reported that near Dunvegan, the Peace River consists of a single-thread channel confined by about 200 m high valley walls. Islands are uncommon and areas of sediment accumulation are typically poorly developed, small point or lateral bars.

Glacier said three sizeable tributary streams enter the proposed headpond and two tributaries flow into the Peace River immediately downstream from the headworks. It said the tributary streams have formed sizeable fans at their confluences with the Peace River and appear to be the most important sediment sources within the local study area (LSA)

Glacier stated that, following construction of the Bennett Dam, reduced peak flows have been less competent to move the coarser sediment load supplied by the tributaries and these materials have deposited as alluvial fans along the downstream bank. These deposits may be locally affecting channel slope and appear to affect the location of bars and islands.

11.2.1.3: SEDIMENT TRANSPORT

Glacier stated that reduced water velocity and associated reductions in shear stress, would affect sediment transport in the reservoir. It said water velocities through the headpond would vary significantly with discharge, causing sediment deposition during low velocity and transport or re-entrainment during higher flows. However, Glacier indicated that, overall, the reduced water velocities would cause much of the headpond to become sand bedded, with the gravel to sand transition zone being near the upper end of the headpond between km 20 and 23.

Further modelling used by Glacier indicated that 22 percent of the total incoming sediment load would be trapped over the initial 10 years of Project operations. This corresponds to an accumulated sediment volume which is 33 percent of the proposed headpond volume at the 50 percent exceedance flow. Glacier predicted that the sediment trapping efficiency of the reservoir would decrease over time as sediment deposits constrict the channel and increase water velocities. Glacier estimated that, over 50 years, the sediment trapping efficiency would decrease to 11.1 to 11.6 percent, which corresponds to a sediment volume of 52 to 54 percent of the initial headpond volume at the 50 percent exceedance flow.

Glacier predicted that coarse, gravel-sized sediments would be deposited at the upstream end of the headpond and finer textured sediment deposited downstream. Glacier expected limited distribution of gravel occurring in the upstream end of the headpond during the initial 10 years of the Project (km 18.2 for fine to medium gravel). Very fine to medium gravel is expected to be deposited by Glacier upstream from km 16 over a period of 50 years, while coarse to very coarse gravels are expected during that time only in the reach upstream of km 21.5. Glacier expected that all other areas of the headpond would develop sand-sized or finer bed material.

Glacier indicated that coarse-textured sediment deposition would modify the geometry of the headpond over the life of the Project, but it did not expect these changes to significantly affect the engineering performance of the structure. Glacier stated that coarse textured materials consisting of gravel would deposit in the upstream end of the headpond and would progress downstream over the life of the structure. Glacier expected sand to be deposited in deeper water areas, while finer textured sediments would be deposited along the channel margin, in slack water areas and upstream from the control weir.

11.2.1.4: CHANNEL MORPHOLOGY WITHIN THE HEADPOND

Glacier reported that the Bennett Dam has significantly reduced the frequency with which the coarser river bed materials are transported and, as a result, a lengthy period of time may be required for significant coarse gravel accumulations to occur in the headpond. Enlargement of a point bar at km 27 and the development of a transverse bar, or possibly more distributed deltaic like sediment accumulation, is predicted between approximately km 28 and 24.

Glacier expected that the prograding tributary fans would continue to enlarge, although headpond formation would further reduce the Peace River’s ability to redistribute the coarser fractions of the incoming tributary sediment load. Glacier‘s modelling indicated that the elevation of the channel bed would increase by an average of 3 to 5 m at the upstream and downstream ends of the headpond, respectively, over a 50-year period. Deposition of fine-textured sediment in the nearshore areas would increase bed elevation by more than 5 m.

It was Glacier’s view that the water surface in the reservoir will form a backwater curve, which gradually approaches the upstream water level in the vicinity of km 26 above the headworks. Glacier said that it was highly confident that above that point, the headpond will not significantly affect water velocities, sediment transport or sediment deposition. It emphasized that there would be no significant incremental sediment deposition above km 26 and the effects of the Project would not extend beyond that point.

Glacier explained that while its one-dimensional sediment transport model did predict that the average depth of sediment deposition across the entire valley bottom at km 26 would be 3 to 4 m after 50 years of deposition, the change in the river bed elevation would be negligible. It said that sediment depth will be greater at the valley sides, but one of more river channels will be incised into the sediment to about the same elevation as the current river bed.

11.2.2: VIEWS OF THE INTERVENERS

The Coalition

The Coalition stated that Glacier only examined future changes based on the current river morphology and not on a future, changing morphology. It was the Coalition's view that, by not looking at how the future reservoir hydraulics would be changed as sedimentation increases, the EIA failed to predict what changes would ultimately occur to the river. Without this information the Coalition believed that the Panel could not draw conclusions on the impacts and therefore could not assess if the Project was in the public interest.

The Coalition stated that Glacier's information on bedload transport in the river and deposition in the reservoir was incomplete. It said Glacier attempted to overcome this deficiency by making comparisons with other superficially similar rivers. The Coalition asserted that none of the estimates of bedload presented by Glacier were credible.

The Coalition estimated that the movement of coarser bedload (> 2 mm) was two orders of magnitude lower than that estimated by Glacier and predicted gravel influx into the reservoir would be negligible. It suggested the highly armoured bed of the river implied a low rate of bed entrainment and hence low rate of local bed material transport.

The Coalition emphasized that gravel delivery to the reservoir would be very small and the bedload would consist predominantly of medium to coarse sand and possible granule gravel. Larger bed materials would be delivered only on rare occasions when unusually large flows occur.

The Coalition expressed concern about Glacier's use of one-dimensional modelling to assess sediment transport. In its view, the one-dimensional approach used may introduce bias into the calculations. The Coalition also suggested that the estimate of long-term sedimentation, using a "representative" annual hydrograph repetitively for each year, did not consider the effect of sedimentation on reservoir geometry and the resulting effect on subsequent sediment deposition and transport. It further suggested this approach risked bias as it did not reflect that disproportionally more sediment would be delivered in years with higher flows than ones with normal flows. The Coalition acknowledged that this affect was minimized in regulated rivers such as the Peace River as upstream hydroelectric dam operators aim to minimize the occurrence of extreme flow events. The Coalition recommended that Glacier reconsider and revise the estimate of fluvial bed delivery to the reservoir. The Coalition explained that obtaining a more detailed forecast of sedimentation patterns in the reservoir and river morphology was extremely important for fish habitat assessment.

The Coalition did not support Glacier's prediction that the Peace River would aggrade on already existing bars and side-channels, but did support Glacier's further characterization as "*more distributed deltaic-like sediment accumulation*." The Coalition explained that, in the reservoir area, the usual gravel bed material in the channel would be replaced by sand. It predicted the channel would shoal (create bed forms that produce shallow areas), and form a number of main threads of flow with extensive sand. The Coalition predicted this would impede boat navigation at low flows when recreational traffic would be greatest, and would change aquatic habitat within the reservoir.

The Coalition stated that Glacier's prediction of substantial sedimentation at the upstream limit of the reservoir implied aggradation upstream from the reservoir. It explained that the usual outcome of this imposed base level was that higher water levels would eventually occur upstream. The Coalition pointed out that Glacier's estimate of the area to be flooded by the reservoir was based on water level estimates for the current morphology. It concluded this was a shortcoming of the EIA and that the area to be flooded had not been estimated by including effects of a long-term sedimentation.

In the Coalition's view, as the reservoir in-filled with sand, dredging would not be required to maintain the headpond channel. Rather, as the headpond filled, the gradient would steepen, water velocities would increase and a greater proportion of sediment would be transported through the reservoir. When the headpond was essentially full of sediment, all of the incoming sediment would pass through the turbines. Once in-filled, the headpond would be a shallow, sandy channel that extends upstream beyond the predicted extent of the reservoir. The Coalition suggested that a single channel may form as the initially marshy channel edges trap silt and became more stable. Upon decommissioning, the Coalition predicted that the river would cut a single channel through the sandy terraces. It characterized Glacier's statement in the EIA, that all sedimentation effects are reversible, as unlikely.

11.3: SEISMICITY

11.3.1: VIEWS OF THE APPLICANT

In its EIA, Glacier stated that the project area is located in one of the most seismically stable regions of Canada. It said that earthquakes with a magnitude greater than 5 on the Richter Scale are considered to be potentially damaging and that only one such earthquake had ever been recorded in the prairie region of Canada south of 60 °N. It said this event occurred in 1909 in southern Saskatchewan and had a magnitude of 5.5 on the Richter Scale.

Glacier said that according to 1998 published information by Natural Resources Canada, the project area is in Zone 0, where seismic hazard is lowest, in terms of peak horizontal ground acceleration. It explained that this parameter is used to measure hazards to small or rigid structures. Glacier further stated that in terms of peak horizontal ground velocity (the parameter used to measure hazards to tall flexible structures such as high-rise buildings) the Project is in Zone 1, where seismic hazard is the second lowest in Canada.

In response to SIR #16, which explained that a magnitude of 5.4 earthquake occurred about 52 miles west-northwest of the proposed headworks in 2001, Glacier stated that the Project would be designed for the maximum credible earthquake, which would take into account all available seismic data as well as the new seismic zone classification which came into effect in 2005. It said it performed the 2005 National Building Code Seismic Hazard Calculation, which resulted in peak ground acceleration (PGA) for the Project of 0.059 gravity (g).

Glacier asserted that the calculation took the 2001 earthquake into account and reflected the relatively stable seismic zone where the Project would be located. It stated that the 2001 earthquake does not affect the hazard potential classification of the development.

Glacier explained that the structure would be designed for an operational basis earthquake equivalent to a peak ground acceleration of 0.059 g in accordance with the 2005 National Building Code Seismic Hazard Calculation, but would also take into account the maximum design earthquake. It said the maximum design earthquake would be derived either deterministically (maximum credible earthquake for a very high consequence structure), or probabilistically (1/10,000 annual exceedance probability event for a very high consequence structure.

Glacier committed to a final design that would include a closer geological interpretation of the region and seismic activity to select the appropriate design earthquake. It also stated that its intent was to meet or exceed safety criteria established by the Canadian Dam Association Dam Safety Guidelines which takes into consideration all loading combinations including high water due to floods and seismic activity.

11.4: VIEWS OF THE PANEL

The Panel concludes that Glacier chose the location of the Project having regard to potential adverse affects of various processes relating to slope stability and related sediment transport to the headpond. In particular, the Panel accepts the geological evidence that geotechnically stable bedrock and unconsolidated sediments are located at both at the headworks and along the entire length of the headpond.

The Panel understands the analysis of past, naturally occurring, slope instability and erosion processes in the project area. The Panel finds that, while these processes will undoubtedly continue to deliver sediment to the headpond, the presence of the headpond will not cause an increase in the sediment load that would be great enough to deter successful operation of the Project over the long term.

