Hello dear Commissioners,

The single best way to understand the task that BCUC is doing on behalf of the citizens of BC and in the public interest is the following perspective from the Joint Review Panel Report:

"Justification must rest on an unambiguous need for the power, and analyses showing its financial costs being sufficiently attractive as to make tolerable the bearing of substantial environmental, social, and other costs."

In my submission I intend to speak to the terms of reference not as an analyst or expert but as a citizen who has a deep and abiding interest in the Peace River Valley (I live in Roberts Creek on BC's Sunshine Coast), in the capacity of the ways we supply and use energy in BC and in the future viability of our province. As a citizen of BC I consider myself an "interested party" under TOR (d).

Given that this is the only public process available to citizens at this time; given it's narrowed scope, limited time frame and constricted processes; and given the disparity of resources between BCHydro and average interested parties, I would ask commissioners to be inclusive, forward looking and wise.

I have reviewed a number of submissions on the BCUC Website for the Site C Inquiry. There I see a number of technical energy and economic analysis both pro and against the SiteC project. My expectation of the BCUC Inquiry is that there is a place in the exploration of the questions posed by government within the Terms of Reference for consideration of analysis that is not numeric, quantifiable, and technical in nature; that commissioners are able and willing to consider a range of thinking and analysis that are outside the norms of BCUC submissions and studies and apply those with equal rigour in responding to the questions in the TOR.

Further, my expectation is that commissioners will understand the importance of issues raised in submissions which in their judgment fall outside the apparent scope of the TOR and will include those issues as appendices in their initial and final reports to government.

Finally I ask commissioners to recognize that the context for construction of mega dams has changed dramatically since BC constructed the Bennett and Peace Canyon dams. Back then the landscape on North Eastern BC was largely intact and not yet industrialized. Now we are faced with an already seriously diminished and distressed environment and the precious nature of intact ecosystems has never been more important. To genuinely assist Government's decisions regarding the Site C dam I believed this BCUC process should be about accurately determining the full costs and benefits of this project not just to ratepayer or the government of the day but to the environment, to our communities, our society and our future generations.

(Note: all publications referred to will be attached below.)

My respectful advice to commissioners with reference to the Terms of Reference for this review is as follows:

A. With regard to TOR (a) (i) - Advice re the implications of completing Site C as planned and (c)(ii) other factors that could reasonably be expected to influence demand:

1. Disruptive Change:

Analysis must consider disruptive changes to the energy market that can be just as accurately anticipated to occur within the same time frame (as the completion of Site C) as can the chronically inflated, past based demand and sales projections of BC Hydro. These changes will constitute a paradigm shift that we had best be prepared for. No one has a crystal ball for predictability but with Site C dam we are looking at a 100+ year timeframe and a minimum of 70 years of public debt. Therefore understanding and taking into account studies and other predictive analysis is fundamental to answering questions (a)(i) and in (c)(ii). Failure to take "disruptive" forces into account will lead, inevitably I submit, to BC Hydro bankruptcy and privatization… neither of which is in the public interest.

I draw to your attention a study done in January 2013 for Edison Electric Institute entitled Disruptive Challenges: Financial Implications and Strategic Responses to a Changing Retail Electric Business. The Executive Summary begins:

> "Recent technological and economic changes are expected to challenge and transform the electric utility industry. These changes (or "disruptive challenges") arise due to a convergence of factors, including: falling costs of distributed generation and other distributed energy resources (DER); an enhanced focus on development of new DER technologies; increasing customer, regulatory, and political interest in demand- side management technologies (DSM); government programs to incentivize selected technologies; the declining price of natural gas; slowing economic growth trends; and rising electricity prices in certain areas of the country. Taken together, these factors are potential "game changers" to the U.S. electric utility industry, and are likely to dramatically impact customers, employees, investors, and the availability of capital to fund future investment. The timing of such transformative changes is unclear, but with the potential for technological innovation (e.g., solar photovoltaic or PV) becoming economically viable due to this confluence of forces, the industry and its stakeholders must proactively assess the impacts and alternatives available to address disruptive challenges in a timely manner."

Obviously this study was done in the US for a very different model of electricity provision. [For example - EEI has played a central role in a national U.S. campaign to reduce renewable energy incentives. The group has been successful in rolling back state-level incentives for rooftop solar energy.]

Indeed the intention of the study appears to be in sinister opposition to BC's long standing values and the purposes of a Public Utility in the interests of the public good. Please take heed of the implications.

That said there are some lessons from this study that apply in BC about the challenges of disruptive forces on the economic viability of large capital intensive "assests" like Site C over time. For example:

- the section on the effects of disruptive technologies - especially solar PV - on the industry and its prospects. And
- the "vicious cycle" effect on customer rates in a .. regulated industry

The following extracts are revealing (coloration is mine):

"First, let's review the current climate for the utility sector. While valuations are near all-time highs, the headwinds facing the sector are significant. Concerns start with the anemic electricity demand, which has been primarily impacted by the overall economic climate but also impacted by demand-side efficiency programs and the emergence of DER (Distributed Energy Resources). Next, there is the need to deploy capital investment at almost twice the rate of depreciation to enhance the grid and address various regulatory mandates. Soft electricity demand plus increasing capital investment lead to rate increase needs and the investment uncertainty created by a future active rate case calendar. While sell side analysts are expecting EPS growth of 4 percent to7 percent overall for the regulated sector, this is likely to be quite challenging. If investor expectations are not realized, a wholesale reevaluation of the sector is likely to occur. "

"*So, what will happen when electricity sales growth declines and that decline is not cyclical but driven by disruptive forces, including new technology and/or the further implementation of public policy focused on DSM and DER initiatives? In a cost-of-service rate-regulated model, revenues are not directly correlated to customer levels or sales but to the cost of providing service. However, in most jurisdictions, customer rates are a function of usage/unit sales. In such a model, customer rate levels must increase via rate increase requests when usage declines, which from a financial perspective is intended to keep the company whole (i.e., earn its cost of capital). However, this may lead to a challenging cycle since an increase in customer rates over time to support investment spending in a declining sales environment (due to disruptive forces) will further enhance the competitive dynamics of competing technologies and supply/demand efficiency programs. This set of dynamics can become a vicious cycle that, in the worst-case scenario, would leave few(er) customers remaining to support the costs of a large embedded infrastructure system, some of which may be stranded investment but most of the costs will continue to be incurred in order to manage the flows between supply and customers.*"

I also draw your attention to this interesting perspective on disruptive change https://www.youtube.com/watch?v=Kxryv2XrnqM If the predictions in this video are even partially realized we are all in a new world either as winners or losers.

In looking at the question in TOR (a)(i) Implications in the context of disruptive change I ask commissioners:

- Can BCUC afford to ignore the question of disruption on Site C's capacity to make money (or even break even) for ratepayers?
- Do we wish to force ourselves into decisions to increase rates to avoid system collapse;
- Paying for power that we can't sell at the cost of production;
- Dismantling progressive programs in DSM (which is already part of BC Hydro's Site C planning);
- Forfeiting public power as a collective public good when the public loses faith in BC Hydro's capacity to manage construction costs (such as has occurred in virtually every other jurisdiction)?

I submit that none of these outcomes are desirable but are both realistic and necessary to include in BCUC's analysis for TOR 3.a.(i).

One can expect the value of a decentralized, responsive, dynamic energy system, that includes and maximizes innovation and technological advances, to fare better in the destabilized circumstances BC will inevitably encounter as the disruptive results of climate change increase over time. (see for example: http://theclimateexaminer.ca/2016/04/21/when-the-glaciers-go-hydroelectric-vulnerability-and-climate-change/)

While I respect that deep analysis of disruption may be beyond the scope and timeframe of this review it remains the responsibility of commissioners to identify and account for the impacts in the advice upon which government may base it's final decision. I note the submission from Harry Swain identifies a significant number of foreseeable disruptive changes that can and will impact the market for Site C energy.

2. Continuing to build the Site C dam TOR (a)(i) - Financial burden of undermined costs:

Continuing to build will mean that ratepayers incur huge financial burdens that have not yet been made fully public, broadly understood, and sanctioned in the light of day. One hopes this review will remedy this egregious situation on the public's behalf.

At this point I ask the question: "Would ratepayers not save at least Five Billion unspent dollars and reduce BC Hydro's (aka ratepayer's and or taxpayer's) long term debt by

NOT spending the money to build Site C Dam?" Note: I arrive at Five Billion by subtracting Four Billion of potentially sunk costs from BC Hydro's projected Nine Billion build cost. Yes this is simplistic but to my way of thinking it is a significant implication of TOR (a)(iii).

It cannot be ignored that continuing to build will incur costs that have not yet been calculated or included in the figures available to date.

I submit for consideration the following examples of as yet undetermined financial costs as a partial list for which the public through BCUC requires accountability from BC Hydro:

1. Lost biodiversity costs (known also as ecosystem services, natural capital etc).

These systems have been well described by Rachel Darvill and Zoe Lindo in their study of the Upper Peace River Watershed. The loss of the unique and irreplaceable values that pertain to this area have not been identified as costs in any of BC Hydro documents. That does not mean that we as ratepayers now and in the future will not have to bear these costs both environmentally and economically.

One study that begins to address the financial/economic costs of lost biodiversity in the Peace River Watershed is the Peace Dividend produced by David Suzuki foundation. I recommend it to commissioners as a example of quantified Biodiversity values such that they do not continue to be ignored in the overall cost benefit question

In my limited understanding the value of biodiversity is like a bank… we as humans value the saving of money so that we know it is there if and when we might need it… we would not appreciate having this money quietly withdrawn and or devalued .. we expect it to be there when we need it. We in the south expect the north to still have the rich, life-sustaining biodiversity we may sometime need as we increasingly use up the biodiversity near the areas of largest human settlement. What a tragedy that by building Site C dam we could lose what we most need without even knowing it was there.

Due diligence by BCUC commissioners would account for these values as real but un-enumerated costs of biodiversity loss.

2. Costs of settlements (both financial and land based) with Indigenous peoples the infringement of whose treaty rights have yet to be addressed, not to mention the costs that ratepayers incur when BC Hydro lawyers defend our public corporation against entirely justified First Nations claims.

I refer you to the very recently released UN Commission on Human Rights (CERD) (excerpts below) report that refers specifically to Site C Dam an egregious example of the abrogation of responsibility to the basic human rights of Treaty 8 First Nations. To avoid mistake - this highly respected body is the UN's top level Committee on Racial Discrimination. There is no more authoritative group in the world.

Although there have been a series of legal challenges to Site C in Canadian courts, the central issues of treaty violations and the failure to obtain the free, prior and informed consent of the affected First Nations have never been dealt with in Canadian courts and were instead pushed off for future consideration if First Nations are able to mount an even more expensive legal challenge.

We can be certain that these costs will be real and will come home to roost. It will be the ratepayers who will pay both financially and morally.

3. Lost opportunity costs TOR

The **impacts of lost opportunities** are not confined to the people of the Peace River Valley. I and all other British Columbians will bear the costs whether we know it or not. Loss of prime agricultural land and it's food security capability hurts us all now and into our increasingly uncertain future. Loss of the rich biodiversity of the Peace River Valley hurts **life not just people**. The incredible debt to build this unnecessary dam hurts us all for generations to come. Indeed the loss of the Peace River Valley to Site C Dam will hurt us all far, far beyond any possible benefits we might derive in the short term.

Specifically

a future with a robust green economy, green jobs or well planned, economically and environmentally viable energy options.

I believe the project threatens the economic and political viability of BC Hydro and thereby threatens my assurance of future stable and dependable energy for myself, my family, my community and my province. I have provided a rationale if time allows: (Note: I want BC Hydro to remain intact as a Crown Corporation to serve the public good. In my view Site C could jeopardize Hydro's stability by incurring the additional $7.9 Billion debt and potential cost over-runs. This huge debt burden will very likely cause political pressure for privatization by putting upward pressure on rates. Indeed if rates were allowed to reflect the cost of Site C they would effectively need to be doubled. It is imprudent for BC Hydro not to adequately anticipate and asses the downward impact of rates pressure on future demand and its projections should be reassessed to include this factor. Additionally the cost of borrowing for such a debt could jeopardize BC's AAA credit rate and result in an increased cost of borrowing for BC Hydro.)

Developing carbon neutral technologies that could create the sustainable "green" economy and "green" jobs BC so desperately needs and without which we cannot prosper. This would be a far better use of our money.

Other lost opportunities derive from the EIS's failure to recognize or account for the **value of the intact Peace River Valley ecosystems** within and outside of the flood, erosion and stability zones. For example:

- It does not adequately recognize or account for how necessary this unique and rare valley bottom habitat is to plant and wildlife in northeastern BC and Alberta; or that this

valley provides critical and irreplaceable winter and birthing habitat for large ungulates such as elk, moose and deer or large predators such as grizzly and black bear.

- Site C does not adequately value the 16,000 acres of prime agricultural land and the valley's unique microclimate that, if freed from the spectre of Site C Dam, could create food security for northern BC in perpetuity; it does not recognize that future population growth will put ever increasing pressure on agricultural land in BC and that we cannot afford to lose this precious resource.

- It does not adequately value the nearly 17,000 acres of mostly intact boreal forest ecosystem and its carbon sequestration and climate change adaptation capability.

- Site C Dam does not adequately recognize or acknowledge downstream impacts, habitat connectivity nor does it assess the question of unintended consequences. **Lost opportunity?: The ability of this valley to continue it's life sustaining capability into a future far beyond the possible 100 year life span of Site C.**

<u>Regarding TOR (b)(iv) greenhouse gas emissions -</u>

Recent studies of CO2 and methane emissions from large Hydroelectric dams are not climate change friendly. In its November 6, 2016 article The Guardian's analysis summarizes some of the findings from research. "Led by Laura Scherer, a research associate at the Swiss university ETH Zurich, that study concludes the "carbon footprint of hydropower is far higher than previously assumed"." Included in this article is evidence that "After examining data from more than 1,400 dams worldwide, it identifies the rate of soil erosion into a reservoir as a leading predictor of carbon dioxide emissions." This finding is particularly pertinent to Site C dam given the well known instability of the slopes in the valley.

While there may be dispute around the significance of greenhouse gas emissions from dams it is clear that Site C dam will contribute significantly more GHG's than have been acknowledged by BC Hydro. It is also clear that Site C will not assist BC in lowering it's GHGs in the near future, a time when we most need to do so, and that it will continue to contribute GHGs over it's lifetime as soil erosion thru siltation continues over it's life time. This outcome is not in line with the purposes identified in the Clean Air Act regarding GHGs nor does it compare favourably with the alternatives currently available and those future innovation will make possible. The mandate to reduce GHGs is fundamentally an imperative for self preservation that we cannot afford to mess up.

And finally the loss of carbon sequestration capacity in the largely timbered inundation areas in and around the inundation zone over the life of the dam must be accounted for in the GHG question to BCUC under TOR (b)(iv) .

Here are some examples of numerous articles from 2016 updating our knowledge re GHG emissions and large hydroelectricity dams like Site C.

https://www.theguardian.com/sustainable-business/2016/nov/06/hydropower-hydroelectricity-methane-clean-climate-change-study

https://academic.oup.com/bioscience/article/66/11/949/2754271/Greenhouse-Gas-Emissions-from-Reservoir-Water

http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0161947

Regarding TOR (a) (iii) terminating the Site C Project and remediating damages to the Peace River Valley -

The majority of my submission focusses on the the implications per TOR (a)(i) to ratepayers of continuing with the Site C project. The premier has stated that BCHydro needs to prove that Site C Dam is needed and, if so, that it is the best alternative to generating electrical power for BC over the course of it's lifetime and over the period of time that ratepayers will be paying for it. In identifying the negative consequences of continuing with the project I have de facto identified a number of rationales, benefits and purposes of terminating the project as per TOR (a)(iii).

I submit that terminating the project and remediating the damages to the degree possible will prove to be the best and least expensive option for ratepayers. By remediating the area we can then allow nature to heal itself. This is by far the least expensive option. The costs and uncertainties that pertain to suspending will not improve over time and will result in significant negative consequences as follows:

What would be possible in terms of remediation needs to include understandings of options that have not been available since the 1950's without losing the integrity of the ecosystem that termination would preserve. This is where the new generation of technological Innovations will be far more advantageous to BC and to ratepayers than the 1st generation technology mega-dam. Others have commented on what these current technologies look like now.

To aid our understanding we can use the most familiar paradigm shift in communication technologies from the early to mid 1990's to 2017 to see how quickly the combination of human imagination and ingenuity can meet needs we didn't even know we had and importantly how this has impacted the market. Given the absence of predictable proven need for power in the foreseeable future identified in other submissions such as Swain, Finn, McCullough et al, it would be foolhardy economically and environmentally to tie BC Hydro ratepayers firmly to the technology of the past.

Regarding TOR (b)(ii) and (iii) costs to ratepayers of suspension over termination:

I submit that the apparent attractions of suspension compared with termination are unfounded in common sense and cost implications. A decision to indefinitely suspend (but not cancel) the site C project would:

1. Freeze future development of the Peace Valley (in such an indecisive state, what financier would invest in any venture in the area?)
2. Leave Peace Valley landowners as tenants on their own land, and expose BC Hydro to litigation and claims for damages and loss of income
3. Leave First Nations treaty and cultural rights in the area unresolved
4. Place further obstacles in the way of the development of a BC renewable power industry and the transition of BC Hydro to an energy services company
5. Be complex and expensive, as BC Hydro would face a costly and contentious decision to either remediate the site or maintain it in its current unstable state

Regarding TOR (b) (iv) other portfolios:

Firstly I submit that DSM must be reinstated and re-envisioned across all sectors of demand/use. It will continue to save us wasted energy use and to save us money. It is the right and responsible thing to do.

Secondly, one alternative energy option is geothermal energy. While Hydro recognizes that geothermal energy appears to be an equivalent cost, and a firm and dependable energy supply option it has treated geothermal as currently unavailable. Hence it does not give the geothermal potential of the Peace River Valley and Northeastern BC adequate weight or consideration as an alternative to building Site C Dam. Its environmental footprint would be much smaller than Site C Dam and its long term job production capability much higher. Failing to include this is unacceptable.

(Note: Quote from 2013 IRP Page 3-67 ***3.4.1.8 Geothermal -*** "Only conventional hydrothermal resources using flash or binary technologies are considered within BC Hydro's resource option assessment. There may be potentially significant unconventional resources that could increase the potential geothermal resource base of B.C., including hot dry rock or low temperature hydrothermal resources in the sedimentary basin.")

Thirdly, I submit that hydropower is 1st industrial revolution technology, developed by Thomas Edison, Nicola Tesla and others when our grandparents were kids. Innovation and engineering design can increase dam efficiency, but the increases year by year tend to be small because the easy inventions have been made, the preferred reservoir sites have been taken and the real value to society of the land sacrificed to reservoirs goes up almost exponentially.

However, 3rd generation industrial revolution technology (eg Solar Power, Wind Power, Sea Power, geo- and hydro-thermal power and other technologies) lies on the cusp of a new understanding of matter, energy and reality. We know for instance that quantum physics principles just discovered and new concepts on the way all promise exceptional

opportunities for engineering designs which immensely increase efficiency while decreasing costs of production through alternatives to hydropower. These low impact sources of energy may soon cost less per kilowatt hour than new hydro technology when we consider all found costs. Positive change in this area is rapid and profound.

So as I understand it, the cost per kilowatt hour of electricity in BC from new hydro dam building is increasing. In contrast, quantum physics concepts leveraged into solar, wind, ocean, hydrothermal and other sources will decrease the cost of power from these sectors, year by year in a fairly dramatic way.

If we were to draw a graph of the all found cost per kilowatt hour of hydro vs 3rd gen technology, we would see that these lines will cross at some point. I submit that the cross over point is about now, but thus far a good clean economic analysis is missing. An objective, independent study would be a real benefit to BC at this point. I encourage the commissioners to recommend such a study.

Submissions Conclusions:

Firstly, under TOR (b)(i) I submit that the total costs to ratepayers for Site C dam have not been accounted for to date and that is now the job of BCUC in a process we all know is after the fact and rigorously perhaps fatally constrained. I further submit that where costs are identified but not yet quantified or assigned they be collected and presented to government as such rather than being ignored.

Secondly, under TOR (a)(i), I submit the argument that the changes we face today are disruptive, accelerating, and non-linear and they will be exponential in impact and magnitude. Therefore I am not in favour of BC Hydro risking all it's power development efforts together with our scarce resources primarily on building new big dams. However under (a)(iii) (b)(iii) I am very much in favour of BC Hydro building up an integrated, power ecosystem using engineering and technology to minimize harmful impacts, maximize benefits and leverage existing hydro dam installations so that the value of existing hydro power increases by way of stabilizing gaps in new technologies like solar, wind and geothermal. This vision will only be possible if we do not build or suspend Site C Dam.

Thirdly, under TOR (a) Implications (i,ii,iii) it is clear that BC Hydro's vision and empowering legislation no longer fits the times and economic environment of the society, and thus it fails to provide the best possible planning options for the public good. That in my view is a major reason we have the Site C Dam Proposal. Building Site C Dam is not an inspired or visionary solution to the energy problems we will face in this province. I submit that BCUC recommend to government that BC Hydro's planning must be guided by new or highly revised energy policy and legislation, which includes new, 3rd generation technology development as a core component and that an independent and thorough economic analysis of BC Hydro be done.

Finally, **I submit that Commissioners must recommend TOR option (a)(iii) to terminate Site C Dam.**

In closing, the TORs ask commissioners to understand and explain the complexities and opaque rationale behind BC Hydro's single minded determination to proceed with the Site C Dam project despite the existence of realistic and better alternative options and in the face of all the harms that will arise. **What we as a province desperately need is the opportunity to try again to get a responsible approach to generating energy in a way that allows the Peace River valley to continue it's life sustaining capability into a future far beyond the possible 100 year life span of Site C.**

Appendix:

A. From CERD:

Here are pertinent excerpts from the report:

Land rights of Indigenous Peoples

19. Taking note of the recent release of a set of 10 Principles Respecting the Government of Canada's Relationship with Indigenous Peoples in 2017, the Committee is deeply concerned that:

(a) Violations of the land rights of Indigenous Peoples continue in the State party, in particular environmentally destructive decisions for resource development which affect their lives and territories continue to be undertaken without the free, prior and informed consent of the Indigenous Peoples, resulting in breaches of treaty obligations and international human rights law.

(b) Costly, time consuming and ineffective litigation is often the only remedy in place of seeking free, prior and informed consent, resulting in the State party continuing to issue permits which allow for damage to lands.

(c) According to information received, permits have been issued and construction has commenced at the Site C dam, despite vigorous opposition of Indigenous Peoples affected by this project, which will result in irreversible damage due to flooding of their lands leading to elimination of plants medicines, wildlife, sacred lands and gravesites.

(d) According to information received the Site C dam project proceeded despite a joint environment review for the federal and provincial governments, which reportedly concluded that the impact of this dam on Indigenous Peoples would be permanent, extensive, and irreversible.

….

20. Recalling its general recommendation No. 23 (1997) on the rights of Indigenous Peoples and reiterating its previous recommendation (CERD/C/CO/19-20, para. 20) the Committee recommends that the State party:

(a) Ensure the full implementation of general recommendation 23, in a transparent manner with the full involvement of the First Nations, Inuits, Methis and other Indigenous Peoples with their free prior and informed consent for all matters concerning their land rights.

(b) Prohibit the environmentally destructive development of the territories of Indigenous Peoples, and allow Indigenous Peoples to conduct independent environmental impact studies.

(c) End the substitution of costly legal challenges as post facto recourse in place of obtaining meaningful free prior and informed consent of Indigenous Peoples.

(d) Incorporate the free, prior and informed consent principle in the Canadian regulatory system, and amend decision making processes around the review and approval of large-scale resource development projects like the Site C dam.

(e) Immediately suspend all permits and approvals for the construction of the Site C dam. Conduct a full review in collaboration with Indigenous Peoples of the violations of the right to free prior and informed consent, treaty obligations and international human rights law from the building of this dam and identify alternatives to irreversible destruction of Indigenous lands and subsistence which will be caused by this project.

Paragraphs of particular importance - Follow-up to the present concluding observations:

40. In accordance with article 9 (1) of the Convention and rule 65 of its rules of procedure, the Committee requests the State party to provide, within one year of the adoption of the present concluding observations, information on its implementation of the recommendations contained in paragraphs 34 (a, b, and d) and 20 (e and f) above.

41. The Committee wishes to draw the attention of the State party to the particular importance of the recommendations contained in paragraphs 16, 18, 20 (a, b, c and d), and 32 above and requests the State party to provide detailed information in its next periodic report on the concrete measures taken to implement those recommendations.

……..

B. <u>Edison Electric Institute Report: Disruptive Challenges:</u> Financial Implications and Strategi Responses to A Changing Retail Electric Business. This will appear as a PDF attachment to my submission by email.

C. JRP Report - see page 322 of 473 - see attached PDF

D. The Peace Dividend - David Suzuki Foundation - see attached PDF

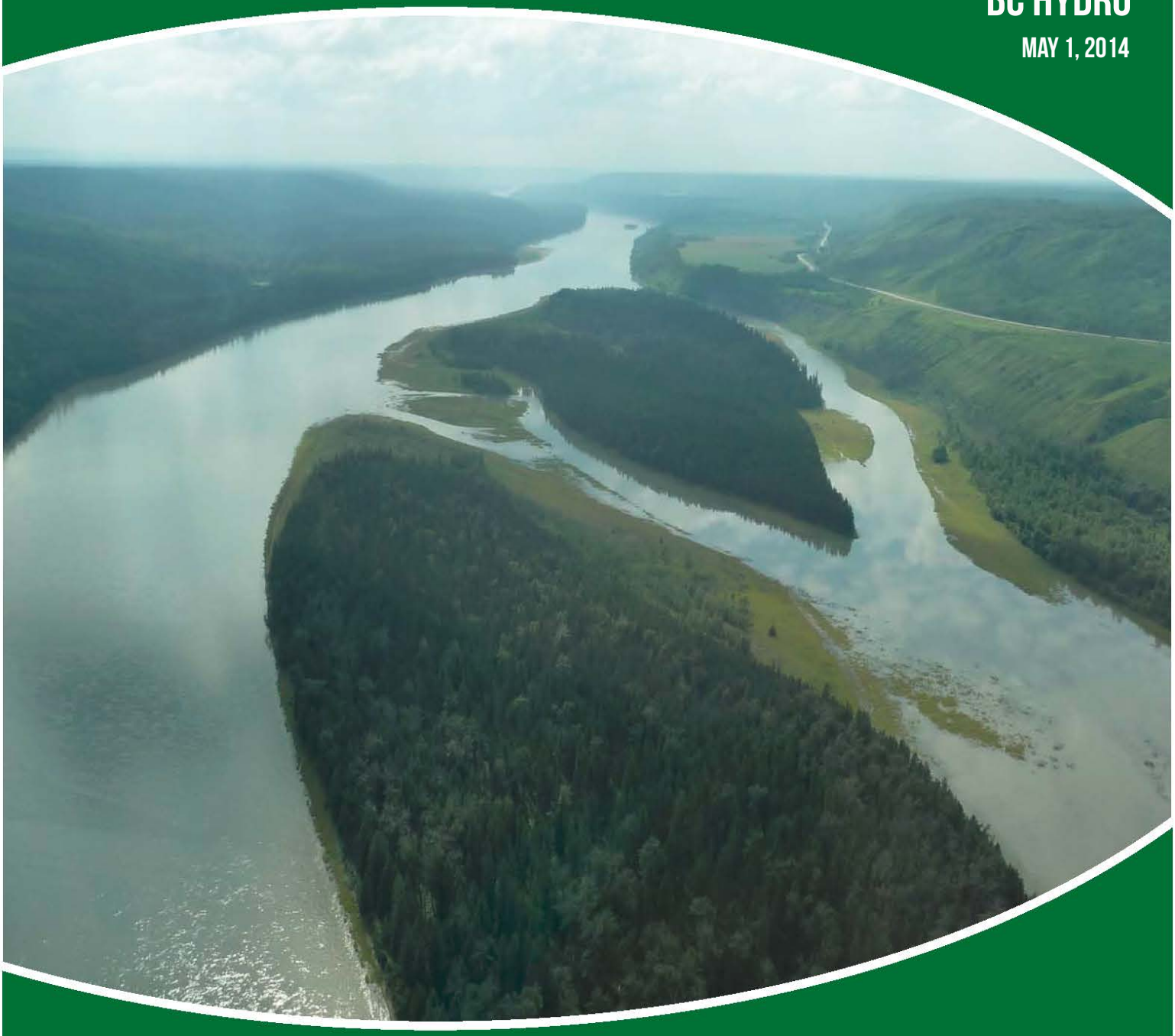
E. Darvill and Lindo - 2015 - Landscape Ecology - see attached PDF

REPORT OF THE JOINT REVIEW PANEL

SITE C CLEAN ENERGY PROJECT

BC HYDRO

MAY 1, 2014



REVIEW PANEL ESTABLISHED BY THE FEDERAL MINISTER OF THE ENVIRONMENT AND THE BRITISH COLUMBIA MINISTER OF ENVIRONMENT

REPORT OF THE JOINT REVIEW PANEL

SITE C CLEAN ENERGY PROJECT

B.C. HYDRO AND POWER AUTHORITY

BRITISH COLUMBIA

MAY, 2014

Report of the Joint Review Panel – Site C Clean Energy Project

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The Panel is solely responsible for the content of this Report.

SUMMARY

In August 2013, the federal and provincial governments named a Joint Review Panel to examine and to hold a public hearing on BC Hydro's proposed Site C Clean Energy Project, a third hydroelectric facility to be built on the Peace River, near Fort St. John. This is the report of the Panel's assessment of the Project, which the governments are required to publish. The Panel was mandated to inquire into the environmental, economic, social, health, and heritage effects of the Project and their significance, to examine proposals for the mitigation of adverse effects, and to record assertions of Project effects on the Aboriginal rights and treaty rights of the affected First Nations and Métis peoples.

Any large industrial project carries with it some costs that are not captured in a narrowly economic analysis. The question is whether the benefits from the project outweigh those costs. It is in the nature of a public hearing process that the advocates for each side speak as forcefully as they can, and that there would appear to be no middle ground. The Panel's mandate required it to weigh both sides, and to present a balance sheet, accounting for its associated recommendations, to allow elected provincial and federal governments to determine if the benefits justify the costs. The decision on whether the Project proceeds is made by elected officials, not by the Panel.

The benefits are clear. Despite high initial costs, and some uncertainty about when the power would be needed, the Project would provide a large and long-term increment of firm energy and capacity at a price that would benefit future generations. It would do this in a way that would produce a vastly smaller burden of greenhouse gases than any alternative save nuclear power, which B.C. has prohibited. The Project would improve the foundation for the integration of other renewable, low-carbon energy sources as the need arises. The Project would also entail a number of local and regional economic benefits, though many of these would be transfers from other parts of the province or country. Among them would be opportunities for jobs and small businesses of all kinds, including those accruing to Aboriginal people.

There are other economic considerations. The scale of the Project means that, if built on BC Hydro's timetable, substantial financial losses would accrue for several years, accentuating the intergenerational pay-now, benefit-later effect. Energy conservation and end-user efficiencies have not been pressed as hard as possible in BC Hydro's analyses. There are alternative sources of power available at similar or somewhat higher costs, notably geothermal power. These sources, being individually smaller than Site C, would allow supply to better follow demand, obviating most of the early-year losses of Site C. Beyond that, the policy constraints that the B.C. government has imposed on BC Hydro have made some other alternatives unavailable.

There are other costs, however, and questions of where they fall. Replacing a portion of the Peace River with an 83-kilometre reservoir would cause significant adverse effects on fish and fish habitat, and a number of birds and bats, smaller vertebrate and invertebrate species, rare plants, and sensitive ecosystems. The Project would significantly affect the current use of land and resources for traditional purposes by Aboriginal peoples, and the effect of that on Aboriginal rights and treaty rights generally will have to be weighed by governments. It would not, however, significantly affect the harvest of fish and wildlife by non-Aboriginal people. It would end agriculture on the Peace Valley bottom lands, and while that would not be significant in the context of B.C. or western Canadian agricultural production, it would highly impact the farmers who would bear the loss. The Project would inundate a number of valuable paleontological, archaeological, and historic sites. It would have modest effects on health, which could be mitigated, although the health effects of methylmercury on people who eat the reservoir fish

require more analysis to be sure. For most users, outdoor recreation and tourism, transportation, and navigation would also experience effects but not significant effects. Because of the significant adverse effects identified on some renewable resource valued components in the long-term, there would be diminished biodiversity and reduced capacity of renewable resources, should the Project proceed. The Project would not have any measureable effect on the Peace-Athabasca Delta.

Risks and associated environmental effects due to potential accidents and malfunctions have been appropriately mitigated by BC Hydro through project design and planned project management.

There would be the usual health and social risks common to boom towns. The low local unemployment rate would mean that most of the Project workers would come from other parts of the province and Canada. However, increased local demand would mean that a broader range of goods and services would become available to all residents of Fort St. John. The local economic upside would largely provide the resources to deal with possible problems, including those related to health, education, and housing, especially if the arrangements BC Hydro is willing to make with local authorities can be concluded.

The Peace River region has been and is currently undergoing enormous stress from resource development. In this context, the Panel has determined that the Project, combined with past, present and reasonably foreseeable future projects would result in significant cumulative effects on fish, vegetation and ecological communities, wildlife, current use of lands and resources for traditional purposes, and heritage. In some cases, these effects are already significant, even without the Project.

BC Hydro proposed a suite of mitigation measures which the Panel accepts. The Panel arrived at its own conclusions about the impact of the proposed Project and made recommendations in consequence. The Panel evaluated all proposals by participants and believes that the ones carried forward here represent a complete and practical list.

For ease of reference, the Panel's specific conclusions are in shaded text boxes in each of the chapters, followed by any necessary recommendations. A complete list of the Panel's conclusions and recommendations to be taken into account under section 5 of the *Canadian Environmental Assessment Act, 2012* is in Appendix 1.

Harry Swain
Jocelyne Beaudet
James Mattison

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INTRODUCTION

British Columbia Hydro and Power Authority (BC Hydro) is a Crown corporation owned by the Province of British Columbia. Its mandate is to generate, manufacture, conserve, purchase, and sell electricity to meet the needs of its customers. The corporation serves 95 percent of the province's population or approximately 1.9 million customers. It is the largest utility in the province and operates an integrated system of 31 hydroelectric facilities and three thermal generating plants, totalling around 12,000 megawatts (MW) of installed generating capacity. The hydroelectric facilities provide over 95 percent of the total electricity generated. It is complemented by additional electricity purchased from independent power producers.

The proposed Site C Clean Energy Project (the Project) under review would be a third dam and generating station built on the Peace River in northern British Columbia. BC Hydro proposes to provide up to 1,100 MW of capacity and about 5,100 gigawatt hours (GWh) of energy each year to the province's integrated electricity system.

In May 2011, BC Hydro submitted a detailed Project description to the British Columbia Environmental Assessment Office (BCEAO). On August 2, 2011, an Order by BCEAO under section 10(1)(a) of the *Environmental Assessment Act* referred the Project to the B.C. Minister of Environment, at which point the Project formally entered the provincial environmental assessment process. The Canadian Environmental Assessment Agency posted its Notice of Consideration to conduct an environmental assessment at this time.

To avoid unnecessary duplication and delays, the federal and provincial governments developed a cooperative environmental assessment process for the Project that included the establishment of a Joint Review Panel. An Agreement was signed by both the federal Minister of the Environment and the B.C. Minister of Environment on February 8, 2012, following public and Aboriginal consultation.

The Joint Review Panel derives its mandate from the *Canadian Environmental Assessment Act, 2012*, the Agreement, and the Panel's Terms of Reference described in the Agreement. The Panel was mandated to determine whether the Project was likely to cause significant adverse environmental, economic, social, health, and heritage effects, taking into account the implementation of mitigation measures that are technically and economically feasible. As per the Agreement, the environmental assessment for the Project is being conducted over three phases: the Pre-Panel, the Joint Review Panel, and the Post-Panel Stages. The Joint Review Panel Stage started on August 2, 2013, and will end with the submission of this report.

The Panel conducted an assessment of the environmental, economic, social, health, and heritage effects of the Project in a manner consistent with the requirements of the Panel's Terms of Reference. The Panel reviewed the amended Environmental Impact Statement and all the information gathered at the Pre-Panel Stage and during the Panel's mandate. The Panel made sure that the impacts of the Project were adequately described and that the mitigations proposed and their appropriateness and feasibility were well understood. The Panel also reviewed the adverse residual effects and their level of significance. The Panel sought information directly from Aboriginal groups on their asserted or established Aboriginal rights or treaty rights and information regarding any measures to avoid or mitigate potential adverse effects of the Project on these rights. Then the Panel conducted an assessment of the need for the Project and potential alternatives and reported on the benefits and economics of the Project to aid the governments in their decisions.This is the report of the Panel's analysis, conclusions, and recommendations.

1 THE ENVIRONMENTAL ASSESSMENT PROCESS

This chapter outlines the process for the Project review. With its appendices, it includes the legislative framework and requirements for the review, the Panel's mandate and responsibilities, a description of the Proponent's environmental assessment methodology, the Panel's approach, and the key milestones of the review process, including public participation.

1.1 THE LEGISLATIVE FRAMEWORK FOR THE REVIEW

The governments of Canada and British Columbia, desiring to avoid duplication of effort, decided that a single joint review of the Project would be the most efficient way to proceed. The review of the Project was accordingly framed by an Agreement under the *Canadian Environmental Assessment Act, 2012* (CEAA 2012) and the *British Columbia Environmental Assessment Act* (BCEAA), which included specific Terms of Reference for the review (see Appendix 2).

1.1.1 Environmental Effects Under CEAA 2012

Under CEAA 2012, environmental effects are defined in subsections 5(1) and 5(2). The environmental effects defined under subsection 5(1) consist of changes that may be caused to components of the environment, defined in the Act, that are within the legislative authority of Parliament, effects occurring on federal lands, transboundary effects and effects of changes to the environmental assessment related to Aboriginal peoples.

In this review, subsection 5(2) is also triggered because the Project requires permits, approvals, authorizations, or licences under the *Fisheries Act*, *Navigable Waters Protection Act*, *Explosives Act,* and *Radio and Telecommunications Act.*

The environmental effects defined in paragraph 5(2)(a) of CEAA 2012 include changes to the environment that are "directly linked or necessarily incidental to" any federal decisions about a project, other than a change already identified in paragraph 5(1)(a) and (b). The Panel interprets the two branches of this definition of effects as follows:

- "directly linked" environmental effects to be effects that are the direct and proximate result of a federal decision; and
- "necessarily incidental" environmental effects are consequential effects due to an change that occurs as a result of a federal decision.

As contemplated in section 3.13 of the Agreement, the Panel points out these linkages in this report. The Panel also identifies which conclusions and recommendations relate to environmental effects under the CEAA 2012.

1.1.2 Five Pillars Under the Agreement

The Agreement requires an environmental assessment to consider the environmental, economic, social, heritage, and health effects of the Project. The BC Environmental Assessment Office (BCEAO) refers to these broadly as "pillars."

A large number and variety of authorizations will be required from the Province under several Acts to facilitate construction and operation of the Project, as well to implement mitigation and compensation measures. These Acts include the *Land, Water, Forest, Forest and Range Practices, Wildlife, Heritage Conservation, Mines, Environmental Management, Industrial*

Roads, Wildlife, Transportation, Transportation of Dangerous Goods and Public Health Acts among others. BC Hydro has provided a list of potential permits that would be required for the Project in Table 8.1 in Section 8 of the amended Environmental Impact Statement. Authorizations issued by the Province would be subject to issuance of an Environmental Assessment Certificate for the Project and must be consistent with any EA conditions.

1.1.3 Documentation and Information

The Panel had to consider key documents and information concerning the assessment and review of the Project received during the Pre-Panel and Joint Review Panel Stages and found on the Canadian Environmental Assessment Registry (CEAR) and the BCEAO website ePIC, both of which record all documentation created or received for this review. Specifically, the Panel reviewed and discussed:

- the approved Environmental Impact Statement (EIS) Guidelines,
- the amended EIS,
- additional information provided by the Proponent in response to the Panel's Information Requests,
- submissions from interested parties,
- public comments,
- comments from government agencies and non-government experts, and
- comments, assertions of rights, and submissions from Aboriginal groups.

1.2 STAGES OF THE REVIEW PROCESS

On April 19, 2010, British Columbia announced that the proposed Project would advance to the stage of environmental and regulatory review, which requires an independent environmental assessment (EA) by B.C. and Canada. Accordingly, the Proponent submitted a Project description on May 18, 2011. A detailed description of the EA process is found in Appendix 3.

For the next 26 months, as BC Hydro worked on its EIS, consultations continued among the public, Aboriginal groups, government agencies, and the Proponent. The objectives of these discussions were to identify issues and concerns regarding potential adverse effects of the Project, opportunities to avoid or mitigate adverse impacts, and avenues to enhance the potential benefits of the Project construction and operation activities for local Aboriginal and non-Aboriginal communities. Issues with the Agreement, the EIS Guidelines, and the Proponent's EIS were also reviewed. Extensive records of this consultation are available in the comment tracking tables and correspondence between interested parties, which are on the CEAR and ePIC websites.

Following a review of the EIS by the public, governments, and Aboriginal groups, the Proponent was directed to make amendments. The amended EIS was deemed satisfactory by officials on August 1, 2013, which marked the beginning of the Joint Review Panel Stage. "Satisfactory" meant that the information presented in the EIS, as measured against the approved EIS Guidelines and in terms of technical merit, was considered adequate.

1.3 BC HYDRO'S ENVIRONMENTAL ASSESSMENT METHODS

BC Hydro conducted its assessment of the potential effects of the Project in accordance with the EIS Guidelines developed for the Project and consistent with CEAA and BCEAO methods for effects assessment.

1.3.1 Effects Assessment

Following wide consultations with governments, Aboriginal groups, and the public, valued components (VCs) were identified by the Proponent in accordance with the EIS Guidelines. Spatial boundaries were delineated, taking into account the scale and extent of potential effects, and, as available, community and Aboriginal traditional knowledge and current land and resource use by Aboriginal groups. These boundaries were:

- Technical study areas covering the physical extent of data collection or the physical boundary for a technical modeling program;
- The Project activity zone (PAZ), or area within which the Project components and activities would be located, excluding existing transportation infrastructure;
- Local assessment areas (LAA), or areas within which the potential adverse effects of the Project would be assessed. Boundaries were determined independently for each VC and defined by the expected maximum geographic extent of the potential of the Project to cause an adverse effect on a VC; and
- Regional assessment areas (RAA), or areas within which other activities may combine with residual effects of the Project, chosen in order to assess cumulative effects.

BC Hydro then identified potential effects as a result of the Project, determined if they were adverse, and if they were, proposed mitigation measures. Four types of mitigation measures were used according to a hierarchy of actions accepted as current best practice. They were to avoid, minimize, restore, and compensate. Adverse residual effects that may remain after taking into account the implementation of mitigation, including compensation, were identified. These effects were then characterized as to their significance according to the following criteria:

- Direction: the ultimate long-term trend of the environmental, social, economic, heritage, or health effect.
- Magnitude: the amount of change in a key indicator or variable relative to the baseline case.
- Geographic extent: the area in which an effect occurs.
- Duration: the period of time required until the VC returns to its baseline condition, or until the effect can no longer be measured or otherwise perceived.
- Frequency: the number of times during a Project or a specific Project phase that an effect may occur.
- Reversibility: the degree to which existing baseline conditions can be re-established after the factors causing the effect are removed.
- Context: the extent to which the area where an effect may occur has already been adversely affected by human activities or is ecologically fragile and has little resilience in the face of imposed stresses.
- Level of confidence: the degree of scientific certainty with respect to effects and their attributes.
- Probability: the likelihood that an adverse effect will occur.

For some VCs, BC Hydro also used thresholds to determine the significance of residual effects. Frequently, in the face of uncertainty, it proposed follow-up programs to verify the accuracy of the assessment or the effectiveness of mitigation measures.

1.3.2 Cumulative Effects Assessment

BC Hydro conducted a cumulative effects assessment (CEA) if a potential adverse residual effect of the Project on a VC had a spatial and temporal overlap with a residual effect of another project or activity. Spatial RAA boundaries for each VC were set out, and three temporal boundaries were established as follows:

- A baseline case describing the current status of a VC, reflecting the residual effects of projects and activities that have been and are presently being carried out;
- A future case without the Project, identifying the potential adverse effects of other projects and activities that will be carried out, in order to predict the status of the VC by taking into account the baseline case and projects and activities that are at least as foreseeable as the Project. September 5, 2012 was chosen to demarcate the baseline case from the future case; and
- A Project case demonstrating the predicted status of the VC, taking into account the residual effects of the Project combined with those due to other projects and activities as identified in the future case without the Project.

BC Hydro created a master list of projects and activities in the largest RAA used in the Project's effects assessment. Projects in the LAA were automatically included. If, for any VC, adverse residual effects were predicted, the overlap with other activities in the region was assessed, and if a cumulative effect existed, mitigation measures were proposed to address these combined effects. Any remaining cumulative residual effects were assessed for their significance.

1.4 THE JOINT REVIEW PANEL STAGE

The Panel was allocated 225 days (not including any time required by BC Hydro to answer information requests from the Panel) to assess the material, hold the public hearing, and prepare its report. The Panel received the amended EIS on August 2, 2013 and was provided with an Evidentiary Update on September 13, 2013. At this point, the EIS as amended totalled more than 18,000 pages.

The Panel, jointly appointed by Canada and British Columbia, consisted of Harry Swain as Panel Chair, Jocelyne Beaudet as the Federal Member, and James Mattison as the Provincial Member. Biographical notes are found in Appendix 4.

The Panel's approach to assessing the potential effects of the Project was based on its Terms of Reference and the legal framework of its mandate. The Panel considered all of the information gathered since the beginning of the review until the close of the Project's official record on February 3, 2014. Broadly, as required by legislation, the Panel based its assessment on the principles of sustainability and precaution.

The Panel was required to determine whether the EIS and related materials submitted by BC Hydro contained sufficient information to proceed to the public hearing. In order to make this determination, the Panel:

- reviewed the EIS Guidelines, the amended EIS, the Evidentiary Update, and all related materials, including consultation records from the Pre-Panel Stage;
- issued three sets of Information Requests (IRs);
- reviewed and evaluated BC Hydro's responses to IRs; and
- requested clarification on IRs submitted by BC Hydro and on some comments submitted by interested parties.

On November 7, 2013, the Panel determined that the amended EIS and additional information provided by BC Hydro contained sufficient information to proceed to the public hearing. At this time, the Panel announced that the hearing would begin on December 9, 2013.

The EIS Guidelines and the EIS itself were drafted and deemed satisfactory before the Panel's existence. This had the advantage of bringing new eyes to the file but inevitably meant there were occasions when the Panel would have come to different conclusions. Notably, the Panel had reservations about the conventional wisdom on cumulative effects assessment, and about the adequacy of the Guidelines in respect of the costs and benefits of the Project.

1.4.1 Public Hearing

The Panel prepared a draft set of Hearing Procedures and posted them on CEAR and ePIC for public comment from August 26, 2013 to September 16, 2013. The purpose of the Hearing Procedures was to ensure that the public hearing would be conducted in a thorough, timely, and fair manner. On November 7, 2013, the Panel issued final Hearing Procedures after considering comments received (Appendix 5).

In accordance with CEAA 2012, the Panel was required to determine who would be considered an "Interested Party" and be eligible to appear before the Panel and present. The Panel determined that any participant who had provided comment in the Pre-Panel Stage be automatically included in the definition. Other persons who wanted to appear before the Panel were required to apply. The Panel received six applications for Interested Party status and accepted all of them.

The Panel considered requests to hold sessions at locations throughout the province, or at least to include the Vancouver and Victoria areas, but given its time constraints and the requirements of the Terms of Reference to hold the hearing in the communities closest to the proposed Project, the Panel held the hearing in the Peace region and surrounding communities. To allow participation from groups and individuals outside of the immediate Project area, the Panel provided audio reception in real time, and encouraged would-be participants who could not travel to the Peace region, Prince George, or Peace River to make submissions in writing or by teleconference. See Appendix 6 and 7 for the hearing schedule and list of participants.

1.4.2 Requests for Confidentiality and Filing of Information

CEAA 2012 requires that, with limited exceptions, all information the Panel uses be made available to the public. However, the Panel had several requests to receive information confidentially. The Panel established a process by which participants could request that the Panel consider confidential information. The requests and the information were referred to the Panel's counsel, who discussed the request with the participant. Ultimately, only one request for confidentiality was referred to the Panel, and the Panel accepted information from the Saulteau First Nations in confidence. The process for dealing with requests for confidential information is included in Appendix 5.