The Panel notes that Glacier has exerted great effort into analyzing, modelling and predicting the total sediment load, its composition, and deposition into the headpond. The Panel finds that while there was agreement between Glacier and the Coalition that the majority of the sediment delivery to the headpond would consist of suspended matter, the two parties disagreed primarily about the distance above the headworks over which, sediment deposition would occur. The Panel notes that these differing views arose because of Glacier's use of a one-dimensional sedimentation model that predicted the average volume of sediment deposition at various locations above the headworks, to a maximum of 26 km.

The Panel understands the Coalition's position to be that since Glacier's model predicted as much as 3 to 4 m of sediment deposition at km 26, the actual sedimentation should occur over much larger distance above the headworks than 26 km.

On weighing the evidence, the Panel has considered the expertise and familiarity of both Glacier and the Coalition with the sedimentation data and the model used in predicting sedimentation into, and the upstream extent of, the headpond. The Panel finds the Glacier's interpretation and prediction to be credible, and its explanation that while 3 to 4 m of sediment may be deposited at km 26, the bottom of the river channel would still be situated at similar elevation than pre-Project after many years of operation.

Accordingly, the Panel finds that the extent of the headpond will not differ significantly from the 26 km predicted by Glacier and the potential changes in extent of inundation and damage to fish habitat that may be associated with a larger headpond will not materialize.

The Panel acknowledges Glacier's assertion that the structure will be designed for an operational basis earthquake equivalent to a peak ground acceleration of 0.059 g in accordance with the 2005 National Building Code seismic hazard calculation, but will also take into account the maximum design earthquake. The Panel also acknowledges the Glacier's commitment to a final design that will include a closer geological interpretation of the region and seismic activity to select the appropriate design earthquake, and to meet or exceed safety criteria established by the Canadian Dam Association Dam Safety Guidelines.

The Panel recommends that the results of the committed-to geologic and seismic investigation, and the selected appropriate design earthquake, be submitted to Alberta Environment for its approval before Project construction begins.

SECTION 12: NAVIGABLE WATERS

Transport Canada administers various regulations and policies related to navigation and is responsible for the administration of the *Navigable Waters Protection Act* as it relates to the Project. This legislation is intended to protect the public right of navigation by reviewing and issuing approvals for any works constructed or placed within the limits of a Canadian navigable waterway.

The Project is expected to affect the public right of navigation on the Peace River and some of its tributaries. This section of the report presents a summary of navigation issues that may result from the Project including sedimentation of the headpond, boat locks, including safety considerations, and access ramps.

The area of the Peace River that would be occupied by the proposed headworks and headpond has low gradient, wide channels and no rapids and therefore would be relatively safe for boaters. Boat traffic on the Peace River is largely restricted to low draft jet boats and canoes.

12.1: SEDIMENTATION, SHOALING

12.1.1: VIEWS OF THE APPLICANT

Glacier noted that sediment would be deposited into the headpond from upstream flows of the Peace River. The amount of sediment is expected to be substantial, although the amount of sediment from other tributaries into the headpond would likely be negligible by comparison. Glacier indicated that the Sawchuck Rapids area is currently difficult to navigate without both a jet boat and knowledge of the area. After construction, Glacier testified that the conditions are not likely to vary from existing conditions in terms of navigation and that shoal development is a slow process. Glacier committed to monitor and provide information on shoal development to avoid navigation and safety issues.

12.1.2: VIEWS OF THE INTERVENERS

The Coalition

The Coalition identified a possibility that one or several of the tributaries to the Peace River might add significant amounts of sediment into the headpond and may bar the river and raise upstream water levels after decades of sedimentation. It suggested that this sediment inflow would potentially result in the creation of an effective block to river navigation.

The Coalition suggested that there should be supervisory activity with respect to boating in the headpond, as the Project would create areas that occasionally may be difficult to navigate.

The Coalition believed that boat passage at high speed might create persistently high-suspended sediment concentrations in the shore zone, primarily within the headpond. The Coalition agreed with Glacier that sediment delivery by the process of wave attack would be quantitatively insignificant. The Coalition suggested that a provision be made to monitor the process to determine if this may become significant and identify operational remedies that may be required.

12.2: BOAT LOCKS AND ACCESS RAMPS

12.2.1: VIEWS OF THE APPLICANT

As the proposed dam would impede boat traffic along the Peace River, Glacier committed to construct a navigational boat lock to allow passage at the headworks structure, and a new boat launch area to allow access to the headpond. The proposed navigational lock was expected to be installed adjacent to the powerhouse structure, and measure 8.5 m wide and 18 m long. The boat launch ramp is anticipated to be 6 m wide and 40 m long, with 20 m submerged to ensure operation, even when the headpond level is drawn down to the fixed crest level.

The boat lock would not be in operation until the fourth and final year of construction. Glacier therefore committed to provide a portage route on the south bank of the river during the construction period. Passage around the construction site would be provided by wheeled carts for canoes and a truck and trailer service for larger boats.

Glacier planned operation of the lock to occur throughout the ice-free season, including periods of darkness or reduced visibility so as not to limit navigation on the river. The boat lock, as planned by Glacier, would operate in such a manner that the longest wait expected for passage would be roughly half an hour.

During ice conditions, flood periods when river flows are discharging over the dam structure, or when substantial debris is present in the river, Glacier indicated that the boat lock is not expected to be operational. Glacier noted that although the lock would not operate at these times, boating activities are not likely to occur during these periods, and therefore navigation would not likely be affected.

Some barges may travel on the river for various commercial purposes (i.e. oil and gas exploration). Glacier noted that barges are often sized by the ability to be towed on highways, and a common size is approximately 5 m by 15 m. Barges of this size should pass through the locks with relative ease. Glacier suggested that if barges were not able to travel through the locks that the truck-based portage system would be available to shuttle barges between the existing and planned boat access ramps.

12.2.2: VIEWS OF THE INTERVENERS

Government of Canada

Transport Canada agreed with the assessment of Glacier, that any potential effects of the Dunvegan Project on water way navigation would not be significant, given the implementation of the proposed mitigation measures.

12.3: PUBLIC ACCESS AND SAFETY

12.3.1: VIEWS OF THE APPLICANT

Glacier noted that the Peace River is easily accessible to the public and used frequently during the open water period from April to November for both recreational and commercial navigation purposes.

In addition to the boat locks proposed by Glacier, a new boat ramp and parking facilities would be constructed upstream of the headworks to allow for direct access to the headpond.

Glacier consulted with Transport Canada on the boat lock design and its operation, as well as on the temporary portage system during the construction period.

Glacier suggested that there may be a safety risk to boaters from the proposed spillway and powerhouse. To ensure that boaters would not come in contact with the Project structures, Glacier proposed the following mitigation measures:

- Two safety booms upstream of the dam and two safety booms downstream of the proposed headworks.
- The boat lock would be positioned as far away from the powerhouse as possible to reduce river flow and turbulence at the approaches to the boat lock.
- Navigational aids to guide boaters and warn boaters of the hazards associated with the facility.
- Facility operators would be trained to recognize risks associated with facility operations and maintenance.
- Implementation of boat safety, rescue and education programs. These programs would include notices in the local newspapers and radio stations, information sessions, and tours of the plant facilities designed to make boaters and the general public aware of hazards associated with the entire facility.
- Availability of informational and instructional brochures at the facility and other local boating associations, municipal office and merchants.
- Maintaining rescue equipment at the facility and providing emergency response training to personnel on site, including medical training and equipment to efficiently execute a rescue.
- Coordination of rescues with local communities.
- Glacier would operate the boat locks manually until such time as there was sufficient boater comfort with the system, at which point a boater-operated system would be used.

Given the above mitigation measures, Glacier indicated that the effect of the Project on boater safety was not significant.

Glacier concluded that the Project, considering design and proposed mitigation measures, would result in no significant adverse effects on the public access to navigation on the waterway.

12.3.2: VIEWS OF THE INTERVENERS

The Coalition

The Coalition indicated that Glacier has not adequately dealt with the possibility of boating accidents on the river in the vicinity of the proposed headworks.

Government of Canada

Transport Canada agreed with Glacier's assessment that after implementation of the proposed mitigation measures the effects of the Dunvegan Project on use of the water way and navigation would not likely be significant.

Transport Canada also agreed with Glacier's assessment that the potential effects of the Project on boater safety would not be significant, given the proposed mitigation measures. It stated that issues related to boater safety with regard to the operation of the locks would be covered by conditions in any approval Transport Canada may issue to Glacier pursuant to the *Navigable Waters Protection Act*. Transport Canada indicated that it did not have a mandate to inspect operation of the locks. For liability reasons, it would be Glacier's responsibility to inspect the locks to ensure they were operating properly. If Transport Canada received any complaints about the operation of the locks, Glacier would be required to take appropriate action as per conditions in its *Navigable Waters Protection Act* approval.

Transport Canada provided a list of approved training courses for commercial boat operators in Canada (one course in Alberta) and a second list of course providers for pleasure craft boating safety (five courses in Alberta). Since many of the courses are offered online, they would be readily accessible to boaters in the Peace region.

12.4: OTHER NAVIGABLE WATERS

12.4.1: VIEWS OF THE APPLICANT

Glacier identified that new bridge crossings would be required over the Hines Creek and Dunvegan Creek, although currently no applications for these crossings were before regulatory authorities. Detailed final designs were not available at the time of the hearing, but would occur in coordination with landowners and Alberta Transportation.

12.4.2: VIEWS OF THE INTERVENERS

Government of Canada

Transport Canada could not provide comment on the effects these proposed crossings may have on navigability of Hines Creek and Dunvegan Creek. Transport Canada noted that Glacier is required to ensure that Transport Canada receives applications for these proposed crossings, and receives any appropriate authorizations prior to their construction.

12.5: VIEWS OF THE PANEL

The Panel finds that while the Project will create a barrier to navigation on the Peace River, navigability of the waterway will be maintained by way of the boat locks included in the project design. The Panel also recognizes that sedimentation in the headpond may result in the development of shoals that may pose a hazard to navigation over time.

The Panel accepts Glacier's commitment to a long-term monitoring program with Transport Canada that includes identification of shoals that may develop within the headpond and to inform boaters of these and other potential hazard areas through the placement of navigational aids, and other means.

The Panel acknowledges that the facility staff will operate the boat locks until such time as the public can safely operate the locks without assistance. The Panel considers this to be both an operational and educational measure to ensure safety and continued navigability of the waterway.

The Panel accepts Glacier's commitment to develop and implement a boater safety, rescue and education program, designed specifically for the Project, and that this will form part of its emergency preparedness and response plans.

The Panel recommends that Transport Canada identify any additional approval conditions necessary to ensure navigational safety and include these conditions in any authorizations it may issue. The Panel notes that Transport Canada has authority to review, and apply additional conditions to any applications under the *Navigable Waters Protection Act* for proposed works that could affect navigability on Dunvegan and the nearby Hines Creek.

Having considered all mitigation measures suggested by Glacier, the Panel finds the Project will not result in significant adverse effects to the navigability of the waterway or boater safety.

SECTION 13: FIRST NATIONS AND METIS CONCERNS

13.1: TRADITIONAL LAND USE, RESOURCES AND ABORIGINAL TRADITIONAL KNOWLEDGE

13.1.1: VIEWS OF THE APPLICANT

Glacier stated that a "*significant adverse affect on traditional land use is one that prevents First Nations from carrying out traditional pursuits, either through the destruction of a resource used or the prevention of access to a resource.*"

Glacier funded a traditional land use study involving elders of the Duncan's First Nation (DFN). This study used aboriginal traditional knowledge and focused on the traditional territory of the DFN. The elders had a number of concerns about the potential impacts of the Project on the DFN's traditional use sites. One traditional use site was found within the local study area (LSA) and consists of a medicinal or sacred plant area on the north side of the Peace River at the confluence of Hines and Dunvegan Creeks. The Project does propose an access road which would cross the lower portion of Hines Creek. Glacier stated that this road is not expected to interact with the traditional land use area on Hines Creek. Glacier also stated that the Project is not expected to interact with any other traditional land uses in the area and that it would continue to consult with the DFN regarding any Project activities that may impact its traditional land use.

Glacier stated that there are no significant adverse effects to traditional food resources (vegetation and wildlife) and that it would engage in consultation, monitoring and further studies during the operation, construction and decommissioning phases of the Project. Glacier also stated that it is committed to mitigation for fish passage including fish passageways, habitat compensation and monitoring as well as carrying out an adaptive fish mitigation strategy if velocity barriers hinder upstream fish movement during construction. Glacier indicated that the DFN had no concerns with quality or quantity of fish, as its members are not traditionally fishermen and don't consider fishing to be a popular activity.

Glacier stated that the Peace Athabasca Delta (PAD) and the Athabasca Chipewyan First Nation (ACFN) and Mikisew Cree First Nation (MCFN) traditional lands would not be affected by the Project.

13.1.2: VIEWS OF THE INTERVENERS

Duncan's First Nation

The DFN was involved in the traditional land use study and sent a letter of support for the Project in May 2008. It did not provide a submission for the hearing and was not in attendance.

Athabasca Chipewyan First Nation

The chair of the Elders Committee of the ACFN, Pat Marcel, attended the hearing. He stated that there should be more work done regarding fish movement and spawning, and it should include traditional ecological knowledge. He suggested that Glacier should consult the elders for information on the spawning period for burbot and whitefish.

Paddle Prairie Métis Settlement

The Paddle Prairie Métis Settlement stated that the Peace River is part of its traditional territory. It indicated that it has used the Peace River as one of its traditional areas for hunting, fishing, trapping, gathering and preparing wild foods. It expressed concern about its aboriginal rights and the impacts to the Peace River.

13.2: RIVER FLOW AND RESTORATION OF THE PEACE ATHABASCA DELTA

13.2.1: VIEWS OF THE APPLICANT

Glacier stated that the perched basins in the PAD are only replenished through periodic spring ice jam flooding of the Peace River. It said as these floods have become rarer and less extensive in recent years, many of the marshy areas of the delta are being transformed into terrestrial landforms. Glacier cited the Northern

River Basins Study (1996) as stating *"some modification of regulation of discharge from the Bennett Dam in late winter and spring, combined with high tributary flows, could be an element of major remedial plans."*

Glacier stated in its Environmental Impact Assessment (EIA) that if the Peace River returned to a completely natural flow regime that existed pre-Bennett Dam then the Project, as designed, would not be viable. However, in its response to SIR #143, Glacier indicated that it saw no reason why a more natural flow regime would significantly affect the Project. Glacier also noted that there would be no conceivable measures that could be used to restore the ecological integrity of the PAD that would materially affect the operation of the Project. It said the Project is designed to operate under a wide range of flow conditions and also can be overtopped during very high flows. The Project does not control flows, rather it makes use of whatever flows are released from the Bennett Dam. The Project is a flow taker, not a flow regulator, and is not designed for water storage. The Project is also not expected to affect the ice regime downstream of Fort Vermilion. Glacier did not believe that the recommendations from the ACFN and Paddle Prairie Métis Settlement regarding naturalization of flows in the Peace River and PAD were appropriate or required as the Project would not regulate flows and would not impede any ecological objectives considered for the PAD.

13.2.2: VIEWS OF THE INTERVENERS

Athabasca Chipewyan First Nation

The ACFN asserted that the PAD is an important part of its traditional territory. It wanted to ensure that the Project would not affect the rehabilitation and restoration of the natural ecology of the PAD.

The ACFN believe that the Bennett Dam has caused destruction of habitat in the PAD and therefore a reduction in various species that are important for the livelihood of the ACFN's people. At the hearing, Elder Pat Marcel stated that he thought there was an agreement to ensure that during the spring flows, the same amount of water should be coming down the river as it did previous to the Bennett Dam. He went on to say that this did not happen. He also testified that the Alberta Government, the Federal Government and BC Hydro made an attempt to do some work to restore the water into the perched basins in the late 1980s as far as he remembered. This work did not materialize except for a rock weir that was built across the river down from Fort Chipewyan.

The ACFN was concerned that the Project would impede or prevent restoration of the natural flow regime to restore the ecology of the PAD. The ACFN wanted to ensure that the Panel include a condition to the Project approval so that approval would be subject to the prior interests of the ACFN, and require both the provincial and federal government to conduct remedial measures to restore the natural flow regime in the Peace River and the water levels of the PAD. It does not want Glacier to be part of any joint management of flow regimes on the Peace River. It also noted the use of the word "*maintaining*" when referring to the ecological integrity of the PAD in SIR #143 and indicated that the word "*restoring*" would be more appropriate.

Paddle Prairie Métis Settlement

The Paddle Prairie Métis Settlement had similar concerns as the ACFN. It also wanted to ensure that the Peace River natural flow regime can be rehabilitated and does not want Glacier to have a vested interest or right to the flow regime in the Peace River or participate in "*joint management*" of the Peace River flow regime.

Government of Canada

Parks Canada sent a letter of submission, but was not represented at the hearing. The letter, however, echoed both the ACFN's and the Paddle Prairie Métis Settlement's concerns. It said that 80 percent of the PAD is located within Wood Buffalo National Park and therefore Parks Canada expressed concern that the Project could cause an adverse effect on the ecological integrity of the PAD and therefore the park.

The Coalition

The Coalition raised similar concerns regarding the potential restoration of the PAD if the Project is not viable under more natural flow conditions.

13.3: CONSULTATION EFFORTS

13.3.1: VIEWS OF THE APPLICANT

Glacier maintained that its consultation efforts with First Nations have been ongoing since 1999. It provided copies of the response to SIRs from the Natural Resources Conservation Board (NRCB) to potentially interested Aboriginal groups in November 2007. These were accompanied by a letter inviting each group to contact Glacier if they wanted to. Glacier said that no responses were received. Glacier followed up in May, 2008 after it was decided that the Canadian Environmental Assessment Agency would be participating in a joint review panel. Letters were sent to any Aboriginal group that had showed interest in the Project within the past ten years.

Glacier stated it had specific meetings and contacts with several Aboriginal groups. It maintained that, in 2007, it met with representatives of the MCFN Industrial Relations Corporation (IRC) and with the Director of the IRC for the ACFN and funded independent reviews of the EIA for each of these groups. Glacier said that in August 2008, it provided written responses to the MCFN's Statement of Concern. Glacier indicated it addressed questions from the ACFN arising from its review and the ACFN requested additional consultation by Glacier in its Statement of Concern in 2007 and requested that Glacier conduct meetings in Fort Chipewyan. Glacier followed up with the ACFN but no meetings were scheduled. Glacier indicated that it provided funding for Elder Pat Marcel of the ACFN to be present at the hearing. After listening to Elder Pat Marcel speak at the hearing, Glacier committed to meeting with the ACFN elders in the future. Glacier indicated that the Memorandum of Understanding signed with the ACFN in 2002 has not been renegotiated but that it plans to uphold its commitments.

Glacier stated it developed a working relationship with the DFN and has a Memorandum of Understanding with them signed in 2002, and revised in 2008. Glacier continues to consult with DFN.

Legal counsel for the Paddle Prairie Métis Settlement contacted Glacier on June 10, 2008 requesting copies of the application materials. Glacier stated that the materials had already been sent to the Paddle Prairie Métis Settlement but that it provided the materials and stated that it was willing to meet with the Paddle Prairie Métis Settlement, however no response was received.

13.3.2: VIEWS OF THE INTERVENERS

Duncan's First Nation

The DFN, stated that it had meaningful discussions with Glacier and that it had also entered into an agreement with Glacier which further promoted the cooperative relations between them.

Athabasca Chipewyan First Nation

Elder Pat Marcel of the ACFN stated that he did not recall anyone coming to the elders of the ACFN to explain the Project to them. He stated that he knew that the ACFN had been approached twice but did not know for sure who was approached. He also stated that communication went to its IRC director or to its Chief but the information did not get to the elders. He expressed that it would be beneficial for Glacier to meet with the ACFN elders in Fort Chipewyan. It was noted by Elder Pat Marcel that its consultation process may not have been followed. He mentioned that there is a seven-step consultation process that has to be followed and that process was not adhered to. When asked by the Panel if the ACFN opposed the construction of the Project Mr. Marcel stated that the ACFN opposes the Project until it knows more about it.

Paddle Prairie Métis Settlement

The Paddle Prairie Métis Settlement stated that it had not yet met with Glacier. The submission also stated that it expected the federal and provincial governments to ensure that the constitutional obligations of the Crown were met and that the Paddle Prairie Métis concerns were addressed.

Mikisew Cree First Nation

The MCFN did not file a submission and were not represented at the hearing. However, it sent a letter for the pre-hearing expressing concern with the lack of consultation by the Alberta, British Columbia and federal governments with regards to the Project. In particular, the Project's impacts considered cumulatively with Bennett Dam, oil sands and Site C.

13.4: VIEWS OF THE PANEL

The Panel finds that Glacier has communicated with the identified First Nations and Métis communities in the project area and in the PAD. The Panel acknowledges that Glacier incorporated Aboriginal traditional knowledge in the EIA by engaging the DFN in a traditional land use study and responded to the results.

The Panel finds that the construction and operation of the Project will not interfere with any potential future actions or programs designed to simulate a more natural flow regime of the Peace River. Periodic releases by the Bennett Dam to flood the PAD, if this were to occur as a potential restoration action, would not affect the viability of the Project.

The Panel takes special note that the nearest First Nation to the Project – the Duncan's First Nation – supports the Project and while it did not appear at the hearing, it did submit written support and signed a Memorandum of Understanding with Glacier. Elder Pat Marcel indicated that he had not been in recent contact with the DFN. The Panel also notes that Glacier has agreed to provide additional information to the Athabasca Chipewyan First Nation at Fort Chipewyan and to keep consulting with interested First Nations' and Métis people.