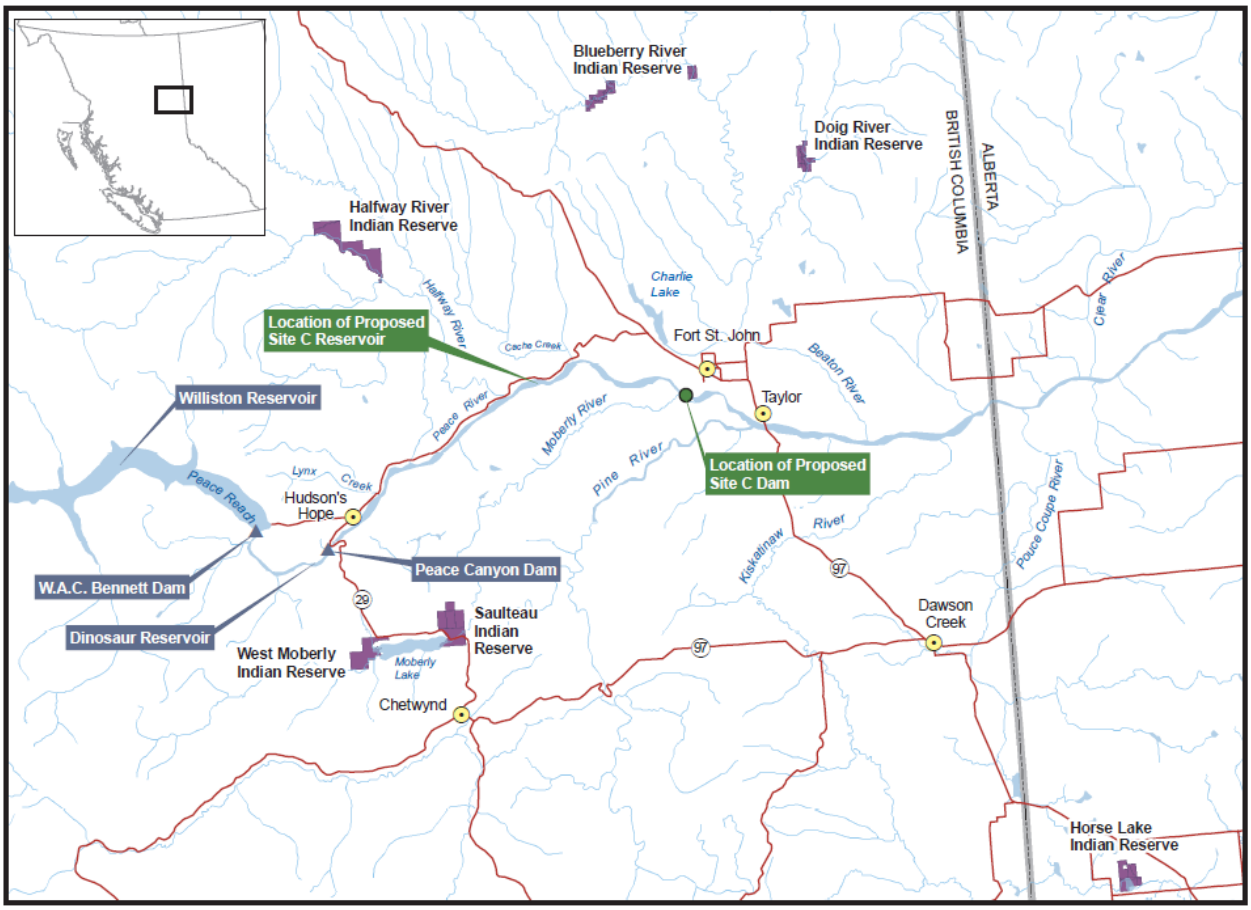
1.5 PANEL REPORT AND GOVERNMENT DECISION PROCESS

In accordance with its Terms of Reference, the Panel produced this Joint Review Panel Report, which was submitted to the federal Minister of the Environment and the Executive director of BCEAO within 90 days of the date that the Chair of the Panel formally closed the hearing process. The Canadian Environmental Assessment Agency and the British Columbia Environmental Assessment Office will publish this report in a manner consistent with section 9

of the Agreement. The Panel fulfills an advisory role and is not a decision-making authority. Decisions regarding Project approval will be made by the federal and provincial governments.

2 PROJECT DESCRIPTION

The Project is a proposed third dam and hydroelectric generating station on the Peace River in northeast British Columbia (Figure 1). The Peace River arises in the Rocky Mountain Trench in north-central British Columbia, flows east across the border into Alberta, and after turning north and joining the Athabasca and Mackenzie Rivers, drains into the Arctic Ocean. The Project would be located approximately 62 river kilometres upstream from where the Peace River crosses the British Columbia–Alberta border, and approximately 1,300 river kilometres upstream from where the Slave River crosses the Alberta–Northwest Territory border. The dam would be located approximately 7 kilometres southwest of Fort St. John, British Columbia. The 83-kilometre inundated area (reservoir) would extend upstream from the Site C dam, west past Hudson's Hope to Peace Canyon Dam.



Note: Map created from BC Hydro and GeoBC data

Figure 1. Project Location

2.1 PROJECT BACKGROUND

Five hydroelectric development sites were identified for a potential third dam on the Peace River in the late 1950s, based mainly on topographical considerations. In the early 1970s, studies by BC Hydro focused on dams at two sites (including Site C), with the goal of developing the entire electric generation potential between Bennett Dam and the Alberta border. Order-in-Council 2452 dated October 11, 1957 and subsequent Order amendments reserved an area of Crown land that is the Site C Flood Reserve. By 1976, the focus of the engineering studies had shifted

to concentrate on Site C. These studies of alternative sites culminated in 1978 with the selection of Site C as the preferred site. An application was submitted to the provincial government for an Energy Project Certificate in 1980. In 1981, the government referred the application to the British Columbia Utilities Commission (BCUC) for review. In 1983, the BCUC concluded that Site C was an acceptable project, but indicated that more work was required concerning the future demand for electricity and alternatives to the project.

From 2001 to 2006, BC Hydro undertook several studies regarding the development the hydroelectric potential of the Peace River between Peace Canyon Dam and Site C. Once the location of the dam was chosen, the Proponent undertook a review of all previously identified alternatives and any new alternatives to each major Project component.

The design of the current Project has evolved since the 1982 BCUC application and BC Hydro's review of alternatives confirmed Site C as the preferred location for developing the hydroelectric potential downstream of Peace Canyon Dam. The dam design was changed from a linear to a right-angled design to take advantage of the best foundation conditions and to achieve the more modern seismic standards that are now recommended for dams of this size.

Two further changes were made to the Project design after the review and commencement of the effects assessment. First, the transmission line right-of-way requirements were reduced by changing the design and sequencing of construction of the two 500 kilovolt (kV) transmission lines so that the two existing 138 kV transmission lines could be removed. Second, the diameter of the diversion tunnels at Stage 2 was increased to create a larger capacity for local flood flows during construction.

2.2 PROJECT COMPONENTS

The Project is planned to generate up to 1,100 megawatts of capacity and an average of 5,100 gigawatt hours of electricity per year for more than 100 years.

The following components of the Project, including alternative means to achieving each component, are summarized in this section:

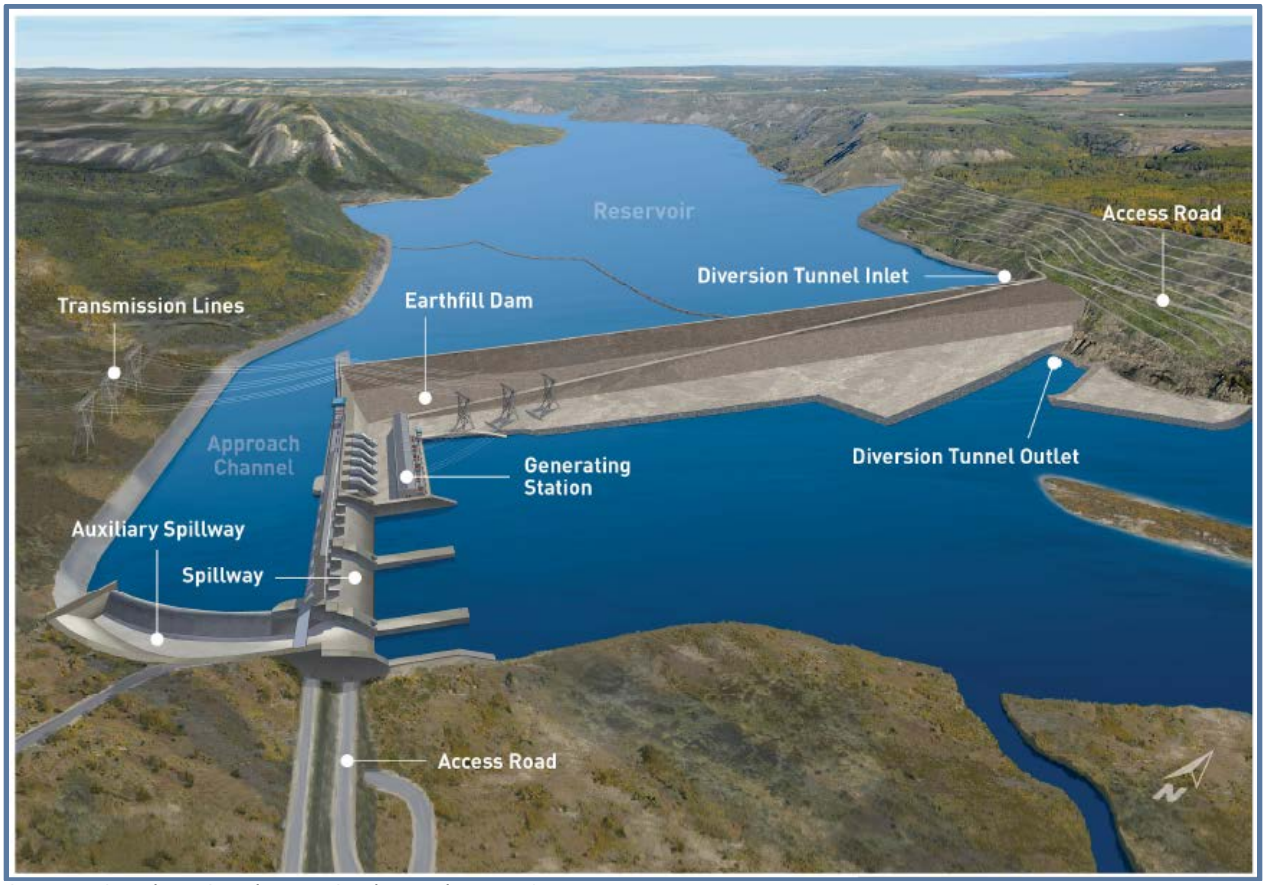
- Dam, generating station, and spillways;
- Reservoir;
- Substation and transmission lines to Peace Canyon Dam;
- Highway 29 realignment;
- Quarried and excavated construction materials;
- Worker accommodation;
- Road and rail access; and
- Construction-related activities.

2.2.1 Dam, Generating Station, and Spillways

The main components of the dam, generating station, and spillways, illustrated in Figure 2, would include:

- A left (north) bank stabilization: a large excavation to remove unstable materials from the bank above the earthfill dam and flatten the slope for long-term stability;
- Two diversion tunnels used for river diversion during construction;

- An earthfill dam across the river valley abutting onto bedrock on the north bank and a buttress of roller compacted concrete (RCC) on the south bank, including the foundation for the generating station and spillways;
- A generating station, consisting of power intakes, penstocks, and six-unit powerhouse;
- A spillway with seven gates and a free overflow auxiliary spillway to discharge inflows that exceed the capacity of the generating station; and
- A lined approach channel to convey water from the reservoir to the power intakes and the spillways.



Source: BC Hydro EIS, Volume 1, Section 4, Figure 4.13

Figure 2. Proposed Dam, Generating Station and Spillways

2.2.1.1 Alternative Means

A comprehensive study, contracted by the Proponent from 2009 to 2011, evaluated the alternate means of developing the hydroelectric potential of the Site C Flood Reserve. This study, the Alternates Study, aimed at reviewing all previously identified alternates, as mentioned above, and any new alternates and comparing them to the Project using a consistent evaluation process.

The following alternates with the goal of reducing the total reservoir area were considered in the study:

- A single dam upstream of the Moberly River to avoid effects on that river, which would not effectively develop all of the available head between Peace Canyon Dam and Axis C3.

1. A dam located at Axis C1, 5.5 km upstream of Axis C3
2. A dam located at Axis C2, 3 km upstream of Axis C3
3. A dam located just downstream of Wilder Creek, 11.5 km upstream of Axis C3

- Cascading dams of two or more lower in height than the proposed Site C dam that would reduce the area of flooded land while maximizing development of all of the head between Peace Canyon Dam and Axis C3.
    1. A two-dam cascade with a dam at Axis C3 and an additional dam located approximately 66 km upstream
    2. A three-dam cascade with a dam at Axis C3 and two other low dams located approximately 22 km and 59 km upstream
    3. A four-dam cascade with a low dam at Axis C3 and three other low dams located approximately 18 km, 39 km, and 61 km upstream
    4. A seven-dam cascade with a dam at Axis C3 and six other dams located approximately 10 km, 23 km, 37 km, 53 km, 65 km, and 79 km upstream

The geological conditions of the area downstream of Axis C3 were found to be less favourable, as the elevation of the bedrock outcrop on the north bank of the river drops and the slopes above the bedrock comprise debris from slides and slumping of the overburden. As a result, moving the dam further downstream, within the eastern boundary of the Site C Flood Reserve, was not considered.

After completing a technical assessment, reviewing the economic feasibility and assessing the environmental effects of the alternative means, the Proponent concluded the following:

- There are no environmental factors that would eliminate an alternative;
- The relative differences in environmental effects and functionality between alternates are small; and
- The small relative differences in benefits between the alternates do not justify the greater costs.

The Proponent determined, based on the Alternates Study, that the Project is the preferred means of cost-effectively maximizing the development of the hydroelectric potential of the Site C Flood Reserve.

2.2.2 Reservoir

The Project would create an 83 km long reservoir that would be on average two to three times the width of the current river. The reservoir would have a number of clearing treatments, including some retention of vegetation.

The reservoir would be a maximum of 55 metres (m) deep at the deepest section at the earthfill dam. The normal operating range between the maximum normal reservoir level and the minimum normal reservoir level would be 1.8 m. The Proponent's scenario analysis predicted that the daily range was expected to be 0.6 m or less 60 percent of the time, and 1.0 m or less 75 percent of the time. In exceptional circumstances such as extreme floods, the proposed reservoir could rise above the maximum normal level for short periods. The reservoir could be drawn down below the minimum normal reservoir level for unusual system requirements or system emergencies. Because the majority of the electricity generation capacity is stored in the existing Williston reservoir, BC Hydro noted that the Site C reservoir would have one of the smallest fluctuations in the BC Hydro system.

Reservoir filling would take place near the end of construction and following the completion of the construction of the cofferdams, diversion tunnels, shoreline protection, and initial bank stabilization efforts and would be required for wet testing and commissioning of the units. The Proponent stated that its preference would be to fill the reservoir in the fall when flows are normally low (after the flood season and before high flows from upstream generation). However, filling may occur at other times of year, depending on the final construction schedule and required Project commitments. During testing and commissioning of the generating units, a portion of the river flow would be diverted through the spillway.

2.2.3 Substation and transmission lines to Peace Canyon Dam

The generating station would be connected to a new substation located to the southeast of the generating station. Two new 500 kV alternating current transmission lines would connect the new substation to the existing Peace Canyon substation, which would be the point of interconnection of the Project to the bulk transmission system, a distance of approximately 77 km. These new lines would be located within and immediately adjacent to an existing right-of-way that is currently occupied by two 138 kV transmission lines, which run from the G.M. Shrum generating station at Bennett Dam to supply electricity to Fort St. John and Taylor.

The Site C substation would include 500 kV to 138 kV step-down transformers to provide service to Fort St. John, Taylor, and the region, and allow for the removal of the existing 138 kV lines. The Proponent stated that this configuration would improve system reliability as the connection to the transmission system would be closer and would reduce transmission system energy losses.

2.2.3.1 Alternative Means

The following alternatives were considered for connecting the Site C substation to the Peace Canyon substation:

- Locating the transmission corridor on the north side of the Peace River; and
- Connecting via submarine transmission cables in the reservoir.

Locating the transmission lines on the north side of the Peace River was rejected as an alternative for the following reasons:

- This would increase the cost of the transmission line.
- This would require the acquisition of rights on 135 parcels of land totaling 1,263 hectares. This would not be required on the south bank where BC Hydro already has a right-of-way.
- There would be fewer environmental effects associated with widening of the existing right-of-way on the south bank of the Peace River.

Connecting the Site C substation to the Peace Canyon substation through submarine cables was rejected as an alternative. It was considered to be uneconomic, with higher risks and lower reliability.

2.2.4 Highway 29 Realignment

Highway 29 connects Hudson’s Hope to Fort St. John and runs along the north side of the Peace River. It is a two-lane rural arterial undivided highway under the jurisdiction of the BC Ministry of Transportation and Infrastructure (MOTI). Creation of the reservoir would require

realignment of approximately 30 km of existing highway at Lynx Creek, Dry Creek, Farrell Creek, Farrell Creek East, Halfway River, and Cache Creek.

2.2.4.1 Alternative Means

The Proponent conducted a multiple account evaluation to determine the potential effects of the alternatives and to identify the preferred alignment for each of these three segments.

Lynx Creek: About 8 km of highway would require realignment, and six alignments were considered. The preferred alignment was selected despite its elevated cost compared to an alternative because it would use part of the existing Millar Road alignment (fewer private property effects); have a lower field footprint and a relatively small forested land footprint (lower potential wildlife effects); not require in-stream work (minimal aquatic or riparian habitat effects); have lower potential for wildlife crossing; and have lower potential agricultural effects. A short bridge would be preferred over a long bridge due to lower capital and maintenance costs.

Halfway River: About 4 km of highway would require realignment, and three alignments were considered. The major concern was the potential effect of a landslide-generated wave on a bridge and its support structures. Therefore, the capital cost estimate included the costs of mitigating the effects from the impact of a landslide-generated wave. The preferred alignment was selected as it would have the lowest overall cost and would have a good balance between environmental and social indicators. The preferred alternative would have the lowest area of in-stream works, no private property impacts, no agricultural land severance, and lower loss of Agricultural Land Reserve (ALR) land. A short bridge would again be preferred due to lower capital and maintenance.

Cache Creek: About 9 km of highway would require realignment, and two alignments were considered. The preferred alignment with a short bridge presented fewer technical challenges, which would result in lower costs and construction risks. The preferred alternative also would impact a smaller area of private land, sever less actively farmed land, and need less ALR land for the right-of-way.

Upland alternative alignments were considered as a result of consultation. However, the preferred lower bench alignments discussed above remained the preferred alignments.

Bridge Removal: The existing Lynx Creek and Cache Creek bridges would be dismantled while the existing bridges at Farrell Creek and Halfway River may remain to avoid the cost of demolition and removal. The impacts of leaving the bridges in place were considered with respect to navigation clearances, currents, and sediment buildup.

2.2.5 Quarried and Excavated Construction Materials

Various quarried and excavated materials would be required for construction of the dam, generating station, spillways, Highway 29 realignments, access roads, and the reservoir shoreline protection at Hudson’s Hope near the upstream end of the reservoir. Materials would be sourced from locations in the Project vicinity. Core materials would come by conveyor from 85th Avenue Industrial Lands. Some quarried materials may be delivered by rail, and the remaining materials would be transported to the construction sites by highway-rated trucks on public roads.

On-site materials refer to materials that would be sourced at the construction site, and come from excavations required for construction of Project components or from a location within the boundaries of the site. The use of on-site materials would be preferred as it allows for lower

costs and fewer environmental effects, especially less ground disturbance, less traffic, and lower emissions. However, if suitable materials were not on-site, off-site materials would be required.

2.2.5.1 Alternative Means

Investigations focused on finding the closest source of materials in order meet the technical requirements to reduce traffic and emissions. On-site materials would be used to the greatest extent possible.

Impervious Core Material: The Proponent conducted geotechnical investigations on the north side of the Peace River in 2009 and 2010 to identify potential sources of impervious core material. The 85th Avenue Industrial Lands were selected as the preferred source of the impervious fill because it was close to the dam site and the material had the following advantages: was most suitable in gradation and plasticity, would require minimal moisture conditioning, could be compacted to a high density, had the highest shear strength, was a more consistent product and in greater thickness, and had the lowest topsoil cover.

Riprap: BC Hydro indicated that the Cretaceous shale does not meet the technical requirements for riprap, but suitable rock can be found in sandstone and limestone outcrops.

Temporary riprap for the dam, generating station, and spillways would be sourced from Wuthrich Quarry, an existing MOTI quarry about 7 km northwest of Fort St. John. Tea Creek, 6 km upstream of the dam site on the north bank, was originally identified as the source for temporary riprap; however, upon preliminary environmental assessment, a resident bat population was found along the outcrop. Other potential effects of using the Tea Creek location were the presence of rare species of plants, haul routes on agricultural lands, and the effect on farm operations and residences within 0.9 km to the east and 2.5 km upstream on Tea Creek.

Permanent riprap for the dam, generating station, spillways, and protection of the river channel slopes would be sourced from the West Pine Quarry on provincial Crown land about 75 km southwest of Chetwynd along Highway 97. Portage Mountain Quarry, an undeveloped quarry 16 km southwest of Hudson's Hope, was considered as an alternative permanent riprap source; however, due to potential negative effects on traffic, it was rejected although it would be $10 million cheaper than using material from the West Pine Quarry. The major concerns associated with Portage Mountain Quarry were the long hills on Highway 29 where trucks hauling riprap would cause considerable delays.

The Castle and Pringle formations on Bullhead Mountain, about 6 km north of Portage Mountain, were considered as riprap sources for Highway 29 and Hudson's Hope shoreline protection. These were rejected due to increased costs, larger footprint, low yield, material specification below requirements, and the need for access and haul roads.

Gravel: The existing Del Rio Pit would be used as a source of gravel for constructing the Project access road. It is adjacent to the western end of the road. Alternative sources of suitable materials are further away, with greater haul distances that would increase traffic and emissions and require development of new pits.

Gravel sources required for Highway 29 realignments and for the Hudson's Hope shoreline protection were identified along the Peace River and tributary river valleys in areas that would be inundated.

Area E, located across the river from Taylor, was identified as a closest off-site gravel source for road construction on the south bank or for construction of the earthfill dam, should it be determined during construction that the dam site area had insufficient suitable material.

2.2.6 Worker accommodation

The Proponent planned to provide worker accommodations during construction. Based on the estimated 10,000 person-years of direct employment during the construction period, the average annual construction phase workforce on-site would be approximately 800 workers, with a peak of 1,700 (with contingency up to 2,100) workers in Year 5 of the construction stage. Approximately 90 percent of the workforce would be required for construction activities at the dam site. About 10 percent of the workforce would be required for off-site construction activities, including Highway 29 realignment, Hudson's Hope shoreline protection construction, road works, clearing, material transport, and transmission line construction.

Temporary camp accommodations and facilities for the construction phase were planned in close proximity to the dam work sites, on both the north and south banks of the Peace River. Temporary accommodations would be removed at the end of the construction phase, and sites would be reclaimed. Options to repurpose some of the temporary camp facilities were also considered. The Proponent also planned to build approximately 40 new permanent housing units in Fort St. John for use by the construction workforce, plus up to 10 new affordable housing units for use by the community in partnership with BC Housing. Following the construction period, all units would become part of the long-term housing stock in the area and be provided to the community for affordable housing.

The Proponent also planned small temporary camps for the reservoir clearing and road construction activities. One camp would be on the south bank in the vicinity of the access road construction near the upper Jackfish Lake Road area, and the other in the vicinity of Hudson's Hope.

2.2.6.1 Alternative Means

Nine alternatives for the two camps (north and south bank) were evaluated. These included: two-camp base design; one south bank camp; one north bank camp; two-camp design with early north bank camp closure; two-camp design optimized for schedule; two equivalent-sized camps, with south bank camp during three peak years; two-camp design with south bank camp during four peak years; two-camp design with 15 percent of workers living off-site; and two-camp design with 15 percent of workers living off-site with reduced infrastructure.

The two-camp design with 15 percent of workers living off-site was selected as the preferred option, based on its ability to accommodate worker preferences, reduce productivity loss, reduce safety hazards, and allow workers to access the community.

An assessment was also completed for the camp water supply and wastewater systems. Connecting the north bank camp for water and sewer to the municipal services of the City of Fort St. John was considered. However, the Proponent concluded that a self-sufficient approach would be the most appropriate means of servicing the camp. Therefore, the north and south bank camps would be outfitted with stand-alone systems. The Proponent concluded that additional analysis would be required to confirm suitable locations for water sources.

2.2.7 Road and Rail Access

Temporary and permanent access roads would be required for the construction and operation of the Project, respectively. Where feasible, existing access roads would be used and upgraded as required. North bank access would occur via existing municipal and provincial public roads, and upgrades would be done as part of the Project. Materials from the 85th Avenue Industrial Lands would come by conveyor to the dam site. The design for new construction and upgrades to public roads would be in accordance with requirements.

An existing CN rail line passes close to the dam site on the south bank. The existing Septimus Siding near the dam site would be upgraded. It is anticipated that most of the bulk materials required for construction, such as cement, fly ash, and fuel, would be transported to the site by rail.

2.2.7.1 Alternative Means

Alternative means for north bank access would involve the construction of new roads that would have a greater effect; therefore, these alternatives were not considered.

These alternatives for south bank access from Jackfish Lake Road to the dam site were considered: following existing 138 kV transmission line right-of-way (two possible alignments), following existing resource development roads and then the transmission corridor (two possible alignments), and following existing resource development roads and a new undeveloped route. The alignment that follows Jackfish Lake Road west to where the road meets the 138 kV transmission line right-of way was selected as the preferred alternative because of an existing corridor.

2.2.8 Construction-related Activities

Project activities included those activities required for construction and operation of the Project. These included site preparation, clearing, transportation of materials, excavation, relocation of materials, placement of concrete, fabrication of penstocks, erection of buildings, the installation of mechanical and electrical equipment, reservoir preparation, road modifications, traffic management, and decommissioning activities.

2.3 PROJECT PHASES

Table 1 describes the four stages of the construction of the dam, generating station, and spillways. They would be constructed under several contracts. Each contractor would be responsible for setting up its own temporary facilities; therefore, there would be overlap for each construction stage. The total construction period would be eight years.

Table 1. Project Schedule

Stage	Description	Preliminary Timelines
Substation and Transmission line construction	The generating station would be connected by three 500 kV transmission lines to a new substation located to the southeast of the generating station. Two new 500kV alternating current transmission lines would connect the new Site C substation to the existing Peace Canyon substation, which is the point of interconnection for the Project to the bulk transmission system, a distance of approximately 77 km. The first of the new 500kV lines would be constructed along the north side of the existing 138 kV lines from Peace Canyon to the Site C substation. After commissioning of the first 500 kV line and the substation, the 138 kV lines to Fort St. John and Taylor would be connected to the Site C substation. The existing 138 kV lines would then be decommissioned and removed. The second of the new 500 kV lines would then be constructed in the portion of the right-of-way previously occupied by the 138 kV lines	2014-2023
Access Road construction	Temporary and permanent access roads would be required for the construction and operation phases of the Project. The construction of the access roads is scheduled from 2014 to 2015, while the Highway 29 realignment construction is scheduled from 2016 to 2020.	2014-2020
Preliminary works	The preliminary works would include site preparation, construction of some temporary access roads, and construction and setup of the temporary facilities required for construction of the permanent works.	2015-2016
River channelization	Cofferdams would be constructed on the north and south banks to confine the river to its main channel. Once the cofferdams have been completed, the water on the inside of the cofferdams would be pumped out to dewater or dry out the area where excavation and construction activities would take place. The cofferdams would isolate the work areas from the river. A temporary construction bridge would be constructed across the Peace River between the cofferdams. The diversion tunnels would be constructed on the north bank behind the cofferdams.	2015-2018
River diversion and dam construction	After completion of the diversion tunnels, the Peace River would be diverted through the tunnels, and the main river channel would be blocked off with cofferdams in order to isolate the area where the earthfill dam would be constructed across the Peace River. The temporary bridge would be removed after access is available across the earthfill dam.	2018-2021
Reservoir filling and commissioning	Reservoir filling would take place near the end of construction and would be required for wet testing and commissioning of the generating units. The preference would be to fill the reservoir in the fall of the year when flows are normally low (after the flood season and before high flows from upstream generation); however, filling may occur at other times of year, depending on the final construction schedule.	2021-2022[1]

Note: the Evidentiary Update states that BC Hydro has revised the expected earliest in-service date to Fiscal 2024.
Source: Modified from amended BC Hydro EIS, Volume 1, Appendix 4F

The Panel concludes that the Proponent's assessment of alternative means of carrying out the Project is appropriate.

3 AQUATIC ENVIRONMENT

This chapter discusses the major physical changes to the aquatic environment as a result of the Project, including alteration of hydraulic conditions and seasonal patterns of water levels, changes to thermal and ice regimes, and changes to water quality in the reservoir and downstream. In addition, the potential effects of the changes to the hydrologic regime on the Peace Athabasca Delta (PAD) are discussed, as a result of the forwarded concerns of participants on the potential effects of the Project on the PAD. Because mercury is of particular concern in new reservoirs, the mobilization of mercury in a reservoir system is discussed here, while the potential effects of mercury on human health are discussed in Section 11.5.

3.1 HYDROLOGY

The construction of the proposed hydroelectric generating station and reservoir would affect the hydrology of the Peace River. This section examines the potential effects of the Project on hydrology.

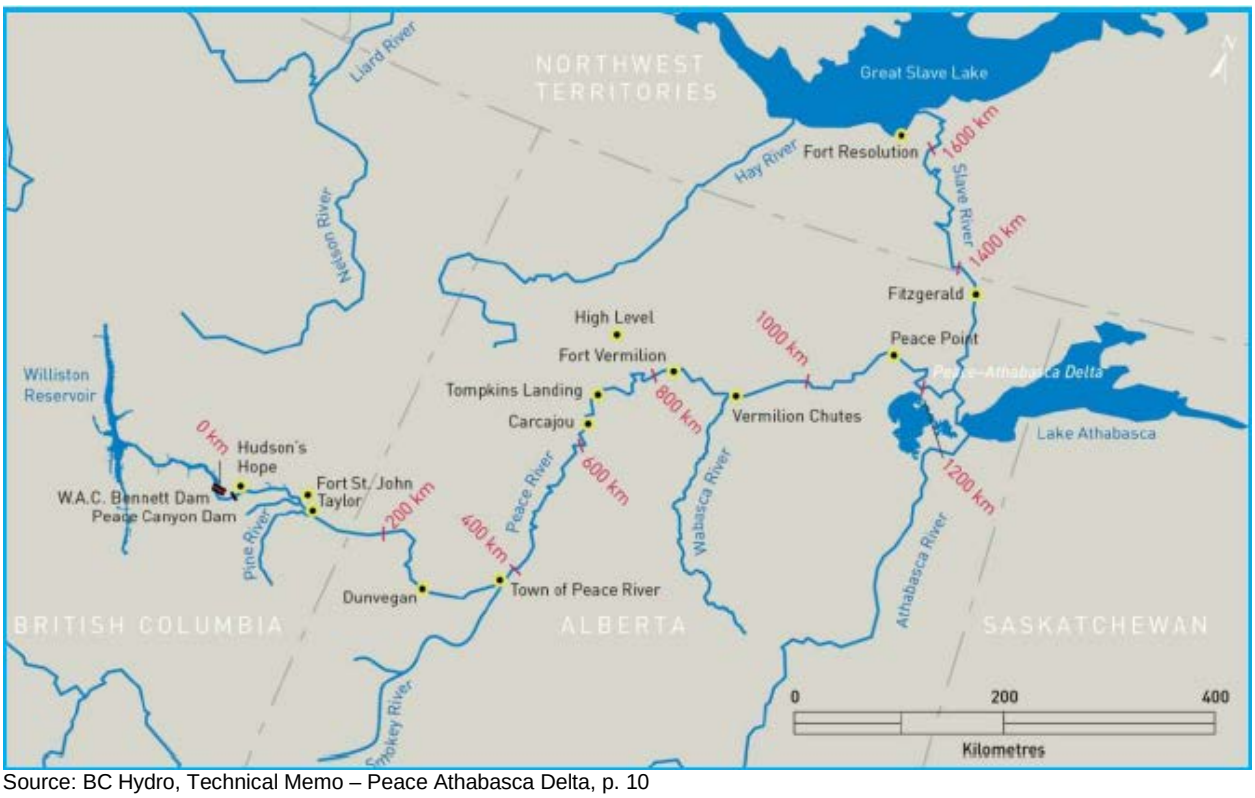
3.1.1 Proponent's Assessment

BC Hydro analysed the aquatic environment in two separate geographical areas, the reservoir study area and the downstream study area. The reservoir study area comprises the 83 kilometres (km) from the Peace Canyon Dam to the Project location. The downstream study area comprises the 1,100 km of the Peace River from the Site C dam site to the community of Peace Point, Alberta, approximately 108 km upstream of the Peace River confluence with the Slave River (Figure 3). The magnitude of the changes related to the Project was predicted to diminish in a downstream direction due to the moderating influence of water and sediment inputs from tributaries. Project-related changes in fluvial geomorphology and sediment transport regime were predicted to be negligible downstream of Peace Point when the downstream study area was established. The Peace Athabasca Delta (PAD) is discussed in this chapter, but it is outside the area studied by BC Hydro.

Surface water regime refers to the quantity, timing, and rate of change of flow and water level. The Proponent described the existing surface water regime of the Peace River (baseline conditions) and potential changes during the construction and operation phases of the Project. Information on the pre-regulation (i.e. prior to the development of the Bennett Dam) surface water regime of the Peace River was also included to provide context for the changes that would be expected with the Project.

The Proponent said that the regulation caused by the Bennett Dam and the formation of the Williston reservoir changed the flow regime of the Peace River: mean winter flows are greater, mean spring/summer flows have lessened, peak daily flows have decreased, and minimum daily flows have increased. Additionally, the daily pattern of flows has been changed by the regulation, moving from gradual changes in river flows and levels pre-regulation to regulated flows that are higher during the day and lower at night to match electricity demand.

With the construction of the Project, the Proponent stated that the upstream river area would become an 83 km long reservoir and average 2 to 3 km wide. The upstream extent of the reservoir would back up to the tailrace of the Peace Canyon Dam.



Source: BC Hydro, Technical Memo – Peace Athabasca Delta, p. 10

Figure 3. Map of the Peace River

At the maximum normal operating level, 461.8 metres (m) elevation, the reservoir would have a surface area of approximately 9,330 hectares (ha) and a volume of approximately 2.1 million cubic metres. The maximum water depth in the reservoir would be approximately 55 m near the dam. The normal operating range of 1.8 m would provide an active storage volume of 165 million cubic metres.

The Proponent modelled reservoir operation and determined that under ideal conditions the Site C reservoir would be operated within the top 0.6 m, between elevations 461.8 and 461.2 m, over 99 percent of the time and the use of the full 1.8 m normal reservoir operating range, between elevations 461.8 and 460.0 m, would be necessary less than 1 per cent of the time. However, when market foresight require the full Project generation flexibility, modelling indicated that the daily reservoir level fluctuations of less than 0.6 m would decrease from over 99 percent of the time to about 60 percent and the daily fluctuation that would exceed 1.0 m would occur about 25 percent of the time. A sensitivity analysis of the model results confirmed that, even if generation is constrained in the future, the Site C reservoir would continue to operate at relatively high levels (within the top 0.6 m, about 83 per cent of time) in order to maximize the value of power production.

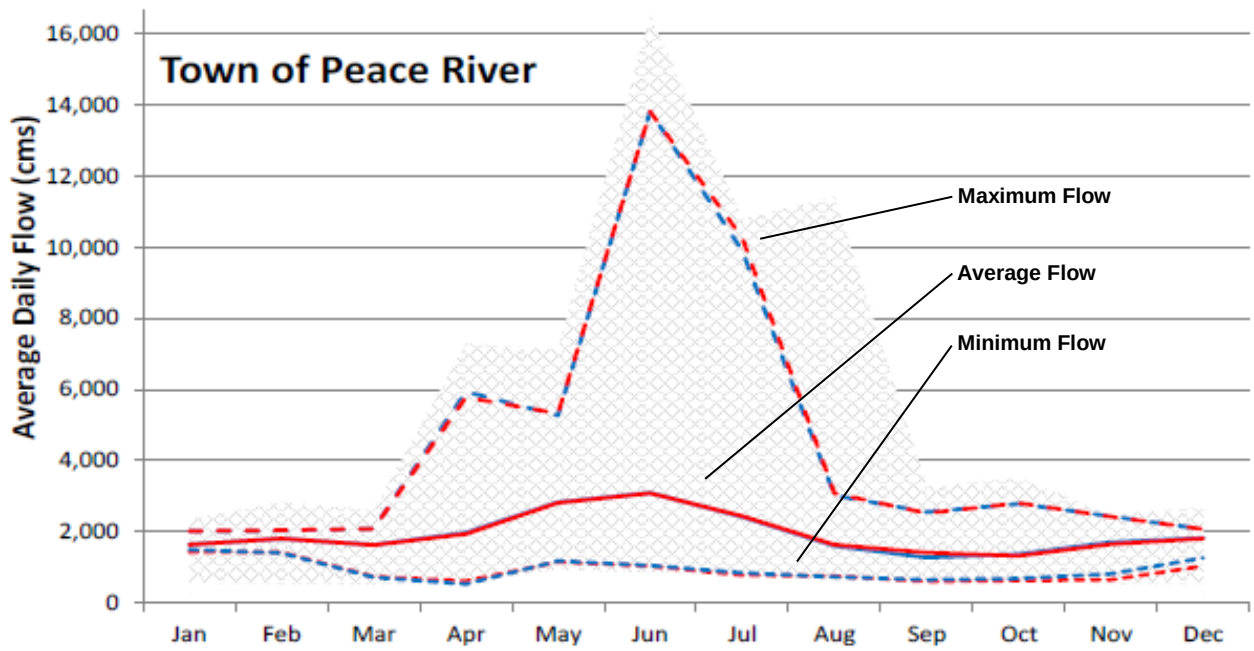
In addition to flooding the Peace River, the Project would also flood the lower reaches of several tributaries, including Halfway River (15.3 km), Lynx Creek (1.3 km), Farrell Creek (3.6 km), Cache Creek (9.0 km), Wilder Creek (3.2 km), Tea Creek (1.2 km), and Moberly River (11.6 km).

The inflows to the Site C reservoir would mostly be determined by the releases from the Bennett Dam, which are attenuated slightly by the operation of the Peace Canyon Dam. Local inflow to the Site C reservoir would be primarily driven by the Halfway and Moberly Rivers. BC Hydro

said the proposed minimum flow releases from the Project would be 390 cubic metres per second (m^3/s). This flow was calculated by adding the required minimum release from the Peace Canyon Dam (283 m^3/s) to the mean annual flow of the drainage basin between the Peace Canyon Dam and the Project. This would include flows from the tributaries downstream of the Peace Canyon Dam, including Halfway River and the Moberly River.

The Proponent said the limited amount of active storage in the proposed reservoir would limit the degree to which the Project could change the downstream flow regime and the Proponent predicted changes of varying magnitude throughout the downstream study reach. Changes in surface water regime would be most pronounced immediately downstream of the Project and upstream of the Pine River, about 16 km downstream from the dam site. Further downstream, for example, at the town of Peace River, the Proponent predicted negligible changes in the surface water regime because those effects would be attenuated by numerous tributaries and inflows downstream of the Project site. As demonstrated in Figure 4, the Proponent believed that the predicted minimum, average, and maximum daily flows at the Town of Peace River would not significantly change with the construction and operation of the Project, and thus determined any changes further downstream would all be negligible.

The Proponent stated that filling would occur in the late summer or fall during a three-month period. The releases from the Site C dam would equal approximately one month of releases between the minimum flow of 390 to 600 m^3/s, one month at 390 m^3/s, and one month 390 to 1,600 m^3/s. BC Hydro committed to consult with downstream interests in planning for reservoir filling.



1. Shaded area illustrates observed range of flows (excluding 1996).
2. Red lines are simulated min/avg/max flows with Site C based on simulated decade of future flows.
3. Blue lines are simulated min/avg/max flows without Site C based on simulated decade of future flows.
Source: Modified from BC Hydro, Technical Memo - Spatial Boundaries, Figure 3, p. 6

Figure 4. Predicted Daily Minimum, Average, and Maximum Flows at the Town of Peace River

3.1.2 Views of Participants

Environment Canada (EC) said that the Proponent's modelling did not consider the effect of ice on flow and water levels. EC also questioned BC Hydro's modelling, because it did not mention simulations to demonstrate potential effects of reservoir filling on flow and water levels at downstream locations. EC, using the Proponent's Reservoir Filling Plan, found that the magnitude and duration of the potential decrease in water flow during reservoir filling would have a noticeable impact on downstream flow and water level conditions. To ensure that a proper assessment was completed on the potential effects of various reservoir filling options on downstream flow and water level conditions and to plan for the least impact scenario, EC recommended that BC Hydro provide estimates of downstream flows during reservoir filling for average, best, and worst scenarios. BC Hydro agreed, in the hearing, to conduct such estimates and continue communication with downstream stakeholders regarding any low flow concerns.

Environment Canada also made suggestions to the Proponent such as:

- Undertake additional work to assess the Project's influence on downstream surface water regime under a scenario of the Project with climate change;
- Undertake additional work in considering the range of projected climate values in modelling, design, and planning activities through the construction and operating stages of the Project; and
- Give additional attention to how possible future changes and Project-relevant climate extremes for the area may affect the Project.

The Province of Alberta noted concern for the minimum flow release and duration, including low flow risk during reservoir filling. It stated that the proposed design minimum flow of 390 m^3/s would cause undue risk to Alberta infrastructure. Alberta said that the proposed design minimum flow does not reflect the seasonal nature of local tributary inflows and that when they are low, and combined with reduced flows from the dam, Alberta infrastructure would suffer. It requested further studies to determine the impacts of the new normal flow on Alberta infrastructure and that a minimum mean daily release rate from the Site C dam be applied. The Province of Alberta further requested a commitment from BC Hydro to always consider natural flows downstream when planning maintenance events.

3.1.3 Panel's Analysis

The Panel understands from BC Hydro that changes in surface water regime would be most pronounced immediately downstream of the Project and upstream of the Pine River, about 16 km downstream from the dam site, and that these effects are attenuated in a downstream direction, such that by the town of Peace River almost 400 km from the dam site, there would be negligible change in the surface water regime.

The Panel recognizes BC Hydro's calculation that minimum flow below the Site C dam would be 390 m^3/s. The Panel believes that this low flow is critical for a proper assessment of the Project.

The Panel concludes that the Project would make small changes to the hydrology of the Peace River, and such changes would be attenuated by the time the flows reach Peace River, Alberta.

The Panel notes the Province of Alberta's concern that because the minimum flow would be released 83 km closer to the Alberta border and would not be increased by the Halfway and Moberly Rivers inflows, there could be risk to infrastructure when other downstream tributary inflows are low.

RECOMMENDATION 1
With respect to minimum flow, the Panel recommends that, if the Project proceeds, a minimum release of 390 cubic metres per second from the Site C dam be a condition of approval.

The Panel concludes that there may be some risk to existing infrastructure in Alberta from low flows and that this risk has not been assessed.

RECOMMENDATION 2
With respect to potential transboundary effects on hydrology, the Panel recommends that, if the Project proceeds, the Proponent must consult with the Province of Alberta and jointly develop an adaptive management plan to manage risks to infrastructure downstream caused by low flows during reservoir filling and operation. The plan should include:

- Assessment of risks to infrastructure;
- Monitoring of flows;
- Identification of problems; and
- Necessary mitigation through flow regulation or adjustment to Alberta infrastructure to minimize impacts.

3.2 THERMAL AND ICE REGIME

The thermal and ice regime refers to changes in water temperature and ice conditions as a result of the Project. A dam can act as a physical barrier to ice transport downstream and cause changes in water temperatures due to the creation of the reservoir.

3.2.1 Proponent's Assessment

For the downstream ice regime study, the technical study area extended from the Peace Canyon Dam and the proposed Project location to Fort Vermillion, Alberta (approximately 726 km downstream) for the scenario without the Project and with the Project. BC Hydro selected this downstream boundary because it is usually where the ice front is first recorded each ice season. Also, previous modelling results indicated that it is well downstream of where ice regime changes would be expected as a result of the Project. Changes to water temperature downstream of the Site C dam were analysed as part of the water quality study, with the

boundaries extending from the forebay of the Williston reservoir to upstream of the confluence with the Alces River (Figure 3; p. 19).

In assessing the thermal regime, the Proponent used baseline conditions that considered the Peace River to be regulated by the Bennett Dam. Those conditions include influences from existing reservoirs and regulated discharges, resulting in a different seasonal pattern of flows and a reservoir of thermal energy. To characterize the baseline thermal regime, hourly temperature time series data was collected at locations downstream of the Project that were then compared with predicted water temperatures with the Project.

The Proponent's modelling results for the reservoir indicated that the thermal regime would behave like that of a lake, forming a two-layer structure. The model predicted 5 to 15 degree temperature stratifications in most summers, from mid-May to mid-October, and temperatures in the spring reduced by 0.4° to 0.9°C from March to June. Typical maximum ice cover in the reservoir, predicted to be 80 to 90 percent of the total area, would occur in late January or February, peaking at 0.5 metres thick in late February or early March.

The Proponent's modelled temperatures for the Peace River downstream of the Project were warmer than existing conditions between July and January, the difference ranging from 0.3°C in July to 1.5°C in October. Where the Pine River enters the Peace River, the temperature effect was predicted to be negligible.

The Proponent determined the behaviour of the ice front on the Peace River would change as a result of the Project; however, it said the current ice regime has a great deal of annual variability in this reach of the river. The modelling predicted that the maximum upstream extent of the ice front would generally move further downstream, compared to existing conditions. The Proponent also said the ice front has not progressed upstream of the BC–Alberta border since 1997. The Proponent also predicted a slight delay in ice front progression, no change in break-up timing, and no change in thickness. These changes to the ice regime from the Project and the Dunvegan project, cumulatively, would be similar in magnitude to a general climate warming, where the ice front would be pushed further downstream up to about 100 km, depending on location and winter severity.

Study results indicated that the downstream extent of the Project's influence on ice regime is approximately 550 km from the dam site, almost to Carcajou, which is more than 500 km upstream of the PAD.

3.2.2 Views of Participants

Dr. Martin Carver, speaking on behalf of the Mikisew Cree First Nation and Athabasca Chipewyan First Nation, challenged the Proponent's assessment of ice jams and freeze-up in general, saying the downstream ice assessment disregarded changes in the surface flow regimes and the flow regime assessment ignored the effects of climate change (including ice effects and the ice-extent modelling under future climates). Additionally, he identified other gaps: the ice assessment only used average climate, which ignored a range of projections; and the reservoir filling assessment did not mention ice jam concerns.

Dr. Carver said the importance or magnitude of the ice jam effect would increase as the climate warms, making an effect that is currently considered negligible to become more significant.

3.2.3 Panel's Analysis

The Panel accepts the Proponent's quantitative modelling of the Project's influence on the downstream ice regime for two future climate scenarios corresponding to the 2050s and the 2080s. The Panel understands the difficulty and uncertainty in estimating regional scale effects from global climate models and is satisfied with the Proponent's approach.

The Panel understands that if the reservoir filling is completed in the fall as proposed, the River will be ice-free during filling and there is no need to model the effects of ice jams on the flow regime for this activity.

With respect to the thermal and ice regime, the Panel understands that 80 to 90 percent of the reservoir is predicted to have ice cover in late January or February, peaking at 0.5 metres thick in late February or early March. Releases of warmer water from the Peace Canyon Dam would keep the upper few kilometres of the Site C Reservoir ice-free.

The Panel agrees with BC Hydro's assessment that there would not be a change in ice thickness, break-up time, or freeze-up water levels with the Project, downstream at Shaftsbury near Peace River Alberta.

The Panel agrees with BC Hydro's study results that indicate the downstream extent of Site C's influence on the ice regime would be approximately 550 kilometres downstream of the dam site at Carcajou.

BC Hydro is committed to working with the Province of Alberta and participating in the joint task force on ice that has been in place for many years.

3.3 FLUVIAL GEOMORPHOLOGY AND SEDIMENT TRANSPORT

Fluvial geomorphology refers to the changes in bedload, river channel shape, and the suspended sediment in the river. Such changes can occur due to bank or bed erosion, sediment deposition, and vegetation encroachment. Sediment transport regime refers to the quantity, temporal pattern, grain-size distribution, and mode of transport of particulate matter by river flows. The sediment transport regime can be altered by the introduction of new sediment sources, by changes in flow patterns, which govern the sediment transport capacity of a river, or by the interruption of downstream sediment transport in sediment sinks such as reservoirs.

3.3.1 Proponent's Assessment

The Proponent said the fluvial geomorphology and sediment transport regimes in the Peace River were naturally dynamic prior to hydroelectric development in 1967. Since then, these regimes have been adjusting to the regulated flow conditions. The Proponent considered potential Project-related changes in fluvial geomorphology and sediment transport regimes because the baseline conditions in the Peace River are both naturally variable and are undergoing a long-term response to regulation. As a result, not all future changes in the Peace River would necessarily be attributable to the Project. The Proponent concluded that Project-induced changes would combine with the changes that result from the current, ongoing response to river regulation without the Project.

To assess Project-related changes to fluvial geomorphology and sediment transport, the Proponent selected two spatial study areas, the reservoir study area and the downstream study area. The reservoir study area comprised the Peace River valley from the Peace Canyon Dam to the Site C dam location, the lower reaches of the reservoir tributary valleys, and up the tributary valleys to the maximum extent of inundation at full supply level. In both of the Halfway and Moberly Rivers, this study area extended an additional 10 km to encompass the potential zones of bedload accumulation that may occur upstream of reservoir confluences.

The downstream study area comprises the Peace River valley from the proposed Site C dam site to the community of Peace Point, Alberta about 1,100 km downstream. Similar to what was described in hydrology, the magnitude of the Project-related changes would diminish as one measures further downstream. Project-related changes in fluvial geomorphology and sediment transport regime were predicted to be negligible downstream of Peace Point when the downstream study area was established.

Overall, the Proponent's studies indicated that the Project would not lead to changes in flows that would influence the geomorphology of the Peace River.

The Proponent said that, during the construction phase of the Project, approximately eight years, the fine sediment inputs from in-stream construction activities would increase an estimated 0.2 to 0.3 percent above mean annual baseline sediment load immediately downstream of the site. Over the four-year diversion stage of construction, the fine sediment inputs related to headpond shoreline erosion would represent an increase of approximately one percent above mean annual baseline sediment load immediately downstream. In-stream construction activities, which could range from hours to months, would elevate levels of suspended sediment concentrations. These increases could be 10 to 1,000 milligrams per litre (mg/L) close to the source, decreasing to lower levels once fully mixed in the river flow downstream of the Pine River confluence. The headpond shoreline erosion events were anticipated to generate incremental increases in suspended sediment concentration of 1 to 20 mg/L in the fully mixed river flow immediately downstream of the tunnel outlets. The Proponent expected these events to occur on approximately 12 percent of the days during the diversion stage, with a greater frequency in the fall and winter.

The operation of the reservoir would likely trap sediment from the tributaries, and the wind-driven waves would erode the valley slopes, creating new sources of sediment in the reservoir. The Proponent said that after 50 years of reservoir operation, the depth of sediment deposition would range from 0.3 to 0.5 m, while depths of several metres are likely near more erodible shoreline sections and the Halfway River embayment.