The Panel makes no assessment regarding potential Project effects on Treaty Rights and/or Federal or Provincial Crown consultation. No First Nation or Métis community came forward and presented any evidence on these matters.

SECTION 14: VEGETATION AND FOREST RESOURCES

Vegetation and forest resources were identified as having potential to be impacted by the construction of the Project, associated access roads, transmission line alignment, development of the headpond, and operations. The potential environmental and socio-economic effects and mitigation measures on vegetation and forest resources are discussed in this section.

14.1: VIEWS OF THE APPLICANT

Glacier identified soil, vegetation and forest resources as a Valued Environmental Component. The vegetation component included the identification of vegetation communities and rare plants. Information on vegetation was summarized from the results of field studies conducted in 1999 and 2000, and an air photo assessment conducted in 2004. Spatial boundaries consisted of both a local study area (LSA) and a regional study area (RSA). The LSA extended from east of the headworks to the upper end of the headpond, a distance of approximately 26 km, and included the proposed north and south access roads, the proposed transmission right-of-way, and a vegetation buffer of 500 m on either side of the alignments extending from the western (upper end of the headpond) to eastern (immediately downstream from the headworks) most boundaries of the LSA. Vertically, the LSA extended across the Peace River valley from top of valley wall break to top of valley wall break. The RSA was defined as the stretch of the Peace River from the Bennett Dam, approximately 258 km upstream, to approximately 275 km downstream and went from valley bottom to valley wall break. Glacier stated that temporal boundaries considered for the assessment extended over the expected life of the Project (2008-2111) and that administrative and technical boundaries included the scale and extent of the natural regions and ecoregion mapping units for the area, and the possibility that some map units in areas that were inaccessible or were not ground-truthed were misclassified.

Glacier described vegetation and forest resources in terms of natural subregion mapping, presence of environmentally significant areas (ESAs), vegetation classification, rare plants, forestry potential, weeds and factors affecting vegetation distribution in the area. Glacier indicated that the LSA falls mostly within the Dry Mixedwood Boreal Forest Natural Subregion (Boreal Forest Natural Region) of Alberta, with the westernmost portion falling within the Peace River Parkland Natural Subregion (Parkland Natural Region). The LSA falls within the Peace River-Dunvegan ESA, which is considered of national importance as the Peace River in west-central Alberta provides an example of one of the most diverse and productive Parkland Natural Region river valleys in Canada.

Glacier grouped vegetation into 24 types, according to similar stand characteristics, dominant species and environmental factors such as aspect, slope, moisture regime and elevation. Field reconnaissance was primarily conducted in the valley bottom, with vegetation types above the inundation levels determined through air photo interpretation and literature review. Vegetation in the LSA was generally confined to the narrow and discontinuous river floodplain, with most plant communities occurring in incised, steep-sided valley walls or along the riparian shoreline.

Glacier reported that forest stands in the LSA were generally in sub-mature to mature successional stages, due to the relative frequency of fire in the region. Timber productivity, which is only available for the north side of the Peace River, received a rating of fair to medium for the south- to west-facing slopes within the LSA. According to Glacier, there are no designated or proposed forestry management agreements in the LSA.

Glacier reported that three confirmed rare plant species were identified in the LSA during field investigations (Table 5): Herriot's sagewort, endolepis, and narrow-leaved goosefoot. Four potentially significant plant communities and three special plant communities that could potentially occur were noted in the LSA. During a second rare plant survey in 2000, Herriot's sagewort was found in multiple places again, but endolepis and narrow-leaved goosefoot were not found again. Glacier indicated that there were no known vascular or non-vascular plants listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) on the *Species at Risk Act* (*Species at Risk Act*, Schedule 1) within the LSA or RSA.

TABLE 5: RARE PLANT SPECIES CONFIRMED WITHIN LSA			
Common Name	**Scientific Name**	**Rank**	**Description of Rank**
Herriot's sagewort	*Artimisia tilesii*	S2	Species with 6-20 known occurrences in Alberta or with many individuals in fewer occurrences
endolepis	*Atriplex suckleyi*	S3W	A Watch species, typically have a restricted distribution in Alberta but are common within their range
narrow-leaved goosefoot	*Chenopodium leptophyllum*	SU	Uncertain status due to either low search effort or cryptic nature of the element

Glacier noted that no restricted weeds were encountered during the 1999 field reconnaissance and that no formal weed surveys were done. The distribution and composition of noxious (three) and nuisance (four) weeds were mostly observed in low-lying riparian shoreline zones, in areas seasonally scoured by ice, and at disturbed sites within the LSA. Glacier reported that the LSA does not contain established wetlands.

Glacier identified a high level of agricultural development in the Peace River Valley, which has exacerbated alteration of vegetation in the region, particularly in riparian areas and on floodplain terraces. Glacier also identified Peace River regulation by the Bennett Dam, and transportation and utility corridor development as being factors that are affecting or have affected vegetation distribution in the LSA and RSA.

Potential interactions, issues and concerns identified by Glacier included those that would take place during the construction, operations and decommissioning phases of the Project, and as a result of malfunctions, accidents, and unplanned events. The results of these interactions were proposed to potentially affect the presence of vegetation, rare plants and significant vegetation communities, ESAs, merchantable timber, and the presence and propagation of weeds.

Glacier stated that during construction, alignments of access roads and the transmission line have the potential to bisect vegetation types and destroy vegetation (including significant plant communities, rare plants, and vegetation important to wildlife), that portions of the Dry Mixedwood and Peace River Parkland Subregions (ESA) may be destroyed or altered, merchantable timber may be lost, and that cleared land would have the potential for weed species invasion. Glacier indicated that a detailed plant survey would be conducted prior to commencement of construction activities.

Glacier stated that vegetation would be removed from a maximum area of approximately 27.21 ha (0.71 percent) of the total LSA during construction activities and that much of this area is currently un-vegetated or disturbed. Approximately 24.84 ha of the area to be affected contain native vegetation and 2.37 ha contain non-native vegetation. Of the 16 vegetation types present that may be potentially bisected by proposed construction, 14 represent native vegetation types (all found elsewhere within the LSA) and two represent cultivated or disturbed lands. Glacier submitted that construction activities would not result in the loss of any specific vegetation type and the effects of construction on vegetation and biodiversity were assessed as not significant.

Glacier identified three significant plant communities and three special plant communities that may be affected during construction. Transplantation, by outside expertise, of rare plants is cited as a primary approach to mitigation of the effects of the Project on rare plants. Additional mitigation measures to minimize the effects on plant communities are included in standard good operating practices. The existence of other significant and special plant communities in the immediate area suggests that the effects of construction on significant plant communities would not be significant. The national ESA extends well beyond the LSA and construction would not result in the loss of any designated or proposed ESA or landscape unit. As such, the effects of construction on ESAs and landscape units were rated as not significant.

Glacier submitted that a maximum of 17.61 ha of forested lands might be affected by construction. Where practical, all harvestable merchantable timber was proposed to be salvaged. The effects on merchantable timber were assessed as not significant. Glacier stated that weed introduction and spread can occur on any plant community that is disturbed. Established populations of weeds and introduced agronomic species occur along man-made development in the LSA, and RSA in general. Standard weed control measures would be employed to prevent the importation and distribution of weeds and to monitor and control weed spread during construction, resulting in the effects of construction on the introduction and spread of weeds being assessed as being not significant.

Glacier stated that during headpond development and operations, vegetation along the headpond may be permanently or seasonally inundated and may be destroyed (including significant plant communities, rare plants, and vegetation important to wildlife), biodiversity of the vegetation types may be affected, portions of the Dry Mixedwood and Peace River Parkland Subregions may be destroyed or altered, merchantable timber may be lost, and weed and agronomic species may be introduced or spread along the floodplain as a result of flooding the headpond. At 95 and 5 percent exceedance levels, 15 of the 24 vegetation types would experience some degree of permanent inundation.

The amount of mixedwood areas that would potentially be flooded varied from 1.59 to 26.75 ha (0.1 to 1.9 percent of LSA). Glacier noted that based on the relatively small areas of vegetation that would be inundated, even during 1:100 year flood events, and the presence of similar vegetation units in the LSA and RSA, the effect of the headpond development and operations on vegetation and biodiversity would not be significant. Glacier also stated that several potentially significant plant communities may be affected by flooding of the headpond, but given the presence of other significant plant communities along the Peace River and the relatively small area inundated, the effects of headpond development and operations were assessed as not significant. Transplantation of rare plants, by outside expertise, is proposed as a mitigation approach. As headpond development and operations would not result in the loss of any designated or proposed ESA or landscape unit and there are proposed mitigation measures should rare plants be found, the effects of headpond development and operations on ESAs, landscape units, and rare plants were also assessed as not significant.

Glacier stated that inundations during headpond development and operations would affect a maximum of 20.94 to 36.93 ha (0.85 to 1.49 percent of the forested lands and 0.55 to 0.97 percent of the LSA) of forested land in the LSA. Given the small amount of lost merchantable timber, the effects of headpond development and operations were assessed as not significant. Glacier stated that the development and operations of the headpond would have no effect on weed introduction and spread.

Glacier noted that the effects of decommissioning on the terrestrial environment area were assessed as not significant. Detailed reclamation specifications would be developed during detailed project design and would include the use of adapted native plant species.

Glacier stated that accident events could result in the destruction of vegetation communities and rare plant species and cause damage to the natural subregions, national ESA and Dunvegan West Wildland Park. These events would be unlikely and the extent of land affected would depend on the size and location of the event, and as such were assessed as not significant. Glacier noted that most past, present, and likely future projects, in the LSA and RSA have had some interaction with the vegetation and forest resources and that clearing for facilities, timber extraction, and accidental events have resulted in local loss of vegetation, rare plants, and merchantable timber, and have allowed for the introduction and proliferation of weeds. Glacier surmised that the contribution of the Project on cumulative effects was rated as not significant.

Glacier stated that given the mitigation measures that would be implemented and that the disturbed vegetation is not unique to the area, the effect of the Project on the vegetation and forest resources Valued Environmental Component was rated as not significant.

14.2: VIEWS OF THE INTERVENERS

The Coalition

The Coalition indicated its goals are to protect wild areas, ecological biodiversity, and to prevent degradation of the natural environment. The Coalition submitted that the Panel did not have enough information to assess the effects of the Project on rare plants and that Glacier needed to conduct more work, such as complete a final plant survey prior to construction. The Coalition stated that Glacier had located some species of concern, that there may be more, and that the Project has the potential to affect rare plant communities. The Coalition noted Glacier had not completed an adequate assessment and that possibly not all species of concern were located. It also noted that all rare plant communities should be protected. The Coalition also felt that the proposed mitigation plan of transplanting encountered rare plants had a lack of evidentiary success and that there was a lack of experience in transplanting rare plants.

Paddle Prairie Métis Settlement

The Paddle Prairie Métis Settlement (Paddle Prairie) stated that it has statutory and constitutional rights to the beneficial use and enjoyment of its lands on the Peace River. The Paddle Prairie wishes to preserve and restore the ecology of the Peace River so that it supports historical levels of flora and fauna.