The mean annual suspended sediment in the Peace River, immediately downstream of the proposed dam site, would reduce by approximately 54 percent over the first 10 years, and drop further over time as shoreline erosion rates declined. Moving downstream, the reduction in suspended sediment load would decrease to approximately 2 percent at the Town of Peace River, which would occur primarily during baseline peak events, spring snowmelt and summer rainstorms.

In terms of channel erosion and deposition patterns, the Project would intercept bedload and locally alter hydraulic conditions in the Peace River. If sustained high flows were to occur, the bed of the Peace River would scour by 1 to 1.5 metres over a 2 km length downstream of the dam. The eroded material would accumulate in a deposition zone over the next 2 km. Continuing downstream, channel erosion and deposition patterns would depend on river flows and tributary bedload inputs.

Overall, the Proponent said the volume of sediment load coming from the Project area would be very small compared to the sediment contributions from downstream tributaries, such as the Pine River, Beatton River, and the Smoky River. The Proponent concluded that the changes in river flows from the Project would not influence the erosion and deposition patterns, and therefore, no changes to the dynamic baseline patterns were predicted.

3.3.2 Views of Participants

Walter Andreeff, presenting for the Peace River Environmental Society (PRES), spoke about sediment changes resulting from the development of Site C, and the possible effects on the Halfway River because of its location upstream of the dam. He said that when metal concentrations build up they are removed from the area by the freshet by attaching themselves to larger sediment particles and get carried downstream. Its concern, therefore, is that the metal would no longer be able to get downriver because of reduced movement of sediment, and the water could possibly reach toxic levels in the Peace River for fish, fish habitat, and other animals along the river. Finally, PRES said that the additional regulation of the Peace River would decrease flows and lead to further aggradation in the area surrounding the town of Peace River. In response to this concern, Craig Nistor, on behalf of BC Hydro, confirmed that the decreases in flow speed from regulation would have no effect on the transport of gravel in the gravel bed section because it is immobile, and there would be no effect on suspended sediment transport because that material isn't flow dependent.

Mike Rudakewich, a resident of Fairview, Alberta, spoke about sedimentation and its effect on fishing success, saying that natural conditions lead to the natural development of frost in early winter that protects the river from erosion and sedimentation. However, should the Peace River flows increase in winter along with higher temperatures than needed for frost formation, he was concerned that elevated levels of sedimentation may result in fewer fish and a decrease in fishing success. He had been unable to catch fish when the rivers were full of sediment, regardless of the source, something he attributed to the fish seeking refuge in order to feed where fresh water was coming into the river system untainted with sediment.

Because of potential effects on navigation from sediment loading and sediment flows down the river, representatives from Transport Canada (TC) raised concerns over leaving the Halfway River and Farrell Creek bridges in place. The Panel wondered if it would be possible to dredge the river should navigation become an issue in the future. BC Hydro stated that, although not done in the past, it would consider this option if necessary.TC stated that if it is proven the sediment build-up was a direct result of the Proponent's work, then it is possible that dredging of the river bottom would require a permit.

Conroy Sewepagaham, a member of Duncan's First Nation, said members of the Duncan's First Nation community have been reporting that the Peace River has been changing and that the sediment regime, in terms of ice tilling, has been almost non-existent. As a result, Mr. Sewepagaham said the prime fishing habitats are no longer present because sediment has filled in these areas.

Elder Earl Evans of the Northwest Territories Métis Nation spoke about the changes that were caused by the Bennett Dam, specifically the creation of sandbars in the Athabasca River and their impact on hunting and traveling on the river. Mr. Evans believes they were caused by the reduced flow that is unable to move the silt and sediment downstream.

Joe Marcel of the Athabasca Chipewyan First Nation said that sandbars have been getting bigger and more frequent in the Athabasca River, which has been taking people's lives because they don't know how to navigate through the changing channels.

3.3.3 Panel's Analysis

The Panel agrees with the Proponent's determination that the volume of sediment load from the Project area would be very small compared to the sediment contributions from downstream tributaries, such as the Pine River, Beatton River, and the Smoky River. The Panel disagrees with the Proponent's conclusion that the changes in river flows from the Project are not expected to influence the erosion and deposition patterns; however, the Panel feels that these changes are not significant.

The Panel concludes that the Project would result in negligible changes to fluvial geomorphology and sediment transport.

3.4 GROUNDWATER REGIME

Altering the hydrology of a river and creating a reservoir can affect the groundwater in the bedrock and soils proximal to the river. This section examines predicted changes to groundwater resulting from the Project.

3.4.1 Proponent's Assessment

The Proponent said the creation of the reservoir would cause the groundwater table to rise in areas inland from the reservoir shoreline. These changes to the groundwater table are dependent on the geology, groundwater levels, and the amount of rise in the surface water from the creation of the reservoir. Groundwater regime, terrain stability, and preliminary impact line studies were conducted on baseline conditions and potential changes to groundwater elevations as a result of reservoir creation.

The Proponent's assessment of baseline conditions found that the groundwater regime within the slopes of the proposed reservoir consisted of water tables perched on silt and clay or bedrock units, with sand interbeds providing drainage to the slope face, resulting in groundwater exiting as springs. BC Hydro's baseline monitoring indicated drinking water and groundwater parameters, including pH, total dissolved solids, barium, iron, manganese, and sodium, in excess of the Guidelines for Canadian Drinking Water Quality. No anthropogenic sources for the exceedances were apparent, and therefore the Proponent considered these exceedances to be natural background conditions.

The Proponent said the largest changes to the groundwater regime would occur close to the Project, where the reservoir water level would increase by up to 50 metres compared to the current Peace River water level.

The Proponent's study on groundwater regime concluded that bedrock and overburden sediments near the reservoir edge would limit changes in groundwater levels due to reservoir formation. Around most of the proposed reservoir, this results in a low potential for it to influence groundwater flow in the overburden sediments above the maximum normal operating level of 461.8 m. The Proponent predicted increases of 1.6 m to 14 m in the deeper groundwater elevations at the reservoir shoreline. The largest predicted changes would occur in the

Hudson's Hope to Farrell Creek stretch of the Peace River, and between Halfway River and Cache Creek. For the majority of sections analyzed, the predicted increase in groundwater level 1,600 m from the proposed shoreline was generally less than 3 m.

The Proponent's assessment found that 5 out of the 40 identified potentially contaminated sites may experience water table rise sufficient to potentially affect groundwater quality from higher groundwater levels mobilizing contaminants.

BC Hydro predicted a low likelihood that groundwater chemistry would undergo change affecting groundwater use as a result of coming into contact with new geologic materials. However, some localized influence on groundwater chemistry was noted to occur in areas where the water table rises into thin interbedded units that differ in physical characteristics and chemical composition.

BC Hydro found that 6 out of 55 known water wells would likely undergo direct inundation during reservoir infilling. A rise in the height of the water table ranging from less than 1 m to 10 m was predicted for the remaining known wells, which would increase well yield.

Approximately 90 percent of the lands within the Proponent's technical study area containing infrastructure or designated within the Agricultural Land Reserve are located topographically above the proposed reservoir levels. Inundation or influence related to water table rise would only be anticipated below the maximum proposed reservoir levels and in directly adjacent areas where groundwater elevation may affect crop growth.

The Proponent's assessment concluded that there would be a low likelihood that groundwater chemistry would undergo a change and affect groundwater use.

3.4.2 Views of Participants

Environment Canada (EC), in their written submission, said the potential changes on the groundwater regime could take several decades to establish a new equilibrium, and the changes were not modelled and not known. EC said that this information is important for the development of the Groundwater Protection Plan to assist in determining areas where the Project would have the greatest impacts on groundwater levels and directions, and on contaminant transport.

Natural Resources Canada, at the hearing, recommended the development of a Water Quality Monitoring Plan in consultation with provincial regulators for construction and operation phases and including detection and tracking of possible groundwater plumes.

George Desjarlais, of West Moberly First Nations, raised concern over the rise of the groundwater table and the potential contamination caused by hydraulic fracturing from the local gas industry. He said that when the water table rises as a result of the Project, the contaminants from hydraulic fracturing would seep out and additionally contaminate the river.

The City of Fort St. John said the Proponent did not fully address the issues of surface water-groundwater interaction, surface water quality, and water supply failure. The City obtains its water from a well field constructed in a thin sand and gravel aquifer situated above bedrock, adjacent to the Peace River. The City believed that the well field was drawing water from the Peace River. The City noted that because its wells are a mix of surface water and groundwater, the interactions between the two and the effects as a result of the Project on these interactions should be assessed prior to dam construction. This would allow for subsequent monitoring to allow the City to protect its water supply.

3.4.3 Panel's Analysis

The Panel understands that the largest predicted changes to the groundwater regime would occur closest to the Project where the reservoir water level would increase by up to 50 metres from the current Peace River water level. The Panel is satisfied with the Proponent's determination that the composition of the sediments and bedrock near the reservoir edge would limit changes in groundwater levels due to reservoir formation. At a distance of 1,600 m from the reservoir shoreline changes in groundwater levels would generally be less than 3 metres.

Therefore, the Panel concludes that there would be a low potential for the reservoir to influence groundwater flow in the overburden sediments above the operating reservoir elevation of 461.8 metres. As a result, the Panel determines that participants' concerns are unlikely to be realised.

The Panel concludes the Project would result in localized adverse effects on groundwater that would not be significant.

3.5 WATER QUALITY

The Panel assessed the change to the water quality in the Peace River and associated tributaries as a result of the proposed Project.

3.5.1 Proponent's Assessment

The Proponent conducted assessments of the existing water quality and sediment quality conditions in the Peace River and its tributaries, then compared results to provincial and federal guidelines. The water quality parameters used included nutrient and metal concentrations, suspended sediment levels, dissolved gas pressures, pH, alkalinity, and temperature. The sediment quality parameters used included metal and polycyclic aromatic hydrocarbon concentrations.

The technical study area for water quality extended from the forebay of the Williston reservoir, through the Dinosaur reservoir and the Peace River valley to upstream of the confluence with the Alces River. It also included the major tributaries that drain into the Peace River (Maurice Creek, Lynx Creek, Farrell Creek, Halfway River, Cache Creek, Moberly River, Pine River, and Beatton River).

To document baseline water quality conditions, the Proponent completed a review of data collected through field programs in support of the Project and available monitoring data collected by government agencies.

The total dissolved gas pressure (TGP) was predicted to exceed the guideline to protect aquatic life, of ≤110 percent, during spillway discharge at Bennett Dam and Peace Canyon Dam, but during moderate discharge period, the levels were predicted to not exceed 110 percent. The TGP measured in the Dinosaur reservoir and Peace River in 2008 often reached 103 percent, but very rarely surpassed that. Immediately below the Peace Canyon Dam, the TGP ranged from 103 to 111 percent. TGP is relevant to fish health because it can cause gas bubble disease from supersaturation of gases in solution.

The Proponent evaluated existing conditions in the Project area and found that the waters in the existing reservoirs, the Peace River, and its tributaries across all seasons and stations were well

above the dissolved oxygen guidelines for aquatic life and are considered to be well oxygenated. Total suspended solids (TSS) ranged from 1.5 to 2,760 mg/L, and were lower in the reservoirs than in the tributaries and the Peace River, because water in reservoirs moves more slowly, allowing TSS to settle. In assessing alkalinity, the Proponent found that the total concentrations were higher in the tributaries than in the reservoirs and Peace River; however, there are no Canadian guidelines that establish thresholds for comparison. Values for pH ranged from 5.8 to 8.8 (acidic to basic).

Nitrogen and phosphorus found in the waters did not exhibit any significant exceedances of the Canadian Council of Ministers of the Environment (CCME) guidelines. However, metals in the surface waters exceeded the CCME Canadian Sediment Quality Guidelines for the Protection of Aquatic Life. These included aluminum, arsenic, barium, cadmium, chromium, cobalt, copper, iron, mercury, nickel, selenium, silver, thallium, vanadium, and zinc. These exceedances were not considered significant because it is recognized that aquatic ecosystems may naturally have concentrations of water quality constituents above guidelines, due to local factors such as geology, soils, climate, and weather. The Proponent said these exceedances do not necessarily imply that the aquatic system is unhealthy because the organisms are able to adapt to their environment.

The Proponent started a geochemical characterization program in 2008 to evaluate the acid rock drainage and metal leaching potential of the materials that would be excavated, exposed, or disturbed by Project construction activities. The Proponent clarified that their characterization program predicted that the creation of the reservoir would not cause issues with acid rock drainage and metal leaching from the coal and any associated mineralization. The rationale stated that the flooding of the coal seams would deprive them of oxygen in the subaqueous environment and not allow contamination of the aquatic environment.

3.5.2 Views of Participants

Acid rock drainage/metal leaching (ARD/ML) concerns were brought to the attention of the Panel by both Environment Canada (EC) and Natural Resources Canada (NRCan).

In its review of the Proponent's assessment, NRCan found sufficient data to indicate that the majority of dam site rocks are potentially acid-generating, with relatively short lag times for onset of ARD, and that selenium leaching may be a concern with other non-acid-generating geologic materials in the Project area. NRCan said it is likely that groundwater plumes with undesirable contaminants could be generated in some of the relocated surplus excavated material areas and that those contaminants could eventually migrate into downstream water bodies. Furthermore, NRCan said ARD/ML prevention and mitigation could pose a serious challenge to the Project, due to the volume of rock and the short lag time to onset of acid generation. As a result, NRCan recommended a thorough water quality modelling study prior to construction to quantify effects from ARD/ML, as well as the development of a water quality monitoring plan for the construction and operation phases, including the detection and tracking of possible groundwater plumes.

EC said that although the majority of rock units to be used as overburden have undergone static and kinetic geochemical testing and subsequent analysis of results, EC requested testing in units where it has not been done and additional testing in all units to better understand the geochemical variability. EC also recommended conducting water quality modelling during sensitive periods to quantify effects from ARD/ML. It believed additional effort would be required to develop appropriate mitigation measures. EC recommended that, to gain greater confidence

in the data, the Panel require the Proponent to complete geochemical characterization of rock and overburden prior to Project construction.

EC suggested that the Panel encourage the Proponent to conduct water quality modelling and develop a monitoring program for metal parameters and other parameters of potential concern. EC recommended that the water quality monitoring program include attention to nutrients, total suspended solids, and dissolved oxygen. It requested that modelling and monitoring represent all Project phases from present condition through construction and operation. If monitoring results indicate adverse impacts on water quality, appropriate mitigation measures should then be implemented.

In response to these requests from the Federal departments, BC Hydro in their closing statement, agreed with the recommendations to undertake water quality modelling for ARD/ML. The results of this modelling would help inform their management plan, and BC Hydro would work with the provincial regulatory agencies to finalize that plan and future monitoring requirements.

3.5.3 Panel's Analysis

In reaching its conclusions on water quality, the Panel considered the following factors to be relevant:

- Because the pH of the water varies from acidic to basic, there is a concern with acid rock drainage and metal leaching.
- Concentrations of several metals are already above guideline levels.
- Environment Canada and Natural Resources Canada requested that the Proponent conduct a water quality monitoring program for acid rock drainage and metal leaching, and the Proponent has agreed to undertake this water quality monitoring.

The Panel concludes that there would be a risk of acid generation and metal leaching from construction activities and reservoir creation. However, if the Panel's recommendation is implemented, the effects would not be significant.

RECOMMENDATION 3
To address the potential risk of acid rock drainage and metal leaching from the Project activities, the Panel recommends that, if the Project proceeds, BC Hydro must consult with Environment Canada, Natural Resources Canada and Ministries of Environment and Forests, Lands and Natural Resource Operations to design a program to monitor water quality and procedures to mitigate related issues that may arise and to implement the program if necessary.

3.6 MOBILIZATION AND FATE OF MERCURY

Under natural conditions, mercury is present in low concentrations in all environmental media including water, soil, sediment, and plants, and in all terrestrial and aquatic animals. Mercury may be transported in a river by adhering to sediment particles and organic materials, as well as directly in the tissue of plankton and fish. Key parameters in the aquatic environment that

influence generation and bioaccumulation of methylmercury are hydrology, limnology, and specific water and sediment chemistry parameters.

3.6.1 Proponent's Assessment

The Proponent detailed the process of mercury methylation at the hearing. Mercury in the atmosphere, primarily inorganic mercury from combustion sources such as coal-fired power plants, forest fires, and volcanoes, transfers to vegetation and accumulates over time, being sequestered and concentrated into soils. When soils are flooded, degradation of organic material creates conditions for sulphate-reducing bacteria that transform or "methylate" the inorganic mercury into organic mercury, primarily methylmercury. The rate of bacterial activity and mercury methylation is governed by many chemical factors, such as the amount and quality of organic carbon, pH, and sulphate, and does not necessarily reflect the amount of inorganic mercury available.

The Project would flood soil and vegetation and create conditions favourable for accelerating methylation rates. The rate and magnitude of methylmercury production is affected by the factors listed above, and the response to inundation differs among reservoirs. Reservoir-specific differences in these factors are responsible for the substantial variability observed in reservoirs regarding the number of years for fish to reach peak mercury concentrations, the magnitude of those peaks, and the return time to pre-flooding conditions. The Proponent said data from Canadian reservoirs show a general pattern of changes in fish mercury concentration over time. These data have shown that mercury in adults of large predatory species increases rapidly, with peak concentrations 3 to 8 years after impoundment, and that levels decline to pre-impoundment (or baseline) concentrations within 15 to 25 years.

The Proponent said methylmercury is much more easily absorbed and accumulated by animals than inorganic mercury and once methylmercury is incorporated into bacterial tissue, it becomes part of the food chain. Methylmercury accumulates at a greater rate than it degrades, accumulating over time within an organism (bioaccumulation) and becoming more concentrated through successive trophic levels (biomagnification). As a result, methylmercury concentrations are higher in large-bodied, longer-living animals, especially those at the top of the food chain, such as predatory fish or fish-eating birds or humans.

Because of biomagnification, the Proponent claimed that fish-eating species, such as lake trout, and bull trout, would have the highest peak mercury concentrations, take the longest to reach maximum levels, and take longer to return to a baseline level, although there is variability in each of these endpoints. These differences relate to many reservoir-specific conditions, especially water residence time, ratio of reservoir area to original wetted area, organic carbon in soils, water pH, amount of flooded wetland, and food web complexity.

3.6.1.1 Baseline Data

In the Peace River technical study area, total mercury concentration in the water seldom exceeded 1 part per trillion. The low total mercury concentration reflects low levels of mercury found in the water discharged from the Williston reservoir. Similarly low concentrations were measured from the Williston reservoir in the early 2000s; therefore BC Hydro believes that conditions have not changed over the last 15 years.

The Proponent found that methylmercury concentrations in the Peace River and tributary stream water were consistently below the laboratory detection limit in nearly all samples. The exceptions occurred in samples from the Moberly River and Halfway River during a high flow

and high sediment load event. Total mercury concentrations in sediment along the Peace River were either below the laboratory detection limits or in low concentrations when detectable.

The zooplankton total mercury concentrations assessed for the baseline of the Project were found to be within the low range for plankton when compared with remote lakes unaffected by anthropogenic or natural sources of mercury and similar to or slightly lower than concentrations observed in reservoirs studied elsewhere in Canada. Methylmercury from various taxonomic groups of benthos was determined to be low, with concentrations ranging from 20 to 37 percent of the total mercury. These concentrations are similar or lower than studies elsewhere in Canadian rivers and lower than other reservoirs.

The Proponent's baseline fish tissue mercury analysis focused on the dominant species in the Project area, including bull trout, lake trout, Arctic grayling, burbot, lake whitefish, mountain whitefish, rainbow trout, longnose sucker, and redside shiner. Mercury concentration data were collected from fish species found downstream of Site C, as far downstream as Many Islands, Alberta. Mean mercury concentrations of all fish species in the Peace River between the Peace Canyon Dam and the Site C dam were less than 0.10 part per million, with concentrations in nearly all fish less than 0.20 part per million. The Proponent concluded that these are low concentrations, especially for the large piscivorous species like bull trout and lake trout. These concentrations were found to be lower than for the same species of a similar size in all other B.C. lakes and reservoirs, for which there are mercury data, and among the lowest in Canada.

3.6.1.2 Effects of the Project

The Proponent explored the relationship between the inundation of soils during reservoir creation and enhanced methylmercury generation, and discussed the general trends that have been observed in other Canadian reservoirs. BC Hydro assessed the physical, chemical, and ecological parameters and how they affect the rates of mercury methylation, demethylation, bioaccumulation, and biomagnification within aquatic food webs of rivers, lakes, and reservoirs. The technical study area for methylmercury included the proposed reservoir and the Peace River as far downstream as Many Islands, Alberta.

The baseline water quality conditions were not predicted to change markedly with the Project, because the Williston reservoir would continue to influence mercury methylation rates in the downstream reservoirs. The Proponent believes that that this would be because of the relatively short 23-day residence time of water in the Site C reservoir.

The Proponent used three independent lines of study to determine how mercury in fish would change due to the proposed reservoir. These were then integrated to determine the change in fish methylmercury concentrations within the Site C reservoir and downstream, expressed as a multiplier of existing baseline concentrations. The harmonized peak increase factor for all species would be approximately three times above baseline levels of mercury, with the possibility that it could reach four times, varying according to fish species and size. BC Hydro predicted that this increase in mercury concentration of would be considered very low relative to other fish populations in B.C. and elsewhere in Canada.

The Proponent was uncertain as to the extent fish mercury levels would change downstream of the Site C reservoir because the two pathways for mercury generally result in different patterns of change in fish tissue concentrations in the downstream environment. Water-borne mercury may lead to low magnitude changes across a broad spatial extent, while biota-based mercury exports may lead to higher magnitude changes in a more localized area.

The Proponent believes that fish with elevated methylmercury concentrations from the Project may extend as far downstream as Many Islands, Alberta; however, only a small percentage of fish, from a fish population perspective, may be affected this far because the mass of mercury in fish entrained out of the reservoir would likely not be enough to result in a widespread increase in mercury in most fish. In addition, only a small proportion of fish that are piscivorous in this region and would find prey that have increased mercury levels.

The Proponent predicted mercury levels for reservoir fish would peak between 3 and 8 years post-inundation and would return to baseline levels between 15 and 25 years after inundation. However, it believes that the return to baseline levels would occur approximately 20 years post-inundation because of the Williston reservoir is a large, oligotrophic, low-mercury reservoir that would continue to dominate water chemistry once the Project is constructed. The Proponent predicted downstream fish would return to baseline more quickly, approximately 4 to 6 years after impoundment.

3.6.2 Views of Participants

Councillor Clarence Willson, of West Moberly First Nations, raised concerns that the Project would introduce mercury-laden fish into the Moberly watershed., noting that members harvest fish from the Moberly River and Moberly Lake that come upriver from the Peace River. He feared that these fish would be contaminated should the Project proceed.

Councillor Willson provided the Panel with a study conducted by West Moberly First Nations on the mercury levels of bull trout that migrate from the Williston reservoir to the Crooked River. It found elevated levels of mercury in the bull trout fish tissue that would be considered above the significance threshold for use by the community. West Moberly First Nations noted that other runs of bull trout that members traditionally harvest in the territory, such as those in the Parsnip River, contain elevated mercury levels as well. Both Councillor Willson and Chief Roland Willson noted that the study found high mercury levels in the smaller fish, not just the larger fish assumed by the Proponent.

Nick Bacchante, on behalf of the Ministry of Forests, Lands and Natural Resource Operations, agreed with Councillor Willson and said mercury in fish is a valid concern. He said monitoring is the only way to properly assess mercury levels in fish and the potential impact of the bioaccumulation in the Moberly River and Moberly Lake.

BC Hydro responded to the study and said the sampling methods by West Moberly First Nations did not record fish size data. Therefore, BC Hydro noted that the results were not a representative sample because it only reflected the mean population that members caught to consume. BC Hydro did note, however, that the mouths of the Moberly and Halfway Rivers would be inundated and those environments would become methylating. Should fish reside and feed in those areas, those fish would then have the same methylmercury concentrations as fish in the reservoir and would carry the mercury as far upstream as they move.

3.6.3 Panel’s Analysis

The Panel understands that the baseline total mercury concentrations in the water of the Peace River study area are low and seldom exceed 1 part per trillion. Furthermore, it appears that baseline water quality conditions are not expected to markedly change with the Project. The Proponent demonstrated mean mercury concentrations less than 0.20 parts per million in all fish species in the Peace River between the Peace Canyon Dam and the Site C dam. The Panel

believes that these would be considered low concentrations, especially for the large piscivorous species like bull trout and lake trout.

No one disagreed that creating the proposed reservoir would cause an increase in mercury levels. Participants and the Proponent agreed, and this has been demonstrated in reservoirs across Canada. It is also well documented that mercury levels rise shortly after reservoir creation and return to baseline levels between 15 and 25 years post-inundation. The Panel understands that the Proponent has predicted a return to baseline levels at approximately 20 years for the Project. The Panel notes that the Proponent has committed to monitor mercury levels until levels have returned to baseline.

The Panel believes it is important to note that mercury, in and of itself, does not result in any obvious or significant health effects on fish or impacts to aquatic systems in general.

The Panel is aware of the bioaccumulation potential from the proposed Project, yet these potential changes are immitigable. As mercury does not have a health effect on fish or an effect on aquatic ecosystems, the Panel believes that the biological effects of increased mercury are not significant. The Panel does recognize that mercury could have implications for human health, which is discussed in Section 11.5.

3.7 PEACE ATHABASCA DELTA

The Peace-Athabasca Delta (PAD), one of the world's largest freshwater deltas, is situated in Wood Buffalo National Park and has been declared a Ramsar wetland and a UNESCO World Heritage Site. This dynamic wetland landscape contains some of the largest undisturbed grass and sedge meadows in North America. The PAD began to form more than 10,000 years ago during the retreat of the continental ice fields at the end of the Pleistocene period and has evolved to its present form over several thousand years due to the interactions of the Athabasca River, the Birch River, the Peace River, and Lake Athabasca.

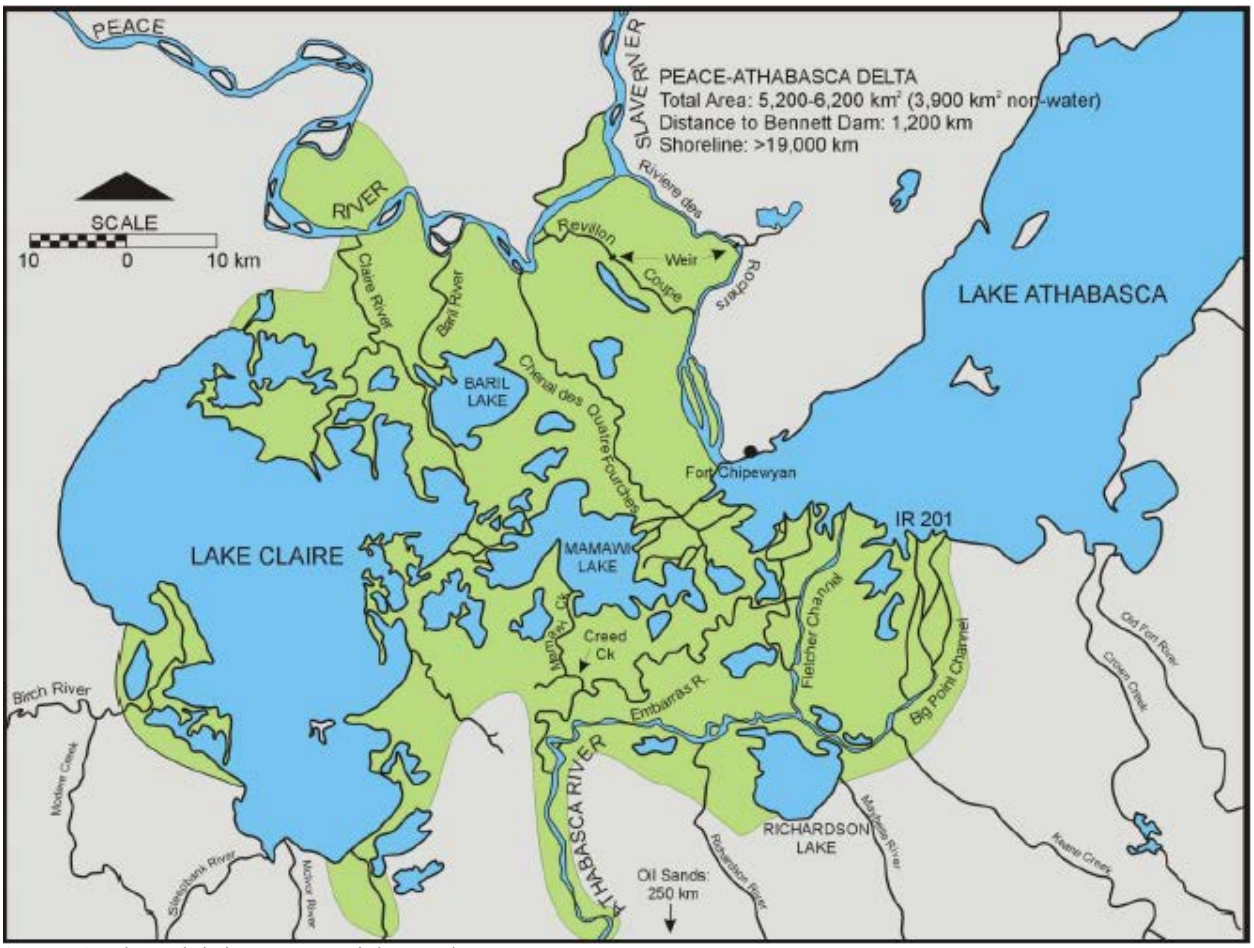
The Delta’s four major lakes are all very shallow (less than 3 m) and have thick growths of submergent and emergent vegetation. Large open grasslands are interspersed with numerous river channels and ponds that have created thousands of kilometers of shoreline habitat that is ideal for nesting waterfowl. Over 400,000 waterfowl have been recorded during spring migration, and estimates have exceeded one million during fall migration. The area also contains critical spawning and nursery habitat for fish from Lake Claire and Lake Athabasca. Over 20 species are known to occur in the lakes, including lake trout, lake whitefish, Arctic grayling, northern pike, and other threatened fish.

The PAD was not within the spatial boundaries of the environmental assessment because the Proponent calculated that there would be no detectable Project effects at the PAD. However, having received numerous comments stating that the PAD should be included in the scope of the environmental assessment, the Panel has included the PAD in this review.

3.7.1 Proponent’s Assessment

The PAD is located in northeastern Alberta about 1,100 km downstream of the proposed Project (Figure 5) and is fed mostly by the Athabasca River. The Peace River flows past the PAD on the north side and was noted to influence water levels on portions of the PAD through one of four mechanisms:

- During sustained high water levels on the Peace River, the flows cause hydraulic damming of outflows from Lake Athabasca leading to higher water levels on Lake Athabasca;
- When the Peace River flow is high and the levels of Lake Athabasca are relatively lower, the Peace River can cause a flow reversal on Rivière des Rochers and the Quatre Fourches connecting the Peace River to Lake Athabasca;
- When the Peace River flow is high, the Peace River can cause the Baril and Claire Rivers to reverse flow, which may allow Peace River water to enter Baril Lake and Lake Claire,; and
- The Peace River can contribute water to the northern portions of the PAD through overbank flooding when ice jams of sufficient size and duration form on the Peace River during spring break-up.



Source: BC Hydro, Technical Memo Peace Athabasca Delta, p. 11

Figure 5. The Peace Athabasca Delta

The Proponent believes the Peace River does not influence water levels on the PAD. BC Hydro reviewed the scientific studies completed on the PAD starting in the 1970s to determine how previous flow regulation had altered the flow regime of the PAD.

Many people said the filling of the Williston reservoir was the most severe cause of observable change in Lake Athabasca water levels at the time, and the subsequent operation of the upstream hydroelectric facilities caused continued change to the ecological conditions because of reduced summer flooding in the PAD. Further engineering studies in the 1970s led to construction of weirs to retain outflows from Lake Athabasca and to retain water in Lake Claire

and Mamawi Lake. Works were also constructed to control flow across the Athabasca River delta, and dredging was undertaken to maintain transportation routes for shipping. The Proponent determined that these anthropogenic interventions irreversibly affected the PAD's geomorphic form and also altered its patterns of water flows and levels.

The Proponent reported that an evaluation of these works in 1983 found the weirs had increased the average water levels in summer and produce higher winter minimum levels. The review concluded that while the weirs mitigated some of the long-term biological impacts resulting from reduced water levels, the decreased range in water levels had led to a reduction in productive wetlands.

Despite the increased water levels resulting from the flow control weirs, the Proponent said that analyses of changes in vegetation communities between 1974 and 1983 suggested that a drying trend persisted. The Proponent also said that the record Peace River flood of 1990 failed to flood the PAD. The Proponent concluded, from this and other research, that spring ice-jam flooding from the Athabasca and Peace Rivers and precipitation were the primary mechanisms to supply water to the perched basin habitats on the PAD.

The Proponent concluded in its 1996 report that:

- both high water levels in summer and low water levels in winter in the PAD are important to maintain water levels in the large lakes and connected channels to sustain productive habitats;
- spring ice jams on the Athabasca and Peace Rivers are important to generate high water levels required to supply flows to the PAD; and
- both climate variation and flow regulation are factors that could influence the occurrence of ice jams on the Peace River.

The Proponent said the Project would release the flows from the Peace Canyon Dam with slightly altered timing. It said that by "Peace Point, Alberta (the downstream extent of the surface water regime study, approximately 40 km upstream of the PAD), negligible change in surface water regime is predicted as a result of the Project compared to the natural variability of the surface water regime at that location."

The Proponent later said there would be "a small increase in the frequency of low flows with the Project in a typical freeze-up period," explaining that the ice cover would form at a low level during a period of relatively low flow in November and would refreeze at a higher level in December. With increasing flows in December, the ice cover in the main channel would release from the border ice attached to the banks, float up to accommodate the higher flow beneath it, and refreeze to the banks at a new, higher level. Consequently, the predicted small increase of low flows in November would not affect the frequency of ice jams in the lower reaches of the Peace River.

In response to a report by Dr. Martin Carver, presenting for Athabasca Chipewyan First Nation and Mikisew Cree First Nation, BC Hydro said that the Project may reduce the level of Lake Athabasca of up to one centimeter when the lake level was at 208.5 m, with an occurrence frequency of one year in ten. Sensitivity analysis indicated that the effect could be as much as four centimetres if the lake level was at 208.0 m; however, a level this low had been recorded very infrequently in the modelled period. The Proponent concluded these small differences would be negligible in the context of the system's variability, and no Project-induced changes would occur in surface water levels in the PAD.

With respect to ice, BC Hydro said its modelling showed "there would be no change to the ice regime (including the timing of ice formation and break-up, ice thickness and ice quality) of the Peace River as a result of the Project downstream of Carcajou, which is located ... approximately 520 km upstream of the PAD."

Dave Andres, on behalf of the Proponent, said ice jams occur during break-up and have a thermal process and a dynamic process. The thermal process is the warming of the water, and the dynamic process is the increased flow caused by melting in the tributaries. Mr. Andres said any thermal influences of the Project would be immeasurable at the confluence with the Smoky River. After that, all processes tend to relate to the effects of the Smoky River and the influences of other tributaries downstream. Mr. Andres said this would be true even under changed climate scenarios.

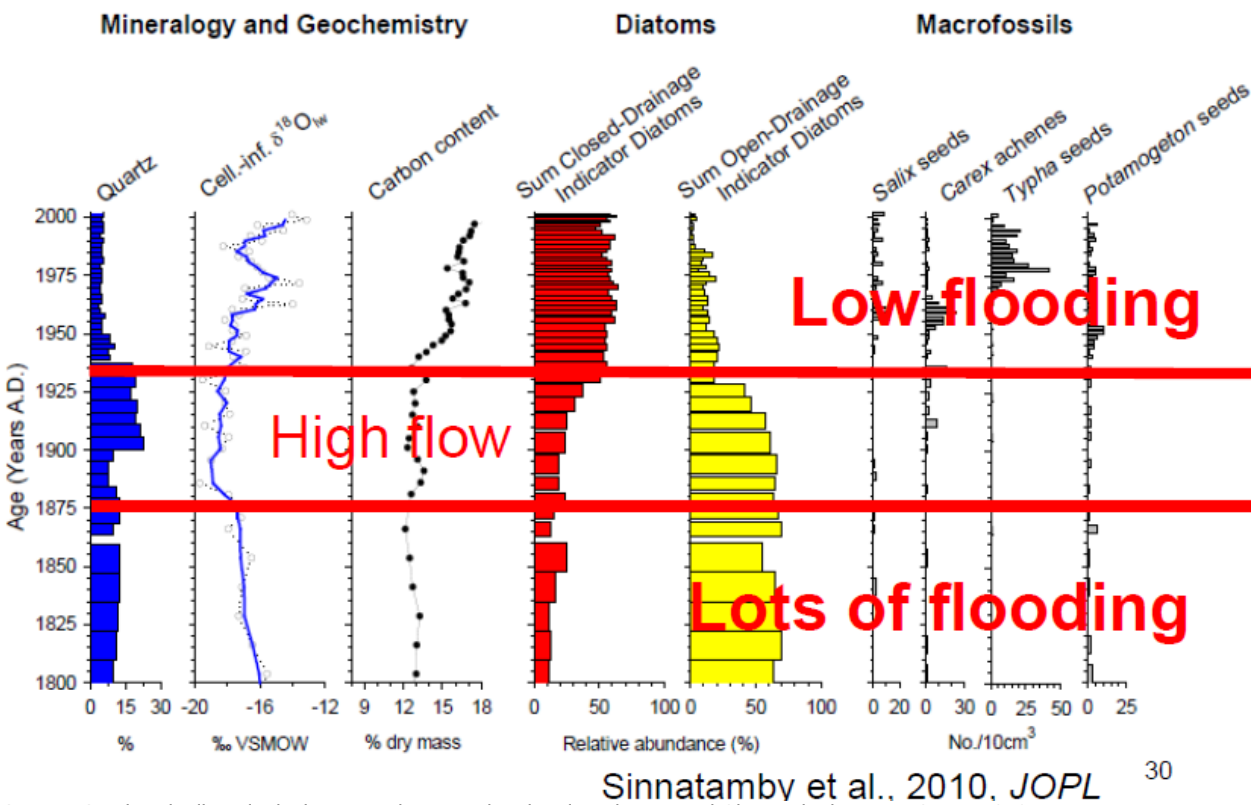
The Proponent concluded that none of the predicted changes to the surface water regime attributable to the Project would result in a change in the probability or magnitude of any of the four flood-causing mechanisms in the PAD, and accordingly the Project would have no effect on the hydrology in the PAD. Having based these conclusions on extensive studies, BC Hydro limited any consideration of any downstream effects from the Project to Peace Point, Alberta, upstream from the PAD.

Dr. Kevin P. Timoney, speaking on behalf of the Proponent, said suggesting flow regulation has dramatically affected the PAD was problematic, stating there is multi-decadal change in the PAD driven by climate change, and one cannot conclude that the change is solely driven by regulation.

Dr. John P. Smol, on behalf of the Proponent, also presented information on the wet and dry periods that have happened naturally in the last 200 years (Figure 6). He said terrestrial macrofossils in the sediment would indicate a dry period, whereas fossilized diatoms indicate a wet time.

His research showed that the 1960s were an anomalous wet period. Dr. Smol stated that the drying pattern started around the early 1900s, and he expected step-wise increases in dry time at and post-1968 when the Bennett Dam was built. However, he recorded a drying trend in lakes that started pre-regulation and continued to the present, with no step-wise change in 1968, as predicted. Dr. Smol stated that the profiles did not record any consistent changes coincident with the start of river flow regulation. This drying trend was also shown in Slipper Lake and other lakes outside of the PAD.

The Proponent summarized its surface water, fluvial geomorphology and sediment transport, and thermal and ice regime studies, concluding that the Project would not influence the hydrological conditions of the PAD. Therefore, it stated that there was no technically valid reason to alter the spatial boundary of the assessment to include the PAD. The Proponent concluded that the Project would have no noticeable incremental influence on the PAD, and therefore, the issue of past regulation on the PAD does not belong in the environmental assessment for the Project.



Source: Smol, Paleolimnological Perspectives on Directional Environmental Change in the PAD, CEAR #2424

Figure 6. Short Core Sampling of the PAD for Paleoenvironmental Reconstruction

3.7.2 Views of Participants

Parks Canada (PC) spoke about the ecological importance of the PAD and explained how it is a flood-dependent ecosystem. PC noted that the interaction of flow regulation and climate change reduced the frequency of ice-jam flooding on the PAD, which dramatically reduced the extent of wetland habitat. PC was concerned that assessing the incremental effects of the Project may not fully evaluate the operational phase of the Project from a cumulative effects assessment perspective.

The Government of Alberta also stated that the Environmental Impact Statement (EIS) did not mention the effects of reservoir filling on the downstream environment and that modelling was not provided showing resulting effects on the PAD recharge.

Members of the Athabasca Chipewyan First Nation and Mikisew Cree First Nation told the Panel about changes they have experienced on the PAD. Several described the PAD as an important hunting, fishing, trapping, and plant gathering area. They said archeological records indicate that the area may have been periodically occupied by northern hunter-gatherers for as much as 7,000 to 8,000 years. Several First Nations participants said the PAD is drying, resulting in reduced access to the delta. They noted that weak or broken ice has made winter travel dangerous and difficult. They also said that muskrat populations have greatly declined, reducing trapping success to very low levels.

Dr. Martin Carver, on behalf of the Mikisew Cree First Nation and Athabasca Chipewyan First Nation, said there are complex linkages and existing and proposed regulation has and would continue to affect the PAD's hydrologic recharge. He said that the Proponent's assessment

contained gaps and uncertainties. Dr. Carver's research found that there were identifiable pathways and effects in how the Project would further impair recharge mechanisms in the PAD.

Dr. Carver said regulation had an effect on flow levels and patterns in the PAD, referencing studies dating back to 1959, showing how regulation has reduced flow volume. He cited a study by Daniel Peters and J.M. Buttle (2009), which simulated natural flows on the Peace River as if the existing upstream dams were not there, that concluded the Bennett and Peace Canyon Dams reduced reversed flow volumes by 90 percent. Dr. Carver said this demonstrated the effect of regulation on open water mechanisms, showing that it can be quantified.

Dr. Carver cited a study by Beltaos et al. (2006) that suggested three conditions for the occurrence of ice-jam flooding sufficient to inundate the perched basins: "One, a mechanical (not thermal) ice break-up is required. Two, the river flow should be at least 4,000 m^3/s. Three, an ice jam should form within the last 50 km of the Peace River." Dr. Carver stated that regulation of the Peace River would interact with climate change and determine the likelihood that these conditions would be met.

Dr. Carver questioned why the Proponent did not assess the effects of ice-jam release waves, or the waves' ability to support PAD recharge. He said the effects of changes in freeze-up levels due to the operating regime, and the potential for the Project to effect changes in ice-jam release waves, should be assessed. Dr. Carver stated that the delta reach, having a shallow gradient, is vulnerable to ice jams.

Both Jeff Langlois, representing the Athabasca Chipewyan First Nation and Mikisew Cree First Nation, and Dr. Carver spoke about the Proponent's conclusion that a small effect could occur on the water levels in Lake Athabasca as a result of the Project. They disputed the conclusion that one centimetre was negligible, and Dr. Carver said this would become more important with future climate change. Dr. Carver also said the magnitude and relative significance of the Project effects should be expected to grow over time with climate change advances, in terms of open water and ice-related effects.

Environment Canada (EC) concurred with the Proponent's modelling of flows, although they cautioned that ice effects can modify the model results. EC also expressed concern with potential downstream effects as far as the PAD due to flow modification during the reservoir filling, stating the Proponent described this only for average flow conditions. EC recommended that simulations be done to predict potential effects of reservoir filling on downstream flow and water levels of the Peace River to the Peace Point study boundary near the PAD, with reference to average, best, and worst-case scenarios.

EC also recommended modelling for Site C effects that take into account the range of projected impacts of climate change on the timing and magnitude (including extreme events) of streamflow generation.

EC referenced the Proponent's analysis showing that flows for the typical freeze-up month would be lower than currently if the Project proceeds. However, EC concluded that its operation would not affect flows that drive spring break-up backwaters associated with ice-jam flood events near the PAD. EC also concluded that sustained flows that occasionally block outflow from, and contribute reverse flows to, Lake Athabasca and the PAD would not be affected. EC said the largest potential effects on flows and water levels would be seen immediately downstream of the Site C Dam, diminishing in a downstream direction due to natural attenuation and the addition of water from several tributaries. EC also said the Project would not modify the downstream flow hydrograph near the PAD beyond occasional short-term fluctuations.

With regards to the ice regime study, EC concluded that state-of-the-art numerical tools and methods have been applied, along with good physical understanding and sound engineering judgment, to predict Project impacts on downstream river ice regimes. Dr. Spyros Beltaos, a research scientist with EC, said that he knows there remain uncertainties in predicting what will happen with the river ice with Site C in place using the Proponent's ice modelling because there are so many unknowns. Dr. Beltaos said that, based on what is known, the results achieved from its modelling make sense, in his view as a river scientist and engineer.

3.7.3 Panel's Analysis

The information provided from both the Proponent and participants (including photographs) demonstrated a general trend of transformation of the aquatic ecosystems of the PAD into terrestrial ecosystems caused by sustained dry periods.

The Panel heard much argument and discussion and references to past studies regarding the regulation of the Peace River flows by the Bennett Dam reducing the flooding on the PAD. However, the Panel also heard there is an influence of many other tributaries in the approximate 1,200 km stretch between the Bennett Dam and the PAD. While the regulation has an effect on the peak flows, the hydrologic studies suggest that open-water floods from the Peace River have rarely flooded the perched basins in the PAD. Those studies further suggested that, even without regulation, overflow of the lower Peace River would have been a rare occurrence during ice-free conditions. The studies presented by the Proponent and some of the participants also concluded that the unregulated Athabasca River produced localized overland flow under both open-water and ice jam conditions. However, these studies suggested that most large-scale overbank flooding has resulted from ice jams during spring break-up.

The work of Dr. Timoney demonstrated that climate change plays a major role, at least as important as regulation, in whether or not an ice jam flood will occur. Dr. Carver cited the work of Dr. Baltaos which concluded that regulation and climate change together determine whether conditions will be right for an ice jam to occur. Therefore, it's clear that climate change has been demonstrated to directly affect the survival of the PAD, as referenced by both Dr. Timoney and Dr. Carver. Since the mid-1970s, there has been a warming during the period of ice cover, favouring thermal over mechanical ice break-up. In addition, climate change has led to more precipitation falling as rain in the fall, giving smaller snowpacks and smaller freshet flow from the unregulated tributaries downstream. Given the information presented on climate change, it is clear that releases from the Bennett Dam are unlikely to be the deciding factor on the survival of the PAD unless they are very large.

The Panel notes that the changes to the PAD that were reported to the Panel are happening now without the Project. In addition, the PAD is 1,100 km downstream of Site C. While the majority of flow regulation on the Peace River is due to the operation of the Bennett Dam, the additional regulation provided by the Project would be attenuated before reaching the PAD.

The Panel agrees with the Proponent that there would be no change to the ice regime, including the timing of ice formation and break-up, ice thickness, and ice quality, of the Peace River as a result of the Project downstream of Carcajou, approximately 520 km upstream of the PAD. The Panel also agrees with the Proponent that the rare instances when the Project may be capable of reducing levels of Lake Athabasca by one centimetre are negligible in relation to the other forces for change at work in the PAD.

The Panel can find no direct links from the operation of the proposed Project to the flood-generating mechanisms on the PAD. As a result of no residual effects on the PAD, a cumulative effects assessment is not required.

The Panel concludes there would be no effects from the Project on any aspect of the environment in the Peace Athabasca Delta, and a cumulative effects assessment on the PAD is not required.

The Panel is not deaf to the importance of the PAD and to the changes that are happening to it. The Panel understands that the PAD is changing as a result of the additive effects of climate change, water withdrawals from the Athabasca River, and flow regulation in the Peace River, among other things.

The Panel recognizes that the Proponent, Parks Canada, the Government of Alberta, and others are in discussions on the value and costs of providing periodic pulses of water in an attempt to create flooding on the PAD for the purpose of trying to preserve or restore the aquatic ecosystems there.

The Panel encourages these agencies to continue the research and analysis into mechanisms to preserve the PAD.

4 FISH AND FISH HABITAT

The Project would transform 83 km of a river ecosystem into a reservoir that would result in a different aquatic ecosystem. The Project would also affect the aquatic ecosystem for some distance downstream of the dam. This chapter reviews how these changes in the aquatic ecosystem would affect fish and fish habitat.

4.1 PROPONENT'S METHODOLOGY

According to the Proponent, the Project may affect fish health and survival by causing direct mortality to fish or indirect mortality by changing the system productivity, the food resource type and abundance, or the environmental conditions on which fish depend.

4.1.1 Proponent's Assessment

The local assessment area (LAA) encompassed the Peace River from the Peace Canyon Dam to Many Islands, Alberta, and also included the associated tributaries entering the reservoir between those two locations (Figure 3; p.19). BC Hydro also included the watercourses and riparian areas within the transmission line study area in its assessment. The downstream boundary for the fish and fish habitat assessment was established at the point where the physical changes in the river were predicted to no longer have a measurable effect. The Regional Assessment Area (RAA) was defined as the Peace River from the Peace Canyon Dam to Vermillion Chutes, Alberta. This area was expected to include the maximum distribution of fish populations currently residing in the LAA.

Potential effects to fish and fish habitat were characterized in three different categories: (1) changes to fish habitat, (2) changes to fish health and survival, and (3) changes to fish movement. BC Hydro assessed effects to fish habitat by evaluating the quality and quantity of fish habitats, habitat availability, water depth, velocity and temperature, sedimentation, water quality, ice regime, aquatic productivity and food resources, and competition for food and habitat. Changes to fish health and survival were assessed based on changes in species diversity, fish population distribution, fish population relative abundance, fish population biomass, sedimentation, stranding, fish entrainment, and total dissolved gas. Changes in fish movement were assessed on fish species population, movement patterns and general life history parameters, swim speeds and entrainment.