14.3: VIEWS OF THE PANEL

The Panel finds that Glacier conducted a reasonable assessment of vegetation and forest resources. Although construction and headpond development will have some effect on vegetation and forest resources in the immediate vicinity of the Project site, the overall areas of vegetation and forest resources potentially impacted are relatively small within the total area and regions identified. The Panel judges that areas potentially impacted by the Project are adequately represented and occur with sufficient abundance elsewhere within the region. While vegetation and forest resources may be destroyed, altered, or seasonally or permanently inundated during construction activities, alignments of access roads, the transmission line, and headpond development and operations, the Panel determines that mitigation and monitoring activities identified and committed to by Glacier would satisfactorily mitigate potential impacts. Also, the Panel is of the view that the capacity of the vegetation, as a renewable resource, to meet the needs of the present and those of the future is not likely to be significantly affected.

The Panel notes that the other projects identified by Glacier are relatively minor in nature, occur on already disturbed areas, and will likely be required to have mitigative measures in place to protect species at risk and minimize surface runoff effects. The Panel finds that other potential projects in the area, in combination with the Project, are not likely to result in significant cumulative effects to vegetation.

Although no known vascular or non-vascular plants listed by the COSEWIC on the *Species at Risk Act* were identified by Glacier, caution should be used prior to and during construction and operation activities. Special attention should be employed, as three confirmed rare plant species were identified (Harriot's sagewort, endolepis and narrow-leaved goosefoot), as were significant and special plant communities. All activities should be conducted in a manner to minimize disturbance on the communities. The Panel recommends that a detailed plant survey be conducted prior to commencement of construction and headpond development in potentially impacted areas. Transplantation of identified rare plant species must be conducted, utilizing the most pertinent procedures and outside expertise, if required.

Standard good operating practices should also be implemented to reduce impacts on vegetation during construction, development and operational activities. The Panel recommends that a monitoring program be initiated in conjunction with the implementation of better management practices to manage, control and reduce the likelihood of weed introduction and invasion. All harvestable and merchantable timber that may be lost, destroyed, or altered as a result of construction and operational activities should be salvaged as best and practical as possible. The Panel recommends that a detailed reclamation and re-vegetation plan be instituted upon completion of the Project and that it include attention to adapted native plant species.

Environmental effects of the Project on vegetation and forest resources are deemed to be acceptable by the Panel, with appropriate mitigation measures that include a detailed plant survey prior to construction and development, transplantation of identified rare plant species, and standard good operating procedures to minimize any other effects.

SECTION 15: WILDLIFE

The Project has the potential to impact wildlife during the construction and operating phases. This section of the report summarizes these impacts which include habitat loss and alteration, wildlife disturbance and vulnerability to predation.

15.1: VIEWS OF THE APPLICANT

Glacier defined wildlife as birds, reptiles, mammals and amphibians and viewed wildlife as a Valued Environmental Component that would be affected by the Project. Spatial boundaries consisting of a regional study area (RSA) and a local study area (LSA) were identified for assessing potential project effects. Quantitative assessments of habitat loss are focused on the LSA, which encompasses riparian and aquatic habitats in the proposed headpond area. The RSA is much more expansive, extending from upstream of the proposed structure to the Bennett Dam and about 275 km downstream of the Project.

Glacier stated that the LSA and RSA provide seasonal or year-round habitat for approximately 44 species of mammals, 204 species of birds and seven species of amphibians and reptiles. It provided a listing of these species, their conservation status and information on the general broad vegetation ecosystem subunits these species are typically associated with.

Glacier indicated that approximately 45 vertebrate wildlife species in the LSA have primary habitat associations with riparian environments that would be affected by the headpond. Its response to SIR #153, Glacier stated that:

- None of the 45 species is considered "*At Risk*" while the Northern Long-eared Bat is classed as "*May Be At Risk*" provincially.
- Only the Western Toad is listed as a "*Species At Risk*" and is classified as a species of "*Special Concern*" under the federal *Species At Risk Act*.

Glacier considered residual adverse environmental impacts on wildlife related to the Project if one or more of the following occur:

- Reduced regional population viability of any given species.
- More than a 10 percent reduction in the availability of primary habitat within the LSA and RSA used by endangered or listed species.
- More than a 10 percent reduction in regionally unique habitat type with high potential to support a unique species.
- A detectable change in the abundance and distribution of a species sufficient to downgrade its conservation status provincially or federally.
- Probable exceedance of an unambiguous provincial or federal threshold for habitat supply or species mortality rate.
- Substantively altered human access to wildlife resources.
- Creation of new environmental conditions that have the potential to result in the establishment of a species previously unsuited to the ecoregion.

Glacier stated that fragmentation of forest cover due to the Project (e.g. roads, transmissions lines) has the potential to reduce habitat suitability for forest interior adapted species. Glacier noted that some habitat alteration has already occurred in the LSA as a result of land cleared for farming approximately 9 km upstream of the proposed headworks and roads/trails between the proposed headworks and the Dunvegan Bridge. Extensive alteration of tablelands for agricultural and infrastructure purposes has also affected the habitat composition of the Peace River valley.

Glacier indicated that wildlife would likely be displaced from the construction area (headworks, access roads and transmission lines) during the four-year construction period. It noted that the area is already subject to extensive human disturbance from vehicle activity on Highway 2, farming activity on adjacent uplands, foot traffic into the nearby Dunvegan Historic Park and recreational use (quad activity, hunting, fishing). To reduce impact on breeding migratory birds, Glacier committed to not conduct vegetation clearing, associated with the construction of the transmission lines and access road, between May 1 and July 31. Glacier noted that wildlife displacement would be much reduced once the Project is operational.

Glacier stated that animal migration across the river is common under current flow conditions and that this migration may be made easier post-Project in the headpond area due to the reduced water velocities. Table 6 shows the expected reductions in water velocity in the Peace River as a result of the Project. According to Glacier, water turbulence would increase for about a 100 m stretch downstream of the headworks that may impact wildlife crossings in this area. Glacier expected this impact to be low since animal populations in the area are already low due to extensive human activity in the area (e.g. boat launch, Dunvegan Historic Park, Highway 2 bridge crossing).

TABLE 6: COMPARISON OF RIVER WATER VELOCITIES IN THE PEACE RIVER PRE- AND POST-PROJECT

	Peace River Flow (m/s)					
	Immediately Upstream of the Headworks		16 km Upstream of the Headworks		Upstream End of the Headpond	
	Pre-Project	Post-Project	Pre-Project	Post-Project	Pre-Project	Post-Project
Low Flow Periods	0.7	0.2	0.9	0.5	1.6	1.5
High Flow Periods	2.4	0.7	1.7	1.1	2.0	1.9

Glacier indicated that moose would likely be affected by habitat alteration caused by the headpond. In its response to SIR #156, Glacier expected the amount of habitat affected to be relatively low and that the loss would be offset over time due to re-establishment of riparian margins along the headpond and the establishment of river islands toward the upstream end of the headpond. It is Glacier’s view that the Project would not affect moose availability for hunting or other purposes.

Glacier expected that ice formation would occur one to two weeks earlier in the headpond area due to lower water velocities and melt about the same time as before the Project. Post-Project ice conditions in the headpond area are also expected to be less rough and unstable than present conditions due to the reduced water velocities. Glacier indicated that these changes to the ice cover in the headpond area are not expected to result in negative effects on mammals migrating across the river. Glacier also expected that a prolonged ice-free condition extending 20 km or more downstream of the headworks would facilitate wildlife crossing. Glacier consulted with provincial biologists who confirmed that there are no reports of unusual wildlife crossing events or concentrations in the study area.

Glacier stated that the Project has potential to increase wildlife vulnerability to predation due to the inundation of river island habitat upstream of the Project. Moose and other ungulates that potentially use the river island for calving would be forced to seek other calving areas in the LSA, which may be less secure. It is Glacier's view that the number of ungulates impacted would be small.

According to Glacier, the existing trails along the Peace River to Hines Creek and Dunvegan Creek would need to be upgraded to roads to allow for access for construction and for ongoing operation of the Project. It indicated that these roads may result in increased animal-vehicle collisions, particularly during the construction period. These roads may also increase vulnerability to hunting. However, Glacier noted that the current animal population is low in these areas due to existing human activity (e.g. Highway 2, recreational use).

Glacier indicated that the potential for avian collision with transmission lines is low because the LSA has not been identified as a significant flyway or migration route. The chance of collision is also reduced because the majority of bird species' flight paths run parallel to the proposed transmission lines in the Peace River and Dunvegan Creek valleys. Glacier stated that the use of low-height pole design and proximity to valleywall-slope position should reduce the frequency of avian-transmission line collisions compared to other potential designs and locations. In addition, transmission lines would be designed so as to reduce the potential for electrocution of birds by minimizing the potential for avian contact with a live wire and a grounding source simultaneously.

Glacier's view is that adverse impacts on wildlife in the LSA as a result of the Project are not expected to be significant. To ensure environmental effects are minimized, it committed to implementing pre- and post-construction monitoring programs for wildlife. Information from the monitoring would be used by Glacier to assess the effects of each phase and to adapt activities as required to minimize any impacts on wildlife.

15.2: VIEWS OF THE INTERVENERS

The Coalition

The Coalition (Alberta Wilderness Association, Canadian Parks and Wilderness Society Northern Alberta, and the Peace Parklands Naturalists and South Peace Environment Association) expressed concerns to the Panel that Glacier had not assessed all of the potential Project impacts on wildlife.

Specifically, it was the Coalition's view that Glacier:

- Had not completed an adequate assessment of the impacts on species that live on the dry south-facing slopes and whether there are any species at risk in the area.
- Had not adequately demonstrated the impact of the Project on habitats such as some species such as moose and beaver.
- Had not adequately outlined mitigation strategies to address wildlife issues.
- Would not commit to limiting construction activities during sensitive times for fish and wildlife.

15.3: VIEWS OF THE PANEL

The Panel finds that the project design and mitigative measures presented by Glacier would be effective in addressing any negative effects of the Project on wildlife. The Panel agrees with Glacier that wildlife is already accustomed to human activity in the area due to the proximity of the nearby bridge, highway, Provincial Park, agricultural activities and residences and that the cumulative effects of the Project on wildlife, in combination with other actions identified, are not significant. Also, the Panel is of the view that the capacity of the wildlife, as a renewable resource, to meet the needs of the present and those of the future is not likely to be significantly affected.

The Panel supports Glacier's commitment to ensuring environmental effects of the Project on wildlife are minimized by implementing pre- and post-construction wildlife monitoring programs.

The Panel finds that the cumulative effects to wildlife as a renewable resource will not be significantly impacted and will meet present and future needs.