A combined approach, using computer modeling of water quality, temperature and ice regime fluvial geomorphology, sediment transport, aquatic productivity and fish population dynamics along with baseline data were used to support the determination of potential effects to fish and fish habitat. BC Hydro identified the species for its baseline assessment through various sources and studies, including traditional ecological knowledge.

Kokanee, lake whitefish, bull trout and Arctic grayling were assessed through single species models to evaluate alternative actions for upstream and downstream passage. Kokanee were modelled by adapting the existing Arrow, Revelstoke and Mica Systems model using data from the Williston reservoir. In this adaptation, the Williston reservoir was modelled on the Mica reservoir and the proposed Site C reservoir was modelled on the Revelstoke reservoir. The Dinosaur reservoir was eliminated from the model because of the short residence time of the water. The model extended to predictions of lake whitefish because long-term model results assume kokanee biomass replaces lake whitefish biomass. Bull trout and Arctic grayling

populations were estimated using a stage- and age-structured Leslie Projection matrix single species growth model using Beverton-Holt recruitment.

The Proponent evaluated the effects of the Project based on the characterization criteria of direction, magnitude, geographic extent, frequency, duration, context, level of confidence and probability of the effect occurring. The effectiveness of the mitigation proposals was then evaluated to determine the degree to which the effects could be reduced. From this, the Proponent was able to determine where residual effects would occur and the significance of those effects.

The criteria used in the analysis of significance were selected to be consistent with the BC Freshwater Fisheries Program Plan and to align with the goals of the federal regulatory direction on conservation of fish species and protection of the productivity of fish, fish habitat and fisheries through the *Species at Risk Act* and the *Fisheries Act*. From these, two significance criteria were chosen. The residual effect was found to be significant if the project component or activity would result in:

- The loss of indigenous fish species, sub-species, populations, or distinct groups or,
- A reduction in the long-term average standing stock biomass of the fish community relative to the existing baseline condition.

4.1.2 Views of Participants

Rick Palmer and Alyssa Murdoch, presenting for Saulteau First Nations, raised concerns about the fish population modeling conducted by the Proponent. They claimed that the modeling was unrealistic and used unsupported assumptions. They said the results were not adequately tested for potential uncertainties in input parameter values. Mr. Palmer and Ms. Murdoch also challenged the use of the Beverton-Holt stock-recruitment model, stating that it is less conservative and not appropriate for the species modelled for this Project. BC Hydro responded that the structure and assumptions of the models and the sensitivity analyses were reviewed at three workshops involving Fisheries and Oceans Canada (DFO) and the BC Ministries of Forests, Lands and Natural Resource Operations and of Environment. BC Hydro also said they were then independently peer-reviewed.

Another critique from Mr. Palmer and Ms. Murdoch was that a secondary risk-based model would provide additional support to predictions and be more conservative to maintain harvestable levels of fish. The response from BC Hydro was that the suggested approach could be applied to post-project monitoring, but it would not be appropriate for pre-project environmental assessment.

Treaty 8 Tribal Association (T8TA) submitted a paper by McKinnon and Lawrence, which stated that an increase in daily water level range downstream may have the potential to adversely affect fish that utilize the lower reaches of tributaries and, in particular, confluence areas. Because tributaries of the Peace River downstream of the Project were not included in the LAA, T8TA was concerned that the assessment did not fully represent the effects of the Project. BC Hydro said that tributaries downstream were sampled in its assessment, but those tributaries above the confluences were not included in the LAA because the Project would not affect fish habitat in those tributaries, and fish would be able to continue using them for spawning, rearing and feeding.

DFO was satisfied with the level of expertise that BC Hydro brought to the assessment, related to the department's mandate. DFO agreed with the use of the Beverton-Holt stock recruitment model and the modeling approach used for bull trout and Arctic grayling.

4.1.3 Panel's Analysis

The Panel notes DFO's agreement with the Proponent's use of the stock recruitment model for bull trout and the modeling approach used for Arctic grayling. The Panel also notes BC Hydro's rationale for the critiques provided by Mr. Palmer and Ms. Murdoch. The Panel is satisfied with the modelling approach taken by BC Hydro to assess the potential changes to fish and fish habitat caused by the construction of the Project.

4.2 ASSESSMENT OF FISH AND FISH HABITAT

This section examines the Proponent's assessment of fish and fish habitat by analysing the baseline studies followed by a discussion of the Project effects and proposed mitigation.

4.2.1 Proponent's Assessment

The Project would place a permanent physical structure in the river that could disturb existing fish habitat and/or could alter fish habitat by changing its physical or chemical characteristics to make it unusable by fish. The Proponent stated that the specific activities during construction likely to alter fish habitat include the construction of the dam and generating station, the Highway 29 re-alignment, the Hudson's Hope shoreline protection, and construction of the temporary weir, diversion tunnels and reservoir filling. The activities during operation that would likely alter fish habitat include transformation from a river to a reservoir habitat, and downstream effects of the proposed dam operation.

4.2.1.1 Fish Baseline

The Proponent said that 32 fish species have been recorded in the LAA. None are listed under Schedule 1 of the *Species at Risk Act* (SARA) (endangered, threatened or special concern) nor are they being considered under Schedule 2 or 3 of SARA, however the bull trout is a Committee on the Status of Endangered Wildlife in Canada (COSEWIC) species of special concern. In British Columbia, the spottail shiner is red-listed and bull trout, goldeye, and pearl dace are blue-listed (see Appendix 8 for additional detail and the glossary of categories). The government of B.C. also considers the bull trout as a species warranting special management concern. All other species are currently yellow-listed in BC, meaning that they are secure and not at risk. The government of Alberta identifies pygmy whitefish and spoonhead sculpins as "may be at risk". Alberta lists bull trout as a species of special concern and five additional species as "sensitive": Arctic grayling, lake trout, brook stickleback, northern pikeminnow and northern redbelly dace. The remaining fish species are secure, not assessed, or not determined in Alberta.

According to the Proponent, any of the 32 fish species in the LAA may have traditional use, recreational use or management value. All fish species have ecological function value and have the potential to be affected by the Project. However, a number of those species recorded in the LAA are rare and are not considered by the Proponent to be part of the existing fish community. BC Hydro stated that even though they are present, individuals of these species represent transients for populations that reside outside the influence of the LAA.

The Proponent recognized two primary categories of sport fish in the LAA: cold-water fish and cool-water fish. Coldwater species reside in cold water habitats and require large-textured sediments and clean, well-oxygenated water. They spawn in summer or fall with extended egg incubation periods. Cool-water species are able to tolerate higher water temperatures and are better adapted to turbid water and cope with higher fine sediment loads. They mostly spawn in spring with short egg incubation periods. The Proponent noted that the transition zone from cold to cool water species is in the LAA. Coldwater species dominate primarily upstream of the Pine River confluence. Cool-water species become more abundant downstream of the Pine River but also migrate or reside in the cold-water-type habitat upstream of the Pine River. The cool-water species are the dominant species at the B.C.-Alberta border.

The cold-water group assessed by BC Hydro included seven sport fish species: Arctic grayling, bull trout, kokanee, lake whitefish, lake trout, mountain whitefish and rainbow trout. The rainbow trout population has limited natural recruitment in the LAA. The cool-water group included the sport fish walleye, goldeye, northern pike, burbot and yellow perch. In addition, the cool-water group included three sucker species and nine species in the minnow group. Three species of sculpin occupy both types of environment.

The Proponent said that large fish species, including sport fish and suckers, are species that generally attain a length of at least 200 mm at maturity. These species are represented as well by their smaller age classes. With small fish, all age classes are smaller than 200 mm. BC Hydro explained that the species size distinction is important because it determines their ability to move extended distances. In fluvial systems, adults of large fish species are able to move long distances upstream against the current. Due to their size, small-fish species undertake shorter upstream movements. All size fish can complete long-distance movements downstream.

BC Hydro stated that fish numbers are much higher in the LAA than further downstream. The Proponent cited work done in the Dunvegan area, 120 km downstream, that recorded an order of magnitude of lower abundance of both large fish and small fish.

The Proponent said that fish residing in the Peace River use movement as a strategy to access important habitats. Several species demonstrated extended movements, including Arctic grayling, bull trout, mountain whitefish, goldeye, and walleye. Arctic grayling were noted to migrate to the Moberly River where they spawn 20 to 60 km upstream from the Peace River confluence. Mountain whitefish were found to migrate throughout the Peace River to the Moberly and Halfway rivers to spawn and bull trout travel as much as 300 km to access spawning habitats in the upper Halfway River tributaries. Walleye were noted to spawn in the Beatton River, Clear River and Pouce Coupe River and can travel as far up the Peace River as the Moberly River, a distance of 100 km. Goldeye spawn in the Peace River and tributaries primarily in Alberta but it is a migratory species that can travel long distances from wintering habitats downstream to as far upstream as the Moberly River.

Few species were found to rely on the mainstem Peace River for spawning and, for those that do, the contribution to recruitment from mainstem spawning is small. However, the Proponent stated that an important source of recruitment for some fish populations in the LAA is entrainment; that is from fish that come from above the upper dams and pass through the turbines or over the spillways. Recruitment via entrainment maintains the rainbow trout, kokanee, and lake trout populations.

Mountain whitefish was determined to be the dominant species in the LAA. The Proponent estimated 275,500 large-size mountain whitefish upstream of the proposed Site C dam site, and

86,000 downstream of the proposed site. Redside shiner is the dominant small-fish species in the LAA both upstream and downstream of the proposed Project.

A balanced population structure would include all size or age groups in appropriate proportions. The Proponent said the Peace River community is dominated by large size fish, particularly upstream of the Halfway River confluence. It found a low abundance of younger fish of the large-fish species and of most small-fish species. The Proponent stated that this is due to the limitation on availability and quality of small-fish habitat caused by the Peace River flow regime. Small fish do occur upstream of the Halfway River, but are more abundant in backwaters and side-channels away from the main Peace River flow. The frequency of occurrence and abundance of small-sized fish is reported to increase downstream of the Halfway River.

4.2.1.2 Fish Habitat Baseline

The Proponent defined fish habitat as any spawning ground and nursery, food supply and migration areas on which fish depend to carry out their life processes. Important habitat is defined as habitat essential for the maintenance of a self-sustaining fish population. Important habitats are located in the Peace River both upstream and downstream of the Site C dam site and in the tributaries both within and outside of the Project inundation zone. The Proponent stated that in general, the lower sections of the Peace River tributaries provide important spawning and early rearing habitats for suckers and minnows. Important spawning and rearing habitats for sport fish have been recorded only in upstream areas of large tributaries.

The Proponent said the upper Halfway River watershed provides spawning and rearing habitats for the Peace River bull trout population. The Moberly River provides spawning and rearing habitats for the Peace River Arctic grayling population, while Maurice Creek provides spawning and rearing habitats for the Peace River rainbow trout population. The Halfway River, Moberly River, and Pine River provide spawning habitats for the Peace River mountain whitefish population. The Peace River downstream of the Halfway River confluence provides rearing habitat for mountain whitefish. Side channels provide habitats for several fish species, in particular northern pike, yellow perch, and spottail shiner. Finally, the mainstem Peace River is a migration area for several species by providing an upstream and/or downstream movement corridor between habitats. Several species require the Peace River as a movement corridor including Arctic grayling, bull trout, mountain whitefish, burbot, goldeye, walleye, largescale sucker, and longnose sucker.

4.2.1.3 Changes in the Reservoir

The Proponent said the creation of the Site C reservoir would change the river ecosystem and result in a new aquatic ecosystem and fish community.

The Proponent calculated that the construction of the dam and generating station would result in the direct loss of 198.5 ha of fish habitat primarily in the Peace River. Habitats affected would include a side channel area along the south bank that provides spawning, rearing, feeding and wintering habitats for several species. Similar habitats would be affected in the main channel. Within the dam and generating station construction zone, two high-quality habitat areas would be affected along the north bank: the first, including the river channel where the approach channel would be installed, provides high-quality rearing areas for Arctic grayling and mountain whitefish; the second, the river channel that would be affected by the construction of the 2.95 km North Bank Haul Road, provides rearing habitat for Arctic grayling, bull trout, mountain whitefish, and rainbow trout. The latter area also provides high-quality feeding habitats for Arctic grayling, bull trout, rainbow trout, and walleye.

The Proponent said the temporary construction bridge would also affect habitats in the Moberly River, including spawning and rearing habitats for mountain whitefish, suckers and minnows and feeding habitats for all adult species, in particular goldeye and walleye. Construction of the Highway 29 realignment would result in the loss of 10.6 ha of fish habitat including 0.2 ha of habitat in the Halfway River and 10.4 ha along a 1.76 km shoreline of the Peace River.

The Proponent also said construction of the Hudson's Hope shoreline protection would result in the loss of about nine ha of fish habitat. These habitats include high-quality rearing habitats for bull trout and rainbow trout, and high-quality feeding habitats for bull trout, mountain whitefish, and rainbow trout. This area is also used by lake trout for rearing and feeding.

The Proponent calculated that during the channelization period (approximately 36 months), a headpond would form with a maximum upstream extent of approximately 10 km. This would flood 387 ha of the Peace River valley. During diversion (another 39 months), the headpond would extend about 27 km from the dam site and 1,630 ha of land would be flooded. The headpond would alter habitat by increasing water depth and lowering water velocity. Clean riverbed materials would be altered by sediment inputs from erosion of newly inundated areas. While the Proponent noted that the increased flooded area would potentially provide increased habitat for fish generally, it said that the water levels would fluctuate, limiting the ability of fish to use the newly formed habitats in the headpond.

The Proponent determined that filling of the Project reservoir would result in the loss of 2,800 ha of main channel fish habitat and 163 ha of tributary fish habitat. These lotic (moving water) habitats would be replaced by 942 ha of littoral area habitats (in-shore or near-shore area defined as having a water depth of less than six metres). The Proponent said that based on the continual change from riverine habitat to reservoir habitat during the headpond and reservoir filling, it is expected that the fish species requiring critical riverine habitat upstream of the Site C Dam, specifically the Moberly River Arctic grayling, mainstem spawning mountain whitefish, and perhaps migratory Halfway River bull trout, would be most affected by the creation of the reservoir.

The Proponent said the net effect of these habitat changes would result in a 1.8 times increase in total biomass of harvestable fish in the Site C reservoir compared to what currently exists in the Peace River, though it would have a very different species composition. The Proponent said most species presently in the Peace River and its tributaries within the reservoir inundation zone would be present in the Site C reservoir after inundation. However, the relative abundance and biomass of fish species within the reservoir fish community would change during the transition of the reservoir. Species such a kokanee, lake whitefish, lake trout, burbot, peamouth and rainbow trout that could adapt to the new environment in the reservoir were described to potentially benefit from the changes. Other species that rely on the riverine ecosystem may decline in the new environment or may be lost.

4.2.1.4 Downstream Changes

BC Hydro said that the hydroelectric operation would modify the surface water regime and the characteristics of the river aquatic ecosystem for some distance downstream of the dam. The dam would also impede upstream movement of migratory species and could directly affect survival of fish passing downstream through it.

The Proponent said that during operation there would be changes to physical conditions and fish habitat downstream of the Project, especially between the Site C dam and the Pine River confluence. The Peace River downstream would be characterized by a regulated flow regime similar to what presently occurs downstream of the Peace Canyon Dam. BC Hydro said these

habitat changes may alter fish movement patterns as they adapt their life history and movement patterns to these physical conditions. Recruitment sources of fish below Site C dam would include entrainment from the upstream Project reservoir as well as the Pine River, which would be the only potential natural downstream tributary source for Arctic grayling, bull trout, and mountain whitefish. However, the Proponent expected these fish to persist in the mainstem Peace River. Others species such as kokanee and lake trout, whose populations would be maintained by recruitment from the Site C reservoir, would establish distributions immediately downstream of the Site C dam.

The Proponent said the dam and generating station would create a complete blockage to upstream fish movement. While species with local movement patterns would not be affected by blocked upstream passage because they could complete their life history in habitats downstream of the Site C Dam, species with extended movement strategies may attempt to move upstream past the dam. In the cold-water sport fish group, adult Arctic grayling, bull trout, and mountain whitefish that originated from upstream of the Site C Dam may be motivated to move upstream past it in an attempt to return to spawning tributaries (i.e., Moberly River for Arctic grayling and mountain whitefish; Halfway River for bull trout and mountain whitefish). In the cool-water group species that may be motivated to move past the dam site include walleye, burbot, northern pike, and the three sucker species. As natural movement upstream past the dam site would not occur, and mitigation would be focused on cold-water species, the Proponent predicted that future distribution of the cool-water fish group would be restricted primarily to downstream of the Pine River confluence.

Burbot, northern pike, walleye, and goldeye populations would remain downstream of the Pine River due to the regulated flow regime, cooler summer water temperatures, and the reduced sediment load during freshet. Burbot, northern pike, and walleye may not reside in the Peace River between the Project dam site and the Pine River confluence, but still might forage upstream of the Pine River when conditions are favourable. Goldeye would migrate as far upstream as the Beatton River. Similarly, the regulated flow regime caused by operation of the Project might limit sucker and minnow populations to at least downstream of the Pine River and as far downstream as the Beatton River.

4.2.1.5 Effects on Fish and Fish Habitat

Of the 15 listed potential effects of the Project on fish and fish habitat, 11 were specific to fish health, survival and movement. The Proponent stated that only three of the effects would be fully mitigated by the proposed measures (discussed below). This leaves 8 identified potential effects resulting in residual impacts to fish health, survival and movement:

- Reduced fish health and survival due to sediment inputs during construction of dam and generating station and during headpond and reservoir filling;
- Reduced fish health and survival due to fish entrainment or increased total dissolved gas during construction;
- Reduced fish health and survival due to fish entrainment or total dissolved gas during operation; and
- Hindered fish movement due to obstruction of fish passage during construction and operation.

Of the 15 listed potential effects of the Project on fish and fish habitat, 4 were specific to fish habitat, none of which would be fully mitigated by the proposed measures. This leaves 4 identified potential effects resulting in residual impacts to fish habitat:

- Loss of habitat due to construction of dam, generating station, Highway 29 and Hudson's Hope shoreline protection and due to headpond construction and reservoir filling; and
- Altered fish habitat due to reservoir operation and downstream of Site C.

The Proponent said that three distinct groups of fish may be lost as a result of the Project: the migratory component of the Moberly River Arctic grayling, migratory bull trout that spawn in the Halfway River, and the mountain whitefish that rear in the Peace River and spawn in its tributaries and the mainstem upstream of the Site C Dam site. This loss is anticipated because of loss of river habitat, reduced fish health and survival during construction and reservoir filling, and hindered fish movement. The Proponent believed that, although these distinct groups would be affected, the three species, as a whole, would continue to be present in Peace River tributaries and downstream of the reservoir and may persist in the reservoir. Because of the potential loss, the Proponent concluded that construction of the Project may result in a significant adverse effect on fish and fish habitat.

The Proponent said although the new reservoir ecosystem would support a different species composition, it would still develop over time to support a new, diverse and productive fish community, with equal or greater levels of biomass, and as such, the change would not be significantly adverse. Similarly, because the changes in downstream habitat would not be large enough to cause a loss in distinct groups of fish or to result in a reduction in the biomass, the Project would not significantly affect downstream fish or fish habitat.

4.2.2 Views of Participants

DFO agreed with the characterization of baseline conditions for fish and fish habitat and with the approach taken to assess the effects of the Project. DFO said the reservoir would be a very unproductive, ultra oligotrophic or low nutrient system that would be modified by the amount of nutrients coming in from the tributaries. More specifically, DFO said the upper end of the reservoir, which would be less turbid, would be more productive than the lower half. However, the department concurred with BC Hydro's predictions of fish abundance and its overall finding that the larger volume of water in the reservoir would likely result in a higher overall biomass than what is currently present in the river. DFO also agreed that the Arctic grayling and bull trout populations assessed would probably be lost, and that the reservoir would probably be colonized by lake trout and kokanee.

Treaty 8 Tribal Association (T8TA) argued that there should be a revised definition of significance for fish and fish habitat by looking at population density, which is related to fishing success, not just increases in biomass. This would impact the numbers when looking at the effects on harvested species. For instance, with rainbow trout, although the change in biomass increases from 1.64 to 1.93 times the current biomass, the number would actually go down in terms of the availability of fish that may be at the end of the (fishing) line. Taking this change into account, considering the impact on fish in terms of preferred species densities, there would be a drop of 84% in availability of fish per unit of surface area.

T8TA said the Proponent presents the view that, as a result of construction of the headpond and reservoir filling, the loss of key riverine habitats required for some distinct groups of fish would be a longstanding feature of dam operation. However, "Altered fish habitat due to transformation from river to reservoir habitat" during the operation phase was not considered to be a significant effect despite the certainty that habitat losses would persist beyond the construction phase and extend through the operational phase.

Many participants, including the Peace River Environmental Society, Dr. Carver and Treaty 8 Tribal Association raised concerns over the spatial boundaries used in the assessment and the extent of effects on fish and fish habitat downstream of the Project. They said the effects predicted by the Proponent were not adequately assessed because several downstream areas, which may be affected by the Project, were not included.

The Proponent's estimation that mountain whitefish biomass would increase downstream from the dam was also questioned by DFO, who stated that, because of conflicting evidence on the subject, there is considerable uncertainty about whether this population would increase after construction. BC Hydro's response was that it was confident in its model, which relied on data from the other rivers that it operates on in the province. As additional support, BC Hydro referenced a sensitivity analysis that was conducted supporting the conclusion that the population of mountain whitefish would double. The analysis also demonstrated that even if the biomass of mountain whitefish did not increase, the overall conclusions on biomass would remain sound. Nevertheless, DFO cautioned that the ability to predict outcomes from a change in the ecosystem deteriorates as you go higher up the food chain, from physical conditions, to the lower trophic levels to fish.

The Ministry of Forests, Lands and Natural Resource Operations (FLNRO) raised uncertainties over the biomass predictions made by the Proponent. FLNRO felt that there was a need for a better understanding of where the aquatic production would come from in the reservoir to support the new fish community. FLNRO noted, when a river is transformed into a reservoir there is an expected productivity loss, nutrient sources would be minimal, the fish community would become less diverse, and there would be a loss of natural fish movement at the dam site. FLNRO stated that run of river reservoirs, because of their high water exchange rates, are not very productive systems. Additionally, FLNRO feels that a better understanding is needed of the role of high-flushing rates of water on productivity and how aquatic vegetation is expected to thrive in a newly created reservoir, as aquatic plants are an attractant to fish. To support their concerns, FLNRO referenced the results of the creation of the Dinosaur reservoir, where it has been found that aquatic vegetation has struggled to thrive.

Concerns over changes in water level fluctuations and the associated impacts to fish populations were brought to the attention of the Panel by FLNRO. The shift from a nighttime fluctuation at a lower magnitude to a daytime fluctuation at a higher magnitude is believed, by FLNRO, to have an impact on fish populations, by altering connectivity between side channels and flows between islands downstream. Those fluctuations downstream of the Pine River were also identified by FLNRO as requiring further quantification by the Proponent.

The Province of Alberta, through their written submission, raised concerns over the Proponent's assessment of the effects of the Project on fish distribution. Alberta stated that the construction of Site C would affect water temperatures downstream, resulting in impacts to current distribution and ranges of cold and cool water fish species within Alberta. Alberta feels that this may cause population declines in some species and increases in others. Additionally, Alberta is concerned that these changes to water temperatures and fish distributions could impact biological processes such as spawning runs, egg incubation rates and access to spawning habitats.

The impacts of the Project on fish passage were of importance to the Province of Alberta, The construction of Site C will not allow upstream fish migrations and will restrict, but not completely, downstream fish movement. This may affect Alberta fish populations that individually migrate past the proposed site and those that rely on other fish populations, that serve as prey, to be able to navigate upstream and downstream of the site. Alberta also stated that the restriction to

upstream and downstream movement would impact access to spawning, rearing, feeding and overwintering areas, which are necessary for gene flow and long term resiliency of fish populations.

4.2.3 Panel's Analysis

The Panel notes that the cool-water and cold-water fish species distributions overlap in the LAA and that this is why there are much higher numbers of fish in the LAA than further downstream. The Panel also understands that large size fish dominate with a proportionately low abundance of small sizes of the large-fish species and that the population structure is not balanced. Nevertheless, the Panel agrees that fish are abundant in the LAA.

The Panel concurs with the Proponent, as well as DFO, that the fish biomass in the reservoir would probably increase from the existing river biomass. However, the Panel recognizes that the amount of the water in the reservoir would increase proportionally more than the increase in biomass. Therefore, the Panel believes there would be a reduction in fish density and this may make it more difficult to find and catch fish in the larger reservoir even though there are more fish available.

The Panel agrees with the Proponent that during operation there would be changes to physical conditions and fish habitat in the Peace River downstream of the Project, especially in that section of the Peace River between the Site C Dam and the Pine River confluence. These changes will include erosion of the river banks and loss of habitat as a result of the frequent changes in flows and levels due to river regulation. The Panel also agrees that fish passage would be completely blocked by the dam to upstream movement of migratory species and could directly affect survival of fish passing downstream through it. The Panel agrees with the Province of Alberta that the habitat changes and limitations on movements will change the species distribution downstream of the dam and may affect the fish genetics and long term resiliency of fish populations. In spite of the river fluctuations, however, the Panel agrees with the Proponent that the tributaries downstream of the Project will still be accessible for use by the fish downstream.

The Panel concurs with the Proponent that there would be a net loss of habitat and a profound change in the type and character of the remaining habitat during both the construction and operation of the Project. These effects would be probable, negative, large, irreversible and permanent so long as the Site C Dam remains. These habitat effects cannot be fully mitigated. The Panel notes that there was no disagreement about the extent of these effects.

There would be a reduction to fish health and survival due to sedimentation during construction and headpond and reservoir filling. There would be a reduction to fish health and survival due to entrainment, increased total dissolved gas pressure and from hindered fish movement during construction and during operation. These effects would be probable, negative, large, irreversible and permanent so long as the Project is in place.

The Panel agrees with BC Hydro that the Project would cause significant adverse effects on fish and fish habitat.

4.3 MITIGATION MEASURES

The Proponent's determination of significant effects of the Project on fish and fish habitat considered mitigation measures that would alleviate effects to fish habitat, health and survival, and movement for the Project construction phase and operation. Several participants opined on the measures proposed by BC Hydro, which will be outlined in this section.

4.3.1 Proponent's Assessment

To assist in the management of fisheries and aquatic habitats, the Proponent intends to prepare a Fisheries and Aquatic Habitat Management Plan. This would cover basic fish and fish habitat mitigation, such as riparian area avoidance, criteria for watercourse crossings, in-stream works guidelines, timing windows, work area isolation and fish salvage and relocation. Erosion and sedimentation mitigation, which would have a significant impact on fish and fish habitat, would be managed through an Erosion Prevention and Sediment Control Plan.

The Proponent would also develop an Environmental Monitoring Program for use during construction to evaluate the effectiveness of standard mitigation measures for reducing sedimentation and fish stranding in the construction headpond and proximal reach of the river downstream of the dam. This program would also help to validate predictions about physical changes to habitat in the reservoir area during the development and operation of the construction headpond in the diversion stage of the project.

BC Hydro determined that three predicted effects would be fully mitigated by the proposed measures. Reduced fish heath and survival during construction caused by sedimentation during the Highway 29 realignment and construction of Hudson's Hope shoreline protection would be fully mitigated through measures designed to reduce erosion, runoff, and dust and the plan to reduce in-stream works to limit sediment disturbance, where feasible. Reduced health and survival of fish due to stranding during construction and operation would be mitigated by surveillance, collection and relocation of stranded fish and enhancement of certain habitat features to reduce stranding potential during low flows.

The transformation of reservoir habitat during reservoir operation has a great deal of uncertainty with regards to future habitat changes, and therefore the Proponent proposed to evaluate mitigation and compensation options by conducting follow-up monitoring. Although there were no technically feasible mitigation options for the loss of the riverine habitat due to reservoir creation, the Proponent instead proposed compensation by means of habitat enhancement works, where a construction activity presents an opportunity to provide potential fish habitat.

The Proponent proposed to address upstream fish passage at the Project by using a "trap and haul facility" that would include a fishway to lure the fish up to a collection, sorting, and loading facility. The fish would be anaesthetised, sorted, and placed into aerated tanks. Transportation would be done with trucks and watercraft capable of carrying tanks and other required equipment. Bull trout completing their upstream spawning migration would be the primary target species for upstream passage, but the facility would also accommodate Arctic grayling, mountain whitefish, rainbow trout, and other large fish that may attempt to pass upstream. Bull trout would be expected to be released into the Halfway River and other species may be

released into the Site C reservoir or other tributaries. Release protocols would be developed to minimize the risk of predation and subsequent entrainment, as well as to maximize the adjustment and survival of the transported species. The facility would be operated during the fish upstream migration window, expected to be April 1 to October 31 based on available information.

Long-term operation of the facility would be contingent on the formal evaluation of its effectiveness in meeting provincial fisheries management objectives, but the commitment is to provide for ongoing upstream fish passage if this is proven to be biologically required, as supported by the follow-up and monitoring program.

4.3.2 Views of Participants

The Alberta government showed interest in participating in the development of the fish and fish habitat mitigation and monitoring programs relevant to Alberta. BC Hydro agreed to consult with Alberta on the fish and fish habitat mitigation and monitoring plans and report on their implementation.

The Ministry of Forests, Lands and Natural Resource Operations (FLNRO) and Saulteau First Nations raised concerns regarding the Proponent's proposed "trap and haul" program as mitigation for bull trout. Saulteau First Nations said fish would get entrained in the turbines and be permanently lost from the reservoir.BC Hydro responded, stating that multiple facilities have already found this method to be successful and that its fish passage management plan would prevent entrainment. MFLNRO requested additional details on the design of the trap and haul program.

The Ministry of Forests, Lands and Natural Resource Operations (FLNRO) raised concerns over the mitigation measures of the Proponent. This led FLNRO to question the viability of a sustainable population and how that may affect the harvesting of fish species. FLNRO also suggested the expansion of the spatial scale for flow impacts to below the Pine River.

Rick Palmer and Alyssa Murdoch, presenting for Saulteau First Nations, made a number of recommendations in the areas of fish habitat compensation, fish stranding and riparian habitat loss, with the goal of identifying deficient mitigation measures or analyses and propose enhancements. Their recommendations included the development of a fish habitat compensation off-setting plan, further detail on the Proponent's fish salvaging program and estimates of the quality and quantity of predicted riparian habitat loss.

4.3.3 Panel's Analysis

The Panel concurs with the Proponent that mitigation would only be effective to eliminate the effects of sedimentation during the Highway 29 realignment and to eliminate the effects of stranding by careful monitoring and fish rescue during construction and by habitat enhancement and good design to eliminate stranding during operation.

The Panel supports the Proponent's planned trap and haul program but notes that it must be combined with a successful management plan to reduce entrainment, especially if bull trout is the targeted species.

These mitigation measures that BC Hydro determined would fully mitigate three of the identified effects to fish and fish habitat are important and should form part of the conditions of approval.

However, despite these and other proposed mitigation measures, as noted above, the effects of the Project on fish and fish habitat cannot be mitigated.

4.4 CUMULATIVE EFFECTS ASSESSMENT

4.4.1 Proponent's Assessment

Cumulative effects on the fish and fish habitat VC were classified by the Proponent as those residual effects from the Project that overlapped with the residual effects from the Dunvegan Hydroelectric Facility and the Montney Gas Play. These two projects lie in the RAA but have no effects in the LAA and therefore the residual effects from these projects would not act cumulatively with the Site C Project.

The Proponent also said in its narrative that the two upstream dams on the Peace River, the Bennett and Peace Canyon Dams, affected and continue to affect fish survival and limit movement of fish populations that have successfully colonized the reservoirs. The dams initially interrupted established patterns of upstream and downstream movement of fish in mainstem habitats in the Peace River. Upstream movements are currently completely blocked, and the dams now interfere with dispersal of fish to downstream environments, which may have consequences for genetic diversity. Passage of reservoir fish through discharge structures of the dams still occurs but also causes injury or mortality to some fish and, in general, reduces the potential productivity of upstream fish populations.

4.4.2 Views of Participants

Treaty 8 Tribal Association (T8TA) noted that the infrastructure and operation of the upstream facilities currently affect the aquatic habitat in the local area, including flow control, changes in thermal regime, sediment obstruction, entrainment, and fragmentation of the river corridor. It noted that the upstream dams should be included in the assessment of cumulative effects because fish passage through the Bennett and Peace Canyon Dams influences fish populations downstream. T8TA also noted that recruitment via entrainment may have an effect on upstream reservoir populations because the ability of the fish to move past the dams is blocked and those fish are, therefore, lost to the upstream populations. FLNRO noted that there could be some impacts to genetic diversity as a result of reduced connectivity along the river.

With reference to BC Hydro's identified downstream entrainment rates for fish species present in the upstream reservoirs, Saulteau First Nations expressed concerns that some species and life-stages of fish may be more likely to be entrained and then not able to return upstream because the "trap and haul" program would not be designed for them. FLNRO also noted that the assessment carried a degree of uncertainty and monitoring would be required to determine impacts to fish species in the reservoir and downstream. The representative noted that even though lake trout and bull trout are predicted to be the dominant predators in the system, if lake trout are out-competed, the sustainability of the population would be dependent on the entrainment from upstream.

4.4.3 Panel's Analysis

It appears to the Panel that the Site C dam would continue the effects currently experienced as a result of the two upstream facilities for another portion of the Peace River. The Proponent has stated that a balanced population structure would include all size or age groups in appropriate proportions. BC Hydro already reported the disproportionate representation of fish sizes in the

area below the Bennett Dam extending downstream beyond the Halfway River caused by the regulated flow regime from the upstream dams.

The Project would result in the probable extirpation of three species and would further unbalance the species diversity in the River through the ascendancy of kokanee, an introduced species, into the reservoir. The further blockage of fish passage combined with the warmer water releases downstream may also have consequences for genetic diversity in the large cool water fish species that would have migrated long distances up and down the river.

The Project, combined with the effects from the upstream dams would alter the species abundance and population distribution. This constitutes a cumulative effect.

When considering the effects of the existing two dams upstream, the Panel concludes that the Project would act cumulatively to affect fish throughout the remaining, previously undammed section of the Peace River in British Columbia.

The Panel concludes that the construction of the Project would result in significant adverse cumulative effects on fish.

5 VEGETATION AND ECOLOGICAL COMMUNITIES

The Panel's Terms of Reference require the Panel to assess the effects of the Project on Vegetation and Ecological Communities and the significance of those effects in a manner consistent with the requirements of the *Canadian Environmental Assessment Act, 2012* and the Agreement.

5.1 PROPONENT'S METHODOLOGY

BC Hydro used quantitative and qualitative methods to assess the effects of the Project on two key indicators for vegetation: terrestrial ecosystems and rare plants. Although all terrestrial ecosystems in the local assessment area (LAA) were mapped, the Proponent focused its effects assessment mainly on at-risk and sensitive ecological communities and federally and provincially listed rare plants.

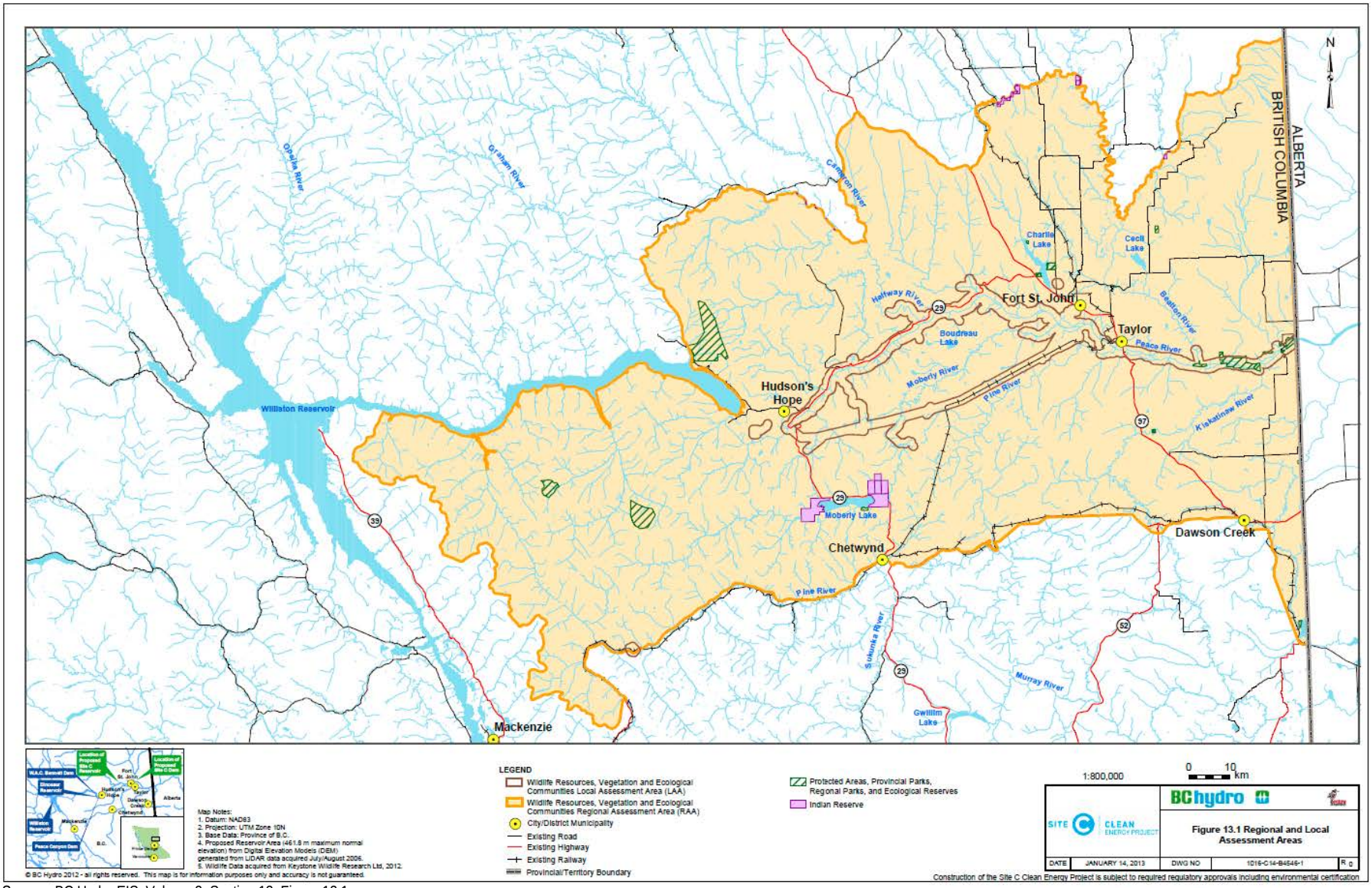
The quantitative assessment was completed using two Geographical Information System (GIS) methodologies that combined existing biophysical mapping (Terrestrial Ecosystem Mapping (TEM), and a broader habitat mapping (BHM), which were verified by ground-truthing. Changes to vegetation and ecological communities that were harder to quantify, such as edge effects, spread of invasive species, or effects due to changes in hydrology, were assessed qualitatively by the Proponent.

For the Vegetation and Ecological Communities valued component, BC Hydro defined the LAA as the Project activity zone with an additional buffer of 1,000 m. It extended downstream from the proposed dam site to the Alberta border. The LAA and the larger regional assessment area (RAA) are illustrated in Figure 7.

The Proponent's assessment on Vegetation and Ecological Communities focused mainly on the general effect of habitat alteration. BC Hydro defined habitat alteration as being the "temporary or permanent removal or loss of habitat or a reduction in habitat suitability." The Proponent determined that effects of the Project could occur as a result of clearing and grubbing during site preparation, changes in water flow regimes, inundation during reservoir filling, habitat changes along the new shoreline of the reservoir, competition with invasive species, contamination, dust deposition, and incidental anthropogenic disturbance.

The mitigation measures proposed by the Proponent for Vegetation and Ecological Communities are found in Appendix 9 of this report.

The Proponent evaluated the significance of residual environmental effects, taking into consideration the residual effects criteria and existing knowledge about the key indicators and the effectiveness of mitigation measures. The Proponent stated that, for species either provincially red-listed or federally listed as threatened or endangered, an adverse residual effect would be significant if the magnitude of the effect is predicted to be high (more than 20% change relative to baseline). For species with a lower listing category, an effect would be considered significant if the magnitude is predicted to be high and the effect may result in elevating the listing status of the species. For rare plants, the Proponent clarified that it looked at the loss of rare plant communities collectively, as opposed to conducting an assessment on individual plants.



Source: BC Hydro EIS, Volume 2, Section 13, Figure 13.1

Figure 7. Regional and Local Assessment Areas for the Vegetation and Ecological Resources VC

5.2 AT-RISK AND SENSITIVE ECOLOGICAL COMMUNITIES

5.2.1 Proponent's Assessment

The Proponent reported that the area of terrestrial ecosystems mapped in the LAA covers 86,424 hectares. It calculated the LAA comprised deciduous forest (44%), coniferous forest (23%), anthropogenic ecosystems (12%), water (8%), wetland (5%), floodplain forest (3%), and non-vegetated areas (2%). The Proponent said the Project components would overlap with over 15,000 hectares, or 17% of the LAA, but that the majority of ecosystem units within the LAA would lose less than 15% relative to the total area available. BC Hydro concluded that the ecosystems that would sustain the largest proportional loss would be the most prominent ones in the LAA: the valley bottom forest and the riparian wetland types that overlap with the reservoir.

The Proponent defined at-risk ecological communities as being provincially red- or blue-listed. Red-listed species are species extirpated, endangered, or threatened in British Columbia, whereas blue-listed species are considered to be of special concern (see Appendix 8 for further details). In predicting effects to at-risk ecological communities, the Proponent assumed that any ecosystem associated with an at-risk ecological community would contain that community. BC Hydro said this constituted a conservative approach that likely overstated the actual effects of the Project on at-risk ecological communities.

The Proponent reported that 2 red-listed and 15 blue-listed ecological communities potentially occur in the LAA. The Proponent determined that the blue-listed riparian and floodplain forests would be the most impacted, with a loss of 45% and 43% of the communities found in the LAA (Table 2). The blue-listed White spruce-Lodgepole pine/Soopolallie/Showy aster would also be highly impacted with a potential loss of 44%.

Table 2. Areas of Ecosystem Units Associated with At-Risk Ecological Communities Potentially Affected by the Project

Ecosystem Unit and Associated At-risk Community	Total area in LAA (ha) – Ecosystem Units	Areas of Ecosystem Unit potentially affected by the Project[1] (ha) (construction and operation)
Sedge Wetland Arctic rush - Nuttall's alkaligrass – Seablite [R] Mat muhly - Arctic rush - Nevada bluegrass [R] Common cattail marsh [B] Scrub birch /Water sedge [B]	1169	197
Willow Sedge Wetland Scrub birch /Water sedge [B]	363	66
Spruce Oak Forest White spruce/Oak fern – Wild sarsaparilla [B]	1215	449
Riparian Forest White spruce/Red swamp currant/ Horsetails [B]	1699	766
Black Spruce-Labrador Tea White spruce - Black spruce /Labrador tea/Glow moss [B] Black spruce/ Common horsetail/ Peat-mosses [B] Black spruce/ Lingonberry/ Peat-mosses [B]	2051	151

Floodplain Forest Balsam poplar – White spruce /Mountain alder – red-osier dogwood [B]	2664	1135
Tamarack Sedge Tamarack/ Water sedge /Golden fuzzy fen moss [B]	1405	115
White Spruce White spruce – Lodgepole pine/ Soopolallie/ Showy aster [B]	52	23
Shore Sedge Narrow-leaved cotton-grass – Shore sedge [B]	9	<1
Lodgepole Pine Huckleberry Lodgepole pine/Black huckleberry/ Reindeer lichens [B]	70	25

[1] These numbers represent the areas for ecosystem units associated with ecological community at-risk, but do not necessarily reflect the area of the actual ecological community at-risk.
[R] red-listed
[B] blue-listed
Source: Modified from EIS, Volume 2, Section 13, Table 13.8, pp. 13-16, 13-17 and Appendix R – Part 1, Table 1.2.4, p. 47, 48

Sensitive ecosystems differ from at-risk communities because, while they are not necessarily red- or blue-listed, they are considered ecologically fragile. The Proponent defined “ecologically fragile” as having little resilience and resistance to imposed stresses. Sensitive ecosystems include wetlands, old-growth forest and Old Growth Management Areas, tufa seeps, marl fens, grasslands, and communities with the highest ranks (i.e.1 or 2) for Goal 2 (i.e. prevent species and ecosystem from becoming at risk) of the BC Conservation Framework that are not red- or blue-listed (see Appendix 8 for further details) (Table 3).

The Proponent determined that five of the seven tufa seeps found in the LAA would be directly affected by the Project, and that the only marl fen found at Watson Slough wetland complex would be lost. The Proponent acknowledged that tufa seeps and marl fen are unusual ecosystems that cannot be recreated.

BC Hydro predicted that 5 percent of old-growth forest and 10 percent of grasslands found in the LAA could potentially be lost as a result of the Project.

The Proponent also identified wetlands as sensitive ecological communities and studied them in more detail. BC Hydro noted that 20 percent of wetlands would be lost as a result of the Project.

Table 3. Areas of Ecosystem Units Associated with Sensitive Ecological Communities Potentially Affected by the Project

Ecosystem Unit for Sensitive ecological communities	Total area (ha) in the LAA	Areas potentially affected by the Project (ha)
Grasslands	2667	277
Old-growth forest	1131	46
Wetlands (6 vegetated and 2 water units)	4074	796
Tufa seeps	7	5 lost
Marl fen	1	1
Communities ranked as high priority by the BC Conservation Framework	305 ha	27

Source: Modified from EIS, Volume 2, Section 13, Table 13.10, p, 13-18, Table 13.11, p. 13-19 and Appendix R – Part 1, Table 1.2.5, p. 50

The Proponent identified four different types of wetlands - bogs, fens, marshes, and swamps -

covering 4,074 hectares or 20% of the LAA. It stated that the Project would result in the loss of 796 hectares of wetlands; 675 hectares of these would be lost as a result of clearing activities, site preparation, and subsequent reservoir filling. An additional 121 hectares of wetlands could also potentially be affected through vegetation maintenance activities along the transmission line corridor. The Proponent noted that the effects of the transmission line are likely an overestimate and that some could be avoided depending on the tower locations.

Wetlands affected by the Project include the Watson Slough and Bear Flat complexes The Proponent noted that riparian wetlands would be the most affected by the Project, with a loss of 39% of the total 1,010 hectares available in the LAA (Table 4).

BC Hydro provided information on the specific functions of the Watson Slough and the Bear Flat wetlands complexes and a more general description of wetland functions in the remainder of the LAA. It said low elevation wetlands and plateau wetlands provide a variety of functions that are similar in nature. These include: providing fish, migratory birds, and other wildlife habitats; supporting biodiversity; and maintaining hydrology.

Table 4. Areas of Ecosystem Units Associated with Wetland Communities Potentially Affected by the Project

Ecosystem Unit for Wetlands	Total Area (ha) in LAA	Area Potentially Affected by the Project (ha)(%)
Shallow Open water	75	18
Pond	34	7
Sedge Wetland	1169	197
Willow-Horsetail-Sedge-Riparian Wetland	1010	393
Willow-Sedge Wetland	363	66
Tamarack-Sedge-Fen	1405	115
Narrow-leaved cotton-grass-Shore Sedge	9	<1
Scrub birch-Water sedge	10	0

Source: Modified from EIS, Volume 2, Section 13 and Appendix R - Part 1

BC Hydro said it would prioritize avoidance and reduction of Project effects to wetlands to the extent possible. However, where avoidance is not possible, it would replace lost wetland habitats by either improving functions of existing wetlands or creating new wetlands with similar functions to those lost to the Project. BC Hydro committed to partnering with Ducks Unlimited in developing its Wetland Mitigation and Compensation Plan. To this end, the Proponent stated that sites within 1 km of the project area would have priority, followed by existing Ducks Unlimited projects within the Peace region and other areas progressively further away. BC Hydro mentioned that the extent of wetlands to be created or enhanced would be determined in consultation with regulatory agencies, but that they had acquired suitable lands already.

BC Hydro concluded that the adverse residual effects on certain ecological communities, such as old and mature riparian and floodplain forests, would be significant because the sustainability of these communities could be threatened and their provincial status may be elevated from blue to red. The Proponent concluded that loss of wetlands would not result in a significant effect because the magnitude would not be high and several wetland complexes found in upland forests and plateaus would not be affected. In addition, the enhancement of existing wetlands and creation of new ones would help reduce the effects.

5.2.2 Views of Participants

The British Columbia Natural Resource Sector agencies noted that overall they were satisfied with BC Hydro's assessment, with regards to baseline habitat mapping and methodology it used for the EA. They stated, however, that the baseline habitat mapping used could result in the over- or underestimations of ecosystem types and render the results less accurate and reliable. They further noted that possible mischaracterisation of some ecosystem types critical for specialist wildlife species or ecological communities could lead to inaccurate estimation of habitat availability, Project effects, and mitigation effectiveness. They made recommendations for subsequent detailed mitigation and compensation planning at the permitting stage.

Environment Canada advised that the Federal Policy on Wetland Conservation applies to federal departments considering projects under the CEAA, 2012. Wetland losses have to be linked to the issuance of federal permits, licences, authorizations, and other instruments under federal jurisdictions that may be applicable, or the associated wetland functions have to support areas of federal jurisdictions (e.g. migratory birds).

EC pointed out that the Federal Policy on Wetland Conservation is based on a no-net-loss of wetland functions objective, and as such, functions need to be considered when assessing impacts to wetlands. This goal can be achieved through three mitigation strategies, which are recommended to be applied in hierarchical order: (1) avoidance of impacts; (2) minimization of unavoidable impacts; and (3) compensation for unavoidable impacts.

EC expressed concerns with the Proponent's assessment of wetland functions, stating that it did not provide sufficient information about specific wetlands in the LAA. Because of this noted lack of specificity, the department was unable to assess the effectiveness of mitigation measures. It said, therefore, that Project impacts may have been underestimated.

EC qualified the Peace River region as a biodiversity hotspot and that the Peace River valley is a unique east-to-west passage of the Rocky Mountains that is below 1,000 metres elevation and has a milder climate than adjacent areas. This unique microclimate makes it one of the last northern areas to be covered in snow and one of the first where it melts. EC said historical surveys and surveys in the Environmental Impact Statement indicate that the valley constitutes an important low-elevation habitat. In EC's opinion, BC Hydro did not provide evidence to support its argument that upland plateau habitat and valley habitat provide the same ecological functions with regards to migration. Several other participants during the hearing commented on the uniqueness of the valley habitats and microclimate.

EC recommended that BC Hydro complete a wetland compensation plan in collaboration with the department and other interested and implicated agencies and Aboriginal groups. It should include and address effects to project-specific wetland functions and, at a minimum, ensure a full replacement of the wetlands lost in terms of area and function. It also recommended, because wetlands are hard to recreate and restoration is uncertain, that BC Hydro use a compensation ratio of 2:1 or 3:1, which could vary by project. It further recommended prioritizing wetlands restoration over enhancement and enhancement over creation.

EC requested that, in addition to wetlands monitoring to assess potential impacts to structure and composition, pre-construction and operation monitoring of migratory birds and species-at-risk use should be conducted in order to assess potential changes in wetland functions.

5.2.3 Panel's Analysis

The Panel recognizes that some ecosystems that are uncommon to the region, such as riparian and floodplain forests, tufa seeps, and marl fen, cannot be recreated and would be lost as a result of the Project. These effects would be permanent and irreversible.

The Panel understands that the magnitude of the effects to at-risk and sensitive ecological communities ranges from low (less than 10% change relative to baseline) to high (over 20% change relative to baseline), with the majority of effects being moderate to high. Furthermore, the Panel understands that some at-risk ecological communities could see their provincial status elevated from blue to red, and it takes this conclusion seriously.

The Panel notes that effects to at-risk ecological communities were determined by looking at the area of associated ecosystem units potentially lost to the Project. While the Proponent stated that this approach likely overestimated the effects to these communities, the Panel believes that the contrary is also possible. That is to say, that because the extent and location of each at-risk ecological community has not been determined, the Project could potentially remove the entire community even if areas of associated ecosystem units still remain.

The Panel acknowledges that the British Columbia Natural Resource Sector agencies were generally satisfied with BC Hydro's baseline habitat mapping but notes the issues and the uncertainties surrounding the models. The Panel, therefore, considers that with British Columbia Natural Resource Sector agencies recommendations that the results of the additional work proposed could help inform the development of appropriate mitigation measures if the Project were to proceed.

The Panel agrees with BC Hydro that the effects of the Project to at-risk and sensitive ecological communities would be significant.

RECOMMENDATION 4
In order to improve the accuracy and reliability of the baseline mapping and habitat interpretations and to inform mitigation measures and compensation, the Panel recommends that, three months before any activity affecting these habitats, BC Hydro must review its modeling and complete the field work needed to improve identification of rare and sensitive communities and aid in delineation of habitats that may require extra care in the development and operation of the Project.

BC Hydro acknowledged that effects to some wetland ecological communities considered at-risk would be significant as a result of the Project. However, because the magnitude was not considered high for wetland losses in general, the overall conclusion on wetlands was these effects would not be significant. The Proponent further stated that that numerous wetland complexes would still be available in upland forests and plateaus, and that these would be enhanced or new ones created.

The Panel found BC Hydro's description of differences in wetland function between the upland and valley bottom wetlands to lack specificity in terms of functions provided to, among others, wildlife. EC said the valley bottom provided a unique climate, and the Panel believes that it is reasonable to assume that wetland complexes in the Peace River valley support different and potentially unique functions not found in upland plateaus.

The Panel acknowledges the Proponent's commitment to develop a wetlands compensation plan that would offset some of the functions lost and would propose mitigation measures such as the design of the transmission line that could potentially reduce the impact to wetlands. The Panel agrees with EC that wetlands are hard to recreate and that restoration is uncertain. As such, the Panel believes that after mitigation the effects would still be significant.

Therefore, because wetlands are difficult to recreate and upland and lowland wetlands are different, the Panel does not agree with the Proponent's rationale as to why the effects of the Project on wetlands would not be significant. Furthermore, the Panel disagrees that the magnitude for effects on wetlands is not high. The Proponent's threshold for high magnitude is 20% of changes relative to baseline. The amount of wetland potentially lost as a result of the Project is 19.6% for all wetlands, including 39% of riparian wetlands found in the LAA.

The Panel disagrees with BC Hydro and concludes that the Project would have a significant adverse effect on wetlands, in particular valley bottom wetlands.

The Panel understands that the Federal Policy on Wetland Conservation applies to the Project because of the decision-making authority of the federal government under CEAA 2012. This Policy is based on a no-net-loss of wetland functions and should guide the development of the Proponent's Wetland Compensation Plan.

The Panel agrees with EC that wetland functions were not described specifically for this Project, but were instead described generally for wetlands, and specific species were not identified. The Panel agrees with EC's recommendations with regards to wetland functions monitoring and compensation plan.

RECOMMENDATION 5
The Panel recommends that, if the Project proceeds, BC Hydro must conduct an assessment of wetland functions lost to the Project that are important to migratory birds and species at risk (wildlife and plants). The Panel also recommends BC Hydro monitor construction and operation activities that could cause changes in wetland functions. The results must inform the development of the mitigation measures to ensure wetland functions at least meet federal and provincial regulatory and policy requirements. BC Hydro must consult with Environment Canada and the Ministry of Forests, Lands and Natural Resource Operations on the duration and frequency of monitoring in relation to migratory birds and species at risk and other wildlife using wetlands.

RECOMMENDATION 6
The Panel recommends that, if the Project proceeds, BC Hydro must complete a Wetland Compensation Plan that includes the results of the functions assessment, surveys, and monitoring program identified above. In developing the Wetland Compensation Plan, BC Hydro must:

a) Discuss migratory birds and species at risk with Environment Canada, the Ministry of Forests, Lands and Natural Resource Operations and Aboriginal groups;

b) Ensure that the Wetland Compensation Plan achieves a full replacement of the wetlands lost in terms of functions and compensates in terms of area;

c) Consult with interested and implicated agencies on the draft Wetland Compensation Plan to ensure effects on Crown land are considered; and

d) Submit the final Wetland Compensation Plan to Environment Canada and other relevant authorities no later than three months prior to any activity affecting the wetlands.

5.3 RARE PLANTS

5.3.1 Proponent's Assessment

BC Hydro identified 39 species of at-risk vascular plants (242 occurrences) known to occur in the LAA. Of these, 11 are provincially red-listed and 28 are provincially blue-listed. The Proponent also reported three blue-listed moss species (5 occurrences) and five blue-listed and five red-listed lichens (28 occurrences) in the LAA. No species listed on the *Species at Risk Act* (SARA) or ranked by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) were found in the LAA.

BC Hydro determined that 142 occurrences of listed vascular plants in the LAA, or 59%, could be affected by the Project during construction and operation. In addition, the Proponent said that all 5 occurrences of listed mosses and all 28 occurrences of listed lichens could be affected by the Project. It added that, for several species of rare plants, the Project would potentially affect their only known occurrences in the LAA. For example, the reservoir would remove 63 known rare vascular plant occurrences, 6 of which are only known to occur at Watson Slough wetlands complex.

The Proponent said the majority of effects would occur during site preparation in the construction phase, reservoir filling, and dam construction, but that effects could also result from changes in downstream water regimes and vegetation maintenance along the transmission line.

BC Hydro concluded that, given the lack of data on how rare plants in the LAA would respond to disturbance, the lack of complete distribution data, and the uncertainties about the effectiveness of mitigation measures, its approach to predict Project effects likely overestimated the actual effects to rare plants. Accordingly, it committed to conducting targeted surveys in the RAA of directly affected rare plants to record additional occurrences and provide the data to the Conservation Data Center. It also committed to consult with EC regarding pre-construction surveys and provide the results. Additional mitigation measures are provided in Appendix 9.

The Proponent concluded that the residual effects of the Project on rare plants would be significant because mitigation measures may not be fully effective and the sustainability of their regional population would be threatened.

5.3.2 Views of Participants

EC noted that mosses and lichens constitute 42% of all potentially occurring rare plants in the LAA, based on the Proponent's literature review, and that BC Hydro's survey efforts for these plants were insufficient. As such, EC was unable to assess potential Project effects and develop appropriate mitigation measures.

The British Columbia Ministry of Forests, Lands and Natural Resource Operations (FLNRO) said that the assessment of rare plants was thorough, but agreed with the recommendation of conducting additional pre-construction surveys. When asked to comment on the capacity of provincially listed species to adapt to habitat changes, it explained that species at risk are typically habitat specialists that may not respond well to variation. It pointed out that a number of rare plants species seem to be restricted to the Peace River valley. and that, while little is known on some of these species, they could be expected to have low resilience.

FLNRO said the Project would likely change the provincial and potentially the federal listing status for some species. It highlighted two species of rare plants (persistent-sepal yellowcress and peace daisy) that appear to be found only in the Peace River valley within the proposed reservoir area, and that, unless they can be found elsewhere, these species would be presumed extirpated. It also pointed out that the status of two red-listed species restricted to the Peace region (Herriot's sage and old man's whiskers var. *triflorum*) could be elevated to the most imperilled rank. Several other species that have a restricted distribution in B.C. could also see their status being elevated, but FLNRO said they had limited information to make a determination.

In response, BC Hydro provided additional details on four of the identified species of rare plants. It said the persistent-sepal yellowcress and the peace daisy were not included in its assessment of effects to rare plants because they had not been assigned a listed status when the EIS was written. It said the persistent-sepal yellowcress was not known to occur in B.C. before BC Hydro's 2008 surveys, and other occurrences may exist elsewhere in the Peace region. For peace daisy, the Proponent said this new species was only recently described by the Conservation Data Center, and although the only known occurrence in B.C. is adjacent to the proposed reservoir, mitigation measures may be able to preserve it. For, BC Hydro said the Project would affect 23 of the 40 known occurrences of Herriot's sage in the LAA, but its status would likely remain unchanged. The Proponent further said the status of old man's whiskers was recently elevated from yellow to blue and, as such, had not been included in the effects assessment to rare plants, but that pre-construction surveys would be undertaken to identify occurrences in the LAA.

5.3.3 Panel's Analysis

The Panel is concerned by FNLRO's views that the Project could further elevate the listing status of several species and potentially extirpate two rare plant species that are only found in the reservoir area. The Panel believes that preserving biodiversity is very important, as discussed in Section 13.5.

The Panel considers that a loss of 65% of known occurrences of rare plants in the LAA is very high. The Panel also acknowledges that the capacity of these plants to adapt to change is not well understood, but that, given their listed status, they are most likely habitat specialists that have low resilience.

The Panel notes EC concerns with the lack of survey efforts for listed mosses and lichens and

agrees with BC Hydro's commitment to undertake additional pre-construction surveys to confirm the presence of rare plants and make adjustments to Project design to the extent feasible. These survey results should be made available to the Conservation Data Centre and EC. The Panel agrees with all other mitigation measures and follow-up programs proposed by the Proponent and believes that they should be implemented if the Project proceeds. However, the Panel believes that after these mitigation measures the effects to rare plants would still be significant.

While the Panel agrees with BC Hydro's determination that the Project would cause a significant effect on rare plants, the Panel finds that these effects would be significant for more rare plants species than identified by BC Hydro.

The Panel agrees with BC Hydro that the Project would cause significant adverse effects on rare plants.

RECOMMENDATION 7
The Panel recommends that, if the Project proceeds, BC Hydro must undertake surveys no later than three months prior to any activity affecting rare plants to determine whether the rare plant species potentially facing extirpation are found elsewhere in the region. If the plants cannot be found elsewhere, appropriate conservation methods to ensure the viability of the rare plant species must be put in place, such as ensuring that seeds are kept or relocation of plant communities is attempted.

5.4 PLANTS OF INTEREST TO ABORIGINAL GROUPS

5.4.1 Proponent's Assessment

The Proponent provided a list of plant species and their associated ecosystems that were gathered by Aboriginal groups as identified in their Traditional Land Use studies. The Proponent did not conduct a specific assessment of potential effects on traditional plants, but considered the collection of food and medicinal plants in its assessment of potential effects to "Changes in other cultural and traditional uses of the land."

The Proponent said that the gathering of plant foods was culturally and economically important for the 29 Aboriginal groups considered in the assessment. Because the Project would be likely to adversely affect terrestrial ecosystems and rare plants, BC Hydro said the same effect pathway would reasonably be expected to apply to traditional plants. For example, the clearing of vegetation and site preparation, the filling of the reservoir, and the transmission line construction would likely have an impact on terrestrial ecosystems and, therefore, also on traditional plants. The Proponent concluded that the Project would likely reduce the opportunities for some Aboriginal groups to continue harvesting plants and berries in the LAA. Plants and berries found in the inundation zone would be lost. In other areas, and depending on Project activities, a number of plants may survive and recolonize the new environment.

In response to questions from the Panel, the Proponent provided the scientific names of the traditional plants (although not verified with Aboriginal groups) and additional information on the proportion of land that could be affected by the Project for each plant. The Proponent identified 33 species of plants were reported by Aboriginal groups; of those, 22 species would lose 20% or less of their associated ecosystem in the LAA, 6 would lose between 21% and 26%, 1 would

lose 34%, and 4 were not observed during rare plant surveys in the LAA. The Proponent said that the presence of a plant in a given ecosystem had not been confirmed through fieldwork. It commented that it was not possible to provide further description of traditional plants because Aboriginal groups had been unable to provide sufficient spatial resolution.

The Proponent proposed to work with Aboriginal groups to identify the location of traditional plants or potential sites for relocation and/or develop a restoration project to compensate for areas lost. The Proponent committed to use only indigenous and/or non-invasive plants and grasses in its revegetation programs. The Proponent noted that it could also provide funding for an indigenous plant nursery. The measures proposed to mitigate effects on terrestrial ecosystem and rare plants would also be appropriate for traditional plants.

The Proponent concluded that a significant effect was likely on some ecosystems where traditional plants could be found and some important cultural sites in the valley would be significantly affected by the Project. A conclusion specific to traditional plants was not provided.

5.4.2 Views of Participants

Several Aboriginal groups raised concerns about the loss of traditional plants.

Dr. Sheri Gurshell, on behalf of Saulteau First Nations, said the Proponent had not assessed the Project's impacts on traditionally important plants, although the data seemed available. She said analysis of additional baseline data is needed to inform the development of the Proponent's proposed habitat compensation and reclamation plan. She recommended an impact assessment of plants and area used by Saulteau First Nations and that the community be involved in the development of the mitigation, monitoring, and reclamation of Project and indirect effects. She also requested that the Proponent be required to support the Twin Sisters Native Plant Nursery.

West Moberly First Nations expressed concerns about the contamination of edible and medicinal plants by pesticides used by BC Hydro, forestry, the oil and gas industry, and the Ministry of Transportation. They said the use of pesticides contributes to the loss of trust in the quality of harvested resources.

Treaty 8 Tribal Association (T8TA) said some rare medicinal plants, found near creek edges and waterways. are in the vicinity of the proposed dam site, including a plant used to cure lung ailments. Some medicinal and food plants, such as wild onion and prickly pear cactus, grow preferentially or solely in the Peace River valley. T8TA also said that sage, a rare medicinal plant growing on the south-facing slopes of the Peace River valley, would be lost with the Project, adding these medicinal plants are difficult to find elsewhere.

5.4.3 Panel's Analysis

The Panel acknowledges that the Proponent conducted an assessment of harvesting sites used by Aboriginal groups and determined that some culturally important sites along the river would likely be significantly impacted.

However, the Panel believes the assessment of effects to traditional plants was cursory and therefore does not give an accurate picture of potential effects to specific traditional plants. While the assessment indicates that the Proponent had an understanding of harvesting sites in the LAA, it did not survey traditional plants in these areas. The only information provided by the Proponent relates to areas of general ecosystems associated with traditional plants that are

potentially impacted. Similar to the Panel's conclusion on BC Hydro's assessment on at-risk and sensitive ecological communities, this carries a degree of uncertainty when the assessment is based on the ecosystem effects, as opposed to the effects on plant species. Adding to the uncertainty, the Proponent based its assessment on unconfirmed plant names and did not conduct field verification.

While recognizing the challenges of obtaining adequate spatial resolution data to conduct the assessment, at a minimum, the Proponent could have ensured that it confirmed which plants are being used by Aboriginal groups and their locations. This may have required targeted surveys of traditional plants at harvesting sites to get a better understanding of the plants likely to be impacted.

The Panel seriously considered the comments by Aboriginal groups regarding plants that are difficult to find and/or seem to grow only in the Peace River valley. Depending on whether some of these plants would still be available in sufficient quantity and accessible if the Project proceeds, this could constitute a significant effect.

Given the lack of assessment by BC Hydro, the Panel cannot conclude on effects of the Project on plants of interest to Aboriginal groups.

RECOMMENDATION 8
The Panel recommends that, if the Project proceeds, BC Hydro must conduct a comprehensive assessment of effects on traditional plants in collaboration with Aboriginal groups, three months before any activity affecting the plants, to identify areas where plants of interest may be. The results should be used to improve the measures needed to fully mitigate any adverse effects of the Project on plants traditionally used by Aboriginal groups.

RECOMMENDATION 9
The Panel recommends that, if the Project proceeds, BC Hydro be prohibited from using herbicides and pesticides near locations of plants of importance to Aboriginal groups.

5.5 CUMULATIVE EFFECTS ASSESSMENT

5.5.1 Proponent's Assessment

BC Hydro determined qualitatively that foreseeable projects in the RAA would likely result in residual effects to vegetation and ecological communities and act cumulatively with the residual effects of the Project. BC Hydro did not propose additional mitigation measures for cumulative effects and stated that it had limited authority to guide regional initiatives that would be better guided by provincial government.

The Proponent said 53% of the RAA had been mapped and the LAA made up 9% of this mapped area. It provided information about general habitat types found in the RAA, but noted that, because quantitative data for other projects were limited, it was not possible to give a quantitative description of the combined effects of the Project with other projects.

The Proponent said the RAA comprised of coniferous and deciduous forests (65%), anthropogenic ecosystems (29%), and wetlands (2%). Floodplain forest was identified as one of the rarest ecosystems found in the RAA, making up less than 1% of the RAA. Of this area, 95% was in the LAA, mainly on the Peace River valley bottom. Floodplain forest supports at-risk ecological communities and has been identified as one of the most impacted ecosystems by the Proponent, with a potential loss of 43% as a result of the Project. The Proponent did not identify the number of tufa seeps and marl fens in the RAA, but said they are rare formations in B.C. and would be highly impacted by the Project.

No surveys of rare plants were conducted outside the LAA, but the Proponent indicated that rare plants were found frequently during the Project surveys so it was reasonable to assume that high-suitability rare plant habitats similar to those found in the LAA contained undiscovered occurrences as well.

The Proponent provided qualitative information about effects of the two existing dams on vegetation communities. It acknowledged the loss of vegetation communities such as floodplain and riparian habitats including wetlands due to filling the two previous reservoirs.

The Proponent said past and current anthropogenic developments had significant impacts on vegetation and ecological communities, impacts that are ongoing. It concluded that the cumulative effects resulting from the Project would likely be significant because the Project effects are considered significant and the region is already significantly impacted.

5.5.2 Views of Participants

Dr. Annette Luttermann, on behalf of Treaty 8 Tribal Association, said the range of ecosystem historical variability needed to be understood to better predict potential impacts to riparian and floodplain habitats. She said the September 2012 baseline used by BC Hydro for the cumulative effects assessment does not fully account for the ongoing effects of previous developments on the Peace River; upstream projects altered the integrity of these habitats, and current conditions are still adapting to water flow changes and will continue to do so for decades. Dr. Luttermann said that, although the Proponent acknowledged that there would be significant effects to riparian and floodplain communities, fragmentation of the riparian corridor is not well described. Understanding connectivity of the riparian habitats along the whole length of the river, including historical characteristics and changes and their functions in a region, is key to understanding cumulative effects to the whole ecosystem. Terrestrial and aquatic plants and animals typically use connected riparian habitats to disperse and move up and down rivers. She also said that riparian habitats of large rivers usually have richer biodiversity and represent some of the most productive habitat within a broader region.

Dr. Faisal Moola, Director General, Ontario and Northern Canada of the David Suzuki Foundation qualified the region as being exposed to an unprecedented intensity of human land use. He stated that more than 20 percent of the Peace region had been impacted by land use change and that if a 500m ecological buffer is added to this, more than 66 percent of the region would have been impacted. He noted that this buffer is a well-known published threshold about the ecological impacts of land use that go beyond the direct footprint of development. He stated that the region has a very low level of protection for wildlife with only 4.2 percent of the region currently protected.

He presented the report *The Atlas of Land Cover, Industrial Land Uses and Industrial-Caused Land Changes in the Peace Region of British Columbia*, which found that in 2012, within the 56,118 km^2 study area, there were 16,267 oil and gas well sites, 8,517 petroleum and natural

gas facilities, 358 km^2 of oil and gas pipeline rights-of-way, and 9,781 km^2 of active oil and gas tenures.

Numerous participants also commented on the high level of anthropogenic disturbance in the region in the past decades, especially from hydroelectric projects, oil and gas industries, forestry, and agriculture.

5.5.3 Panel's Analysis

With respect to activities that have been carried out, the Panel agrees with the Proponent and participants that the region has been and is still being impacted by anthropogenic developments. The fact that 29% of the area mapped within the RAA is considered anthropogenic ecosystem is also compelling. Effects on vegetation and ecological communities, namely the loss of riparian habitats due to the existing dams, are also undeniable. The Panel agrees that the cumulative effects on vegetation and ecological communities are likely already significant and are going to become more so with the planned development in the region. The maps provided by participants demonstrating the level of disturbance caused by gas wells, in particular, are striking. Their surface areas, attendant water requirements for fracking, associated service roads, gathering pipelines, straddle plants, and transmission lines may be constructed even before the in-service date of the Project. The Panel believes that the case of "already significantly impacted" is understated in the region.

Although limited quantitative information on foreseeable projects is available, the Panel agrees with the Proponent that it is reasonable to assume that the footprint of each of these projects and activities is likely to have an effect on vegetation and ecological communities.

The Panel does not accept the Proponent's assumption that, since rare plants occur frequently in the LAA, they must also occur frequently in the RAA. As described in Section 5.3, some of these plants seem to be restricted to the Peace River valley and could see their status elevated as a result of the Project. The assessment would have been stronger if the Proponent had conducted field surveys and determined species-specific distribution in the RAA. As it stands, the Panel has low confidence in BC Hydro's significance determination for cumulative effects on rare plants.

Notwithstanding the lack of information on rare plants and other ecological communities in the RAA, the significant effects of the Project combined with the already significant cumulative effects and the effects of future projects can only be significant. However, the Panel notes that the Project would affect 40% of the floodplain forests available in the region. The Panel, therefore, views the Project as a serious contributor to the significant cumulative effects.

The Panel agrees with BC Hydro that cumulative effects on vegetation and ecological communities would be significant.

6 WILDLIFE RESOURCES

The first section of this chapter describes the Proponent's methodology and provides the Panel's observations on issues raised by participants. The following sections focus on the effects assessment for certain indicator groups which the Panel considers most likely to be impacted or where many issues were raised by participants. These indicator groups are namely species at risk, migratory birds and ungulates. The last section addresses cumulative effects of the Project on wildlife.

6.1 PROPONENT'S METHODOLOGY

6.1.1 Proponent's Assessment

BC Hydro assessed effects to the wildlife valued component (VC) using the following eight species groups: butterflies and dragonflies; amphibians and reptiles; migratory birds; non-migratory game birds; raptors; bats; furbearers; ungulates; and large carnivores. For each of these groups, key indicators were also selected. For example, grizzly bear and wolves were the key indicators for large carnivores. Species were selected as key indicators if they were provincially and/or federally listed species, a species of regional management concern or a harvested species. BC Hydro said their approach accounted for nine years of early and continued consultation with regulatory agencies and Aboriginal groups and of field studies.

BC Hydro excluded several species from the assessment: ptarmigan, muskrat, squirrel, snowshoe hare, American marten, wolverine, Canada lynx, bison, caribou, black bear and cougar. For ptarmigan and bison, the Proponent determined that no interaction with the Project was expected. For muskrat, American marten, and black bear, BC Hydro said they had been assessed under the umbrella of other key indicators, respectively the American beaver, fisher and grizzly bear. For the remaining species excluded, the Proponent said that low interaction with the Local Assessment Area (LAA) was expected, or that, based on species characteristics, the Project would not result in changes in the population.

When asked by the Panel to conduct an effects assessment for small mammals, lynx, cougar and black bear, the Proponent reiterated that these species are not at risk, are habitat generalists and that the Project effects on them would not be significant. Subsequently, BC Hydro determined that squirrels could lose between 16 and 22% of suitable habitat in the LAA, snowshoe hare could lose 13% and black bear could lose 18%. BC Hydro said the numbers were imprecise because no field verification was conducted.

The LAA for the wildlife VC included the Project activity zone, extending downstream from the dam to the Alberta border, buffered by one kilometre. The regional assessment area (RAA) included most of the Peace lowlands ecosection and incorporated all Project components and activities. BC Hydro said the RAA was based on five Wildlife Management Units (MU 7-31, 7-32, 7-33, 7-34, and 7-35) that provided a larger area of RAA than the Environmental Impact Statement Guidelines required. When asked how wide-ranging animals were considered in the selection of spatial boundaries, the Proponent said the one-kilometre buffer was conservative for most species and wide-ranging animals had been considered in the characterization of the geographic extent of the effects (Figure 7; p.58).

BC Hydro assessed the potential for the Project to result in habitat alteration and fragmentation, disturbance and displacement, and direct and indirect mortality to individual animals in each species group.

It used a GIS-based approach to assess changes to habitat including fragmentation for most key indicator species of butterflies and dragonflies, amphibians and reptiles, non-migratory game birds, raptors, bats and most migratory birds. The Proponent determined that the habitat modelling was not effective for predicting effects to swallows, waterfowl, shorebirds and the olive-sided flycatcher. Effects of habitat alteration and fragmentation on ungulates and fisher were assessed using Resource Selection Function modelling and tree density modelling, respectively.

For all indicator species, the assessment of potential effects due to disturbance and displacement was conducted qualitatively and considered both timing and extent of disturbances in adjacent suitable habitats.

The Proponent reported that effects to wildlife due to mortality were hard to quantify and as such, conducted a qualitative assessment of the likelihood of mortality taking into account the timing and frequency of activities as well as the proximity of roads and Project components to suitable habitat.

The mitigation measures proposed by the Proponent for wildlife are found in Appendix 9 of this report.

The Proponent evaluated the significance of each residual environmental effect taking into consideration the residual effects criteria of direction, magnitude, geographical extent, duration, frequency, reversibility, context, level of confidence and probability and, existing knowledge about the key indicators. The Proponent assessed whether the effect could threaten extirpation of a key indicator, elevate the provincial or federal listing status or cause the key indicator to become a management concern. The Proponent said an adverse residual effect would be significant if the magnitude of the effect was high (more than 20 percent change relative to baseline) and if the species was either provincially red-listed or federally listed as threatened or endangered. For species with a lower listing category, an effect would be considered significant if the magnitude was high and the effect may result in elevating listing status.

The Proponent concluded that the effects of the Project would be significant for five species of migratory birds: yellow rail, Canada warbler, Cape May warbler, bay-breasted warbler, and Nelson's sparrow.

The Proponent's findings indicated that a high magnitude effect could occur on a number of federally and/or provincially listed species: western toad, Le Conte sparrow, Arctic skipper, and several waterfowl and shorebirds, but that because their listed status would not be elevated, the effect would not be significant. The Proponent gave the same rationale when asked why effects to listed species with a magnitude close to 20 percent (e.g. common nighthawk where 17.8 percent of the habitat would be affected) were not considered to be significant.

The Proponent said the 20 percent threshold had been established considering professional judgment and experience with other environmental assessments. It said that for species that were provincially red-listed or federally listed as threatened or endangered, the use of the threshold would maintain objectivity and help flag concerns, but that elevation in status or change in management concern were the main elements to determine a significant effect. The Proponent said the same process was used to determine significance for non-listed species.

6.1.2 Views of Participants

Numerous participants raised concerns with the choice of key indicators for the assessment and disagreed with the species that had been excluded.

Environment Canada said that using species at risk as surrogates does not represent all ecosystem functions of the Peace River valley and limits the development of species-specific mitigation and compensation measures. It recommended that the data collected by the Proponent should be used to produce an effects pathway that indicates how key indicator species are representative of the ecological needs of the larger groups of migratory birds and species of interest to Aboriginal groups.

The British Columbia Ministry of Forests, Lands and Natural Resource Operations (FLNRO) said some indicator species were not appropriate representatives of a group. For example, it noted that the butterflies and dragonflies were grouped together even though they had different life cycles and habitat requirements. It also said mitigation measures should not be restricted to listed species, but should provide for a holistic consideration of wildlife resources and ecosystems.

Dr. Scott McNay, presenting for Treaty 8 Tribal Association, said that an assessment for small mammals and black bears should have been conducted and that without this information it would be impossible to assess possible cumulative effects on these species. High Prairie Outfitters and Tracks BC also disagreed with the lack of assessment of black bears, cougars and grizzly bear that are hunted in the region.

FLNRO and Dr. McNay disagreed with the Proponent's approach to determine significance. The Ministry advised that the threshold of high magnitude was too limited and that significant effects could occur even if the provincial status of a species did not change. Dr. McNay said the approach lacked transparency on how the residual effects criteria resulted in the final determination, adding that the Proponent used mixed spatial scales to support its conclusion. For example, the effects at the provincial level that likely underestimated the effects to local populations.

6.1.3 Panel's Analysis

The Panel acknowledges the comments that disagree with the choice of key indicator species and the exclusion of several species from the assessment. Although the Panel understands the use of key indicators for harvested species, it believes that, aside from ungulates, the species chosen by the Proponent are not representative of those harvested in the region. While the lack of assessment on these species may not affect the conclusion of significance for wildlife, it limits the assessment for harvest of these wildlife (see Section 9.1).

The Panel acknowledges that the Canadian Environmental Assessment Agency's guide *Determining Whether a Project Is Likely to Cause Significant Adverse Environmental Effects (November 1994)* advises that, in the absence of established thresholds, authorities need to rely on a qualitative approach based on their best professional judgment. The British Columbia Environmental Assessment Office's *Guideline for the Selection of the Valued Components and Assessment of Potential Effects* (September 2013) advises that, where legislated or regulated thresholds do not exist, the significance definition should consider relevant VC-specific factors, such as species population, integrity, or resource management objectives. In such instances, the assessment should identify the relevant VC-specific factors and explain how they were considered in the determination of significance

The Panel notes that because there is no established threshold for determining significance of adverse effects on wildlife for this Project, the Proponent developed an approach based on its professional judgement in accordance with the federal and provincial guidance noted above.

The Panel needs to consider whether it agrees with the Proponent's approach or if it believes another approach is better suited, based on the Panel's own professional judgement.

The Panel notes that previous assessments by review panels (e.g. Joslyn North Mine Project Joint Review Panel and Jackpine Mine Expansion Project Joint Review Panel) established the threshold for significance to be 20 percent of habitat lost for wildlife. The Panel also notes the conclusion by Joslyn North Mine Project Joint Review Panel that any effect on a species at risk would be considered significant.

In the absence of an established threshold that could be used as a "pass or fail" test, the Panel agrees with BC Hydro's approach to use a threshold of 20 percent (high magnitude) as an indicator of significance and then determine if the status of a species could be elevated or if the species could become a management concern. However, the Panel believes that this threshold is only appropriate for non-listed species and that magnitude should not be considered in isolation of the other effects criteria. The Panel also believes that, consistent with the BC Hydro's methodology for other VC's, the determination of significance should have included the level of confidence and it should evaluate uncertainties in baseline data collection, the identified effects or effectiveness of mitigation measures.

For species at risk, the Panel does not agree with the Proponent's approach for determining significance. The Panel believes that species at risk are, by definition, already significantly impacted and any additional adverse effects on these species should be taken seriously. The Panel agrees, in theory, with the principle that any effect on a species at risk should be considered significant. However, the Panel recognizes that, in practice, other factors such as the magnitude of the effects, the ecological context and level of confidence should be considered. For species at risk, the Panel believes that a more cautious approach should be taken and will rely on a magnitude of 10 percent or more (moderate magnitude) as an indicator of significance and a consideration the other factors described above. For species at risk that are imperilled or at risk of extirpation, any effect would be considered significant, regardless of the magnitude.

6.2 SPECIES AT RISK

6.2.1 Proponent's Assessment

The Proponent identified a total of 63 species at risk in the LAA listed provincially, federally or both. Out of the 63 listed species, 23 were invertebrates, one was amphibian, 30 were migratory birds, two were raptors and six were mammals. Appendix 8 provides an overview of listed species identified by the Proponent, their status, and the amount of predicted habitat loss.

Of the species identified by BC Hydro as being potentially affected by the Project, three species are listed as threatened under schedule 1 of the *Species at Risk Act (*SARA*)*, (Canada warbler, olive-sided flycatcher and common nighthawk), and four as special concern (western toad, rusty blackbird, yellow rail, short-eared owl). In addition, the two species of bats, northern *myotis* and the little brown *myotis* are listed as endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and grizzly bear are listed as special concern. Although excluded from the assessment by the Proponent due to low interaction with the Project, the caribou (northern mountain population) is also listed as a SARA species of special concern. Only the yellow rail and the caribou have a management strategy that has been released by Environment Canada. Effects to migratory birds listed under SARA are discussed in Section 6.3.

Two species of raptors are provincially blue listed (broad-winged hawk and short-eared owl).

These species would respectively lose 11.1 percent and 14.6 percent of suitable habitat as a result of the Project. In addition to habitat loss, BC Hydro pointed out that raptors could be displaced and disturbed by noise and that increased competition for unaffected foraging habitat and nesting sites could result in additional displacement. The Proponent noted that direct and indirect mortality is expected to occur for raptors. Habitat alteration due to construction and flooding was predicted to have the highest risk to cause mortality depending on timing of activities. Potential collisions with vehicle or transmission lines may also results in mortality.

The Proponent evaluated effects on two species of non-migratory game birds that were of particular interest to Aboriginal groups (ruffed grouse and sharp-tailed grouse). All Project components and activities, mainly vegetation clearing and filling of the reservoir, were predicted to result in a potential habitat loss of approximately 15 percent for ruffed grouse and of approximately 18 percent for sharp-tailed grouse of growing season and winter habitat. The Proponent also noted that the realignment of Highway 29 has the potential to affect a known lek site but would depend on the final alignment. BC Hydro said these values were most likely an overestimation because quarry sites would be smaller than the area used in the assessment and the right-of-way for the transmission line may increase suitable habitat.

Effects to bats were assessed for all bats in general and the Proponent determined that 25% of foraging habitat and 13 percent of reproducing habitat could potentially be lost as a result of the Project (construction and operation phases combined). Listed bats included the red-listed eastern red bat, and yellow-listed little brown *myotis* and blue-listed northern *myotis*. These bats have recently been classified as endangered by COSEWIC due to the effects of a fungal disease, but have not yet been listed under SARA. BC Hydro noted that the fungal disease is not yet present in the Peace region.

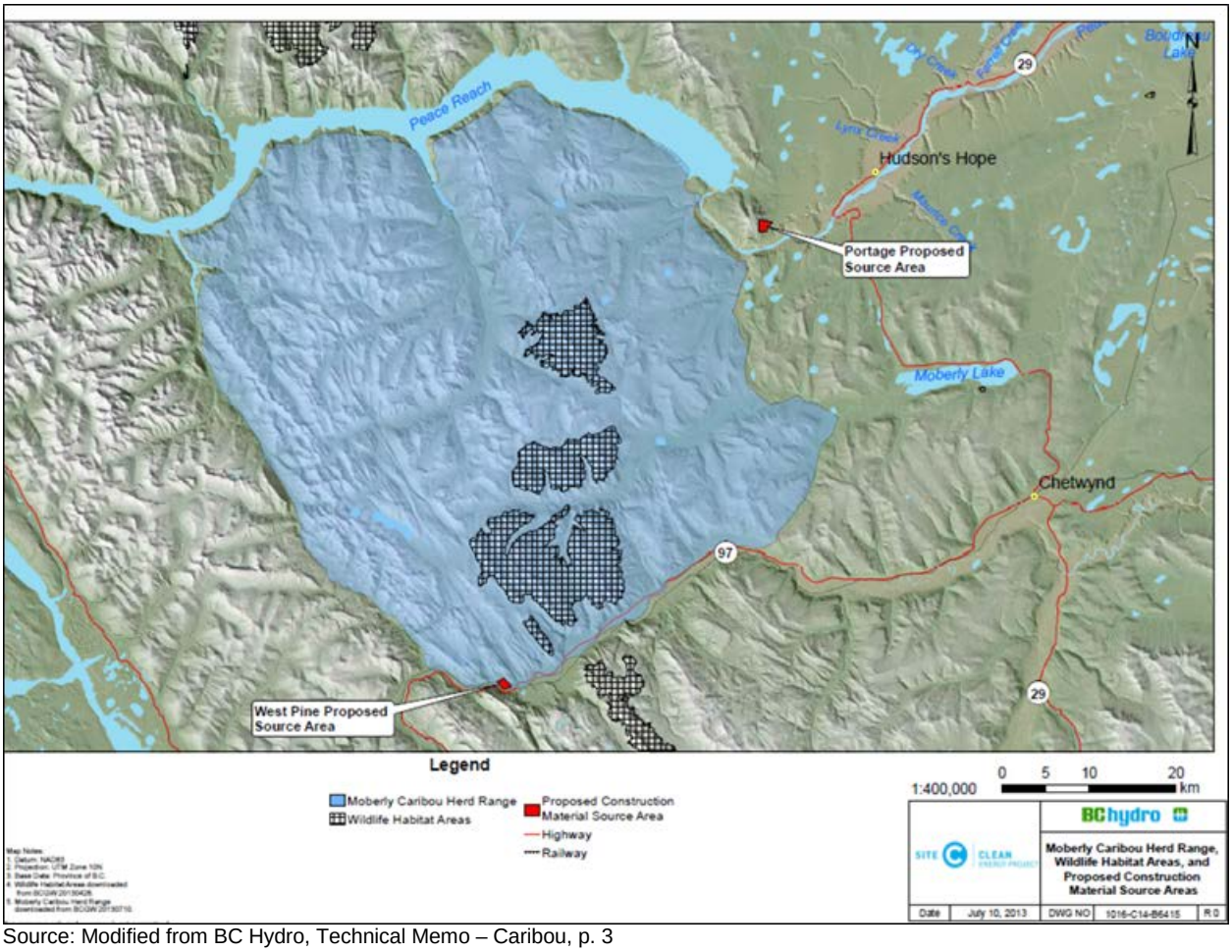
For the provincially blue-listed fisher, the Proponent determined that 14% of reproductive denning habitat available in the LAA could be removed. These effects would be mainly the result of reservoir filling. The Proponent estimated that 4.28 fishers are present in the LAA and that 0.72 fishers would be affected by the habitat loss. The Proponent noted, however, that several factors indicated that the south population was below carrying capacity. BC Hydro also said that riparian habitats used as travel corridors could become fragmented due to construction of roads and transmission lines and this could restrict fisher movement.

The Proponent explained that although grizzly bear are known to occasionally visit the area, resident grizzly bear are considered scarce or nonexistent in most of the LAA. For this reason, no assessment of habitat loss was conducted. BC Hydro said that grizzly bear were extirpated because of the high level of development in the area and the high road density, conditions known to be intolerable to grizzly bear.

For the western toad, the Proponent explained that even though this species would lose 29% of its habitat, wetland compensation could replace some of this habitat and address the concerns. It was also reported that mortality could occur as a result of site preparation and construction activities, including the filling of the reservoir and potential release of deleterious substances.

Caribou (northern mountain population) are provincially blue-listed and federally listed as SARA special concern. The Proponent said the West Pine Quarry was the only component of the Project that could interact with this species. The Proponent explained that the quarry is currently operated by the British Columbia Ministry of Transportation and Infrastructure and that the blasting intensity and frequency due to the Project would not exceed the current levels. Because BC Hydro believed that the quarry would continue to operate in a manner that would not interfere with the caribou, an assessment was not conducted. As seen in Figure 8, while the

quarry overlaps with the herd range, it does not intersect with core caribou habitat. The Proponent also would not operate the quarry during January through March in order to avoid potential interaction with caribou during critical winter months.



Source: Modified from BC Hydro, Technical Memo – Caribou, p. 3

Figure 8. Caribou Herd Range and Wildlife Habitat Areas in the Vicinity of the West Pine Quarry

6.2.2 Views of Participants

Environment Canada (EC) said the purposes of the *Species at Risk Act (*SARA) are to prevent wildlife species from being extirpated or becoming extinct, to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity and to manage species of special concern to prevent them from becoming endangered or threatened. According to EC, approximately 21 species at risk can be found in the RAA.

EC identified gaps in the baseline information, analysis of impacts or mitigation and follow-up proposed, for a number of species at risk (western toad, bats, caribou, and short-eared owl). Additional concerns raised by EC on migratory birds are provided in Section 6.3.

For western toad, EC said additional data were required to ensure that all habitats used during the life cycle were identified in order that potential effects and mitigation measures could be developed.

EC said the Proponent may have underestimated the magnitude of effects to bats. EC said

Myotis species have low reproduction rates and are highly vulnerable to mortality. It advised that further data on population estimates and the number and distribution of hibernacula should be collected. EC also stated that the effectiveness of the Proponent's measures for bats, namely the creation of hibernacula and roosting sites, is unclear to them.

Environment Canada noted that the short-eared owl is a ground-nester and sensitive to habitat fragmentation because of increased predation pressure. It was unclear to EC how habitat fragmentation was considered in the assessment of impacts.

For the caribou, EC noted that although BC Hydro determined that the West Pine Quarry does not intersect with their important habitats, it does overlap with the recovery plan area, and as such, it would be important to assess the potential habitat loss from the expansion of the quarry. Treaty 8 Tribal Association said effects on caribou should be considered significant because of this overlap. Dr. Apps, presenting for the Yellowstone to Yukon Conservation Initiative, felt that the recovery plan was inconsistent with the planning for Site C. Because the recovery plan area overlaps with the LAA, he said the Project could have an effect on future possible caribou habitat.

EC said most of the Proponent's mitigation measures are general in nature and do not address effects on specific species. The department advised that for species at risk close to the Proponent's threshold of 20 percent for significance, such as the Common Nighthawk, the precautionary principle would suggest that species-specific mitigation measures should to be developed.

EC also said that since species at risk are more likely to be affected by a combination of threats, any effects at the local or regional scale on habitat loss, displacement/disturbance and mortality should be mitigated. As such, Environment Canada recommended a rigorous hierarchal approach that first considers avoidance, than reduction of effects and, as a last resort, compensation.

EC made a number of recommendations for mitigating effects to species at risk. It requested that BC Hydro identify individual locations of all species at risk together with ecosystem unit associated with each Project component, differentiating between disturbance level (habitat lost, fragmented or intact). It also recommended that BC Hydro track updates to the status of COSEWIC and SARA species.

When asked to comment on the ability of provincially listed species to adapt to habitat changes, the British Columbia Ministry of Forests, Lands and Natural Resource Operations explained that, in general, species at risk are habitat specialists that have low resilience to disturbance.

In response to a question asked by the Panel, the British Columbia Ministry of Forests, Lands and Natural Resource Operations said the Project would be likely to change the provincial and potentially the federal listing status for some species. It cited two provincially red-listed birds (Nelson's sparrow and yellow rail) and five species of invertebrates (old world swallowtail, *pikei* subspecies; Alberta arctic; striped hairstreak; great spangled fritillary, *pseudocarpenteri* subspecies; coral hairstreak, *titus* subspecies) which could be elevated in status. Two blue-listed birds (eastern phoebe and Le Conte's sparrow) and five species of butterflies (common wood-nymph, *nephele* subspecies; Uhler's arctic; tawny crescent; Arctic blue, *lacustris* subspecies; Aphrodite fritillary, *manitoba* subspecies) could possibly become red-listed. FLNRO also identified two species of birds currently listed as yellow (sharp-tailed grouse, *jamesi* subspecies; and Baltimore oriole) that may be elevated to the blue list.

Several other species that have a restricted distribution in British Columbia may also see their

status elevated, but FLNRO said it had limited information to make a determination at the time of the hearing.

Numerous participants raised concern with the lack of assessment to grizzly bear, pointing out that grizzly bear are sighted in the area. FLNRO commented that although grizzly bears are seen in the area, resident grizzly bear are indeed extirpated in and around Fort St. John and within the study area due to the high level of anthropogenic disturbances.

6.2.3 Panel's Analysis

The Panel evaluated all of the species at risk listed in Appendix 8 including those designated by COSEWIC and determined significance in accordance with its approach described in Section 6.1.3 above. The Panel considered the FLNRO's comment that most species at risk are likely to have low resilience when evaluating ecological context. The Panel also recognizes the high level of anthropogenic disturbances sustained in the region. As noted in its methodology above, the Panel also considered concerns raised by participants regarding the effectiveness of mitigation measures and uncertainties with the baseline methodology.

For the species that would likely see their status elevated as identified by FLNRO, the Panel believes that this is a serious concern. For all of these species, the Proponent determined that the percentage of habitat loss is expected to be above 10 percent (i.e. moderate magnitude), with the majority above 20 percent (i.e. high magnitude), and that other effects attributable to disturbance or displacement and mortality could also occur.

The Panel concludes that the Project would likely cause significant adverse effects to the following species that may see their status of protection elevated.

These species are: Nelson's sparrow; yellow rail; eastern phoebe; Le Conte's sparrow; old world swallowtail, *pikei* subspecies; Alberta arctic; striped hairstreak; great spangled fritillary, *pseudocarpenteri* subspecies; coral hairstreak, *titus* subspecies; common wood-nymph, *nephele* subspecies; Uhler's arctic; tawny crescent; Arctic blue, *lacustris* subspecies; Aphrodite fritillary, *manitoba* subspecies; sharp-tailed grouse, *jamesi* subspecies and Baltimore oriole.

For the western toad, the Panel disagrees with BC Hydro that the wetland compensation plan would replace enough lost habitat to alleviate concerns. More than 1,200 hectares of western toad habitat would have to be created to result in a less than 20 percent loss, which seems unlikely given that wetlands are hard to recreate. The Panel also recognizes that effects due to displacement or disturbance and mortality would add to the effects on these species.

The Panel disagrees with BC Hydro and concludes that the Project would likely cause significant adverse effects on the western toad.

For the two species of raptors (the broad-winged hawk and the short-eared owl) the magnitude of effects was predicted to be moderate (between 10 and 20 percent). The eastern red bat, little brown *myotis*, and northern *myotis* would experience high magnitude effects (above 20%). The Panel also recognized that additional effects due to displacement, disturbance and mortality

would add to the effects on these species. In addition, although the white-nosed disease hasn't arrived in the Peace region, bats elsewhere in Canada are under heavy threat.

The Panel disagrees with BC Hydro and concludes that the Project would likely cause significant adverse effects to broad-winged hawk, the short-eared owl, eastern red bat, little brown *myotis*, and northern *myotis*,.

The Panel notes that, for fishers, habitat loss is expected to be of moderate magnitude, or 14 percent of reproducing denning habitat. The Panel acknowledges the Proponent's conclusions that the area is below carrying capacity and that "0.72 fisher" would be lost as a result of the Project. Given the Proponent's statistics, detailed research on fishers in the LAA, and the small number recorded, it is impossible to determine the direct effect on this species; however, the measures proposed would likely provide sufficient mitigation such that the effect would not be significant.

The Panel acknowledges the numerous concerns raised for grizzly bears. The Panel agrees with the Proponent and the British Columbia Ministry of Forests, Lands and Natural Resource Operations that grizzly bears are extirpated of most of the LAA and as such the Project is unlikely to have an effect on this species.

The Panel agrees with BC Hydro that the Project would not likely cause significant adverse effects on fisher and grizzly bear.

With respect to caribou, the Proponent provided information and mitigation measures on effects due to disturbance and displacement, but did not detail the extent of the quarry expansion and its potential effects on habitat. However, the Panel notes that the quarry is currently in use. Because the quarry is located at the edge of caribou habitat and does not overlap with critical habitat, even though the habitat loss would be above zero percent, the effect of the Project on caribou would not be significant.

The Panel concludes that the effects on caribou as a result of the Project would not be significant.

The Panel agrees that all of the Proponent's mitigation measures and follow-up plans for wildlife, including species at risk (Appendix 8), should be implemented if the Project proceeds.

RECOMMENDATION 10
The Panel recommends that if the Project proceeds, the Proponent must conduct field work to verify the modeled results for surveyed species at risk and determine, with specificity and by ecosystem, the habitat lost or fragmented for those species. The Proponent shall use these data to inform final project design and to develop additional mitigation measures, as needed, in consultation with appropriate authorities.

RECOMMENDATION 11
The Panel recommends that if the Project proceeds, the Proponent must track updates to the status of listed species identified by the Province, Committee on the Status of Endangered Wildlife in Canada, and the *Species at Risk Act*. Should the status of a listed species change during the course of the Project, the Proponent must work with Environment Canada and the Ministry of Forests, Lands and Natural Resource Operations to mitigate effects of the Project on the affected species.

RECOMMENDATION 12
The Panel recommends that Environment Canada complete a recovery strategy, in a timely manner, for the species listed under schedule 1 of the *Species at Risk Act* for which recovery strategies have not yet been developed (Canada warbler, olive-sided flycatcher and common nighthawk, rusty blackbird, short-eared owl and western toad).

6.3 MIGRATORY BIRDS

6.3.1 Proponent's Assessment

BC Hydro reported that more than 150 species of migratory birds are present in the LAA. The Proponent's assessment focused mainly on provincially and federally listed migratory birds regrouped into seven main categories: songbirds, waterfowl, shorebirds, marsh birds, woodpeckers, swallows and Common Nighthawk.

The Proponent said it focused its assessment on listed species using habitat suitability modeling as requested by the EIS Guidelines and as agreed in previous consultation with the Technical Advisory Committee of the Pre-Panel Stage. It also said its approach was based on provincial standards that have been used in a number of environmental assessments. BC Hydro acknowledged that, while the models were based on professional judgment and literature review, field data were collected to validate assumptions.