SECTION 16: HEALTH AND SAFETY

16.1: FOGGING ON THE DUNVEGAN BRIDGE

16.1.1: VIEWS OF THE APPLICANT

Glacier indicated that the Dunvegan Bridge is a known provincial hotspot for vehicle accidents, likely due to the prevalence of fog and ice conditions. Glacier noted that increased open water downstream of the proposed headworks would result in an increase in the frequency of fog conditions on the bridge.

Glacier evaluated the post-Project potential for fogging and bridge icing on the Dunvegan Bridge for the months of January to March using the following information:

- Real observations from winter periods in 2000, 2001, 2002 and 2003 to determine the conditions that lead to fogging, which included wind direction and speed, relative humidity, water vapour emissions and temperature
- Meteorological data from 1995 to 2000 from the Peace River airport were used to predict the number of days of fogging combined with the predictions of open water conditions

Glacier indicated that the frequency of fogging at the Dunvegan bridge deck level, due to the Project would increase from:

- 163 hours in an average January, pre-Project, to 203 hours post-Project.
- Zero hours in February, pre-Project, to 66 hours post-Project.
- 5.6 hours in an average March, pre-Project, to 35 hours post-Project.

Glacier indicated that the fogging events at bridge deck height are limited to night-time hours and expected to dissipate a few hours after sunrise.

According to Glacier, as icing of the bridge decks occurs during fog events that coincide with ambient temperatures below zero degrees Celsius, the increased frequency of icing would be the same as the increased frequency of fogging.

Glacier proposed to mitigate the effects associated with increases in fog with warning signs and it made a commitment to Alberta Transportation (AT) to fund the signs. AT has installed improved lighting on the bridge and electronic modifiable message boards. Glacier stated it remained committed to implementing any additional measures as necessary in consultation with AT.

Glacier assessed that the effects of increased fogging and icing at the Dunvegan Bridge as a result of the Project would not be significant.

16.1.2: VIEWS OF THE INTERVENERS

The Coalition

The Coalition indicated that Glacier had not adequately dealt with the possibility of post-Project increases in traffic collisions on the Dunvegan Bridge.

16.2: INCREASE IN TRAFFIC DURING CONSTRUCTION

16.2.1: VIEWS OF THE APPLICANT

Glacier indicated that the anticipated effect on local traffic during construction is an increase in average annual daily traffic (determined by counting the total number of vehicles to cross a point in both directions on a highway during a year and dividing this value by the number of days in that year) from:

- 2,707 to 2,819 in August and September of the 1st year of construction
- 2,752 to 3,100 in August of the 2nd year of construction
- 2,815 to 3,127 in August of the 3rd year of construction
- 2,879 to 3,105 in June of the 4th year of construction

Glacier indicated this increase in traffic represents a 4 to 13 percent increase in traffic volume over the four years and would only be evident during the construction phases of the Project. AT is currently resurfacing the Dunvegan Bridge and is expected to complete the work by the end of the 2009 construction season, therefore potential overlap of the AT work with the Project would be minimal.

Glacier indicated that with the road improvements that have taken place near the bridge, a majority of the improvements that would be needed for the construction of the Project would have already been constructed. In order to mitigate the effects of the increased traffic, Glacier proposed the following mitigation measures:

- Extra pullout, turning and merging lanes
- Widening of Highway 2
- Flashing lights, construction signs
- Speed reduction
- Temporary lighting
- Dust control
- Safe driver training

Glacier assessed the effects associated with increased traffic during construction of the Project as not significant.

16.2.2: VIEWS OF THE INTERVENERS

There were no intervener concerns regarding traffic during construction.

16.3: RISK OF ACCIDENTS AND MALFUNCTIONS

16.3.1: VIEWS OF THE APPLICANT

Glacier committed to developing a Project-specific Construction Environmental Management Plan prior to construction and a Project-specific Emergency Response Plan and Emergency Preparedness Plan that would be submitted to Alberta Environment prior to operation of the Project. As part of the final design of the Project, a complete dam failure assessment and development of flood inundation mapping would be completed as is required in accordance with the Canadian Dam Association guidelines. In addition to the development of the above plans, Canadian Hydro (Glacier's parent company) has an Environment, Health and Safety Management System that would apply to all staff and contractors onsite during construction and operations.

Glacier predicted that in the unlikely event of a complete fair weather failure of the headworks structure, the river levels in the Peace River could rise up to 4.3 m above present river levels downstream of the headworks, but remain within the banks of the present channel. The resulting wave would attenuate to less than a 1.5 m crest at the Town of Peace River, where it would be similar to the daily water level fluctuations presently experienced.

Glacier stated that all hazardous goods associated with Project operations would be transported and stored according to government regulations. Products that may be used on site include vegetable based or bio-friendly lube oil, hydraulic oil, cooling water, transformer oil, gear box oil, trash and weed control chemicals. Glacier indicated that Canadian Hydro, its parent company, has extensive experience in the best practices to prevent any potential contamination of waterways where hydroelectric facilities operate.

Glacier indicated that the potential for accidents and malfunctions during construction would be extremely low. Mitigation measures would eliminate the potential for contaminant inputs from minor spills during construction activities; therefore, there would be negligible effect on the fish community.

16.3.2: VIEWS OF THE INTERVENERS

The Coalition

The Coalition indicated that Glacier had not adequately addressed emergency response planning and how the public would be protected in the event that there was a fair weather failure. It also indicated that Glacier had not adequately assessed the impacts of accidents or malfunctions during construction on the environment, including spill response and the handling of hazardous goods.

The Coalition felt it would be wise if the complete dam break assessment and emergency preparedness plan were available prior to the Joint Review Panel's (the Panel) decision so the Panel could better understand the possible impacts of the Project and how Glacier plans to address them if such an event occurred.

16.4: NOISE

16.4.1: VIEWS OF THE APPLICANT

Glacier conducted a complete noise assessment for the Project with sound level contributions during construction and during operations. The nearest receptor was identified as 1.4 km downstream. Glacier used a noise measurement scale known as A-weighted sound level, or decibel (dBA) to describe the existing and anticipated sound levels. The A-weighting accounts for the frequency content of the sound and assesses it with a frequency response similar to that of human hearing. Glacier also explained that its description of sound levels was an equivalent continuous sound level (L_{eq}), which quantifies sound that varies over time, such as that commonly occurring in outdoor environments. It is the average sound level of time varying sound, measured over a specific time period.

Glacier indicated that construction and decommissioning activities would cause increased noise levels above existing conditions. The increase in noise would be short term and similar to that associated with agricultural activities. The predicted daytime value for noise due to construction at the receptor was 51.7 dBA L_{eq}. The daytime baseline sound level contribution from Highway 2 at the receptor was 40.7 dBA L_{eq}.

The noise generated by the turbines would be minimal due to their submersed state, concrete encasement and masking by noise created of flowing tail-water and water flowing over the weir. The predicted Project sound level at the receptor was less than or equal to the threshold of hearing.

Glacier indicated that mitigation measures to reduce the impact of construction noise would include limiting when high noise activities could be conducted and implementing measures to comply with ERCB Directive 038 Noise Control.

Glacier assessed that the effect of the Project induced increases in noise during construction and during operation of the Project were not significant.

16.4.2: VIEWS OF THE INTERVENERS

There were no intervener concerns regarding noise presented to the Panel.

16.5: VIEWS OF THE PANEL

The Panel finds that Glacier has done extensive research and modelling of the fog conditions at the Dunvegan Bridge and recognizes that there may be an increase in the frequency of fog occurrences. Glacier has proposed mitigation measures to AT and committed to fund implementation of these measures. AT has incorporated many of these measures into the recent bridge work (2007/2008), including enhanced lighting and improved signage. The Panel is confident Glacier will continue to be committed to assist financially to these measures and to minimize the impact of extended fog periods on the bridge. The Panel finds that the implemented and proposed improvements to the lighting and signage at the Dunvegan Bridge will adequately mitigate any increase in the frequency of fog occurrences.

The Panel recognizes that during the construction period there will be an increase in vehicle movements in the area. The Panel finds that any increase in traffic on the Dunvegan Bridge resulting from the Project would be incremental and easily handled given the recent repairs and maintenance done on the bridge. The Panel suggests that Glacier and the Alberta Government be aware of visitor traffic to the Project and consider providing opportunities for these visitors to observe the Project.

The Panel finds that Glacier has committed to a Project-specific emergency response plan as well as an emergency preparedness plan, which would be submitted to Alberta Environment. Glacier further stated that a dam failure assessment would be part of its final design in accordance with requirements in the Canadian Dam Association Standards. The Panel finds that Glacier adequately addressed the risks of accidents or malfunctions and has committed to creating an emergency response plan and other plans during the final stage of the Project and prior to its operation.

In considering the potential impacts of noise from the Project on residents in the area during construction and operation, the Panel finds that during operation of the Project, there will be a negligible increase in noise, and therefore no cumulative effects are expected in this respect. The Panel finds that Glacier has adequately assessed noise from the construction of the Project and notes that Glacier must comply with the AUC Rule 012 (which adopts ERCB Directive 038).

SECTION 17: HERITAGE AND VISUAL RESOURCES

17.1: HERITAGE RESOURCES

In 1973, Alberta passed the *Alberta Heritage Act* (now the *Alberta Historical Resources Act*) which provides the framework for Historic Resources Impact Assessments (HRIA) when persons or companies undertake any activities that could result in the alteration, damage or destruction of an historic resource.

In March 2008, this responsibility became part of the Alberta Department of Culture and Community Spirit (ACCS). The Historic Resources Management branch required Glacier to conduct studies on three categories: historic buildings and other structures, archaeological sites, and paleontological sites (containing fossilized remains of plants and animals). Glacier was also required to avoid damaging any historic sites that could be endangered by the Project and to conduct comprehensive mitigative studies.

Glacier was required to apply for and obtain permits to conduct its examinations under strictly controlled conditions and then had to submit its information to the branch (Archaeological Survey Section) for review and to the Alberta Archaeological Site Inventory.

17.1.1: VIEWS OF THE APPLICANT

Glacier indicated that HRIAs for the Project application were conducted in 2004 and 2005. The HRIAs focused primarily on the local study area (LSA) and the effects of Project-related water levels, access roads, transmission lines and other associated facilities.

According to Glacier, the environmental effects noted in the 2000 studies on downstream communities were indicated as insignificant given the design and scale of the Project. This conclusion had not changed with the new application. Thus, it was Glacier's view that there would be no effects on historic resources downstream of the Project.

In this application Glacier concentrated on areas directly affected in the LSA but provided some additional information on historic resources in the regional study area (RSA) that extended from the Smoky River near the town of Peace River to the Bennett Dam in British Columbia.

Glacier worked closely with the responsible ACCS Archaeological Survey Section and identified most of the sites or areas with high or moderate potential for heritage resources. There were 22 pre-contact sites, 3 historic sites and no well-defined or primary paleontological sites identified. Fossil traces were collected and sent to the Tyrell Museum.

A traditional knowledge and land use assessment was conducted for the Duncan's First Nation (DFN), whose main reserve is located 40 km east of the Project headworks. According to Glacier, no effects are expected on the reserve or on medicinal or sacred plant use.

Glacier noted that Project activities can interact with heritage resources during all Project phases and outlined potential disturbances. It provided a listing of possible effects and committed to reporting any additional sites that might arise during construction, operations, accidents or malfunctions. Mitigation recommendations and activities were also noted. Glacier was able to avoid most historic and pre-contact sites in the LSA by altering some road alignments and has suggested monitoring for the other sites.

Glacier stated that there has been an increase in knowledge that has added to the existing database and current scientific knowledge of the culture and history of the area. Glacier committed to monitoring, reporting and responding to future mitigation requirements.

Glacier has submitted its work to the responsible authorities. It also committed to continue to consult with the DFN. It believed that, after mitigation and any additional studies required, the impact of the Project on historical resources within the LSA and on the DFN's traditional land uses would not be significant.

Regarding the RSA, Glacier indicated that it was more difficult to assess the cumulative effects of its Project because of a host of other factors affecting the larger area. It outlined some data from inventories produced by other HRIAs and provided some estimates of possible effects. Glacier noted that there was a lack of information to do more than present a broad picture. There is a lack of available information in the site data available from British Columbia. Some 865 sites were identified in the RSA with perhaps nine being affected by this Project and 251 by other developments such as agriculture.

17.1.2: VIEWS OF THE INTERVENERS

There were no intervener concerns regarding impacts to heritage resources.

17.2: VISUAL RESOURCES

A visual effects assessment was conducted. This assessment examined any direct effects of the Project on the views of the landscape, the reactions of people who were affected by impacts to the views and the overall effects on visual amenity. There was only one study area for the assessment of the visual resources and it included all areas where the Project infrastructure was visible. Glacier defined a significant effect on visual resources to be *"when a moderate to high level of adverse change to the resource, or high level of viewer response to visual change, is such that architectural design and landscape treatment require extraordinary mitigation practices or cannot mitigate the effects."*

17.2.1: VIEWS OF THE APPLICANT

Glacier stated that it designed the Project such that it was integrated with the natural and cultural environment and maintained the character of key views.

Glacier stated that various phases of the Project could have effects to visual resources with the operations phase having long-term, yet reversible effects (after decommissioning) and the construction and decommissioning phases having temporary effects. Glacier indicated that mitigation measures for temporary effects included:

- Minimizing vegetation cutting and re-vegetation.
- Using existing roads and trails as much as possible.
- Having the transmission lines follow the access road and trail.
- Having single wooden pole power lines.

Glacier assessed effects to visual resources as not significant and confined to the LSA. No cumulative effects were noted.

17.2.2: VIEWS OF THE INTERVENERS

There were no intervener concerns regarding impacts to visual resources.

17.3: VIEWS OF THE PANEL

The Panel acknowledges the written clearances provided by the responsible Alberta Government departments for the work done thus far on heritage resources. The Panel accepts ACCS's indication of satisfaction with the work done on historical resources.

The Panel is aware that more archaeological work may be required of Glacier by HRIA once the full design of the Project is complete and construction has been undertaken and completed. There will also be an ongoing monitoring component to observe whether or not additional sites become exposed at any time during the operation of the facility. ACCS did not appear at the hearing.

The Panel notes that Glacier has done its EIA work and responded to SIR questions in a way that has met the ACCS requirements. The Panel notes that Glacier will need to monitor its activities and seek further departmental approvals regarding any historic sites discovered or impacted.

In the Panel's view, the impacts of the Project on historic resources in the LSA and the DFN's land use are not significant. The Panel accepts that the impacts on heritage resources will be minimal or adequately studied or mitigated in the project area. The Panel also accepts that the impacts will be minimal in the headpond area because the water levels will not exceed pre-Bennett Dam levels, so therefore new sites are not likely to be uncovered. The Panel is unable to comment on regional impacts because of the limitations of the data available.

Alberta and British Columbia government departments responsible for heritage resources may need to assess the need for additional studies in the RSA when considering future projects.

With respect to visual resources, the Panel finds that there are no negative impacts regarding the visibility of the Project. Glacier worked to minimize any negative visual impacts of the Project to ensure it is aesthetically acceptable.

SECTION 18: DECOMMISSIONING

18.1: VIEWS OF THE APPLICANT

Glacier indicated that the lifespan of the Project was a minimum of 100 years but components could be replaced as necessary to extend the lifespan of the Project. When closure becomes necessary, a decommissioning plan would be prepared and submitted to Alberta Environment. At the time of decommissioning, Glacier planned to prevent the release of sediment behind the structure from occurring as a single event, by removing some of the turbines first and allowing the sediment to pass through the structure. It also indicated that it would conduct ongoing monitoring during the decommissioning process and ensure it was managed adaptively in response to the results of water quality testing. Glacier suggested that this plan satisfied the requirement of the Environmental Impact Assessment (EIA) for assessing decommissioning.

Glacier also indicated that there are very few dams that have been decommissioned in Canada, but commented that dams have been successfully decommissioned in North America meeting current local regulatory requirements.

18.2: VIEWS OF THE INTERVENERS

The Coalition

The Coalition indicated that the EIA for the Project is deficient in that Glacier has not provided a plan for decommissioning or abandonment of the Project, which is required under the *CEAA*.

18.3: VIEWS OF THE PANEL

The Panel finds that Glacier did provide response in the EIA process indicating how it would mitigate impacts of sediment release on water quality at the time of decommissioning. The Panel is aware of the Coalition's concerns and is of the understanding that they will be properly addressed in the *Environmental Protection and Enhancement Act* approval. The Panel also notes that the life of this Project is greater than 100 years and is confident that upon the occasion of decommissioning, Glacier will use the most current science and engineering to decommission the Project.

SECTION 19: CUMULATIVE EFFECTS

19.1: VIEWS OF THE APPLICANT

Glacier assessed the cumulative effects scenario, which included the baseline case, application case and anticipated future projects and activities. Future projects considered included new borrow pits, the expansion of the Dunvegan Historic Site, and the expansion of transportation and utility corridors. Glacier noted that while BC Hydro's Site C at Taylor has been announced and considered in its application, there was no project-specific information available to assess. Glacier indicated that any effects of the Bennett Dam (located upstream of the Project on the Peace River in British Columbia), were included in the baseline case. Glacier provided evidence showing that, for this assessment, the Canadian

Environmental Assessment Agency agreed with the assessment scenarios developed by Glacier.

Glacier assessed that the Project did not alter the flow regime of the Peace River downstream of the headworks structure and had no capacity to regulate flows. Therefore, Glacier concluded the Project would not have any effect on the Peace Athabasca Delta (PAD) as the Project would not alter the flow regime of the Peace River. As a result, Glacier did not assess the cumulative effects of its Project in combination with other projects on the PAD.

If the Project was projected to have a measurable effect on an environmental component and the effect was expected to act in a cumulative fashion with other past, present or future projects, cumulative effects were assessed by Glacier. Cumulative effects were assessed by Glacier on the following environmental components: surface water hydrology and groundwater, ice formation fish habitat, climate, air quality, noise, water quality, soil, vegetation and forest resources, wildlife, transportation, land and water use, visual resources, heritage resources, health and safety and climate change. Glacier asserted that the cumulative effects assessment met the Alberta Environment Terms of Reference for the Project. Glacier indicated that the contribution of the Project to the environmental effects in combination with the other projects considered would be not significant.

19.2: VIEWS OF THE INTERVENERS

The Coalition

The Coalition asserted that the cumulative effects of multiple developments in relation to the Project were not realistically considered, which would better place the Dunvegan hydroelectric development in a historical and ecosystem-based context. It indicated that the cumulative effects assessment did not consider the ecological role of the study area as part of the Peace River Basin ecosystem, or the impact of past development on this study area and the basin as a whole. The Coalition suggested that this context is essential to determine whether there is sufficient ecological room to accommodate another major development in the basin without pushing the aquatic ecosystem over a critical threshold.

BC Hydro

BC Hydro stated that there has been no decision by the Province of British Columbia to enter into a regulatory process or to build Site C, and therefore the Project should not be considered within the cumulative effects context for this application. If and when a Site C proposal enters the regulatory process, its cumulative effects with the Dunvegan Project would be assessed at that time.

Government of Canada

Parks Canada noted a concern about regional cumulative effects in Northern Alberta and in the Peace Athabasca Slave drainage system, in light of increased activities from development of hydroelectric, oil sands, conventional oil and gas, forestry and agriculture. It indicated that there might be an increase in the potential for adverse cumulative effects on national parks, such as Wood Buffalo National Park. Parks Canada noted that it was its understanding that Glacier had indicated the Project would not cause an adverse cumulative effect on the ecological integrity of that park and indicated willingness to continue to work with all parties to fulfil its mandate in a mutually satisfactory manner.

19.3: VIEWS OF THE PANEL

The Panel notes that this report includes consideration of the Project's cumulative effects.

The Panel finds that the cumulative effects that are likely to result from the Project, in combination with other projects or activities that have been or will be carried out, are not likely to result in significant adverse environmental effects. In making this determination, the Panel recognized that, while BC Hydro's Site C dam has been announced, specific details are not available for analysis and that the cumulative effects of the two facilities would be considered at the time of a review process for the Site C project. The Panel also considered that the Project is not designed to regulate flows of the Peace River and as a flow taker, the Project will not have an effect on the flow regime downstream of Fort Vermillion. Therefore, the Project is not likely to result in cumulative effects, in combination with other projects, on the PAD or on Wood Buffalo National Park.

The Panel encourages Glacier to work with other proponents and operators in the area to mitigate and manage any unforeseen cumulative environmental effects that may be identified during its monitoring programs.

SECTION 20: JOINT REVIEW PANEL DECISION

In reaching the conclusions contained in this report, the Joint Review Panel has considered all relevant materials comprising the record of this proceeding, including the evidence and argument provided by each party. Accordingly, references in this report to specific parts of the record are intended to assist the reader in understanding the Panel's reasoning relating to a particular matter and should not be taken as an indication that the Panel did not consider all relevant portions of the record with respect to that matter. The Panel has completed an assessment of the social, economic and environmental effects of the Project, both beneficial and adverse. Conclusions of the Panel regarding the public interest have been made with the full benefit of extensive submissions from all participants.

The Panel conducted this review having regard for its Terms of Reference and relevant federal and provincial legislation. With regard to its responsibilities under the *CEAA*, the Panel assessed and considered the environmental effects of the Project and their significance. This included effects resulting from possible accidents and malfunctions. The Panel also took into account measures to mitigate these effects, and measures to enhance beneficial environmental effects. The purpose and need for the Project, the feasible alternatives and the need for a follow-up program were also reviewed, as well as the capacity of renewable resources to meet the needs of current and future generations.