The Proponent said the songbird diversity in the valley is the highest when compared to upland habitat and said the Project would have an effect on several songbird species. The Canada warbler, the Cape May warbler, and the bay-breasted warbler were expected to lose the highest percentages of habitat, 21.9 percent, 20.9 percent, and 20.1 percent, respectively. For the olive-sided flycatcher, the Proponent did not assess specific amount of habitat loss, but determined that large amounts of suitable forested habitat would remain on the plateau, south of the Peace River, and that effects to this species are therefore not considered significant.

The Proponent reported six red-listed species of waterfowl and shorebirds and ten blue-listed species. To assess the effects of habitat loss on waterfowl and shorebirds, it evaluated the change in river, backchannel, lake, and wetland instead of completing habitat modeling. BC Hydro estimated that over 20% of river and backchannel habitats would be converted into a reservoir. As a result, the waterfowl species assemblage was predicted to change and overall productivity would be dependent on forage potential and availability of both security cover and nesting substrates. The Proponent predicted that effects on waterfowl and shorebirds would be reversible because these species are known to be resilient and persist in disturbed environment.

For the three listed species of marsh birds assessed with habitat modeling, Le Conte's sparrow was expected to lose 23.3 percent, Nelson's sparrow 23.3 percent and yellow rail 23.8 percent of suitable habitat.

The Proponent, estimated that woodpeckers would lose around 14 percent of suitable habitat and that the provincially and federally listed common nighthawks could lose 17.8 percent. As for swallows, nests would be affected by the reservoir filling, bank erosion, dam construction, and bridge removal, but it is expected that nests would re-colonize once the work is completed and slopes are stabilized. The Proponent also pointed out that the dam and facilities would offer nesting sites for a number of species, including barn swallows.

BC Hydro said early spring migrating birds, namely Canada goose, common goldeneye, and common merganser, would potentially be affected by ice formation; however, it expected these species would congregate immediately downstream of the proposed dam, which would remain ice free in the winter. The Proponent also said that, while low-elevation river valley habitat may provide valuable migration stopover, plateau habitat is also suitable and the loss of valley bottom habitat should not be a barrier to travel.

The Proponent identified a number of activities that could result in disturbance and displacement of migratory birds, but said that the magnitude of disturbance would be dependent on the type of activities, the proximity to individuals, the timing and the frequency.

The Proponent said mortality would be expected to occur for most species of migratory birds. Habitat alteration due to construction and flooding has the highest risk to mortality depending on timing of activities. Potential contact with harmful substances and collision risks with vehicle or transmission lines may also results in mortality. The Proponent committed to use transmission towers designed to reduce the risk of collision and electrocution and also said clearing activities would occur in the winter, when feasible, to avoid conflict with nesting birds. If clearing activities have to be scheduled during breeding season, a nest search protocol would be developed in collaboration with relevant authorities and implemented to avoid disturbance and possible mortality to nesting birds.

Taking into account available mitigation measures, the Proponent concluded that the residual effect of the Project on habitat alteration and fragmentation would be significant for five species of migratory birds - yellow rail (SARA-special concern, red-listed), Canada warbler (SARA-threatened, blue-listed), Cape May warbler (red-listed), bay-breasted warbler (red-listed), and Nelson's sparrow (red-listed), because the sustainability of these species could be threatened.

The Proponent concluded that effects to the remaining listed species of migratory birds would not be significant either because less than 20 percent of the available suitable habitat in the LAA would be lost or because the sustainability of the species is not threatened.

6.3.2 Views of Participants

Environment Canada (EC), emphasized its mandate to protect migratory birds and their habitat, including the enforcement of the Migratory Birds Regulations under the *Migratory Birds Convention Act, 1994,* which prohibit any person from killing a migratory bird or disturbing, destroying or taking a nest, egg or nest shelter of a migratory bird.

EC reported that three-quarters of British Columbia's bird species (approximately 247) use the Peace region: 32 of these are provincial and/or federal species at risk. EC said the 169 species of birds detected by the Proponent in the LAA is likely an underestimation because it does not account fully for wintering birds and birds in migration. EC agreed with the Proponent's statement that the valley supports a higher diversity of birds compared to the upland habitat.

In response to the Panel's question on the abundance and density of birds, BC Hydro noted that this was note required as part of the EIS Guidelines and would be unreliable. However,

according to EC, knowing the abundance of birds informs ecosystem functions, while the number of species speaks to ecosystem complexity. Characterizing all ecosystem functions could help gain a better understanding of mitigation and compensation. It explained that abundances of birds and species diversity can vary across habitat types and size. For instance, two habitat patches of the same size but in different habitat types could potentially support different numbers of birds, both in terms of numbers of species and in terms of abundance of one particular species. Population estimates are important to quantify effects either within the LAA or at a broader scale mainly for species at risk.

EC said the baseline characterization for listed migratory birds was incomplete. It said many of the habitat suitability models appeared to be subjective and based on professional judgment; therefore, it was impossible to determine how the models were validated and uncertainties considered. It said, for some species, field observations appear to be outside of suitable habitat, which raised concerns about the validity of the models. It added that, because habitat descriptors and scales used in the bird assessment were inconsistent with those used in the vegetation assessment, comparison between the two was difficult.

EC qualified the Peace River region as a biodiversity hotspot and noted that the valley is a unique east-to west-passage in the Rocky Mountains that is below 1,000 meters elevation and has a milder climate than adjacent areas. With its unique microclimate, the valley is one of the last northern areas to be covered in snow and one of the first where it melts. EC said historical surveys and surveys in the EIS seem to indicate that the valley constitutes an important low-elevation habitat that supports a greater species diversity and productivity than the more extensive uplands. It was their opinion that BC Hydro did not provide evidence to support its argument that upland plateau habitat and valley habitat provide the same ecological functions with regards to migration.

EC stated that the conversion of the river ecosystem into a reservoir would have various effects on the physical and ecological environment of the Peace River. For example, it would remove island habitats and reduce the amount of shallow water areas that are important to birds that depend on aquatic invertebrates or fish. EC said the Proponent had not demonstrated that effects on waterfowl and shorebirds are reversible, and it is unlikely that effects on food supply would be fully reversible.

For the purpose of informing the development of appropriate mitigation measures for migratory birds, EC provided the Panel with a number of recommendations, including additional surveys and analysis and the development of mitigation and follow-up plans.

EC said it recognized that the Project could potentially cause mortality of migratory birds, either by killing individuals or destroying active nests. It said these impacts would likely be cumulative with impacts of the existing upstream dams. It noted the absolute prohibition on incidental take of migratory bird or destruction of an active nest under the *Migratory Birds Convention Act* and that the department did not have any permitting capacity in the matter. It said that it does not support active nest searches because the results are unreliable, and there is an associated risk to disturbance. It recommended that BC Hydro develop a monitoring-mitigation strategy to address the loss of active migratory bird nests due to the reservoir and downstream of the dam.

EC said bird mortality could also occur from collision or electrocution with the transmission line. It advised that a Transmission Line Bird Collision Management Plan be put in place. BC Hydro responded that such a plan was not warranted because the design of the transmission line reduces risk of mortality.

6.3.3 Panel's Analysis

The Panel agrees with the determination of significance for the five species identified by the Proponent and agrees with the importance of protecting them and their habitat. However, the Panel believes that the significant effects of the Project would not be restricted to these species.

For most migratory birds assessed, the magnitude of habitat loss was determined to be high, mainly due to the loss of valley bottom habitat, including riparian, floodplain, wetland and grassland habitats, and lowland river habitat. The Panel acknowledges the general recognition that the Peace River valley presents unique conditions that differ from the upland plateaus and recognizes the value of the valley during migration. The Panel also considered the additive effects due to displacement, disturbance, and mortality.

The Panel evaluated the wetland compensation plan and other mitigation measures for migratory birds proposed by the Proponent and believes that, although they could reduce some of the Project effects on migratory birds, they would not fully compensate for the loss of valley bottom habitat and river ecosystem.

The Panel concludes that the Project would likely cause significant adverse effects to migratory birds relying on valley bottom habitat during their life cycle and these losses would be permanent and cannot be mitigated.

Given the concerns and uncertainties EC raised regarding effects of the Project, effectiveness of mitigation measures, and the low confidence of the modeling conducted by the Proponent, the Panel recommends the following to be included in the mitigation measures and follow-up plan already proposed by the Proponent:

RECOMMENDATION 13
The Panel recommends that, should the Project proceed, BC Hydro must develop a monitoring and mitigation program in consultation with Environment Canada to avoid the loss of active migratory bird nests in the reservoir area and downstream of the dam.

RECOMMENDATION 14
The Panel recommends that, should the Project proceed, BC Hydro must develop mitigation measures specific to migratory bird species in the Project area that address the changes in aquatic and riparian-related food resources and other habitat features associated with the change from a fluvial to a reservoir system, in consultation with Environment Canada.

RECOMMENDATION 15
The Panel recommends that, should the Project proceed, BC Hydro must conduct a risk assessment for bird collisions under the current transmission line design. BC Hydro must determine if additional mitigation measures (e.g. line marking and diversions) could be implemented to reduce the risk, in consultation with Environment Canada.

RECOMMENDATION 16
The Panel recommends that, should the Project proceed, BC Hydro be required to develop a Compensation Plan for non-wetland migratory birds in consultation with Environment Canada, and implement the plan to address significant adverse effects on Canada warbler, Cape May warbler, and bay-breasted warbler. The plan must be submitted to Environment Canada three months prior to any activity affecting the habitat.

6.4 UNGULATES

6.4.1 Proponent's Assessment

The Proponent considered effects to moose, elk, white-tailed deer and mule deer in its assessment of the Project on ungulates. It said the Project could result in the loss of habitat for all four groups and that the Project could also result in disturbance, displacement and mortality. BC Hydro's assessment focused mainly on the area along both sides of the Peace River. The Proponent noted that additional studies are underway to address potential issues with the transportation corridor, but that the transmission line and associated clearing would not likely affect ungulates because it was an existing line.

BC Hydro said that, based on provincial population data, there are around 10,000 moose in the four Management Units (MU) in the RAA and around 2,600 for the Management Unit 7-32, where the Project is mainly located. It stated that, based on surveys, approximately 900 animals were along the Peace River from Hudson's Hope to the Alberta border, and approximately 200 could be in the Project footprint. BC Hydro said most animals were collared.

BC Hydro reported that, while the loss of wintering habitat was considered to be the most important, all seasonal habitats were considered in the assessment for each ungulate species. The Proponent said moose would lose 20 percent of habitat, and the number of moose is expected to decrease in the LAA, but that overall, the long-term population would be stable. Mule-deer would lose the greatest amount of winter habitat (29 percent), but the Proponent noted that winter severity has the biggest influence on population fluctuation and habitat loss does not seem to affect mule deer as much as for other species. For elk and white-tailed deer, the Proponent said the Project would remove 21 percent and 15 percent of suitable habitat respectively, but that the habitat loss would have little effect on these species. BC Hydro explained that the area's elk population has steadily increased and that government programs are currently trying to reduce the number. It added that white-tailed deer rarely use wintering habitat potentially affected by the Project.

BC Hydro said it has reasonable confidence in the assessment results because they are consistent with the results obtained from studies in the 1990's.

The Project could also cause disturbance to and displacement of ungulates, especially if the construction and clearing activities take place in the winter. Sources of mortality include possible drowning, collision with vehicles and increased access for hunters or poachers.

BC Hydro said its studies indicate that elk and moose do not seem to have any problem crossing the river although they tend not to cross in the winter. Mule deer were also noted to occasionally cross the river, but not white-tailed deer. The Proponent said the implementation of the clearing and debris management program and the active shoreline monitoring would identify and address risks associated with ungulates crossing the reservoir.

The Proponent said the residual effects of the Project would not result in a significant effect on

ungulates because, despite past disturbances in the RAA, the moose population appears to be stable, elk populations are increasing, the mule deer population appears to be limited by winter severity rather than habitat loss and white-tailed deer appear to rarely use the LAA. The Proponent concluded the same for cumulative effects of the Project and future activities.

BC Hydro did not propose a follow-up monitoring plan for ungulates because the level of confidence in the prediction of effects was high.

6.4.2 Views of Participants

Several participants said the valley was used as a wildlife refuge during severe winters and that they had noticed ungulates in high numbers during critical winters in the valley. The British Columbia Ministry of Forests, Lands and Natural Resource Operations agreed that the Peace valley constitutes high-value winter range for ungulates. It also acknowledged that, because the upland areas were more altered by industrial activities, the valley was likely used as a corridor to travel east-west.

Ross Peck, a valley resident and biologist, raised concerns with the timing of the collaring for moose, which was done in January. He explained that several valley residents had observed moose coming down to the valley at the end of February and March. As such, the study did not account for these moose and may have underestimated the valley's importance as a refuge.

A number of participants said they have observed a decline in moose populations, which has resulted in less successful hunts. Aboriginal groups repeatedly said there were fewer moose now than a generation ago.

According to a study conducted by the British Columbia Ministry of Forests, Lands and Natural Resource Operations (FLNRO) and reported the moose population in the region has remained stable over the four surveys from the last 27 years (1984, 1996, 2004, and 2011) with a density of 0.72 moose per square kilometre (km2). It noted that the calf-cow ratios were similar between years, but that the bull-cow ratio was the lowest in 2011. However, the consistency of calf-cow ratio suggests that there are enough bulls to maintain a stable pregnancy rate. All aerial surveys were conducted in the winter when snow coverage ensured good sightability. FLNRO noted that moose can be grown with good management and habitat practices. Incidental species that were surveyed included elk with a density of 0.45 per km2, mule deer with a density of 0.29 per km2, and white-tailed deer with a density of 0.12 per km2. This study also depicted most of the MU 7-32 as being very high or high winter capability habitat for moose.

Several Aboriginal hunters reported shooting moose that were found to have multiple tumours, skin lesions, and a strong smell of hydrocarbons. They were deemed not fit for consumption and were buried. When asked to comment on these reports, FLNRO advised that most diseases were naturally occurring and did not affect the quality of the meat. With regards to hydrocarbons smell in moose carcasses, FLNRO said they would be interested in testing samples.

Dr. Scott McNay, presenting for Treaty 8 Tribal Association, reported a number of gaps in the assessment on ungulates, notably that the sample size and assessment of seasonal range and habitat modeling could result in underestimating the Project effects.

Brian Kopach, presenting for Saulteau First Nations, stated that because the Proponent did not consider the level of habitat fragmentation and the zone of influence (the buffer area adjacent to intact patches of habitat), it likely underestimated the area available for moose in the LAA and RAA. He said this was because fragmentation and zones of influence around existing disturbances can lower the habitat quality regardless of its vegetation structure.

Mr. Kopach said empirical data on moose distribution or habitat are only available along the river corridor and have not been collected for large portions of the transmission line and key areas of concern for Aboriginal groups. He also said the mitigation measures were too general and lacked detail on their implementation and effectiveness.

Dr. John A. Nagy, presenting for the North Peace Rod and Gun Club, raised concerns with the methodology used to assess impacts to ungulates. He said the habitat models generated may have underestimated the Project impacts on preferred seasonal habitat for ungulate populations. He also said the effects on ungulate population at the regional level are not reported. He said most high-suitability moose habitats are located around the proposed dam, which underlines the importance of the area.

6.4.3 Panel's Analysis

The Panel notes that despite the moderate to high magnitude of effects on habitat, of the ungulates species, only caribou are at risk and all were demonstrated to be relatively resilient species. The Panel has considered caribou Section 6.2.

For moose, the Panel finds compelling the evidence presented by the Province indicating that the populations in MU 7-32 are stable and have been relatively stable for the last 27 years despite the increasing amount of anthropogenic disturbance. The Panel believes this finding indicates that moose populations are able to adapt to disturbed environments and that the Project effects are likely to be local in scale and not affect the regional population.

For other ungulates groups, the Panel considered the Proponent rationale that elk populations are increasing, that mule deer populations appear to be limited by winter severity rather than habitat loss and white-tailed deer appear to rarely use the LAA. The Panel was presented with little evidence to contradict these conclusions.

The Panel acknowledges the numerous concerns about the methodology used for ungulates. The Panel believes that, although uncertainties remain regarding Project effects on ungulates, the extent to which BC Hydro's results could have been underestimated remains unclear. However, the Panel doubts that effects could significantly be higher than what was predicted.

The Panel agrees with the mitigation measures provided by the Proponent for wildlife (Appendix 9) and supports their implementation should the Project proceeds.

The Panel agrees with BC Hydro that the Project would not likely cause significant adverse effects on moose, elk, white-tailed deer and mule deer.

As mentioned in other sections, the Panel agrees that the Peace River valley constitutes a unique and highly valuable environment for wildlife, including ungulates. The Panel acknowledges that the Proponent has committed to manage the lands to the east of the Halfway River and west of Wilder Creek to maintain these areas as winter range and access to them. The Panel believes this measure could attenuate some of the effects of habitat loss for ungulates and recommends that the Proponent determine whether additional lands could also be kept as winter range.

RECOMMENDATION 17
The Panel recommends that, if the Project proceeds, the Proponent must, in collaboration with the Province, determine whether additional lands owned by BC Hydro or Crown Lands could be maintained as winter range for ungulates.

While the Panel agrees with the Proponent's conclusion, the Panel believes that uncertainties and concerns raised by participants warrant a follow-up program to ensure that the effects to ungulates would indeed be not significant.

RECOMMENDATION 18
The Panel recommends that, if the Project proceeds, the Ministry of Forests, Lands and Natural Resource Operations must conduct bi-annual ungulate surveys in Wildlife Management Units overlapping with the LAA during Project construction and for a period of 5 years after. This information must be provided to the Proponent to confirm the effects of the Project and used by the Ministry to determine if mitigation is required (for direct or indirect effects).

6.5 CUMULATIVE EFFECTS ASSESSMENT

6.5.1 Proponent's Assessment

The Proponent determined that the Project was likely to result in adverse residual effects to wildlife resources and therefore conducted a cumulative effects assessment. BC Hydro determined qualitatively that the foreseeable projects in the RAA would likely result in residual effects to wildlife and act cumulatively with the residual effects of the Project. BC Hydro did not propose additional mitigation measures and stated that it had limited authority to guide regional initiatives that would be better guided by provincial government.

The Proponent said 53 percent of the RAA had been mapped and that the LAA made up 9% of this mapped area. It provided suitable habitat information for several key species in the mapped RAA, but noted that quantitative data for other projects were limited and it was therefore not possible to give a quantitative description of the combined effects of the Project with other projects.

The Proponent provided a qualitative summary of potential effects of foreseeable projects in the RAA. Most projects were expected to have effects on species at risk including common nighthawk, barn swallow, short-eared owl, warblers, olive-sided flycatcher, western toad, bats and fishers. Several projects also identified potential effects to ungulate winter range and migratory and non-migratory birds.

The Proponent provided qualitative information about effects of the two existing dams on wildlife. It acknowledged the loss of wildlife habitat and displacement of wildlife to upland habitats or adjacent river valleys due to the filling of the two previous reservoirs. It added that the landscape had been and is still being shaped by past and current anthropogenic developments that have already significantly impacted wildlife resources. It concluded that the cumulative effects resulting from the Project for five species of migratory birds would likely be significant because the Project effects are considered significant for these five species and the region is already significantly impacted. BC Hydro said this effect would be significant with or without the Project.

When asked to provide an overview of the cumulative effects of the Project in combination with other projects in the RAA for ungulates and fur-bearers, the Proponent responded that these cumulative effects would not be significant. It explained that, despite the level of industrial activity in the RAA in recent decades, the moose population appears to be stable, elk populations are increasing, and mule deer populations fluctuate based on winter severity rather than habitat loss. For fisher, it stated that results indicated uncertainties regarding what drive fisher density in the RAA and that, although the Project would not likely result in significant effects, the cumulative effects may reduce the fisher population such that the listing status may be elevated.

6.5.2 Views of Participants

Yellowstone to Yukon Conservation Initiative (Y2Y) and Dr. Faisal Moola of the David Suzuki Foundation said the region is a critical pinch point of the Yellowstone to Yukon wildlife corridor in western North America. They highlighted that this corridor is a continental-scale conservation priority for the protection of core wildlife habitat and large mammal movement. They stated that because the region constitutes the narrowest portion of the corridor, cumulative effects resulting from the two existing dams and other industrial development combined with the Project would sever ecological connectivity for some of the wide ranging wildlife species such as grizzly bears. Yellowstone to Yukon Conservation Initiative also noted that the continental corridor is reasonably intact which is extremely rare globally.

Y2Y said a quantitative assessment of cumulative effects had not been conducted. It stated that characterizing existing and future impacts on the resources and species would be the first step in maintaining and restoring viability of wildlife resources, thus the baseline must go back to pre-disturbance conditions. It believed that since the landscape is already significantly impacted, the additional effect of the Project would automatically be significant. Given the predominant presence of BC Hydro in the region, Y2Y suggested that the Proponent lead a regional cumulative effects assessment before starting the Project.

Dr. Clayton Apps, presenting for Y2Y, conducted a broad-scale assessment of regional impacts for six species of wide-ranging mammals (fisher, lynx, wolverine, grizzly bear, wolf, and caribou) and concluded that the regional impacts to date on these are significant and that the Project would further erode landscape effectiveness and connectivity. For caribou, he noted that the Project would not likely have direct effects on the species, but that it could impede further recovery efforts.

Dr. Apps said the RAA was too small to assess population-level cumulative effects for carnivores and ungulates and should have been large enough to encompass regional populations. He added that typically the size of an LAA is based on the home ranges of the species at issue; for wide-ranging mammals, home ranges are approximately 300 square kilometers, and therefore, the LAA should have been 10 times bigger.

The British Columbia Ministry of Forests, Lands and Natural Resource Operations presented a preliminary list of species of particular concern that are already experiencing an impact from development in the area and for which the Project effects would act cumulatively. It did not specify whether the cumulative effects would be considered significant or what the Project's contribution would be. The species of particular concern included listed warblers, fisher, bats, northern goshawk, moose, Nelson's sparrow, yellow rail, rusty blackbird, western toad, short-eared owl, mule deer, Rocky Mountain elk, and sharp-tailed grouse.

Chief Roland Willson of the West Moberly First Nations said the best moose habitat in the

Peace region was lost to the Williston reservoir and that the moose are now left with second-class habitat. He said the Peace Moberly Tract located in Management Unit 7-32 was one of the two remaining best moose habitats B.C., the other one now being an industrial zone for shale gas on the north side of the river.

Dr. Scott McNay, presenting for Treaty 8 Tribal Association, said information on predator-prey relationships is missing from the assessment. He said the Project was likely to displace animals, and displaced animals would likely be competing with other members of their species and other species, but that no information on available habitat in the RAA was provided.

Dr. Petr Komers, presenting for Saulteau First Nations, said BC Hydro's choice of foreseeable projects seemed arbitrary. He stated that, to acquire a good understanding of potential cumulative effects to the region, BC Hydro should have considered all possible projects and then compared the effects with those of only the most certain projects. This approach would have given a bracket that the cumulative effects would likely fall into. He said measuring existing conditions is not the same as identifying existing effects, and that there is a need to understand what influenced the existing condition and how fast it is changing.

6.5.3 Panel's Analysis

The Panel notes that the Proponent provided limited quantitative information for the RAA. The Panel agrees with participants that additional information on habitats available in the RAA, a description of potential risks of intra- and inter-species competition, an assessment of cumulative effects on wildlife movement, and a more exhaustive inclusion of potential future projects in the RAA would have been informative and improve the quality of the cumulative effects assessment. The Panel considered these limitations in its decision.

With respect to activities that have been carried out, the Panel agrees with the Proponent and participants that the region has and is still being impacted by developments. Effects on wildlife and wildlife habitats from past and existing developments including the two existing dams are undeniable. The Panel agrees that the cumulative effect on wildlife resources in the region are likely already significant.

Although limited quantitative information on foreseeable projects is available, the Panel acknowledges that most of these projects would likely have an effect on wildlife resources as well. The Panel notes the information provided by the British Columbia Ministry of Forests, Lands and Natural Resource Operations that several species could be potentially cumulatively impacted by the Project and other projects.

As described above, the Panel agrees with the Proponent that the Project is likely to cause significant effects on the five species of birds identified by the Proponent. The Panel also concludes that the effects would be significant on a number of species at risk and migratory birds. Therefore, notwithstanding the lack of quantitative information on wildlife resources in the RAA, the significant effects of the Project combined with the already significant cumulative effects in the region and the effects of future projects can only be significant for these species. However, given the scale of the Project, the Panel believes the contribution of the Project to the cumulative effects would be serious and should not be disregarded because of the already significant cumulative effect in the region.

The Panel concludes that the wildlife species that would experience significant effects as a result of the Project would also experience significant cumulative effects.

The Panel concludes that the Project would not likely cause significant effects on fishers and ungulates. The Panel notes the uncertainties raised by the Proponent regarding potential cumulative effects to fishers. The Panel also considered the view of the FLNRO and Dr. Apps that fishers are likely already cumulatively impacted.

The Panel concludes that, given that fisher are blue-listed and likely already impacted by human pressures, the Project effects in combination with past, existing and future projects may cause significant cumulative effects.

The Panel received contradictory information from participants regarding effects on moose. On one hand, participants stated their less successful hunts indicated a declining population over the years. On the other hand, FLNRO provided information that indicated moose populations in the region are stable, although subject to natural variations (see Section 6.4). The question is whether the population decline in the region observed by participants is due to less productive populations or whether the distribution of moose populations has changed and they are no longer associated with known hunting sites. As stated above, the Panel agrees that the region has already been significantly impacted; however, the provincial data demonstrate that moose populations are resilient and capable of adapting to disturbed environments. The Panel believes that this is evidence that the moose populations remain productive and that other factors are affecting hunting success. Hunting success is further discussed in Chapter 7.

The Panel believes that the Project, in combination with past, existing, and future projects is likely to cause cumulative effects on ungulates, but that these effects would not be significant. The Panel based its decision on the same factors that lead to the decision for the Project effects: moose populations in the region appear to be stable, elk populations are increasing, mule deer populations appear to be limited by winter severity rather than habitat loss, and white-tailed deer appear to rarely use the Project LAA and are unlikely to be affected by the Project. The Panel also considered that the mitigation measures proposed by the Proponent and the Panel and additional follow-up plans would be critical in mitigating the addition of the Project's effects to the cumulative effects on ungulates.

The Panel concludes that the Project would not likely cause significant cumulative effects on ungulates.

7 CURRENT USE OF LANDS AND RESOURCES FOR TRADITIONAL PURPOSES

In this section, the Panel evaluates BC Hydro's assessment of the Project's effects on the current use of lands and resources by Aboriginal groups in terms of fishing, hunting, trapping, and other cultural and traditional uses of the land. Although intertwined with culture, the Panel focuses here its analysis of other uses of the land on traditional uses such as harvesting of plants, the use of camps and trails and sources of water. Changes in use of and access to culturally and spiritually important places, burial sites, valued landscape, and intangible heritage resources are evaluated by the Panel in Chapter 12.

7.1 PROPONENT'S METHODOLOGY

The Proponent was required to consult with 29 Aboriginal groups in its assessment of effects of the Project on current use of lands and resources for traditional purposes.

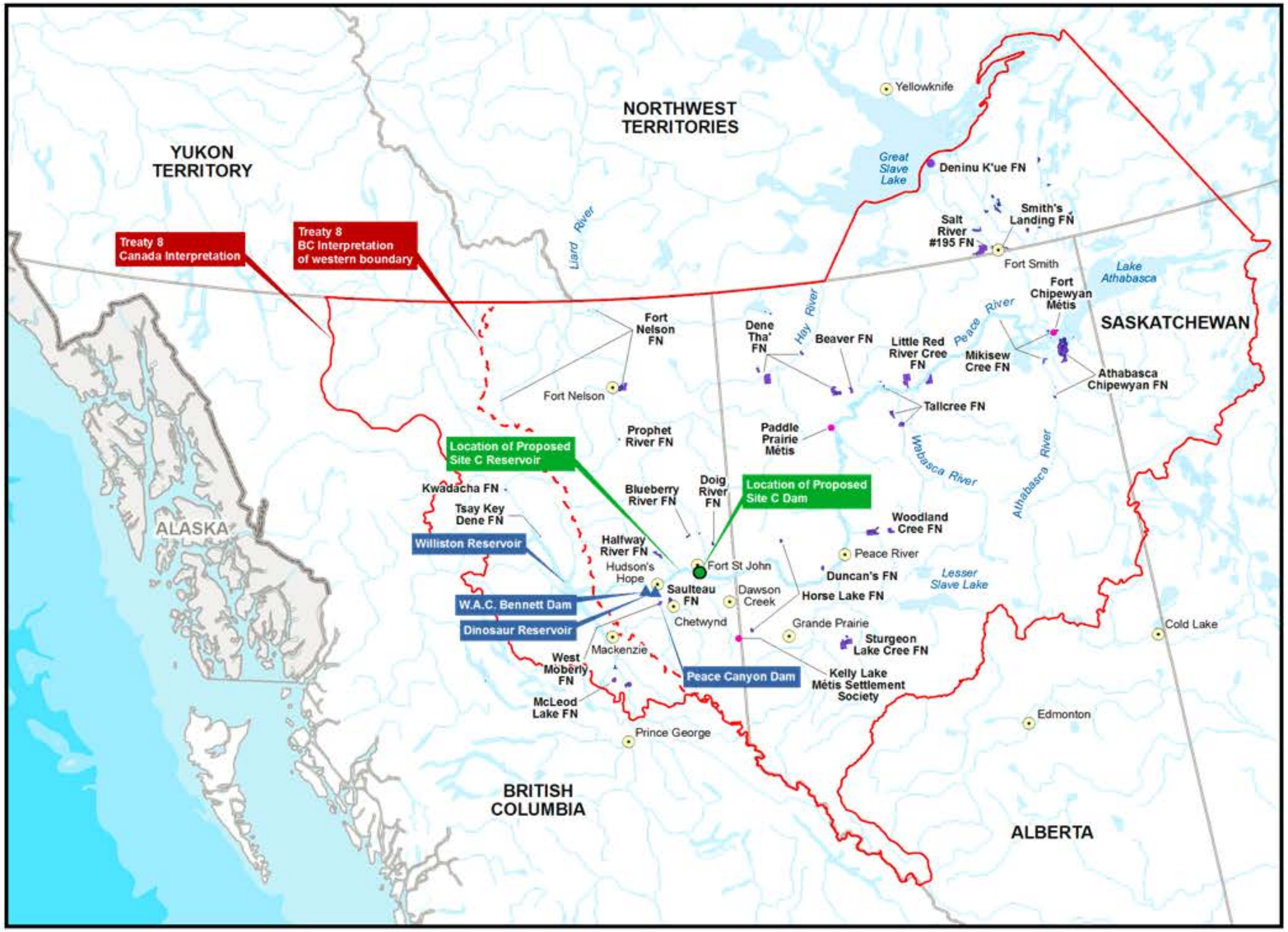
7.1.1 Proponent's Assessment

BC Hydro prepared Aboriginal Land Resource Use summaries for these groups based on published and unpublished reports and, where available, the traditional land use studies and other information provided by the Aboriginal groups. Figure 9 indicates the location of each group in relation to the Peace River.

The Proponent said that 12 Aboriginal groups indicated use of the land within the Project's Local Assessment Area (LAA). These groups include the four first nations of Treaty 8 Tribal Association (Doig River First Nation, Halfway River First Nation, Prophet River First Nation and West Moberly First Nations), Saulteau First Nations, Blueberry River First Nations, McLeod Lake Indian Band, Dene Tha' First Nation, Duncan's First Nation, Horse Lake First Nation, Kelly Lake Métis Settlement Society and Métis Nation British Columbia. For Kelly Lake Métis Settlement Society, BC Hydro said the information provided by the group did not allow for a determination about whether they use the LAA.

The Proponent's assessment of current use of lands and resources for traditional purposes took into account the Project's potential to result in changes to three key aspects: fishing opportunities and practices; hunting and trapping opportunities and practices; and other cultural and traditional uses of the land.

The Proponent said the key aspects evaluated differed from the Environmental Impact Statement (EIS) Guidelines, which required considering (1) use of and access to lands used for traditional purposes, (2) availability of harvested species and (3) other relevant considerations raised by Aboriginal groups. BC Hydro explained that its approach facilitated a separate analysis of the specific key aspects of current uses and was therefore favorable.



Note: Map created from BC Hydro and GeoBC data

Figure 9. Location of the Aboriginal Groups Consulted by BC Hydro

To assess effects on the current use of land and resources for traditional purposes, the Proponent relied on the assessment of effects to the biophysical and human environment of the Peace region with information collected from Aboriginal groups on how they use the valley. It then determined the impact of the Project on the ability of individuals to continue to use lands and resources for traditional purposes, given its assessment on those other valued components.

BC Hydro proposed several mitigation measures for the effects of the Project on current use of land and resources for traditional purposes, which are found in Appendix 9 of this report. The proposed measures included a communication program to inform land users of potential events that would affect their use of the land.

The Proponent evaluated the significance of each residual environmental effect and determined that a residual effect would be significant if:

- A current use of lands for traditional purposes would be permanently undermined and its practice cannot be readily reproduced elsewhere; and
- The current use and area was indicated to be of high value or importance to Aboriginal groups for traditional purposes.

The Proponent used the concept of adaptability to characterise magnitude where a low magnitude would indicate that the current use of lands and resources for traditional purposes is adaptable and may be readily transferred elsewhere without undermining the traditional purpose and a high magnitude would mean that current use is highly impaired and is not adaptable or readily transferrable elsewhere.

BC Hydro defined “adaptable” as “a demonstrated quality of Aboriginal community land uses, where patterns of land use are spatially and temporally flexible, capable of taking in multiple environments (lacustrine, riverine), species, and opportunities. For example, adaptability can be seen in a community’s reported use of multiple localities (Peace River, Moberly, Williston reservoir) and settings (lake, river, reservoir) for the pursuit of multiple species of fish (jackfish, whitefish, kokanee). Our use of ‘adaptability’ arises from the studies provided by Aboriginal communities, and is supported by additional research.”

In response to assertions from Aboriginal group that “adaptability” was synonymous with “go elsewhere,” the Proponent clarified that no Aboriginal community members were being told to leave the LAA or exercise their practices beyond their traditional territories. BC Hydro said Treaty 8 First Nations would still be able to fish, hunt, and trap within their own traditional territory in a portion of the LAA and would not be required to go elsewhere within the Treaty 8 territory. It said that this statement was recognition of the rights held by all of the Treaty 8 First Nations to hunt in the broader treaty territory. BC Hydro said the adaptability of Aboriginal groups in northern B.C. and Alberta was well documented in the historical record and information provided by Aboriginal groups. It quoted the work of Hugh Brody, *Maps and Dreams,* which identified Aboriginal groups as being “flexible in the face of ever-changing circumstances”.

7.1.2 Views of Participants

Numerous participants disagreed with the concept of adaptability used in the significance determination and reported that the Proponent had failed to assess the ability of First Nations to practice their traditional land use elsewhere.

Treaty 8 Tribal Association (T8TA) argued that the Proponent's significance threshold was unusual and not technically sound, because an effect could only be deemed significant if permanent and "not readily reproduced elsewhere." It said the Proponent had not provided justification for this threshold and proposed four additional criteria for the assessing significance: the importance of a particular use (i.e. if that use was for subsistence), the importance of the landscape to the users, and the multiplicity of practical uses and of cultural uses.

Dr. Petr Komers and Dr. Peter Douglas Elias, presenting for Saulteau First Nations said traditional practices can only be reproduced elsewhere if seven social and cultural conditions exist: (1) the practice is not associated with a particular place; (2) the traditional knowledge underlying the practice is completely portable and the environmental context is unimportant; (3) the people have no attachment to specific places; (4) and (5) the practice can be shifted to a different location without encroaching on areas used by another family or members of another First Nation or non-aboriginal land users; (6) areas not alienated to other interests and accessible to Aboriginal peoples are available; and (7) the displacement to other locations is not too costly in terms of time, technology and money. They said the Proponent has not evaluated if these circumstances exist and concluded that the notion of traditional practices being reproduced elsewhere is wrong.

Dr. Craig Candler, presenting for T8TA, said BC Hydro's idea of adaptation of practice was unsound. He said Treaty 8 First Nations harvesting is location and resource specific, is highly dependent on the unique cultural and ecological context of the Peace River valley, and is not likely to easily adapt to the Project. He also noted that BC Hydro has not presented evidence that preferred species and similar context are available elsewhere in the Treaty 8 First Nations territories.

Rick Hendriks, speaking on behalf of the T8TA, said additional information was needed to assess the ability of Aboriginal groups to go elsewhere. For instance, for fishing, information was needed on the capability of fish populations elsewhere to sustain additional harvesting, the abundance and quality of fish species, the catch rate, accessibility and knowledge of fishing sites, proximity of those sites to First Nations communities, other environmental characteristics of the sites such as noise and other pollution sources, potential risks of conflicts with other users, and most importantly the value of the sites. He noted that when comparing other sites to sites affected by the Project, the ones located on the Peace River increase in value.

Matt Munson, a member of the Dene Tha' First Nation, said, given the high level of development in the region, there would be no guarantee that areas would be available elsewhere and would remain available in the future. He also said BC Hydro should have consulted with land users to determine the significance thresholds.

Mr. Brian Toth, on behalf of McLeod Lake Indian Band, agreed with the threshold for determining significance but said BC Hydro's interpretation was questionable. He said the notion that Aboriginal groups can move their practices elsewhere had been given a cursory treatment, and that traditional activities can generally not exist outside of the setting that is provided by a large river environment.

Former Chief Garry Oker expressed his discontent with BC Hydro's interpretation of *Maps and Dreams* by Hugh Brody. He explained that Mr. Brody was talking about traditional economies, and how people use resources in the natural system, rather than generally stating that Aboriginal people are adaptable.

7.1.3 Panel's Analysis

The Panel heard many Aboriginal groups say they did not agree with BC Hydro's suggestion that Aboriginal traditional practices can readily be reproduced elsewhere and are therefore adaptable. The Panel considers that the Proponent's threshold for determining significance may be appropriate, but agrees with participants that its interpretation has been superficial and that conclusions based on adaptability have generally not been supported.

The assumption that traditional practices of Aboriginal groups are adaptable requires a demonstration that alternative areas of equivalent value and quantity are available for traditional use. More specifically, for each aspect of this valued component (VC), the Proponent should have determined whether alternative areas in the traditional territory were comparable in terms of uses, environmental conditions, accessibility, proximity to Aboriginal communities, animal and plant species availability, and intrinsic value to Aboriginal groups. The Proponent also should have looked at the potential for competition with other users of those areas and whether those areas are really available for traditional practices. The Panel considered these limitations of the Proponent's methodology in making its determination of significance for all aspects of current use discussed below.

The Panel considers a moderate or high magnitude effect to be significant. The Panel based its conclusion on information provided by the Proponent and participants, and in some cases, where the Proponent determined a moderate magnitude, the Panel found the effect could be high if the current use of the LAA would be severely undermined for a particular group.

With respect to mitigation measures, the Panel believes that the Proponent's proposed communication programs do not mitigate or reduce the significance of effects but serve to inform users of potential dangers and give an indication on how and when to plan activities. Although these programs are useful, the Panel does not consider them as mitigation for effects in the determination of significance for all aspects of current use discussed below. The Panel agrees with all of the Proponent's other proposed mitigation measures and recommends they be implemented if the Project proceeds.

7.2 CHANGES IN FISHING OPPORTUNITIES AND PRACTICES

For this VC, the Proponent looked at the current use of and access to fishing areas, the availability of targeted species, and the resulting changes during construction and operation of the Project.

7.2.1 Proponent's Assessment

To assess effects to changes in fishing opportunities and practices, the Proponent considered five key indicators: current use of lands and resources for fishing, location and access to the activity, species targeted, and use of the harvested species.

The Proponent said several Project components may reduce fishing opportunities and practices by changing access to fishing sites and fish health, movement, survival, and habitat. The Proponent said the results and mitigation measures of the assessment on fish and fish habitat were used to inform this section.

The Proponent used the same spatial boundaries as for the Fish and Fish Habitat Valued Component in its assessment.

The Proponent determined that the following groups conduct fishing practices in the LAA: Doig River First Nation, Halfway River First Nation, Prophet River First Nation, West Moberly First Nations, Saulteau First Nations, Blueberry River First Nations, Dene Tha' First Nation, Duncan's First Nation, Horse Lake First Nation, McLeod Lake Indian Band, and Métis Nation British Columbia.

The Proponent said boat and shore-based river fishing and practices along the proposed reservoir would be altered due to construction activities and inundation. This loss encompasses the flooding of stream mouths valued by Aboriginal groups, notably Halfway River and Moberly River.

The Proponent said the change from a river to a reservoir would result in a change in fish species and an increase in fish biomass as discussed in Chapter 4. BC Hydro predicted that the new aquatic environment would support a community of equal or greater productivity than the existing riverine environment. It was noted that species such as kokanee, lake whitefish, lake trout, burbot, peamouth, and rainbow trout could adapt to the new ecosystem and would benefit. Other species that rely on riverine habitats were predicted to decline in the reservoir environment. BC Hydro said three distinct species groups in the new ecosystem may be lost: the migratory component of the Moberly River Arctic grayling, migratory bull trout that spawn in the Halfway River, and mountain whitefish that rear in the Peace River and spawn in tributaries of the Peace River or the Peace River mainstem upstream of the Site C dam site.

Although these distinct groups would be affected, BC Hydro noted that Arctic grayling, bull trout, and mountain whitefish would continue to be present in Peace River tributaries and downstream of the reservoir and may persist in the reservoir.

The Proponent said the reservoir would support a greater variety of boats than the river and would offer new ice fishing opportunities. It said gill net fishing would be more accessible and fishing from the shore would still be available.

The Proponent concluded that the effects on changes in fishing opportunities and practices by all Aboriginal groups would be adverse, but not significant. It said that, while there would be a change in fishing methods and species harvested, the increased biomass would still support a fishery, and that the fishing practices of Aboriginal people are adaptable, spatially and temporally, and would not be undermined by the Project.

7.2.1.1 Fishing by Doig River, Halfway River, Prophet River and West Moberly First Nations

The Proponent, referencing the traditional use studies provided, said fishing by T8TA members would be adversely affected by the Project, but the impact would not be significant. BC Hydro noted that, within the LAA, T8TA members fish in the Peace River at the Farrell Creek, Halfway River, and Lynx Creek confluences, downstream and upstream of the Halfway River, and in the Peace Canyon Dam tailrace. As recorded by the Proponent, fish species harvested include trout, rainbow trout, bull trout (Dolly Varden), northern pike (jackfish), walleye, whitefish, and sucker.

Of these species, BC Hydro identified that mountain whitefish at the Lynx Creek confluence and upstream of the Halfway River would no longer be available. The other species would continue to be available in areas identified by T8TA members in the LAA. All species would continue to be available in the RAA. BC Hydro also identified two other areas outside the RAA that would be available for fishing (Williston reservoir and Charlie Lake).

BC Hydro determined that the effect would be moderate in magnitude, local in scale, and would persist until the reservoir stabilized. However, it was noted that fishing practices of Aboriginal people are adaptable and fishing could continue downstream at the confluences of the Pine, Beatton, Kiskatinaw, Pouce Coupe, and Clear Rivers.

7.2.1.2 Fishing by Saulteau First Nations

The Proponent said the current use of lands and resources for fishing by Saulteau First Nations would be adversely affected by the Project; however, the impact would not be significant. BC Hydro said that, within the LAA, Saulteau First Nations fish in the Peace and Moberly Rivers, harvesting species such as trout, rainbow trout, bull trout (Dolly Varden), northern pike (jackfish), walleye, whitefish, Arctic grayling, burbot (lingcod), and sucker.

Of these species, BC Hydro said that Arctic grayling in the Moberly River would no longer be available. The other species would continue to be available in areas identified by Saulteau First Nations in the LAA. All species would continue to be available in the RAA. BC Hydro also identified two other areas outside the RAA that would be available for fishing (Carbon Creek and Moberly Lake).

BC Hydro said the effect would be moderate in magnitude, local in scale, and persist until the reservoir stabilizes. However, it was noted that the fishing practices of Aboriginal people are adaptable and fishing could continue downstream at the confluences of the Pine, Beatton, Kiskatinaw, Pouce Coupe, and Clear Rivers.

7.2.1.3 Fishing by Blueberry River First Nations

The Proponent said the current use of lands and resources for fishing by Blueberry River First Nations would be adversely affected by the Project, but that the impact would not be significant. BC Hydro noted that, within the LAA, Blueberry River First Nations fish in Farrell Creek, Halfway River, Moberly River, Peace River at Bear Flat, Peace River at the Beatton and Halfway River confluences, and in the mainstem Peace River, harvesting species such as rainbow trout, bull trout (Dolly Varden), northern pike (jackfish), walleye, whitefish, Arctic grayling, burbot (lingcod), and sucker.

Of these species, BC Hydro said that Arctic grayling, walleye, and Mountain whitefish at the Halfway River confluence, and Arctic grayling in the mainstem Peace River would no longer be available. Arctic grayling in Farrell Creek would also not be available. Although identified by the group as a fishing location, baseline data demonstrated that this species does not appear to migrate into Farrell Creek, and few are currently present. The other species would continue to be available in areas identified by the Blueberry River First Nations in the LAA. All species were noted to continue to be available in the RAA. BC Hydro also identified 12 other areas outside the RAA that would be available for fishing: Beatton River, Carbon Creek, Charlie Lake, Chinaman Lake, Gwillim Lake, Halfway River, Jackfish Lake, Moberly Lake, Pine River, Stuart Lake, Upper Stoddart Creek, and Williston Lake.

BC Hydro said the effect would be moderate in magnitude, local in scale, and persist until the reservoir stabilizes. However, it was noted that fishing practices of Aboriginal people are adaptable, and fishing could continue, in some cases, downstream at the confluences of the Pine, Beatton, Kiskatinaw, Pouce Coupe, and Clear Rivers.

7.2.1.4 Fishing by Dene Tha' First Nation

The Proponent said the current use of lands and resources for fishing by Dene Tha' First Nation (DTFN) would be adversely affected by the Project, but that the impact would not be significant. BC Hydro said the Peace River section within the LAA used by Dene Tha' First Nation is at the periphery of their fishing territory. Fish species harvested include rainbow trout, bull trout (Dolly Varden), northern pike (jackfish), walleye, whitefish, burbot (ling cod), and sucker. DTFN also used the Project area for transportation, hunting, and fishing.

BC Hydro determined that these species would continue to be available in areas identified by DTFN in the LAA and would continue to be available in the RAA. BC Hydro also identified two other areas outside of the RAA that would be available for fishing (Charlie Lake and Sulphur Lake).

BC Hydro said the effects of the Project on fishing would be low in magnitude, local in scale, and persist until the reservoir stabilizes. It was noted that the fishing practices of Aboriginal people are adaptable and fishing could continue in other areas important to the Dene Tha' First Nation.

7.2.1.5 Fishing by Duncan's First Nation

The Proponent said the current use of lands and resources for fishing by Duncan's First Nation would be adversely affected by the Project, but that the impact would not be significant. BC Hydro said that, within the LAA, Duncan's First Nation people fish in the Peace River at the Beatton and Moberly River confluences, Hudson's Hope, and upstream of the Halfway River. BC Hydro said the Peace River section within the LAA used by Duncan's First Nation is at the periphery of their traditional fishing territory. Fish species harvested include trout, bull trout (Dolly Varden), northern pike (jackfish), walleye, whitefish, and burbot (ling cod).

Of these species, BC Hydro said walleye upstream of the Halfway River would no longer be available. The other species would continue to be available in areas identified by Duncan's First Nation in the LAA. All species would continue to be available in the RAA. BC Hydro also identified three other areas outside the RAA that would be available for fishing (Beatton River, Charlie Lake, Pine River).

BC Hydro said the effect would be low in magnitude, local in scale, and persist until the reservoir stabilizes. However, it was noted that fishing practices of Aboriginal people are adaptable, and fishing could continue in other areas important to the Dene Tha' First Nation.

7.2.1.6 Fishing by Horse Lake First Nation

The Proponent said the current use of lands and resources for fishing by Horse Lake First Nation would be adversely affected by the Project, but that the impact would not be significant. BC Hydro said that within the LAA, Horse Lake First Nation people fish in the Peace River at the Pine River confluence, and upstream and downstream of the Halfway River. BC Hydro said the Peace River section within the LAA used by Horse Lake First Nation is at the periphery of traditional fishing territory. Fish species harvested include northern pike (jackfish) and walleye.

Of these species, BC Hydro said that walleye upstream and downstream of the Halfway River would no longer be available. The other species would continue to be available areas identified by Horse Lake First Nation in the LAA. These species would continue to be available in the RAA. BC Hydro also identified four other areas outside of the RAA that would be available for fishing (Beatton River, Charlie Lake, Moberly Lake, Pine River).

BC Hydro said the effect would be low in magnitude, local in scale, and persist until the reservoir stabilizes. It noted that fishing practices of Aboriginal people are adaptable, and fishing could continue in other areas important to Horse Lake First Nation.

7.2.1.7 Fishing by McLeod Lake Indian Band

The Proponent said the current use of lands and resources for fishing by McLeod Lake Indian Band would be adversely affected by the Project, but that the impact would not be significant. BC Hydro said that, within the LAA, McLeod Lake Indian Band people fish in the Peace and Moberly Rivers. Species harvested include rainbow trout, bull trout (Dolly Varden), and Arctic grayling.

BC Hydro said these species would continue to be available in areas identified by McLeod Lake Indian Band in the LAA and in the RAA. BC Hydro also identified 12 other areas outside of the RAA that would be available for fishing (McLeod Lake, Carp Lake, Turner Lake, MacKinnon Lake, Deer Lake, Pine River, Beatton River, Williston reservoir, Parsnip River, Dinosaur reservoir, Dwyer Creek, and Porter Creek).

BC Hydro said the effect would be low to moderate, local in scale, and persist until the reservoir stabilizes. However, it noted that fishing practices of Aboriginal people are adaptable and fishing could continue in the Dinosaur reservoir, downstream of the Peace, McLeod Lake, and other areas that would not be affected by the Project.