The monetary costs associated with developing and operating the Project will be borne by the proponent while considerable economic and social benefits occur to the public. Most significant to the Panel among these benefits is the addition of a stable and reliable source of green hydroelectric power to Alberta with minimal GHG emissions. The Panel concludes that the adverse environmental effects are reasonably well understood. Mitigation measures, monitoring and adaptive management committed to by Glacier have led the

Panel to conclude that no significant adverse environmental effects are anticipated. While the Panel has found that there will be some adverse social effects related to the Project, notably, the potential for an increase in groundwater related seepage flooding in the Town of Peace River and the effects on Shaftesbury Crossing, it has concluded the benefits associated with the Project warrant its approval. The implementation of potential mitigation of these and other adverse effects identified and described in detail elsewhere in this report have the potential to enhance project benefits.

The Panel, taking all relevant evidence into account, finds the Project to be in the public interest. Attached as Appendix A to this report are a number of recommendations to Canada, Alberta and Glacier that the Panel believes will provide further benefit.

The Panel will deliver a copy of its report to the Federal Minister of Environment, the responsible authority (Department of Fisheries and Oceans) and to the Government of Alberta. In accordance with the Alberta *Hydro and Electric Energy Act*, the AUC cannot approve the construction of a hydro development without the prior Royal Assent being given to a Bill passed in the Alberta Legislative Assembly. The *Natural Resources Conservation Board Act* approval may not be issued without the prior authorization of the Lieutenant Governor in Council. This Panel trusts that this report will be of some assistance to the various federal and provincial departments who are tasked with related approval functions.

DATED at CALGARY, ALBERTA, this 19th day of December, 2008.

Original signed by:

Vern Hartwell, Chair

George Kupfer, Ph.D.

Douglas A. Larder, Q.C.

APPENDIX A: SUMMARY OF RECOMMENDATIONS

Panel Recommendations to the Government of Canada:

1: That Glacier implement an ongoing construction monitoring program, to the satisfaction of DFO, aimed at successful implementation of the construction mitigation measures, and to monitor their effectiveness.

2: That if monitoring reveals any problems regarding mitigation measures or fish passage during construction, an adaptive management plan will be implemented to the satisfaction of DFO.

3: That Glacier complete additional near field modelling of the trash racks and the submerged vertical slot located at the upstream end of the fishway to the satisfaction of DFO.

4: That a review of post-construction monitoring of the upstream fish passage be conducted and if necessary, an adaptive management plan implemented to the satisfaction of DFO.

5: That Glacier continue to work with DFO and ASRD to finalize a comprehensive monitoring program for the upstream and downstream fish passage systems to inform adaptive management strategies and achieve effective fish passage.

6: That Glacier develop and implement an ongoing monitoring program, to the satisfaction of DFO, aimed at verification of predictions related to fish migration and fish population impacts for mountain whitefish and bull trout from the Project.

7: That Glacier develop and implement an adaptive management plan, to the satisfaction of DFO, intended to minimize effects if any issues are identified regarding effect to local fish populations during the fish population monitoring,.

8: That Glacier develop and implement an ongoing monitoring program, to the satisfaction of DFO, aimed at verification of predictions related to burbot migration and impacts through the project area.

9: That Glacier develop a burbot study. The purpose of the study is to gain a better understanding of the impacts that a lack of winter movement may have on the resident burbot population.

10: That Glacier prepare an adaptive management strategy to address potential fish passage blockages and/or turbine mortality issues for burbot and, should monitoring indicate a negative effect, implement this strategy to the satisfaction of DFO.

11: That Glacier Power continue to work with ASRD and DFO to finalize the No Net Loss Plan to include designs, construction activities, schedules, monitoring, contingencies and amount of financial security required to achieve permanent fish habitat gains that offset direct fish habitat losses.

APPENDIX A: SUMMARY OF RECOMMENDATIONS

12: Monitoring should include an ongoing evaluation of impacts from headpond formation on fish and fish habitat. The monitoring plans should be designed and implemented by Glacier to the satisfaction of DFO. Should monitoring of the headpond indicate negative impacts to fish and fish habitat, Glacier will be required, to the satisfaction of DFO, to plan, construct and maintain additional habitat compensation to offset impacts within the headpond area.

13: That Glacier continue to work closely with Navigable Waters Protection Officials to finalize the design and operation elements of the proposed works to ensure that they are carried out in accordance with the requirements of the NWPA and associated regulations.

Panel Recommendations to the Government of Alberta:

1. That Glacier Power continue to work with DFO and ASRD to finalize a comprehensive monitoring program for the upstream and downstream fish passage systems to inform adaptive management strategies and achieve effective fish passage.

2. That Glacier Power continue to work with ASRD and DFO to finalize the No Net Loss Plan to include designs, construction activities, schedules, monitoring, contingencies and amount of financial security required to achieve permanent fish habitat gains that offset direct fish habitat losses.

3. The Panel recommends that Alberta Transportation proceed with timely consideration of commissioning of a new ferry for Shaftesbury Crossing.

4. The Panel recommends that the results of the geologic and seismic investigation committed to by Glacier, and the selected appropriate design earthquake, be submitted to Alberta Environment for its approval before project construction begins.

Panel Recommendations to Glacier Power Ltd.

1. The Panel recommends that Glacier conduct a detailed plant survey in potentially affected areas prior to the commencement of construction and headpond development.

2. The Panel recommends that Glacier. transplant any identified rare plant species utilizing the most pertinent procedures and outside expertise.

3. The Panel recommends that Glacier design and implement a monitoring program and management practices to manage, control, and reduce the likelihood of weed introduction and invasion.

4. The Panel recommends that Glacier, on completion of construction, design and implement a detailed reclamation and re-vegetation plan that includes adapted native plant species.

APPENDIX B: THOSE WHO APPEARED AT THE HEARING

PRINCIPALS AND REPRESENTATIVES	WITNESSES
Athabasca Chipewyan First Nation	
Eva Chipiuk Richard Secord	Pat Marcel
BC Hydro	
Diana Valiela	Martin Jasek, M.Sc., P.Eng. Kelvin Ketchum, M.Eng., P.Eng. Darren Sherbot, BE, B.Sc., MRM
Coalition	
Eva Chipiuk Richard Secord	Michael Church, Ph.D., P.Geo. David Mayhood, M.Sc. Chris Wearmouth, B.A.
CROSS	Roy Callioux
Ron Kruhlak Lisa Semenchuk	Rick Carson, M.Sc., P.Eng. Carolyn Chenard Cristi Heins Maurice Lemay Jason Ouellet
Government of Canada	
Robert Drummond	Allen Cadenhead Yvonne Carignan, M.Eng., P.Eng. John Cowan, M.A. Chris Katopodis, M.Sc., P.Eng. Gabrielle Kosmider, B.Sc. Capt. Craig Miller Beverly Ross, Ph.D.
Glacier Power Ltd.	
Matthew Keen Ryan Rodier	Dave Andres, M.Sc.CE, P.Eng. Peter Barlow, M.Sc., P.Eng Barry Chilibeck, P.Eng. Gloria Fedirchuk, M.A., Ph.D. Jim Howell, M.Sc., P.Geol. Maarten Ingen-Housz, M.A., M.Sc. Ross Keating, P.Eng. Paul Kemp, P.Eng. Kelly Matheson, B.Sc. Claire McAuley, M.Eng, M.Sc, P.Eng.

APPENDIX B: THOSE WHO APPEARED AT THE HEARING

PRINCIPALS AND REPRESENTATIVES	WITNESSES
Glacier Power Ltd. (continued)	
	Rick Pattenden, M.Sc., P. Biol. Michael Miles, M.Sc., P.Geo. Kirk Strom, M.Sc., P.Biol. Joan Williams, M.Sc., P.Biol.
MD of Fairview No. 136 Ben Boettcher Walter Doll	
Paddle Prairie Métis Settlement Eva Chipiuk Richard Secord	
Town of Fairview Anne Grayson Dale Harris Rick Nicholson	
Town of Peace River Iris Callioux Norma MacQuarrie	

PARTIES WHO FILED HEARING SUBMISSIONS BUT DID NOT ATTEND HEARING

Birch Hills County
British Columbia Ministry of Environment
City of Grande Prairie
Clear Hills County
Fairview Chamber of Commerce
Health Canada
MD of Peace No. 135
Northern Sunrise County
Parks Canada
Peace Region Economic Development Alliance
Saddle Hills County

JOINT REVIEW PANEL EXPERT WITNESS

Faye Hicks, Ph.D.

APPENDIX B: THOSE WHO APPEARED AT THE HEARING

STAFF ATTENDING HEARING

Jill Adams
Jim Allen
Allan Anderson
Walter Ceroici
Tom Chan
Dominic Cliche
Jim Fujikawa
Andrea Hiba Brack
Mike Iwanyshyn
Carly Kaban
Mark Kavanagh
Bill Kennedy
Scott Morrison
Brian Morse
Joseph Ronzio
Susan Schlemko
Richard Stein
Charles Tamblyn
Peter Woloshyn

APPENDIX C: ACRONYMS AND ABBREVIATIONS

ACCS	Alberta Culture and Community Spirit
ACFN	Athabasca Chipewyan First Nation
AIES	Alberta Interconnected Electric System
AT	Alberta Transportation (formerly Alberta Infrastructure and Transportation)
ASRD	Alberta Sustainable Resource Development
ATPR	Alberta Tourism, Parks and Recreation
AUC	Alberta Utilities Commission
AUCA	Alberta Utilities Commission Act
CEAA	Canadian Environmental Assessment Act
CO_2	carbon dioxide
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CRISSP	Comprehensive River Ice Simulation System Project
CROSS	Concerned Residents for Ongoing Service at Shaftesbury
dBA Leq	A-weighted decibel energy-equivalent sound level
DFN	Duncan's First Nation
DFO	Department of Fisheries and Oceans
EIA	Environmental Impact Assessment
ERCB	Energy Resources Conservation Board
ESA	Environmentally Significant Area
EUB	Energy and Utilities Board
g	gravity
GDP	gross domestic product
GHG	greenhouse gas
Glacier	Glacier Power Ltd.
GWh	gigawatt hour
Ha	hectare
HEEA	Hydro and Electric Energy Act

APPENDIX C: ACRONYMS AND ABBREVIATIONS

IRC	Industry Relations Corporation
JTF	Joint Task Force on Peace River Ice
kV	kilovolt
kW	kilowatt
kWh	kilowatt-hour
Leq	energy-equivalent continuous sound level
LSA	local study area
MCFN	Mikisew Cree First Nation
Mt	megatonne
MW	megawatt
MWh	megawatt hours
NO_x	nitrous oxides
NRCB	Natural Resources Conservation Board
NRCBA	Natural Resources Conservation Board Act
PAD	Peace Athabasca Delta
Panel	Joint Review Panel
PRICE	Peace River ICE Model
Project	proposed Dunvegan hydroelectric project
RICE	River ICE Model
RSA	regional study area
SIR	Supplemental Information Request
SO_x	sulphur oxides
TRICEP	Trillium Engineering ICE Model
W/m^2	watts per square metre

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