7.2.1.8 Fishing by Métis Nation British Columbia

The Proponent said the current use of lands and resources for fishing by Métis Nation British Columbia would be adversely affected by the Project. BC Hydro said that, within the LAA, Métis Nation British Columbia fish in various locations on the Peace River. Fish species harvested include trout, rainbow trout, bull trout (Dolly Varden), northern pike (jackfish), whitefish, and Arctic grayling.

Of these species, BC Hydro said that Arctic grayling and walleye in the mainstem Peace River would no longer be available. The other species would continue to be available in areas identified by Métis Nation British Columbia in the LAA. All species would continue to be available in the RAA. No areas were identified outside the RAA that would be available for fishing.

BC Hydro said the effect would be low to moderate in magnitude, local in scale, and persist until the reservoir stabilizes. BC Hydro said the Métis harvesters who fished within the LAA were not members of any contemporary Métis community. As a result, BC Hydro could not determine if the use was representative of historical use, and it would not be appropriate to determine the significance of Project effects.

7.2.1.9 Fishing by Kelly Lake Métis Settlement Society

BC Hydro noted that the Kelly Lake Métis Settlement Society use the Peace River valley in general, but did not provide specific information on its use of sites or harvested species within the LAA. BC Hydro identified four areas outside of the RAA (Belcourt Lake, Onion Lake, Blue Lake, and Steep Rock Creek) where species including bull trout (Dolly Varden), rainbow trout, walleye, and suckers could be harvested.

7.2.2 Views of Participants

The following Aboriginal groups identified fishing sites in the LAA, mainly in the Peace River and at the confluences of its tributaries: Saulteau First Nations, Treaty 8 Tribal Association (Doig River First Nation, Halfway River First Nation, Prophet River First Nation, and West Moberly First Nations), Blueberry First Nations, Kelly Lake Métis Settlement Society, Dene Tha' First Nation, McLeod Lake Indian Band, Horse Lake First Nation, Duncan's First Nation, and Métis Nation British Columbia.

Aboriginal groups had concerns about the change in harvestable fish species as a result of the Project. Most identified the potentially lost species – bull trout, Arctic grayling, and mountain whitefish – as part of their preferred species. Métis Nation British Columbia said the majority of fish harvested by members are Arctic grayling, trout, and pike. Participants said that, although there was a predicted increase in kokanee, Aboriginal members had little interest in that species. Chief Roland Willson of West Moberly First Nations said kokanee had been introduced to the ecosystem by BC Hydro without consultation.

Treaty 8 Tribal Association (T8TA) said the Proponent's assessment did not take into account the preferred harvested species of Aboriginal groups, but instead looked at harvestable species in general. It said the Proponent determined that fish biomass would increase, but did not consider density (fish mass per unit area) recognizing the increased size of the reservoir. T8TA argued that the biomass density of harvestable species would decrease by 55 percent, and the biomass density of preferred species would decrease by 84 percent in the reservoir. It also said the proposed trap and haul mitigation for bull trout would have limited effectiveness, and the loss of fish density would only be reduced by 81 percent, meaning that, where there used to be five fish per unit area, only one would remain, consequently reducing fishing success. Saulteau First Nations also disagreed with the concept that total biomass may serve as a reliable measure of adverse effects because BC Hydro did not take into account the Aboriginal right to fish preferred species.

Most Aboriginal groups said fishing for their members relied on specific places, species, and means, and these places were critical for both the unique cultural and subsistence activity of their members. Many indicated that knowledge about fishing sites and fishing stories had been transferred for generations.

T8TA said preferred fish species are harvested in specific culturally known locations that are unique to the Peace River valley and qualified the Peace River valley as its "grocery store." It said the valley was a preferred area for fishing, hunting, and food and medicinal plant gathering for several reasons, including accessibility, deep cultural attachment, proximity to areas where members live, abundant wildlife and natural resources, and unique cultural and ecological value.

Chief Darlene Hunter from Halfway River First Nation said that the Peace River was in many ways their last refuge, given the high level of development in the Region.

McLeod Indian Band said they rely on the Peace River for subsistence and that other viable hunting, fishing, and harvesting sites are limited within their territory. They said their territory along the Peace River is highly valued because of the great animal and plant diversity and the abundance of natural resources.

Saulteau First Nations said the debris that would be released by the Project into the waterways used by community members would impede access to fishing locations by boat. T8TA said that boats were rarely used, and that preferred fishing means are rod and reel and net where

possible from the shore, and that the shore access points for fishing would be modified by inundation.

Many members of Aboriginal groups had fears about the high level of mercury in fish and explained that they would refrain from eating big fish or fish in large amounts because of this issue.

7.2.3 Panel's Analysis

The Panel believes that the assessment of effects on fishing opportunities and practices needed to consider the effects on fish resources, taking into account preferred harvested species as well as the uniqueness of the area potentially affected and the value placed on that area by users.

The Proponent demonstrated that the Project would likely have a significant effect on fish due to the loss of indigenous species. The Panel believes this should have been translated into the assessment of fishing opportunities and practices for Aboriginal people. The Panel agrees with Participants that the change in harvestable species and reduced biomass density would impede fishing for traditional purposes by Aboriginal groups.

The Panel heard repeatedly that the Peace River and the Peace River valley are unique. The Panel believes that Aboriginal groups demonstrated their strong cultural attachment to this large river environment and that the area is of high value for the sustenance of Aboriginal lifestyle. Although the Proponent stated that fishing practices are adaptable and can be reproduced elsewhere, the Panel agrees with participants that an alternate comparable natural setting cannot be found nearby.

In particular, the First Nations represented by T8TA and Saulteau First Nations demonstrated high use of the LAA for fishing. Although Blueberry River First Nations did not present their use of the LAA directly to the Panel, the Panel takes BC Hydro's assessment at face value in that it recorded the effect to this group as moderate in magnitude. The Panel considers the current use for these groups as severely undermined.

The Panel notes that fishing from the shore would be impeded during construction and until the reservoir stabilised. Aboriginal groups would also have to modify their fishing practices because they would have to either access the reservoir using boats or find new shore access points.

Even if Aboriginal groups would still be able to fish in the reservoir if the Project proceeds, the Panel recognizes that knowledge of fishing sites, preferred species, and cultural attachment to specific sites would be lost. The Panel discusses the implications of mercury in Section 11.5, but believes that Aboriginal groups not being able to fish for two or three decades until methylmercury returns to current levels also represents a significant temporal gap.

Consequently, the capacity of Aboriginal groups to transfer their knowledge and culture to future generations would also be impeded.

The Panel disagrees with BC Hydro and concludes that the Project is likely to cause a significant adverse effect on fishing opportunities and practices for the First Nations represented by Treaty 8 Tribal Association, Saulteau First Nations, and Blueberry River First Nations, and that these effects cannot be mitigated.

7.3 CHANGES IN HUNTING AND NON-TENURED AND SUBSISTENCE TRAPPING OPPORTUNITIES AND PRACTICES

The Proponent evaluated the changes in use and access to hunting areas and the availability of targeted species during construction and operation of the Project.

7.3.1 Views of the Proponent

To assess effects of changes in hunting and non-tenured and subsistence trapping opportunities and practices, the Proponent considered five key indicators: current use of lands and resources for hunting and trapping, location and access to the activity, species targeted, and use of the harvested species.

The Proponent said the Project may affect hunting and non-tenured or subsistence trapping opportunities and practices through changes to access and effects to wildlife, namely habitat alteration and fragmentation, disturbance and displacement, and mortality. The Proponent used the results and mitigation measures of the assessment on wildlife resources to inform this section. It noted that several key indicators for the wildlife assessment were selected based in part on Aboriginal concerns for these species.

When asked by the Panel why the choice of key indicators did not necessarily reflect all the species harvested by Aboriginal groups, the Proponent responded that some species such as bison and caribou would not interact with the Project. Others like squirrels were common, and either a change in population was not expected, or they could be effectively grouped under another key indicator. For instance, the Proponent assessed marten under the umbrella of fishers because marten use similar habitats, but are not as selective.

The Proponent used the same spatial boundaries as for the Wildlife Resources valued component in the assessment.

The Proponent said the current use of lands and resources for hunting and trapping by Treaty 8 Tribal Association (T8TA), Saulteau First Nations, Blueberry First Nations, Duncan's First Nation, Dene Tha' First Nation, Horse Lake First Nation, McLeod Lake Indian Band, and Métis Nation British Columbia would be adversely affected by the Project due to temporary reductions in availability of targeted species and temporarily reduced access to hunting areas during construction.

The Proponent said that, while some species would experience habitat loss, only small changes to populations of preferred species harvested by Aboriginal groups were expected. For example, BC Hydro noted that almost all Aboriginal groups identified moose as their preferred species, but the result of the wildlife assessment predicted that this species population would remain stable even if adversely impacted by the Project. The same would be expected for other ungulates. The Proponent also said the Province, through its harvesting regulations, has the ability to manage ungulates and predator populations. For harvested fur-bearers, bears, and

birds, BC Hydro said the wildlife assessment also predicted no harvested species would become vulnerable.

The Proponent said changes to navigation on the Peace River and its tributaries and access to roads in the Project area would be affected during construction, which would affect access to hunting and trapping locations. It said most of these areas would become accessible after the first several years of operation, with the exception of some near the dam and the Moberly Reach that may be restricted for longer periods due to slope stability concerns. The Proponent would also install three new boat launches to provide access the reservoir. The details are provided in Section 9.6.

The Proponent concluded that, taking into account mitigation measures, the effects on hunting and non-tenured trapping would be adverse but not significant. It explained that the effects of the Project would be temporary because access restrictions would be lifted within the reservoir, and animals, Aboriginal hunting practices, and non-tenured trapping would adapt to the post-Project environment.

7.3.1.1 Hunting and Trapping by Doig River, Halfway River, Prophet River and West Moberly First Nations

The Proponent said the current use of lands and resources for hunting and trapping by the four First Nations would be adversely affected by the Project; however, the impact would not be significant. BC Hydro characterized the area affected as within T8TA's core current use hunting area.

BC Hydro said the four First Nations harvest moose, elk, deer, caribou, mountain sheep, bison, black bear, rabbit, beaver, fur-bearers, coyote, grouse, geese, and duck. BC Hydro said none of these harvested species would be lost or become vulnerable and would continue to be available in the LAA and elsewhere in the RAA. It said that harvest of moose, deer, and elk may be affected at hunting locations within the LAA: areas in the path of the future transmission line (moose) near the Peace Canyon Dam due to increased access and competition; areas on the north shore of the Peace River at Lynx Creek (white-tailed and mule deer); on opposite banks between Farrell Creek and the Halfway River (deer and moose); and along the north bank near the mouth of the Red/Cache Creek (moose, elk, and deer) would be inundated; and areas on the south side of the Peace River (moose) could be affected by changes to downstream flows. Loss of fur-bearers and small game would be confined to the construction period, but the flooding of the reservoir would affect two beaver and one marten harvesting sites.

BC Hydro determined that the effect would be moderate in magnitude, local in scale, and persist until access restrictions were lifted within the reservoir and animals and hunters adapt to the post-inundation environment.

7.3.1.2 Hunting and Trapping by Saulteau First Nations

The Proponent said the current use of lands and resources for hunting and trapping by Saulteau First Nations would be adversely affected by the Project, but that the impact would not be significant. BC Hydro characterized the area affected as within Saulteau First Nations' core current hunting area.

BC Hydro said Saulteau First Nations harvest moose, elk, deer, caribou, mountain sheep, mountain goat, black bear, grizzly bear, rabbit, beaver, fur-bearers, coyote, wolf, geese, duck, and grouse. It said none of these would be lost or become vulnerable and would continue to be available in the LAA or RAA. Beaver, marten, wolves, squirrel, muskrat, weasel, coyote,

jackfish, mink, wolverine, and fox are also harvested along the Moberly and the Pine Rivers, around Boucher Lake, and in other areas in the RAA.

The Proponent, however, said hunting for moose, mule-deer, and elk in the southwestern portion of the LAA would be affected by changes in ungulate distribution, and hunting in the Monias and Boucher Lakes may be affected by increased access and competition. Loss of fur-bearers and small game would be confined to the construction period.

BC Hydro determined that the effect would be moderate in magnitude, local in scale, and persist until access restrictions were lifted within the reservoir and animals and hunters adapt to the post-inundation environment.

7.3.1.3 Hunting and Trapping by Blueberry River First Nations

The Proponent said the current use of lands and resources for hunting and trapping by Blueberry River First Nations would be adversely affected by the Project, but that the impact would not be significant. BC Hydro characterized the area affected as within Blueberry River First Nations' core current use hunting area.

BC Hydro said Blueberry River First Nations harvest moose, elk, deer, mountain sheep, black bear, rabbit, beaver, geese, duck, grebes, and grouse. It determined none of these harvested species would be lost or become vulnerable and would continue to be available in the LAA or RAA.

BC Hydro determined that the effect would be low to moderate in magnitude, local in scale, and persist until access restrictions were lifted within the reservoir and animals and hunters adapt to the post-inundation environment.

7.3.1.4 Hunting and Trapping by Dene Tha' First Nation

The Proponent said the current use of lands and resources for hunting and trapping by Dene Tha' First Nation would be adversely affected by the Project, but that the impact would not be significant. BC Hydro said the affected areas would be at the periphery of Dene Tha' First Nation's current hunting area.

BC Hydro said Dene Tha' First Nation harvest moose, elk, deer, black bear, rabbit, beaver, geese, duck, and grouse. Hunting of sharp-tailed grouse and ruffed grouse occurs also at Monias Lake. The Proponent noted that, with respect to waterfowl (Canada goose, mallard, pintail, blue- and green-wing teal, and greater and lesser scaup), two hunting areas may be impacted by the creation of the reservoir: at the slough side on the south side of the Peace River, opposite Wilder Creek, and on the wetlands north of the lower Moberley River. BC Hydro said none of these harvested species would be lost or become vulnerable and would continue to be available in the LAA or RAA.

BC Hydro determined that the effect would be low in magnitude, local in scale, and persist until access restrictions were lifted within the reservoir and animals and hunters adapt to the post-inundation environment.

7.3.1.5 Hunting and Trapping by Duncan's First Nation

The Proponent said the current use of lands and resources for hunting and trapping by Duncan's First Nation would be adversely affected by the Project but that the impact would not

be significant. BC Hydro said the affected areas would be at the periphery of Duncan's First Nation's current use hunting area.

BC Hydro said Duncan's First Nation harvest moose, elk, deer, and black bear. It said none of these harvested species would be lost or become vulnerable and would continue to be available in the LAA or RAA.

BC Hydro determined that the effect would be low in magnitude, local in scale, and persist until access restrictions were lifted within the reservoir and animals and hunters adapt to the post-inundation environment.

7.3.1.6 Hunting and Trapping by Horse Lake First Nation

The Proponent said the current use of lands and resources for hunting and trapping by Horse Lake First Nation would be adversely affected by the Project but that the impact would not be significant. BC Hydro said the affected areas would be at the periphery of Horse Lake First Nation's current use hunting area.

BC Hydro said Horse Lake First Nation harvest moose, elk, deer, and black bear. BC Hydro said none of these harvested species would be lost or become vulnerable and would continue to be available in the LAA or RAA.

BC Hydro determined that the effect would be low in magnitude, local in scale, and persist until access restrictions were lifted within the reservoir and animals and hunters adapt to the post-inundation environment.

7.3.1.7 Hunting and Trapping by McLeod Lake Indian Band

The Proponent said the current use of lands and resources for hunting by McLeod Lake Indian Band would be adversely affected by the Project but that the impact would not be significant. While the Peace River valley has become the preferred place for McLeod Lake Indian Band hunting, it was also depicted outside of the LAA. McLeod Lake Indian Band indicated having two active trap lines outside the LAA.

BC Hydro said McLeod Lake Indian Band harvest moose, elk, deer, caribou, grizzly bear, black bear, fur-bearers, grouse, geese, and duck. BC Hydro said none of these harvested species would be lost or become vulnerable and would continue to be available in the LAA or RAA.

BC Hydro determined that the effect would be low to moderate in magnitude, local in scale, and persist until access restrictions were lifted within the reservoir and animals and hunters adapt to the post-inundation environment.

7.3.1.8 Hunting and Trapping by Métis Nation British Columbia

The Proponent said the current use of lands and resources for hunting by Métis Nation British Columbia would be adversely affected by the Project due to reductions in availability of beavers and temporarily reduced access, but the impact would not be significant. BC Hydro noted that the beavers were expected to recolonize after construction, and the LAA is not in the core current use hunting area for the Métis harvesters interviewed.

BC Hydro said Métis Nation British Columbia harvest moose, elk, deer, caribou, mountain sheep, bison, black bear, rabbit, fur-bearers, grouse, geese, and duck. It said none of these

harvested species would be lost or become vulnerable as a result of the Project and would continue to be available in the LAA or RAA.

BC Hydro determined that the effect would be low in magnitude, local in scale, and persist until access restrictions were lifted within the reservoir and animals and hunters adapt to the post-inundation environment.

7.3.1.9 Kelly Lake Métis Settlement Society

BC Hydro said the Kelly Lake Métis Settlement Society uses the Peace River valley in general and hunt at the edge of the Peace River, north of Fort St. John around Blueberry. BC Hydro said the Society harvests large mammals, including moose and bear. BC Hydro said these harvested species would not be lost or become vulnerable and would continue to be available in the LAA and RAA.

BC Hydro said the Kelly Lake Métis Settlement did not provide sufficient specific information on its use of the LAA to enable an effect assessment.

7.3.2 Views of Participants

The following Aboriginal groups identified hunting or non-tenured trapping sites in the LAA: Saulteau First Nations, Doig River First Nation, Halfway River First Nation, Prophet River First Nation, West Moberly First Nations, Blueberry First Nations, Kelly Lake Métis Settlement Society, Dene Tha' First Nation, McLeod Lake Indian Band, Horse Lake First Nation, Duncan's First Nation, and Métis Nation British Columbia.

As discussed in Section 7.2, Aboriginal groups described the Peace River valley as being a unique landscape that provides for great hunting and trapping sites and an abundance of resources. The Peace-Moberly Tract (PMT) and the Area of Critical Community Interest (ACCI) that intersect with the LAA and RAA were identified, in particular, by West Moberly First Nations and Saulteau First Nations as being important hunting and trapping areas. Stewart Cameron from Saulteau First Nations said the areas that would be impacted by the Project are Saulteau First Nations' figurative schools, universities, medicine cabinets, and grocery stores. Many groups said that game constituted a large part of their diet.

McLeod Lake Indian Band said the Project would have an impact on overall access to their preferred hunting sites and preferred species. Wildlife populations in the Peace River valley have behaved in predictable manners and the knowledge about associated hunting sites, methods, and timing that has been passed on for generations would be rendered useless.

Saulteau First Nations said the new and improved roads proposed by BC Hydro would increase access and hence use of their preferred hunting and trapping areas by non-Aboriginal people. The roads would also result in increased wildlife mortality via vehicle collisions, facilitation of predator movement, and destruction and fragmentation of habitat. The resulting decrease in hunting success due to competition may lessen their ability to provide for their families. Members said the existing transmission line already increased access for non-Aboriginal hunters and that some now access the area with off-road vehicles. The hunting practices of non-Aboriginals were said to be wasteful and destructive, which limited the traditional practices.

All Aboriginal groups using the LAA reported hunting moose, which most identified as the preferred species. Other species hunted or trapped in the LAA include elk, mule deer, white-tailed deer, beaver, marten, geese, duck, and grouse. Naomi Owens from Saulteau First Nations said moose and its preparation is the backbone of their community, and that moose

was a major component of their culture and tradition and involved their spirituality. Clarence Apsassin from Blueberry River First Nations noted the importance of moose hide for making clothing and accessories. Christopher Gall of the Métis Nation British Columbia said harvesting of country foods was critically important for Métis cultural continuity.

Numerous members of Aboriginal groups had concerns about the decline in moose in the past few decades. Councillor Clarence Willson of West Moberly First Nations said this decline was concerning, as was the location and availability of those moose for the community. He said the problem was that a large amount of land had been taken up or put to other uses, and that now moose are often located on private properties that are not accessible for hunting.

Aboriginal groups also had concerns with the health condition of wildlife resources due to contaminants. Several noted that animals are being exposed to contaminants via sumps and flare pits and are in poor condition. Aboriginal hunters reported shooting moose that were found to have multiple tumours, skin lesions, and a strong smell of hydrocarbons. They were judged not fit for consumption and were buried. A member of the McLeod Lake Indian Band said she limits her consumption of beaver and moose meat because those animals eat trees in riparian and wetlands areas associated with the Williston reservoir and may be contaminated. She feels that, like fish, these animals are bound to be contaminated as well.

7.3.3 Panel's Analysis

The Panel believes that the assessment of effects on hunting and non-tenured trapping needs to take into account the effects on preferred harvested species, as well as the uniqueness and the value of the area potentially affected.

The Panel agrees that the Peace River valley is a unique landscape and believes that Aboriginal groups have clearly demonstrated their strong attachment to the valley. Despite the affirmation of the Proponent that other hunting and trapping sites are available in the LAA and RAA, the Panel heard repeatedly from Aboriginal groups that their preferred hunting sites would be impacted by the Project and that other sites elsewhere were limited. The Panel also agrees with participants that hunting and trapping for traditional purposes is linked to specific sites and that intergenerational knowledge about the practices would be lost if the Project proceeds.

In particular, the First Nations including those represented by T8TA and Saulteau First Nations demonstrated high use of the LAA for hunting and non-tenured trapping. BC Hydro recorded the effect to these groups as moderate in magnitude. The Panel considers the current use for these groups as severely undermined.

The Panel notes the concerns of Aboriginal groups about increased competition due to additional access or fewer hunting sites. This concern was acknowledged for Saulteau and the four Nations represented by T8TA but was hardly addressed as a potential issue by the Proponent.

Most concerns expressed by Aboriginal groups were related to moose. The Proponent's determination of significance for wildlife resources mainly relied on whether a species would become vulnerable as a result of the Project. For moose, the Proponent concluded that the effect would not be significant because the sustainability of the population would not be threatened. The same argument was carried over in current use. As reported in Chapter 6, the Panel concluded that the Project would likely have an adverse effect on moose, but it would not be significant. The Panel made that conclusion partly based on the fact that moose populations had been stable for three decades and that the Project was unlikely to affect their sustainability.

However, the Panel believes that the ability to traditionally hunt or trap a species could be impacted regardless of whether this species would become vulnerable as a result of the Project. The Project would reduce moose populations in the LAA and current populations would be disturbed and displaced which, the Panel believes, may in turn affect hunting success. The ability to traditionally hunt or trap could be adversely affected by hunters having to travel farther into unfamiliar or already-alienated territory as a result of prey displacement. Hunting success for other wildlife resources is likely to be impacted by the Project in the same way.

The Panel disagrees with BC Hydro and concludes that the Project would likely cause a significant effect on hunting and non-tenured trapping for the First Nations represented by Treaty 8 Tribal Association and Saulteau First Nations, and that these effects cannot be mitigated.

7.4 CHANGES IN OTHER TRADITIONAL USES OF THE LAND

In its assessment of changes in cultural and traditional uses of the land by Aboriginal groups, the Proponent examined cultural heritage, such as cultural, sacred sites, and burial sites, including intangible heritage. The Proponent also assessed changes to other traditional uses of the land such as habitation sites, feather-gathering sites, harvesting of firewood, drinking water, trails and water routes, berry and plant gathering, or sites that served a combination of uses. In this section the Panel assessed these other uses of the land for traditional purposes. Aspects related to cultural heritage are reviewed in Chapter 12.

7.4.1 Proponent's Assessment

Habitation sites

BC Hydro reported that Treaty 8 Tribal Association (T8TA), Saulteau First Nations, Blueberry First Nations, Duncan's First Nation, Horse Lake First Nation, Métis Nation British Columbia, and McLeod Lake Indian Band identified habitation sites within the LAA, and that the majority of habitation sites were associated with seasonal traditional use activities.

The Proponent said T8TA identified 136 habitations sites within the local assessment area (LAA): 59 gathering places, 53 temporary habitations, and 24 permanent habitations. The Proponent said most habitations were within the inundation zone and a small number, concentrated at Fort St. John Historic Park and Taylor, would also be affected by access restrictions in the area of the proposed dam site. BC Hydro said that T8TA asserted that 77 habitation sites were located within the inundation zone and Project footprint, but that the data were too imprecise for BC Hydro to confirm this.

BC Hydro said Saulteau First Nations referred to 96 habitation sites within the LAA, but that this could be an overestimation as stated by Saulteau at the hearing. The Proponent said the maps provided were too imprecise to assess accurately whether the sites would be impacted by the Project. However, several sites along the Peace River seem to be located in the inundation zone.

The Proponent reported that Blueberry River First Nations identified six camp sites within the LAA. The camps are used during hunting, fishing, and recreational camping activities with an elderly-youth "cultural" camp held at Bear Flat.

BC Hydro said that, on some Saulteau traplines, cabins are next to the river and trapping activities are conducted on the shore of the Peace and Moberly Rivers. It said up to six cabins associated with traplines would be inundated or are within the reservoir impact lines. Safety considerations related to existing or proposed trapline cabins and supporting structures within reservoir impact lines would be evaluated based on erosion, stability, and landslide-generated wave hazards. Some of the existing cabins could potentially be moved to another area of the tenure or remain where they are, pending further site-specific analysis.

The Proponent said it would engage tenure holders and, based on further geotechnical investigations, enter, as needed, into agreements to address the removal or relocation of these buildings, or outline the conditions upon which the buildings could remain. It said camps areas, camping sites, tipis, and numerous cabins can be found on the traplines, and some cabins are used for ceremonies or traditional healing. It said standard mitigation of effects on tenure holders would apply for cabins affected by the Project.

For Blueberry First Nations, the Proponent said five of the six camps identified by the group would be impacted by the reservoir. It said one McLeod Lake seasonal camp at the mouth of the Halfway River would likely be impacted and that out of the six sites identified by Duncan's First Nation, one opposite to Farrell Creek may be impacted. The Proponent reported that Métis Nation British Columbia identified several sites along the Peace River that appear to be within the inundation zone. BC Hydro is not expecting that habitation sites reported by Horse Lake First Nation would be impacted.

Harvest of berries, herbs and medicinal plants

BC Hydro said T8TA, Saulteau First Nations, Blueberry First Nations, Duncan's First Nation, Horse Lake First Nation, Métis Nation British Columbia, Dene Tha', and McLeod Lake Indian Band harvest plants within the LAA.

BC Hydro said the effects on the harvesting of berries, herbs, and medicinal plants for traditional purposes were assessed based on information reported in Traditional Land Use studies and on the biophysical effects described for vegetation and ecological communities. BC Hydro said that while the section on vegetation and ecological communities does not assess effects on individual plant species reported to be used for traditional purposes, it assesses effects to those terrestrial ecosystems within the vegetation and ecological communities LAA that are vulnerable to environmental effects of the Project, some of which are known to have plants harvested by Aboriginal people. BC Hydro said that, by extension, the interactions and effects described for vegetation and ecological communities can be used to inform this indicator.

For specific sites identified by Aboriginal groups for plant harvesting in the LAA, the Proponent said some would be partially or completely affected by the Project. Bear Flat and its eastern slopes would be partially affected. Other areas identified by Aboriginal groups near the confluences of the Peace River with Farrell, Lynx, and Cache Creeks may be affected. Sites found along the Moberly River or within the reservoir inundation area would be inundated and lost. The islands adjacent to the Halfway River confluence, which were noted to contain medicinal plants, would also be inundated. Some identified slopes may also be within the stability or erosion impact lines. For other locations identified, the Proponent said it lacked the site-specificity to allow a determination as to whether it would be affected.

According to BC Hydro, the Project would affect the opportunities for Aboriginal groups to harvest plants and berries in the LAA. While in some cases it may be possible for them to find alternate harvesting areas; these may be farther afield relative to their current travel distance, more costly to access, or less abundant. BC Hydro concluded that, as a result, harvesting

success may be reduced. In areas where clearing has occurred, but plants and berries remain, perceived or real effects on the quality and safety of the foods may limit the availability of desirable harvesting locations and the desire to gather and consume the resources.

Gathering of firewood

The Proponent reported that Saulteau First Nations, T8TA, and Métis Nation British Columbia harvest wood in the LAA. BC Hydro said three areas used by Saulteau First Nations would be impacted, one within the inundation area and two within the proposed transmission line corridor. T8TAalso identified four firewood harvesting areas that would be affected by the reservoir. BC Hydro noted that Métis Nation British Columbia harvests firewood and one speciality wood in two areas of the LAA that would be inundated.

Gathering of eagle feathers

BC Hydro reported that Saulteau First Nations and T8TA harvest eagle feathers. The Project may affect bald eagle gathering locations for Saulteau First Nations found on the south side of the Peace River between the mouths of the Pine and Moberly Rivers. Golden eagle resource sites in the LAA may also be affected by the road realignment and transmission line corridor. The Proponent said two feather-gathering sites identified by T8TA may be affected by the Project.

Drinking water

BC Hydro said T8TA identified several sources of freshwater sources within the LAA. The Proponent determined that six freshwater sources are located in the inundation zone.

Trails and Water routes

BC Hydro said Saulteau First Nations identified 22 trails in the LAA. BC Hydro said the trails located south of Boucher Lake and to the south and west of Monias Lake would not be affected. The trails close to the mouth of the Moberly River and at two locations on the south side of the Peace River would be affected by clearing and inundation.

According to BC Hydro, T8TA identified 30 transportation values within the Project footprint and flood zone including: portions of trails, horse crossings, raft or boat crossings, and water routes. Portions of these trails or routes that cross the river in its flood zone would be disrupted and several other transportation and boat routes along the Peace would be flooded. BC Hydro added that the transportation lines depicted within the Peace River would be submerged and fragmented by the dam site. The transportation lines running along the Halfway River from its mouth to Halfway River Reserve 168 would not be adversely affected.

BC Hydro said McLeod Indian Band identified the Peace River and the Williston reservoir as their main transportation routes. The Peace River would be fragmented as a result of the Project. The Proponent said portions of the Rocky Mountain Portage Trail used by the band could also be impacted by the Project.

7.4.2 Views of Participants

T8TA reported that, based on surveys of its members, 796 sites of values were identified in the LAA; out of those, 368 sites or 46 percent would be within the inundation zones or Project footprint. It noted that 42 sites of cultural or spiritual values would be inundated, including spiritual places, burials, medicine collection areas, teaching areas, ceremonial and prayer

offering places, and locations associated with place names and oral histories. In addition, 77 habitation sites, temporary or permanent, used for camping or gathering, including places that have been used for generations and are still being used, would also be inundated; 30 sites identified as having transportation values, such as portion of trails, horse crossings, raft or boat crossings, and canoe and boat routes along the Peace River and adjacent tributaries, would be lost.

Several members of Aboriginal groups commented that the Peace valley riverside provides for beautiful campsites that they visit every year.

Chief Roland Willson said he did not believe that any permanent residences of the West Moberly First Nations would be affected by the Project, although he said trapper cabins could be found throughout the area. He explained that they had the right to erect a trapper cabin or a campsite without having a tenured trapline. He said the lack of specificity with regards to location of campsite or hunting/trapping sites was because they wanted to avoid competition.

Several members of the Halfway River First Nation said the land at the confluence of the Halfway and Cameron Rivers is the only place where they can keep their cattle and horses in the summer. They also said these areas were used for camping, harvesting berry and medicinal plants, as well as fishing and hunting.

Elder Margaret Dominic from Doig River First Nation said they cannot find berries around their communities, and they have to go down to the Peace River to pick berries and huckleberries.

Saulteau First Nations said inundation of the reservoir would lead to the permanent loss of some vegetation communities and would impact access to plant harvesting sites. Plants are used by Saulteau First Nations for healing purposes, and therefore they consider the value of these plants differently than BC Hydro's scientific or technical approach.

The Elder panel of Saulteau First Nations said there is an abundance of rose hips, but not rat root and mint tea. They said healers believe that transplanting medicinal plants causes them to lose their potency, which impacts the effectiveness of traditional healing. They said some medicinal plants, specifically a type of cactus and buffalo sage, would be lost forever if the Project proceeds.

The Elder panel explained that Saulteau First Nations pray with the eagle feathers. They respect eagles as messengers, and their feathers are of great ceremonial importance. It is considered an honor to find an eagle feather. They raised concerns for the potential of the Project to negatively impact the shorelines, thus leading to adverse impacts on nesting sites for species such as eagles and swans.

McLeod Lake Indian Band said the Project would have an impact on traditionally utilized sites, navigation routes, landmarks, and seasonal residences. It also reported that several plants and berries harvesting sites would be eliminated or reduced as a result of the Project.

Métis Nation British Columbia indicated having cultural and overnight sites as well as harvesting sites along the Peace River within the LAA and within the RAA. It also identified drinking water sources along the Halfway River and within the proposed dam construction area.

The Kelly Lake Métis Settlement Society said that water as a source of drinking water was sacred. As stewards of the land and water, members try to ensure that the water remains as clean as possible.

T8TA told the Panel that its people now carry drinking water when on the land because of loss of faith in the quality of water in the Peace River valley. The result is increasing cost and efforts required when harvesting resources. It also said access to the spring water source near Bear Flat is an important part of exercising their rights.

7.4.3 Panel's Analysis

Panel understands that for habitation sites that would likely be affected by the Project, BC Hydro would discuss appropriate mitigation with the owners and move affected habitations if possible. BC Hydro said it would follow mitigation processes that it has developed for tenure holders and apply that process in these cases. The Panel understands, therefore, that mitigation for loss of habitation sites may include compensation. Similar to how trappers and outfitters would be compensated for loses, the Panel understands that there is no legal guidance on appropriate compensation and that compensation is based on negotiations between parties. The Panel's recommendation made in Section 9.1.4.3 regarding trapping and guide outfitter compensation would be appropriate in this case as well. Although mitigation is proposed, the number of habitations potentially affected is high, especially for Saulteau First Nations and the First Nations represented by the T8TA.

For berries, herbs, and medicinal plants, the Panel acknowledges the suite of mitigation measures proposed to mitigate effects on vegetation. The Panel notes that there was low confidence in the mitigation measures and their effectiveness, as mentioned in Chapter 5. Several sites identified by Aboriginal groups for the harvesting of plants would be lost, such as sites along the Moberly River, islands adjacent to the Halfway River confluence, which were noted to contain medicinal plants, and some identified slopes possibly within the stability or erosion impact lines. BC Hydro said other sites are available in the LAA, but these sites may be further afield and more costly to access. There is also no guarantee that the preferred or needed species would be present or abundant, as discussed in Section 5.4.

The Panel also notes that the Project would adversely affect several traditional trails and navigation routes, nesting sites of eagles, and spring water sources and that these sources are important to Aboriginal people when using the land for traditional purposes.

Because inundation as a result of the Project would permanently remove these resources, mitigation is not possible in all cases.

The Panel concludes that the Project would likely cause a significant adverse effect on other traditional uses of the land for the First Nations represented by Treaty 8 Tribal Association, Saulteau First Nations, and Blueberry River First Nations, and that some of these effects cannot be mitigated

7.5 CUMULATIVE EFFECTS ASSESSMENT

The Proponent determined that the Project would likely result in adverse residual effects on the current use of lands and resources for traditional purposes for some groups and conducted a cumulative effects assessment on Saulteau First Nations, Treaty 8 Tribal Association, Blueberry River First Nations, Dene Tha' First Nation, Duncan's First Nation, and Horse Lake First Nation.

7.5.1 Proponent's Assessment

To assess cumulative effects on fishing for traditional purposes, the Proponent used the results of the assessment conducted for fish and fish habitat. Given that the Project would unlikely result in cumulative effects on fish and fish habitat, the Proponent concluded the same for fishing for traditional purposes.

In its assessment for hunting and trapping for traditional purposes, the Proponent assessed six foreseeable projects in the RAA. For other projects and activities, it extrapolated potential residual effects based on the potential effects to wildlife habitats. It determined that three projects would result in a measurable reduction of ungulates, fur-bearers, non-migratory birds, and migratory waterfowl habitats, but that they would not affect the sustainability of those populations. The other projects assessed were predicted to have no measurable effect on wildlife or a small or non-existent effect on the current use, and a cumulative effect was unlikely. For oil and gas and forestry activities, BC Hydro stated that, when combined with the Project, these activities would result in a decrease in the regional populations of fur-bearers and ungulates, but that because these species would likely persist, hunting and trapping would still be permissible. The Proponent said populations of waterfowl and game birds would remain relatively unchanged.

For other current use of the lands and resources for traditional purposes, BC Hydro said other projects and activities are well removed from the LAA and their residual effects were unlikely to overlap with residual effects of the Project in the LAA. Consequently, it was unlikely that that the Project would result in cumulative effects on other current use of the lands and resources for traditional purposes.

BC Hydro concluded that overall the Project was unlikely to result in cumulative effects on the current use of lands and resources for traditional purposes, and as such it did not assess significance or propose additional mitigation measures.

7.5.2 Views of Participants

The groups that identified use in the LAA (Saulteau First Nations, Treaty 8 Tribal Association four Nations, Blueberry River First Nations, Dene Tha' First Nation, Duncan's First Nation, Horse Lake First Nation, McLeod Lake Indian Band, Métis Nation British Columbia, and Kelly Lake Métis Settlement Society) also discussed areas of use within and outside the RAA established for the Project. Many members expressed concerns with the potential high cumulative impact on these areas.

Many Aboriginal participants had concerns about the existing impacts on their current use of lands and resources for traditional purposes and stated that the upstream hydroelectric projects were part of this. They noted that these facilities were not adequately addressed. They said a baseline assessment considering a pre-Bennett Dam environment would have been required to fully understand the cumulative and incremental effects of the Project on current use. T8TA said the construction of these two dams and associated transmission lines and ancillary facilities had effects including: displacement from preferred sites, creation of a reservoir system that changed wildlife migration and distribution and increased mortality and morbidity, changes in fish population and species, increased methylmercury, increased access to non-Aboriginal hunters, and loss of habitation sites and trails. As a result of these changes, T8TA noted that Aboriginal access to traditional resources had been affected. Members of T8TA said that ignoring these past effects does not acknowledge that their use of lands and resources for traditional purposes has already been affected, and that the Project would exacerbate these losses. McLeod Lake

Indian Band and Kelly Lake Métis Settlement Society said the loss of traplines, plant harvesting areas, and fish and animal resources as a result of the upstream dam construction had a severe impact on their traditions.

Aboriginal participants said the RAA has been affected by industrial, agricultural, and urban development over the past century. Carmen Marshall of Saulteau First Nations said the amount of industrial development in Saulteau's traditional territory was overwhelming, adding that, this year alone, the Province was proposing 161 coal tenures. West Moberly First Nations also said, area developments in recent years included two pulp mills, six approved coal mines, additional forestry, shale gas and wind farms, and expansion of the mountain pine beetle. Chief Roland Willson said these impacted the landscape directly, and associated infrastructure, such as seismic lines, pipelines, and power lines, caused fragmentation of the territory and opened up access for recreational hunters. Dene Tha' First Nation also provided maps that indicated an underrepresentation of the amount of disturbance in the RAA by the Proponent.

Carmen Marshall said that since the Province had not conducted a cumulative effects assessment, that no threshold to development existed and there were no limits to the amount industrial development that could occur in Saulteau territory.

Participants said that, because of the extensive resource development in the region, the alternate locations BC Hydro identified in the RAA for the practice of current use of lands and resources for traditional purposes represented, in many cases, a second displacement. Carmen Marshall from Saulteau First Nations said that because the animals throughout the region are being impacted by other industries, there are limited places to hunt. Dene Tha' First Nation said there are continually fewer "elsewheres" suitable to the exercise of treaty and Aboriginal rights due to the high amount of disturbances within its traditional territory. McLeod Lake Indian Band also said that traditional practices lose their integrity and value when disconnected with the landscape and ecosystem. It said the Project would add to the existing disruptions and further impact cultural practices.

Duncan's First Nation also rejected the Proponents approach to assessing the impacts of the Project on its rights, physical and cultural heritage, health and socio-economic conditions, and current use of lands and resources for traditional purposes, stating that it wrongly used the concepts of "almost limitless" and "adaptability." Duncan's First Nation claimed that BC Hydro's consultants substituted the unevidenced idea of adaptation of practice and the unsupported notion that people can go elsewhere for a proper assessment on the current use of lands and resources, resulting in an underestimation of the significance of the effects of the Project. Duncan's First Nation claimed the Peace River and its valley to be irreplaceable, saying there were no comparable sites where Duncan's members can go, from both a cultural and ecological standpoint.

In response to BC Hydro's statement that currently "fishing is done in a number of small lakes, creeks and streams outside of the LAA," T8TA said these areas were not only already impacted by industry, they were also affected by over-fishing by non-Aboriginals, were not readily available, or were not ecologically or culturally similar to the areas that would be affected by the Project. T8TA said the other locations BC Hydro suggested were either inaccessible or not suitable for meaningful rights practice similar to what currently exists and would be affected by the Project. It also said no clear alternate locations were identified by BC Hydro to replace areas for hunting, trapping, or plant gathering.

T8TA said the Dinosaur and Williston reservoirs were not suitable locations to exercise traditional rights because of problems with access, preferred species, species densities, and

methylmercury concerns. Chief Willson of West Moberly First Nations said that, historically, families had fish camps on the Parsnip and Crooked Rivers but now refrain from fishing or conduct only catch and release due to fears of methylmercury contamination.

Aboriginal groups that do not use the LAA

Athabasca Chipewyan First Nation and Mikisew Cree First Nation said their current use of lands and resources for traditional purposes mainly revolved around the Peace Athabasca Delta (PAD). They said the flow of the Peace River was crucial to the practice of their cultural traditions and exercise of their rights throughout the PAD, inside and outside Wood Buffalo National Park and in proximity to their reserves. They said the PAD has been drying since the erection of the Bennett Dam, and the resulting lower water levels in various water bodies is adversely affecting their hunting, fishing, and trapping. They said the waterways within the PAD act as highways and allow their members to access important harvesting and cultural sites in the PAD. They said areas such as Richardson Lake, Lake Mamawi, Goose Island, Lac Claire, Flour Bay and others are becoming difficult to access, and they cannot use their boats to transport game as they used to because of the low water levels.

Other downstream groups, including Woodland Cree First Nation, Little Red River Cree First Nation, and TallCree First Nation also had concerns about reduced downstream flows. Little Red River Cree First Nation, in particular, was concerned about the wetlands near Vermillion Chutes. Dene Kue First Nation had concerns that the water levels of the Great Slave River were significantly lower than historically. Dene Kue First Nation said these water bodies are important for their subsistence fishing and hunting, and the drying of the land impacts their ability to hunt and trap several species, including migratory birds.

Fort Chipewyan Métis Association said members could no longer access their traplines in the Lake Claire area due to the decreased water. Fort Chipewyan Métis Association worried that the decreased water level prevented geese from stopping in the area anymore and that muskrats were increasingly difficult to find.

Some of these downstream groups said the study area for the cumulative effects assessments should also have been extended to include the PAD. The primary rationale was that the existing upstream facilities on the Peace River continue to have significant adverse effects on the current use of lands and resources for traditional purposes of Aboriginal peoples in the PAD. Moreover, they noted that, because the Project relies on the reservoir storage capacity of the existing dams, the cumulative and incremental effects of all three dams on the Peace River should be assessed for the full study area including the PAD.

Kwadacha First Nation said members practice their traditional uses in the hills surrounding the LAA where traplines were located and game and medicinal plants could be found. Members lived in fishing or hunting camps and on traplines or other seasonal spots for most of the year and used the river to travel within the region. Kwadacha said the construction of the Williston reservoir destroyed many of these transportation networks and isolated members to the north of it. Kwadacha said it had concerns about the narrow scope of the review with respect to wildlife in the LAA and the long-term impacts on the larger area that were not adequately considered in the assessment. It worried that the Project workforce would travel and hunt in its traditional territory and threaten its members' ability to collect food and practice traditional culture. Kwadacha recommended that workforce management and access restrictions be put in place. It further suggested that, in light of the extensive activity across the Peace region, the Province limit hunting, fishing, and trapping activities in the Regional District to tenure holders and

individuals exercising Aboriginal rights, or alternatively, reduce bag limits during the construction of the Project.

Peace Moberly Tract and Area of Critical Community Interest

West Moberly First Nations and Saulteau First Nations identified an area close to their communities as an Area of Critical Community Interest (ACCI) and expressed significant concerns, particularly with the Peace-Moberly Tract (PMT) located within the ACCI (Figure 10). The PMT comprises approximately 1,090 km^2 of land lying between Moberly Lake and the Peace River. The northern boundary of the PMT follows the Peace River between Dinosaur reservoir and Peace Boudreau Park, while the southern boundary follows the Moberly River watershed both upstream and downstream from Moberly Lake. Most of the West Moberly and Saulteau First Nations reserve lands lie within the PMT.

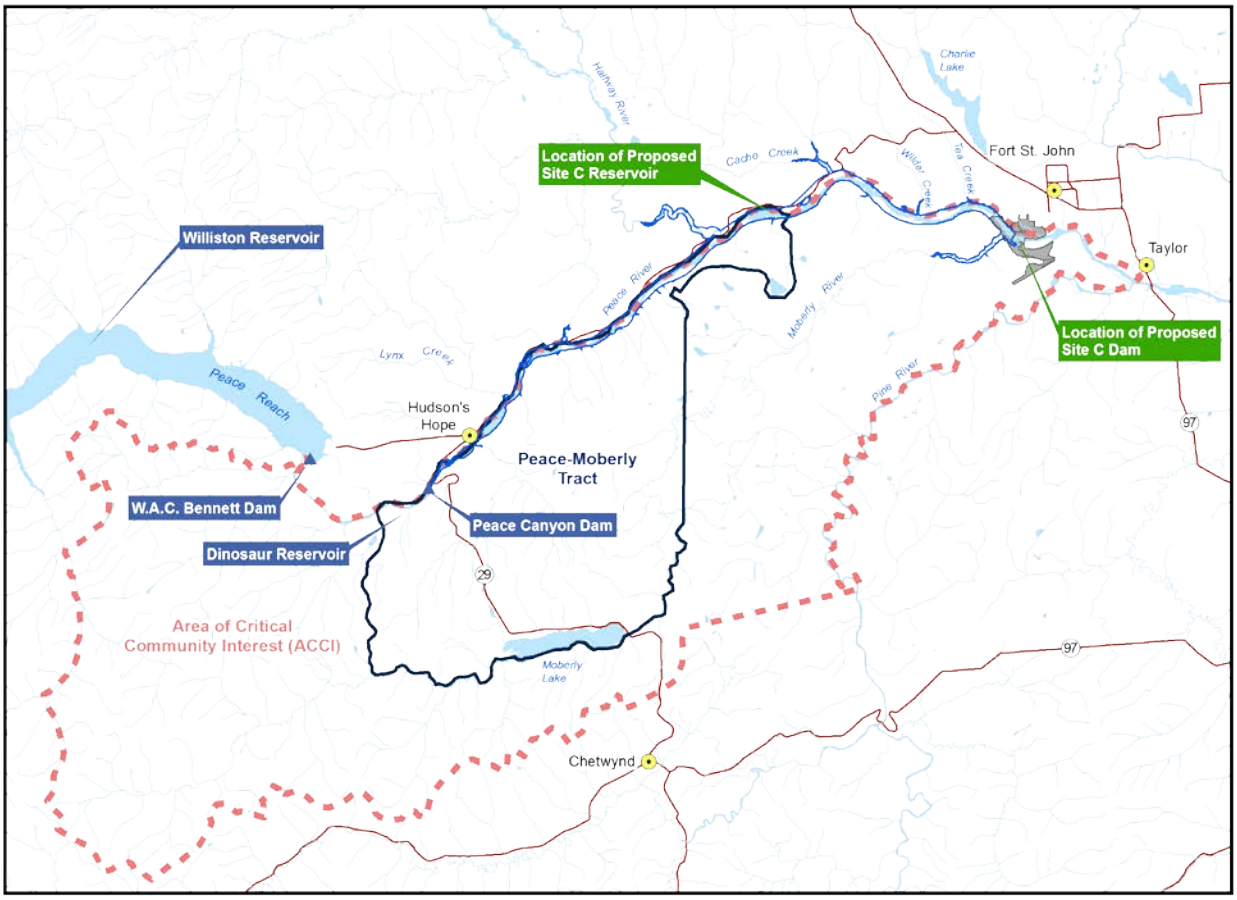
Chief Willson and Jim Webb described the PMT as a relatively undisturbed area that should have special protection because of its unique character, proximity, and importance to the communities. Saulteau First Nations said it is a place of sustenance and cultural significance and that it is used extensively for traditional purposes.

Participants had concerns that the existing transmission line has become an access route for people to hunt in the PMT. They said the expansion of the right-of-way to accommodate the Project transmission line would result in increased industrial development within the PMT and the larger ACCI. Maps provided from participants and BC Hydro demonstrated that several well sites and access roads are currently in the PMT. Participants mentioned additional planned development in the PMT, including the Prince Rupert Gas Transmission Project and the Spectra Transmission Line, as referenced by Hudson Hope Mayor Gwen Johansson, and the Coastal Gas Link Pipeline and the Merrick Mainline Pipeline, as referenced by Chief Willson.

Participants said there are no restrictions on hunting by non-Aboriginal people in the PMT. Several First Nations expressed the desire to have the PMT protected for their exclusive use.

Saulteau First Nations requested that the Panel recommend that BC Hydro limit hunting access in the ACCI and PMT for non-residents and the Project's temporary employees. When asked to comment on the possibility of such a request by the Panel, the Province indicated that it was not a feasible recommendation. It explained that if there were a legitimate conservation concern, hunting could be limited to First Nations people only, followed by others if there were further allowable harvest.

West Moberly First Nations said that, in response to concerns raised by Saulteau and West Moberly First Nations, the Province entered into negotiations with them with the objective of developing a sustainable resource management plan for the protection of the PMT. They requested that a limit of 5 percent of the land be set for development in the PMT. The Site C inundation zone would be a large fraction of that percentage. The result of the negotiation was rejected by the First Nations because they stated that B.C. refused to reconsider Site C, to end the privatization of Crown lands within the PMT, or to make the plan binding on all agencies of the provincial government, notably the Ministry of Energy, Mines and Petroleum Resources.



Note: Map created with BC Hydro and GeoBC data

Figure 10.Peace-Moberly Tract, Area of Critical Community Interest and Site C Project Activity Zone.

BC Hydro said they were in discussions with Saulteau First Nations on options to mitigate effects on the PMT and the ACCI. These measures could include Crown land transfers, land protection measures, and special management designations under a proposed Impact Benefit Agreement.

Agreements

Tribal Chief Liz Logan provided an historical overview of other negotiations between First Nations and the Province. She said that in the 1990s the seven nations that belonged to the T8TA started to negotiate an oil and gas agreement with the B.C. government after a rapid escalation in the development of that industry. She said that, during the discussions, there were five recurring themes of interest to Treaty 8 First Nations that the Province did not want to address: cumulative effects, co-management of resources, revenue-sharing, overlapping territory claims, and protection of the integrity of the Treaty 8 territory. She said the B.C. government finally agreed to negotiate co-management and revenue sharing and that the resulting agreement was a first stepping stone toward improving relationships with the BC government.

A series of Collaborative Management Agreements (CMAs) were negotiated between British Columbia and T8TA in recognition of Treaty 8 governance and management rights, in a spirit of shared decision-making. T8TA argued that, contrary to the case law and the CMAs, the Site C process was not conducted in a spirit of shared decision-making and was based on an outdated

conception of the role of the Treaty 8 First Nations in the review of these types of projects. T8TA said any possible process of shared decision-making on the Site C Project was precluded from the outset by actions and policies that remain unchanged since the 1960s. These include the government's Two Rivers policy, the establishment of the flood reserve, the construction of two existing dams, the project-specific objective of maximization of hydroelectric potential of the Peace River, and the *Clean Energy Act,* which exempted the Project from oversight by the British Columbia Utilities Commission.

Flood Reserve

Participants said the flood reserve, established in 1957, has affected land use planning in that area. Ken Boon said it placed a moratorium on oil and gas drilling on Crown land in the valley. He likened the area to a "sanctuary" and a "time capsule," adding that the value of this untouched land was priceless.

Other participants said that, as a result of the limited development, the flood reserve has provided some refuge for wildlife. Brian Churchill said the wildlife that has benefited from the establishment of the flood reserve includes: reptiles, ungulates, carnivores and other large mammals, and small mammals. Jim Webb said these wildlife populations are supported within the flood reserve on either side of the river.

T8TA had concerns that, should the Project not proceed and the flood reserve is lifted, the lack of an up-to-date land use plan may result in development occurring in the flood reserve in a less-than-orderly fashion, with significant consequences for the values that were intended to be protected; Ken Boon had similar concerns, and both recommended a "stage removal" of the flood reserve in conjunction with a comprehensive land use plan.

7.5.3 Panel's Analysis

The Panel heard from groups whose traditional territories overlap with the LAA and would be affected by the Project and from others who do not use the LAA as part of their traditional territory. Because the effects of the Project would directly affect areas within the LAA, the Panel finds that no cumulative effects of Site C exist on the current use of lands and resources for traditional purposes for Aboriginal groups that do not use the LAA: Athabasca Chipewyan First Nation, Mikisew Cree First Nation, Tallcree First Nation, Little Red River Cree First Nation, Kwadacha First Nation, Woodland Cree First Nation, Dene Kue First Nation and Fort Chipewyan Métis Association.

BC Hydro assessed current use by assuming that the present state of use reflected all previous effects. Many Aboriginal groups said limiting the assessment from the current baseline did not provide any substantive understanding of the cumulative effects of successive projects, past, present, and future. These cumulative effects represent a steady process of erosion of access to healthy and unencumbered lands and waters for Aboriginal peoples and others to use today and in the future. The Panel agrees that if each successive project used a new baseline, assuming that prior impacts were reflected in that baseline, then entire Aboriginal cultures and practices of Aboriginal and treaty rights could become effectively extinct before there is adequate appreciation for what has been lost. The Panel heard that, in the Peace region, the use of land for traditional purposes has already been limited by the vast losses occasioned by the construction of the Bennett Dam. The Site C Project would add to these losses.

For hunting and trapping, it appears that the Proponent examined resource development activities individually, past, present, and future, and their interaction with the Project, rather than

looking at the combined residual effects of these activities and Site C. The Proponent found residual effects for several foreseeable projects, either on wildlife or current use, but concluded that the effect would be small or it would not result in the decline of regional wildlife populations, and therefore, cumulative effects were unlikely. The Panel believes that this kind of assessment defeats the purpose of assessing the incremental effects that may be significant even though the effects of each action, when independently assessed, are considered not.

The Panel also believes that BC Hydro's methodology of using the results of the biophysical assessment is only part of the analysis. To conduct a proper cumulative effects assessment on current use of lands and resources for traditional (including cultural) purposes, the Proponent should have assessed how other developments could act cumulatively with Site C on fishing opportunities, hunting and trapping opportunities, and other current uses for traditional purposes, as opposed to assessing the effects on the resource itself.

By restricting the assessment of cumulative effects to fish and fish habitat, the Proponent did not capture cumulative effects to fishing opportunities in the region. To assess cumulative effects on fishing opportunities, it should have first established a regional area large enough to encompass preferred fishing locations of Aboriginal groups likely to be impacted by the Project in the LAA. Then, the Proponent should have looked at other projects and activities (past, existing, and future) that may have an impact on these preferred fishing locations. Finally, it should have determined how the effects of these projects and activities combined with the effects of Site C would change fishing opportunities for these Aboriginal groups in the RAA. The same method should have been applied for hunting and trapping opportunities. The Panel believes that the Proponent's assessment does not provide a clear understanding of cumulative effects on current use as it does not provide information on how the practices and uses of the lands and resources in the RAA have been and would be impacted cumulatively.

For the cumulative effect assessment on the use of lands and resources for other cultural and traditional purposes, the Panel disagrees with the Proponent's methodology. The Panel considers that assessing how effects of other Projects in the RAA would overlap with effects of the Project in the LAA is inadequate. The Proponent should have assessed cumulative effects on other cultural and traditional uses using the methodology described above by the Panel for fishing, hunting, and trapping.

The Panel believes that the region has already been significantly impacted by resource development and the creation of the Williston and Dinosaur reservoirs, which had an impact on many of the same people who now use the LAA. Looking forward, the effects of natural gas development, coal mining, and forestry are reasonably foreseeable. As such, and in light of what the Panel heard from Aboriginal groups, it is reasonable to assume that the current use of lands and resources for traditional purposes has been and is being impacted by past and existing projects, including the two existing dams, and will be by foreseeable future developments.

The Panel has already concluded that the Project by itself is likely to cause a significant effect on current use of lands and resources for traditional purposes. Considering the extensive development in the region, the significant effects of the Project combined with the already significant cumulative effects of past and future projects can only be significant.

The Panel concludes that the Project would likely cause significant adverse cumulative effects on current use of lands and resources for traditional purposes.

A Shared Territory

To hunt, fish, and trap elsewhere also means that the land has to be shared, but information provided by participants showed that sharing tended to be unidirectional. Traditional land users found their access systematically restricted by agriculture, transfer of Crown lands to private ownership, mining, oil and gas development, forestry tenures, the creation of the Williston reservoir, and the contamination of fish.

The Panel examined proposals presented and discussed at the hearing that were said to be in the spirit of a harmonious sharing of the land. The desire to continue to fish, hunt, trap, and harvest was a basic request heard from all Aboriginal groups; financial compensation was never a preferred solution.

The Panel heard from many participants in the hearing, including Aboriginal and non-Aboriginal groups, that the flood reserve has developed as an important place for wildlife. The Panel believes that if the flood reserve had not been in place, the landscape conditions would be as highly disturbed as the downstream areas not in the flood reserve. The Panel agrees that, if the Project does not proceed, there is a risk that this land would be developed for other purposes and would lose the inherent value that it has gained.

RECOMMENDATION 19
The Panel recommends that, if the Project does not proceed, the Province, after consultation with affected local parties, remove the flood reserve in a manner that preserves the agricultural, wildlife, and heritage values of the Peace River valley.

Another proposal was the protection of the PMT and the ACCI, which are areas in close proximity to the Saulteau and West Moberly communities and within their preferred hunting territories. There were also indications that other T8TA groups, the McLeod lake Indian Band, the Kwadacha First Nation, the Métis Nation British Columbia, and Kelly Lake Métis Settlement Society use this territory.

The Panel also notes that the PMT and the ACCI would potentially be affected by future oil and gas developments, such as the Westcoast Connector Gas Transmission Project, the Prince Rupert Gas Transmission Project, the Coastal Gas Link Pipeline, the North Montney Mainline, the Spectra Transmission Line, and the Merrick Mainline Pipeline, coal mining, and forestry operations.

The Panel finds that a large quantity of information provided by Aboriginal and non-Aboriginal organisations shows that, in the recent past, an increase in the industrial development combined with the privatization of lands decreased the available areas where Aboriginal persons could exercise their traditional activities. The Panel also finds that the region expects a high rate of industrial development in the upcoming years.

RECOMMENDATION 20
The Panel recommends that the Province set aside the hunting, fishing, and trapping rights in the Peace Moberly Tract for people holding Section 35 rights under the *Constitution Act*, *1982*. The Panel also recommends that the Province and affected First Nations enter discussions on the Area of Critical Community Interest with a view to the harmonious accommodation of all interests in this land.

The Panel takes note that Aboriginal groups consider that the Site C review process has not

been conducted in a spirit of shared decision-making and that the Collaborative Management Agreements have set out, among other things, sector-specific consultation processes from which Site C has been excluded. As brought up at the hearing, several of the agreements have a bearing on the Project and it is clear to the Panel that there is the need for a comprehensive land use planning vision to prevent further unnecessary cumulative effects. The agreements to date have been narrow and sectional. The Panel sees a need for something more comprehensive.

8 ASSERTED OR ESTABLISHED ABORIGINAL RIGHTS AND TREATY RIGHTS

The Terms of Reference mandates the Panel to receive "information regarding "the manner in which the Project may adversely affect asserted and established Aboriginal and treaty rights;" "information provided by Aboriginal persons or groups regarding the location, extent and exercise" of those rights; and "information regarding any measures to avoid or mitigate" such effects. Those asserted or established rights, the impacts articulated by Aboriginal groups, and the proposed avoidance or mitigation measures are detailed in Appendix 9, and described more generally in this chapter.

The Panel used the information set out in Appendix 10 to inform recommendations to avoid or minimize potential adverse effects of the Project on valued components (VCs) related to asserted or established Aboriginal and treaty rights, and the assessment of the potential environmental, economic, social, health, and heritage effects of the Project. Those recommendations and assessments are found in the chapters on the particular VCs.

As required by the Terms of Reference, the Panel does not draw conclusions or make recommendations on "the nature and scope of asserted Aboriginal or the strength of those asserted rights;" the scope of the Crown's duty to consult Aboriginal Groups" or "to accommodate their interests in respect of the potential adverse effects of the Project" or whether it has met those duties; "whether the Project is an infringement of Treaty No. 8;" or "any matter of treaty interpretation."

8.1 AFFECTED ABORIGINAL GROUPS

The Environmental Impact Statement (EIS) Guidelines directed BC Hydro to consult with 29 Aboriginal groups (Table 5) that may be adversely affected by the Project.

Table 5. Aboriginal Groups Consulted by BC Hydro

Treaty 8 First Nation Signatories		
British Columbia	**Alberta**	**Northwest Territories**
Blueberry River First Nations Fort Nelson First Nation McLeod Lake Indian Band Saulteau First Nations Treaty 8 Tribal Association (T8TA): Doig River First Nation Halfway River First Nation Prophet River First Nation West Moberly First Nation	Athabasca Chipewyan First Nation Beaver First Nation Dene Tha' First Nation Duncan's First Nation Horse Lake First Nation Little Red River Cree Nation Mikisew Cree First Nation Smith's Landing First Nation Sturgeon Lake Cree Nation Tallcree First Nation Woodland Cree First Nation	Deninu K'ue First Nation Salt River First Nation
Non-treaty British Columbia First Nations		
Kwadacha First Nation Tsay Keh Dene First Nation		

Métis		
British Columbia	**Alberta**	**Northwest Territories**
Métis Nation British Columbia (as directed by the CEA Agency) Kelly Lake Métis Settlement Society (as directed by the CEA Agency)	Métis Nation of Alberta – Region VI Paddle Prairie Métis Settlement Society Fort Chipewyan Métis Local 125	Northwest Territory Métis Nation

The level of participation by each Aboriginal group varied. The following six groups did not participate in the Joint Review Panel Stage (Table 6), but they did provide information to BC Hydro at the Pre-Panel stage on their assertions of Aboriginal or treaty rights and the articulation of any impacts the Project may have on those rights. The Panel used that information, as recorded by BC Hydro, for this chapter and Appendix 10.

Table 6. Aboriginal Groups that did not Participate in the Joint Review Panel Stage

Treaty 8 First Nation Signatories	
Alberta	**Northwest Territories**
Beaver First Nation Sturgeon Lake Cree Nation Tallcree First Nation	Salt River First Nation
Non-treaty British Columbia First Nations	
Tsay Keh Dene First Nation	
Métis	
Paddle Prairie Métis Settlement Society	

The Panel also received information from the Kelly Lake Cree Nation (KLCN), although it is not recognized as an Aboriginal group by Aboriginal Affairs and Northern Development Canada or as holding Aboriginal rights protected under section 35 of the *Constitution Act*, *1982*. Although BC Hydro was not required by the EIS Guidelines to consult with KLCN, it did so with respect to the heritage assessment. KLCN presented information on its assertions of Aboriginal rights and potential impacts of the Project on those rights, during the public hearing.

Figure 9 (p.94) provides the locations of the Aboriginal groups, except the three Métis Associations and KLCN.

8.1.1 Treaty 8 First Nations

Site C would be constructed, and virtually all of the physical effects of the Project would occur, on land expressly included in Treaty 8. There are 21 First Nations who assert rights under Treaty 8 that may be affected by the Project. These 21 First Nations also assert Aboriginal rights under section 35(1) of the *Constitution Act, 1982.*

Treaty 8 provides that the First Nation signatories “DO HEREBY CEDE, RELEASE, SURRENDER AND YIELD UP to [Canada, for the Queen] …all their rights, titles and privileges whatsoever, to the lands…” there described and other lands,

> And Her Majesty the Queen HEREBY AGREES with the said Indians that they shall have right to pursue their usual vocations of hunting, trapping and fishing throughout the tract surrendered as heretofore described, subject to such

> regulations as may from time to time be made by the Government of the country, acting under the authority of Her Majesty, and saving and excepting such tracts as may be required or taken up from time to time for settlement, mining, lumbering, trading or other purposes.

The Treaty 8 First Nations (T8FN) assert that their treaty rights include the right to continue their traditional hunting and fishing activities in an effective and meaningful way, which establishes an ongoing Crown obligation to secure a continued supply of game and fish. Each T8FN asserts the right to hunt, fish, and trap for preferred species, in the particular areas of the treaty land where its members traditionally did so. And they assert that the Treaty guarantees continuity in traditional seasonal patterns of activity. They say that the rights must be viewed in the context of the fundamental place of the land in their culture, including incidental rights to occupy the land and to pass on traditional knowledge to future generations.

The T8FNs assert that the words in the Treaty are to be considered in the context of oral promises made at the time and are to be broadly interpreted. They find support for this interpretation in the decision of the Supreme Court of Canada in *Mikisew Cree First Nation v. Canada (Minister of Canadian Heritage)*, 2005 SCC 69, which found that a First Nation's "meaningful right to hunt is not ascertained on a treaty-wide basis (all 840,000 square kilometres of it) but in relation to the territories over which a First Nation traditionally hunted, fished and trapped, and continues to do so today" (para. 48).

The T8FNs find support for the assertion that these are livelihood rights, to be exercised in accordance with their traditional seasonal round, in the B.C. Court of Appeal decision in *West Moberly First Nations v. B.C. (Chief Inspector of Mines)*, 2011 BCCA 247, which held that Treaty 8 "guarantees continuity in traditional patterns of economic activity and respect for traditional patterns of activity and occupation" (para. 137).

They look to the interpretation of the Treaty by the Supreme Court of Canada in *Simon v. The Queen*, [1985] 2 SCR 387 to say that to be "effective," the right to hunt must "embody those activities reasonably incidental to the act of hunting itself" (*Simon*, at 403).

Several First Nations' witnesses gave the Panel their perspective on Treaty 8. Former Chief Stewart Cameron of the Saulteau First Nations gave us his, in part, as follows:

> Whether they were written or not, we know what the true spirit and intent of Treaty 8 is to us… for hunting, fishing, trapping, yes, but it goes way more than that also. It's a way of life, mode of life, meaning that's the land. It's related to the land. The land and then our language is related to the land. Our teachings come from that. Our way of life, our laws come from that, from all this.

The concerns of the T8FNs are that, with the cumulative effects of Site C and other industrial development in the Peace region, there would be more human competition for smaller populations of wildlife and fish, that some preferred species would be put at risk of extirpation in their traditional territories, and that the fish and animals that do remain would be contaminated.

T8FNs articulate several potential specific negative impacts to their Aboriginal or treaty rights from Site C, including,

- inundating land they currently use for traditional hunting and gathering medicinal plants,
- inundating islands that are important refuges for preferred species,
- severing access and migration routes that are important for preferred species,

- changing the mix of fish stocks from preferred river species to less desirable species that will inhabit the reservoir,
- causing mercury contamination of fish in the reservoir,
- causing drying of the Peace-Athabasca Delta, and
- creating access for others to compete with them on their traditional lands.

First Nations downstream of the Project, in particular those with interests in the Peace Athabasca Delta (PAD), were critical of BC Hydro's decision not to extend the spatial boundary for downstream assessment to include the PAD.

8.1.1.1 Duty to Consult

The T8FNs also assert Aboriginal rights under section 35(1) of the *Constitution Act, 1982*. In particular, they say that the honour of the Crown places a positive obligation on it to inform itself of the impact of the Project, communicate this to the signatory First Nations potentially affected by the Project, and undergo meaningful consultation. In *Mikisew*, the Supreme Court of Canada held that when exercising its right under Treaty 8 to take up lands, the Crown must act honourably, engage in meaningful consultation, and if necessary, seek a workable accommodation for its proposed actions. (*Mikisew*, at para. 57). The level of consultation will vary depending on the seriousness of impact on the exercise of a First Nation's treaty rights.

8.1.2 Non-Treaty First Nations

Kwadacha and Tsay Keh Dene First Nations have asserted Aboriginal rights as First Nations under section 35(1) of the *Constitution Act, 1982*. The traditional territories of both are in the area of the Williston reservoir.

The Kwadacha First Nation asserts the right to hunt and fish effectively over its traditional territory and to ancillary rights to pass on traditional knowledge from that territory to future generations. It also asserts the right to be consulted on construction and operational decisions. It describes how its Aboriginal rights may be adversely affected by the Project by further fluctuation of water levels in the Williston reservoir to maximize energy production, by impeding movement of large carnivores, and by increased access by non-Aboriginals to their traditional territory.

Neither Kwadacha nor Tsay Keh Dene First Nation assert Aboriginal rights over the Current Use of Lands and Resources for Traditional Purposes local assessment area (LAA).

The Kelly Lake Cree Nation has not been recognized as having Aboriginal rights protected under section 35 of the *Constitution Act, 1982.* It does, however, assert Aboriginal rights over a traditional territory that straddles the BC–Alberta border some 150 km south of the Project. It asserts the right to hunt, fish, and trap in that traditional territory.

It is unclear whether the KLCN asserts Aboriginal rights over any part of the Current Use of Lands and Resources for Traditional Purposes LAA.

8.1.3 Métis

Métis in British Columbia, Alberta, and the Northwest Territories all assert Aboriginal rights under section 35(1) of the *Constitution Act, 1982*, by virtue of the inclusion of Métis as "aboriginal people of Canada" by section 35(2), rights they say would be affected by Site C.

While Métis in B.C. assert Aboriginal rights, the Provincial government does not recognize a duty to consult with Métis because it is of the view that they are not a 'Métis community' as described in R. v. Powley (SCC 43, 2003, 2, SCR 207). British Columbia Métis assert affected rights to traditional harvesting (hunting, fishing, plant harvesting for food and medicine) and drinking water, rights related to preservation and transmission of Métis traditional knowledge and land use information. Métis Nation British Columbia and Kelly Lake Métis Settlement Society assert that they use the Peace River valley and the LAA for current use activities including hunting, trapping, fishing, and other uses of the land for traditional purposes.

The Aboriginal rights of Alberta and Northwest Territories Métis relate to territories downstream of the Project. They assert Aboriginal rights to fish, trap, hunt, gather plants, and use areas of the Peace, Slave, and Athabasca Rivers and the PAD for transportation and for ceremonial purposes. They assert that these uses must be seen in a spiritual and cultural context.

9 LAND AND RESOURCE USE

In this chapter, the Panel considers the Project's effects on uses of the land by non-Aboriginal peoples. It includes sections on harvest of fish and wildlife resources, agriculture and other resources industries, outdoor recreation and tourism. Three sections are reserved for effects on ground, air and water based transportation.

9.1 OTHER HARVEST OF FISH AND WILDLIFE RESOURCES

The Peace River and surrounding areas are used for the harvest of fish and wildlife resources. The Project would affect the opportunities to harvest these resources through physical change of the land base. This section covers harvest by non-Aboriginal people with the exception of tenured traplines held by First Nations.

In British Columbia, fishing and hunting is regulated by the *Wildlife Act* which is administered by the Fish, Wildlife and Habitat Management Branch of the Ministry of Forests, Lands and Natural Resource Operations. The Ministry systematically collects data on anglers, hunters, and harvest and also establishes catch and bag limits to protect and sustain healthy fish and wildlife populations. For management purposes, the Province is divided into eight regions. The Region 7B - Peace refers to the Peace and Liard River watersheds, comprising 27 wildlife management units (WMUs).

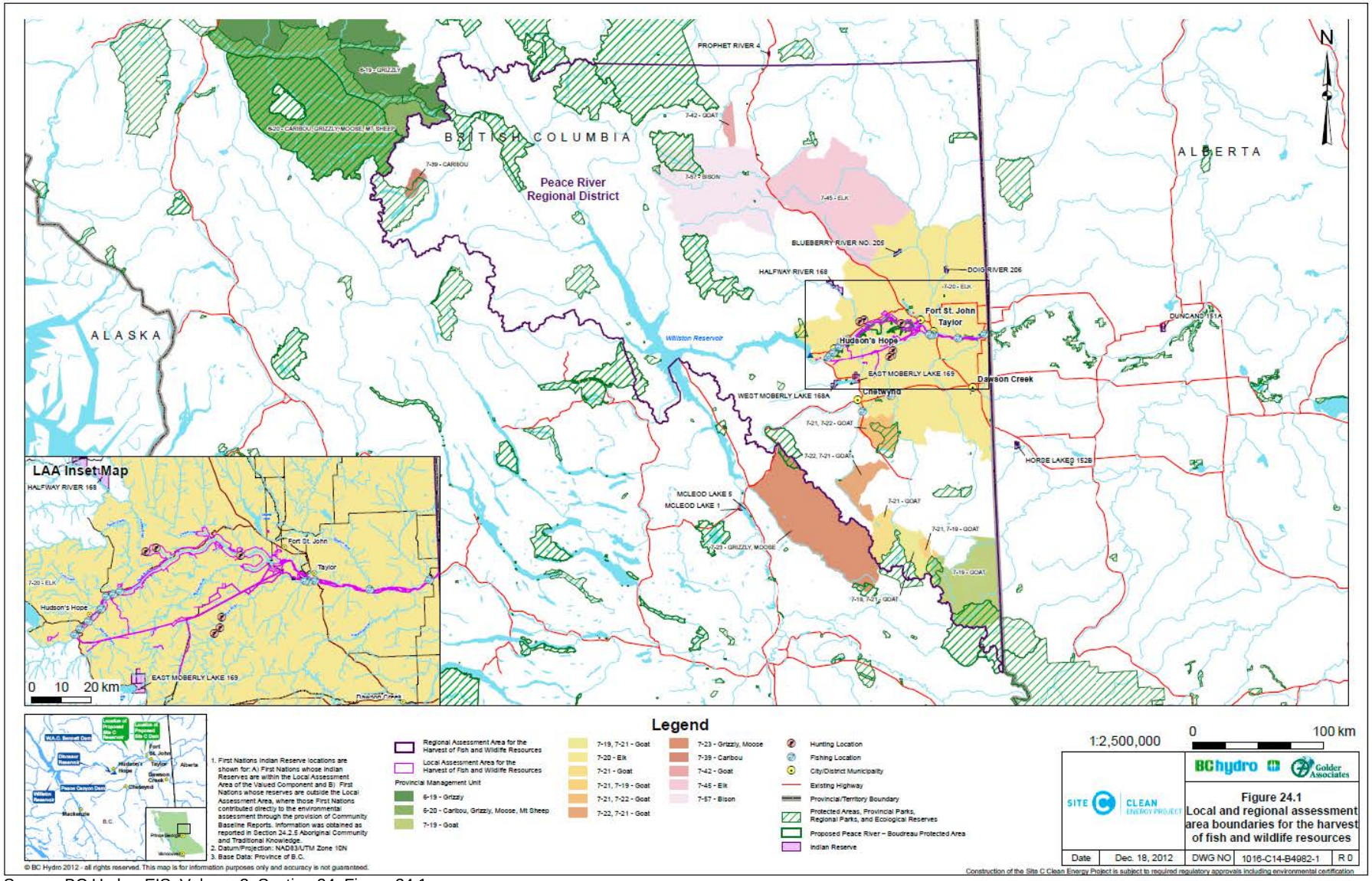
The Proponent's local assessment area (LAA) for the harvest of fish and wildlife resources valued component (VC) includes the Project activity zone, the area including the preliminary reservoir impact lines and the Peace River downstream to the Alberta Border. The regional assessment area (RAA) boundaries correspond to the Peace River Regional District.

Figure 11 indicates the local and regional assessment area boundaries for the harvest of fish and wildlife resources.

BC Hydro assessed the effects of the Project on harvest of fish and wildlife resources considering Project changes to the use of and access to hunting, fishing, traplines, and guide outfitter tenure areas. It also used the availability of harvested species based on the results of its assessment on fish and wildlife resources.

BC Hydro's key indicators for this VC included relevant measures of public fishing and hunting, such as licence sales, surveys on catch, tenured trapline and guide outfitting activities, and equipment. The indicators also include potential Aboriginal participation in tenured activities.

When determining significance, BC Hydro said it gave particular consideration to magnitude, geographic extent, duration and context as they reflected the way the Province manages fish and wildlife in response to industrial activities. The Province evaluates changes in the status of fish and wildlife populations to set catch and bag limits for specific bodies of water and management units. Therefore, a significant residual effect could occur on fishing and hunting opportunities if the changes are beyond historic norms (magnitude), result in the reduction of catch or bag limits in management units in the LAA (geographic extent), occur over the long term (duration), and are such that anglers and hunters cannot respond and adapt their fishing and hunting locations to take advantage of alternative opportunities in the RAA (context).



Source: BC Hydro, EIS, Volume 3, Section 24, Figure 24.1

Figure 11. Local and Regional Assessment Area Boundaries for the Harvest of Fish and Wildlife Resources

The Proponent concluded that the potential residual effects during construction and operation on fishing and hunting did not meet the above thresholds. It explained that fishing opportunities would increase during operation, catch and bag limits would not be reduced as a result of the Project, and hunting would continue in areas around the Site C reservoir. Therefore, BC Hydro considered the residual effects not significant.

The Proponent did not propose monitoring or follow-up programs due to a high level of confidence in its assessment for this VC.

9.1.1 Harvest of Fish

9.1.1.1 Proponent's Assessment

According to BC Hydro, the Peace River and its tributaries support angling for a variety of sport fishing including lake trout, northern pike, walleye, Arctic grayling, bull trout, rainbow trout, burbot, mountain whitefish, lake whitefish, kokanee and goldeye. The tributaries used in the LAA by anglers are the Moberly, the Halfway, the Beaton, and the Pine Rivers and several smaller streams. Fishing in the LAA represents 16 percent of the total outdoor recreation activity.

BC Hydro presented sport fishing information from 2005, showing that over 6,000 anglers fished in the Peace region, where 152,000 fish were caught, of which over 34,000 were kept. This resulted in a release rate of almost 80 percent.

The Proponent identified 15 recreation sites in the LAA where fishing occurs on the Peace River between Hudson's Hope and the Alberta border. Eight are located within the proposed reservoir where shore or boat access to the river is provided; four sites would be lost and would be replaced by three new boat launches.

BC Hydro said 53 percent of the angling activity happens between Hudson's Hope and the Site C dam site. Surveys conducted in 2008-2009 showed that rainbow trout was caught most frequently in the Peace River mainstem, followed by bull trout and mountain whitefish, and the largest numbers were caught within the proposed reservoir area. Retention rates were the highest for lake trout (27%) and northern pike (14%).

BC Hydro said the Project would have an adverse effect on fishing during construction due to reduced access to fishing areas and reduced harvested fish availability. It said changes to fish resources were expected, but that access to areas where fish would likely be the most affected would be restricted during construction. Therefore the Proponent anticipated that effects to fishing opportunities would be mainly caused by changes in access rather than reduced availability of harvested species. Construction activities would adversely affect fishing opportunities until boat launches could be replaced and full access to fishing areas on the reservoir were made available (at least after Year 1 and Year 2 of operation, in consideration of ongoing access restrictions to the dam site for public safety reasons). The Proponent said anglers would likely fish in alternate areas such as downstream of the Site C dam and other areas in the region.

During operation, the Proponent said the Project would have an overall beneficial effect on fishing areas. Once access restrictions were lifted, BC Hydro said the Site C reservoir would provide new fishing areas from the water and the shore and that the surface area of the reservoir would increase. The reservoir fishing opportunities would be expected to increase over baseline conditions as the Project reservoir would support increased boating and angling use, and would continue to support sport fish.

BC Hydro said that during operation the fish species composition would change with the reservoir, but that the overall fish biomass would increase 1.8-fold. It said species such as kokanee, lake whitefish, lake trout, burbot, peamouth and rainbow trout would benefit from the new reservoir environment, but that the total biomass of Arctic grayling, mountain whitefish and bull trout would decline.

The Proponent proposed measures that would support recreational shoreline use, boating access and water-based navigation to mitigate construction effects on changes in public fishing harvest areas. It proposed measures that would support fish and fish habitat, and therefore fish populations, which would mitigate construction effects on changes in public fishing harvest. The mitigation measures proposed for this VC are found in Appendix 9.

9.1.1.2 Views of Participants

The British Columbia Ministry of Forests, Lands and Natural Resource Operations (FLNRO) commented that although the Proponent predicted that fish biomass would be equal or greater in the reservoir, effects of the Project on fish populations were hard to predict. It explained that changes to fish in the reservoir may have management implications. As such, it noted that an assessment of angler preferences in the reservoir based on a better quantification of fishing opportunities was needed. FLNRO said that alternatives should be developed if the productivity estimates in the reservoir were overestimated and the reservoir could not support a harvestable supply of desirable fish. It also recommended monitoring of effects to changes in fisheries.

FLNRO said the Peace River was unique as one of the few places where large migratory bull trout are present. It said bull trout was a very desirable species as well as Arctic grayling and rainbow trout, which fly fishermen like. Whitefish and lake trout were also important species for anglers.

Alberta Environment and Sustainable Resource Development stated its concerns about potential Project effects on harvest of fish and angling opportunities downstream in Alberta, such as changes in water temperature, changes in species composition, and hindered fish passage.

A study on fishing from FLNRO compared the Region 7B - Peace to the province of British Columbia between 2000 and 2007. The results showed fishing has gone up by 7 percent for the Peace region and declined by 6 percent for the province. Peace River surveys done from 1985 to 2009 indicated that the main species caught were rainbow trout, whitefish, bull trout, and Arctic grayling.

FLNRO states on their website that, unlike the commercial sector, the economic stability of the sport fishery is not totally dependent on numbers of fish harvested. The critical factor is the maintenance of opportunity and expectation. To be viable, the sport fishery must provide anglers with opportunities to go fishing and an expectation to catch fish. The expectation of a good day is a powerful motivator, although recreational anglers seldom catch their allowable limit. The fishing experience means different things to different anglers in terms of species pursued, fishing techniques, and locations.

The North Peace Rod and Gun Club said the species composition of fish available for harvest in the proposed reservoir would shift to less desirable recreational fish species. It said that measures to mitigate the change from river to reservoir-based activities were limited. It also stated that measures to mitigate the impacts of increased use of fish resources by construction workers and redistribution of existing local harvesting activities on local fish resources are needed.

Some participants said the Peace River offers good fishing opportunities and that secret fishing spots and access to fishing areas would be lost to the Project.

9.1.1.3 Panel's Analysis

The Panel heard concerns about the change in fish species composition and that some desirable species would likely decrease as a result of the Project. However, the Panel received limited information on whether non-Aboriginal anglers were only interested in fishing as an activity or if species preferences were also important. There was also no indication if fishing occurs on the Peace River because of availability of preferred species, ease of access, or for other reasons. The Panel notes that release rates are high and may indicate that anglers fish for the experience rather than for sustenance.

As stated in Chapter 7, the Panel believes that, due to increased size of the water body, which would be significantly larger than the increase in biomass, the effort required to catch fish would be higher. This would also result in a potential decrease in the accessibility of remaining preferred species to anglers. Increased mercury levels would also impact harvest of fish for a length of time.

The Panel is also not convinced that that the affected recreation sites and boat launches on the Peace River can be replaced by three boat launches on the future reservoir. Several accesses to fishing sites located on private land would also likely be lost. The Panel does recognize, however, that there would be a fund to create new shoreline recreational activities.

The Panel considers that access restrictions, change in species composition, reduced biomass density, and mercury increases would have a negative impact on anglers in the Peace River mainstem. Anglers would have to adapt and possibly fish elsewhere for some time. However, the Region seems to support a variety of alternatives sites for fishing. The fishing experience on the Peace River mainstem would change, but anglers would still be able to fish and some of the most caught and preferred species, namely the rainbow and lake trout, would still be available.

The Panel agrees with BC Hydro that the effects of the Project on harvest of fish would not be significant.

Because the resource would be protected by the adjustment in catch limits, if need be, the Panel agrees with FLNRO that an assessment of anglers' preferences in a reservoir-based environment and monitoring of effects to fishery would help support efficient resource management. This is especially relevant because study results show that there is increased interest in fishing in the Peace region currently without the Project.

9.1.2 Harvest of Wildlife

9.1.2.1 Proponent's Assessment

The LAA overlaps with four WMUs (7-32, 7-33, 7-34, and 7-35). The larger management unit 7-20A is designated for Limited Entry Hunting (LEH) and fully encompasses WMUs 7-32, 7-33 and 7-34, and portions of 7-35. For WMU 7-20A, hunting opportunities for elk (antlerless) are allocated by lottery to help meet wildlife management objectives. LEH was introduced to limit the number of hunters, the number of animals that may be taken, and the harvest of a certain class of animal. BC Hydro said longer hunting seasons and bigger bag limits had increased hunting opportunities in the RAA over the last three years.

The Proponent said hunting is an important lifestyle element in addition to contributing to the local economy. Big game species harvested in the LAA include black bear, elk, moose, mule deer, white-tailed deer, and wolf, with ungulates being the most harvested species. BC Hydro said wildlife was abundant and hunting areas on Crown and private lands were readily accessible in the Peace River valley, by boat or road. Hunters interviewed by BC Hydro said hunting along the Peace River was preferred over other areas and that islands especially were relatively rare in the region.

The Proponent determined that the Project would have an effect on hunting opportunities due to reduced access to hunting areas during construction. No-access zones would be put in place at the dam site and off-site construction material locations. Other work areas, access roads, Highway 29 realignment corridors, and reservoir vegetation clearing area, would also be restricted. During reservoir filling, for public safety and site management reasons, access restrictions would be put in to place. These would reduce the use of and access to hunting areas along the Peace River. Access would be affected by construction activities until boat launches could be replaced and full access to hunting areas made available (after the Year 1 and Year 2 of operation, in consideration of ongoing access restrictions to the dam site for public safety reasons). BC Hydro said the maximum hunting area affected by construction in the LAA would be 0.8 percent of hunting areas in the LEH 7-20A. Hunting within the reservoir impact lines would not be restricted, but hunting on Peace River islands would be lost. The Proponent noted that hunting activities would be displaced to other areas within and outside the LAA.

BC Hydro said potential effects on the availability of harvestable animals were assessed in its assessment of wildlife. The Proponent reported that non-migratory game birds and ungulates would likely be impacted by the Project. For ungulates, BC Hydro said that, although animals would likely be displaced and may suffer some mortality, there would be a harvestable surplus of ungulates in the Region and hunters could move to new areas. Hunting of large carnivores would not be affected. BC Hydro said ultimately it is the Province's responsibility to determine the availability of hunting opportunities and manage any change in availability of harvestable animals through changes to the current hunting regulations.

The Proponent said the Project would not have effects on hunting areas and availability of harvested species during operation. It said that, if success rates changed, the Province would adapt its quotas to maintain its harvesting objectives.

The Proponent proposed measures that would support recreational shoreline use, boating access, and water-based navigation to mitigate construction effects on changes in public hunting areas. It also proposed measures that would support wildlife and wildlife habitat, and therefore harvestable game populations, which would mitigate construction effects on changes in public hunting harvests. The mitigation measures proposed for this VC are found in Appendix 9.

9.1.2.2 Views of Participants

For the period of 2000-2007, FLNRO said hunting has increased by 2 percent for the Peace region, compared to a decline of 6 percent for the province. It said its number-one priority was to ensure that wildlife populations are sustained over time. If a harvestable surplus is available, First Nations have first right of access to the resource, followed by licenced hunters if enough allowable harvest is available. The Province manages game species and maintains hunting opportunities through hunting seasons, licensing, and regulations of various types of permits

designed to retain the sustainability and health of the resource. The Province is not anticipating changes to the harvest management regime.

Guy Lahaye from the North Peace Road and Gun Club said a number of activities can impact surplus of animals and hunting, such as access development, traffic levels, vehicle mortality, logging activity, and general high levels of anthropogenic disturbance. He said the construction phase would greatly increase the level of activity and demand for recreational activities due to the influx of workers. The Club believes that the WMU 7-32 south of the Peace River between Hudson's Hope and Taylor is the most critical area for maintaining wildlife populations and hunting activity in the Fort St. John area.

Dr. John A. Nagy, an expert presenting for the North Peace Rod and Gun Club, said the highest harvest densities (species harvested by square kilometer) recorded for moose, elk, mule deer, white-tailed deer, and black bear in the Fort St. John area takes place in the four WMUs overlapping the LAA. He said this suggests these WMUs are among the most valued areas for hunting in the area. He believed there is higher harvest in these areas because of animal presence, the accessibility to the river system, and the adjacent roads for local and regional residents.

The North Peace Rod and Gun Club requested that a mitigation plan be developed to address the redistribution of existing local fish and wildlife harvesting activities on local fish and wildlife resources after the construction of the Project. Dr. Nagy said increased pressures on harvest due to an influx of people may reduce availability of resources to a point where quotas and a tag system may need to be established. He said such a system could have impacts on hunters relying on game for sustenance if they are not fortunate enough to get a tag. Hunting may also need to be redistributed to other areas and cause added travel costs. He said that, given that the four WMUs overlapping the LAA are preferred areas, they were more likely to require a tag system.

Participants said that hunting was an important industry around the Peace River. A family residing in the Peace River valley said all of their meat supply for the last two decades had come from wild game.

9.1.2.3 Panel's Analysis

The Panel acknowledges that FLNRO is responsible for determining the availability of hunting opportunities and managing any changes in availability of harvestable animals through updates to the current hunting regulations. The Panel understands that no change in bag limits is currently anticipated.

Ungulates were reported as being the most hunted animals in the WMUs overlapping the LAA. As stated in the Section 6.4, the Panel concluded that the Project would not cause significant effects to ungulate populations.

The Panel acknowledges that the WMUs overlapping with the LAA sustain the greatest level of harvest in the area and agrees that the proximity to Fort St. John and ease of access are probably determining factors. While some important areas such as the Peace River islands and portions south of the Peace River would be lost or restricted during construction, the Project would not affect most of the WMUs.

The Panel believes that the hunting experience in the Peace River valley would change and that the Project would have a negative impact on hunting, especially for subsistence hunters. However, the Panel considers that hunting opportunities and preferred harvestable species

would still be available in the LAA. The Panel trusts the ability of the Province to manage resources in a sustainable way despite the already increased level of hunting observed presently in the 7B region.

The Panel agrees with BC Hydro that the effects of the Project on harvest of wildlife would not be significant.

9.1.3 Tenured Traplines

9.1.3.1 Proponent's Assessment

Registered traplines are the main management tool for the commercial use of fur-bearing animals and are administered by the British Columbia Ministry of Forests, Lands and Natural Resource Operations. On a trapline, the holder has exclusive trapping rights. Other uses such as timber, grazing, and mineral, oil, and gas exploration are permissible. In the case of oil and gas activities, the industry has established a referral and compensation policy when traps need to be moved. The Proponent identified 16 traplines overlapping with the LAA, half of which are held by Aboriginal trappers mainly from Saulteau First Nations, either as registered owners or through agreements with the registered trapline owners. Figure 12 illustrates the location of the registered traplines in the LAA

BC Hydro said trappers use a variety of means to access their trapline areas including: snowshoe, horse, snowmobile, all-terrain vehicle, boat, truck, or by foot. It said trappers have reported trapping along the Peace River, but others said they avoid trapping there due to water level fluctuations which affect trapping success. One trapper said trapping locations are influenced by animal distribution.

BC Hydro said that, from 2001 to 2008, the main species trapped on all traplines in the LAA combined were squirrel (4072), marten (1684), weasel (334), beaver (255), coyote (90), muskrat (73), fisher (37), lynx (31), mink (25), wolf, (7) and wolverine (5).

From 2005 to 2008, the average annual revenue for the traplines in the LAA was $65,175 for all animals combined, with the major income coming from marten. The Proponent said that since Aboriginal trappers were not required to supply the Province with harvest reports, up to half the data may not be included in this figure. BC Hydro believes that trapping is pursued more as a lifestyle or as a subsistence activity rather than as a primary income source, due to low annual revenues.

The Proponent assessed effects to traplines considering use of and access to trapline areas and availability of harvested species. It said that losses for each trapline would range from zero to 11.7 percent. All disruptions were taken into consideration in the percentages calculated, including the loss of islands and potential erosion on the Peace River. Of the 16 traplines, 14 would be impacted by more than one Project component, although minimally in some instances. Two of the most impacted traplines are held by Saulteau First Nations members. The Proponent said up to six cabins associated with traplines may need to be removed or relocated.

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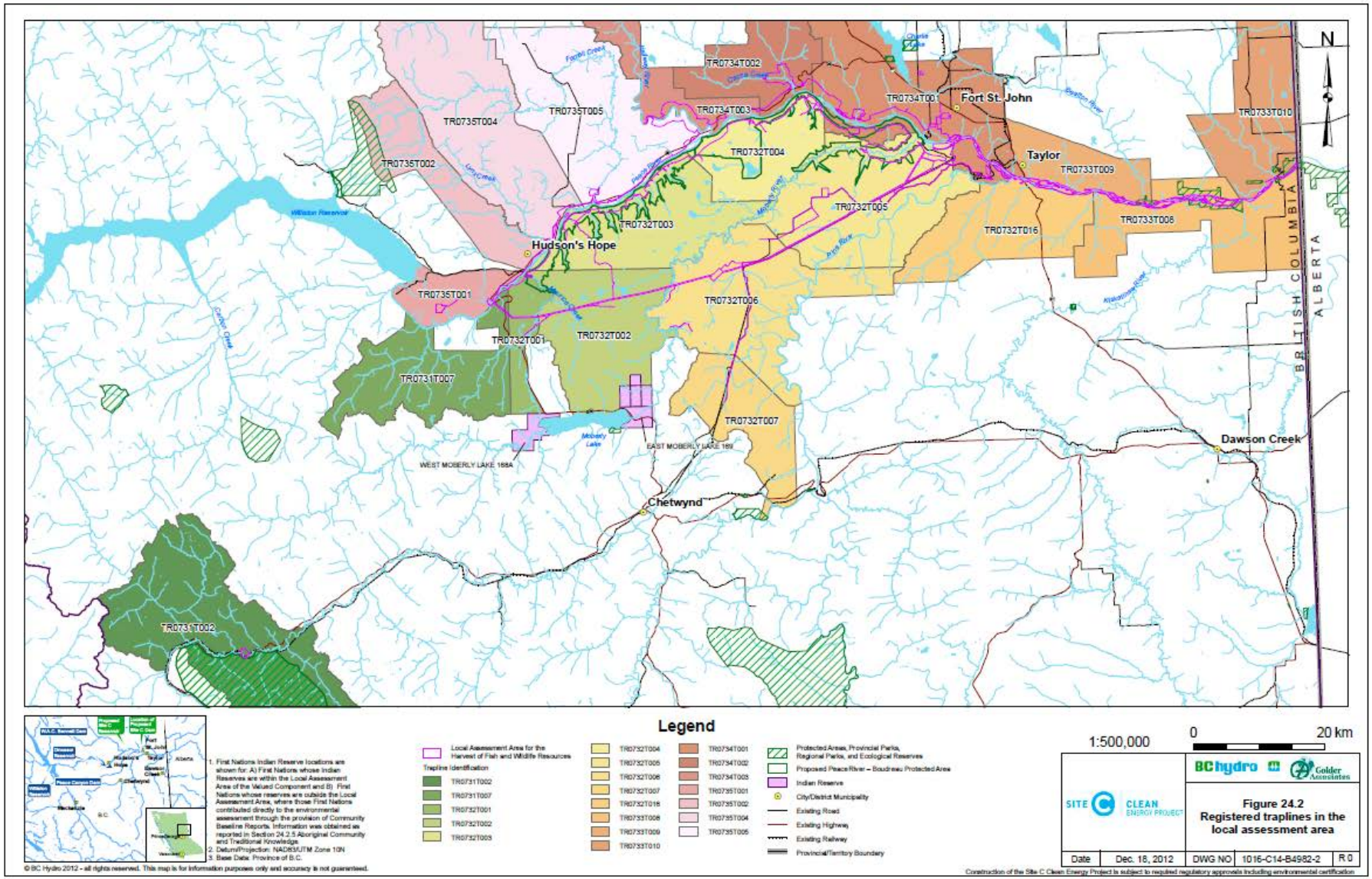


Source: BC Hydro, EIS, Volume 3, Section 24, Figure 24.1

Figure 12.Registered Traplines in the Local Assessment Area

The Proponent considers that construction may impact fur harvest during construction because beaver and fisher might be affected by habitat loss, disturbance, and displacement, as well as direct and indirect mortality. Portions of traplines outside the reservoir were not expected to experience a change in fur harvests.

BC Hydro said no additional effects on trapping would be expected as a result of operation. It said the reservoir level fluctuations (1.8 m) could improve trapping conditions along the shoreline, compared to baseline conditions, because the fluctuations would be small.

The Proponent said mitigation measures proposed for wildlife resources would support availability of harvestable species for trapping. It said it may also permit local trappers to hunt beaver prior reservoir flooding to further prevent losses of the resource during inundation.

BC Hydro said effects on traplines would be mitigated through discussions and, where appropriate, compensation agreements that would be negotiated with the affected tenure holders. It detailed the rules that would be used to set compensation for holders of registered traplines, in consideration of the Provincial guidelines for resolving tenure conflicts. A commercial compensation, including, where appropriate, loss of actual income caused by loss of trapline area due to flooding and erosion, would be offered to all trapline holders. The compensation formula, which, according to BC Hydro, is still to be finalized, would be based on the impact of the Project on the actual income derived from trapping and the impact to affected trapline infrastructure. The first considerations are the percentage of the total trapline area affected by the Project, the annual net revenue of the trapline holder over the last ten years, and the duration of the effect of the Project on the tenure, be it temporary or permanent. Another consideration would be the cost of replacement or relocation of infrastructure that is directly impacted by the Project. BC Hydro confirmed that there are cabins that would be relocated.

BC Hydro considered that trapping would remain viable on all trap-lines overlapping with the Project. The Proponent did not expect residual effects and therefore did not assess significance.

9.1.3.2 Views of Participants

Saulteau trappers raised concerns over the potential for disruption and impact on their tenure traplines with respect to the availability of fur-bearing animals.

Other Aboriginal groups complained of how little compensation trappers received when the Bennett Dam was built. For members of these groups who rely on commercial trapping to pay the bills, compensation offered is a poor solution compared to the guarantee to trap animals for generations to come if the Project does not proceed.

9.1.3.3 Panel’s Analysis

The Panel disagrees with BC Hydro that trapping is pursued more as a lifestyle or subsistence activity rather than as a primary income source. The Panel heard the contrary at the hearing from Aboriginal trappers. Members of Saulteau First Nations presented evidence, in the community session and in confidence, that traplines have been used for family income for several generations and are also used for transmission of cultural practices.

The Panel notes that the percentage of traplines lost varies from nothing to 11.7 percent. The Proponent considered this loss small and said other parts of the traplines could be used. However, when looking at Figure 12, some traplines would be affected by different activities or a combination of them, such as the construction of the dam and the transmission line, which would fragment the territory. Some of the traplines are also located partly on private lands. The

potentially affected areas could be where target species live, and are not necessarily found elsewhere.

Since there would be access restrictions employed for a ten-year-period during construction and reservoir filling, there was no indication if the southern traplines, located along the Peace River closer to the dam site, could still be accessed by boat or other means of transportation during this time. The Panel also has no indication as to what extent instability after reservoir filling and water level fluctuations would prevent access from the river or reduce trapping success, or, if the small water level fluctuations would indeed improve the present conditions.

As for species harvested, there are small mammals and other fur-bearing animals trapped in the LAA. Squirrel, mink, wolverine and Canada lynx are caught but were excluded from the Proponent's analysis of Project effects on wildlife resources because they were reported as having low interaction with the LAA or, based on species characteristics, the Project would not result in population changes. The Panel considers that mitigation measures proposed for the fur-bearing wildlife key indicator, which is fisher, would not necessarily apply for marten or other fur-bearing animals trapped in the LAA.

9.1.4 Tenured Guide Outfitter Operations

9.1.4.1 Proponent's Assessment

BC Hydro identified four guide outfitters that hold hunting territories overlapping the LAA. The clientele come from the USA, Europe, New Zealand, Australia, and other parts of Canada.

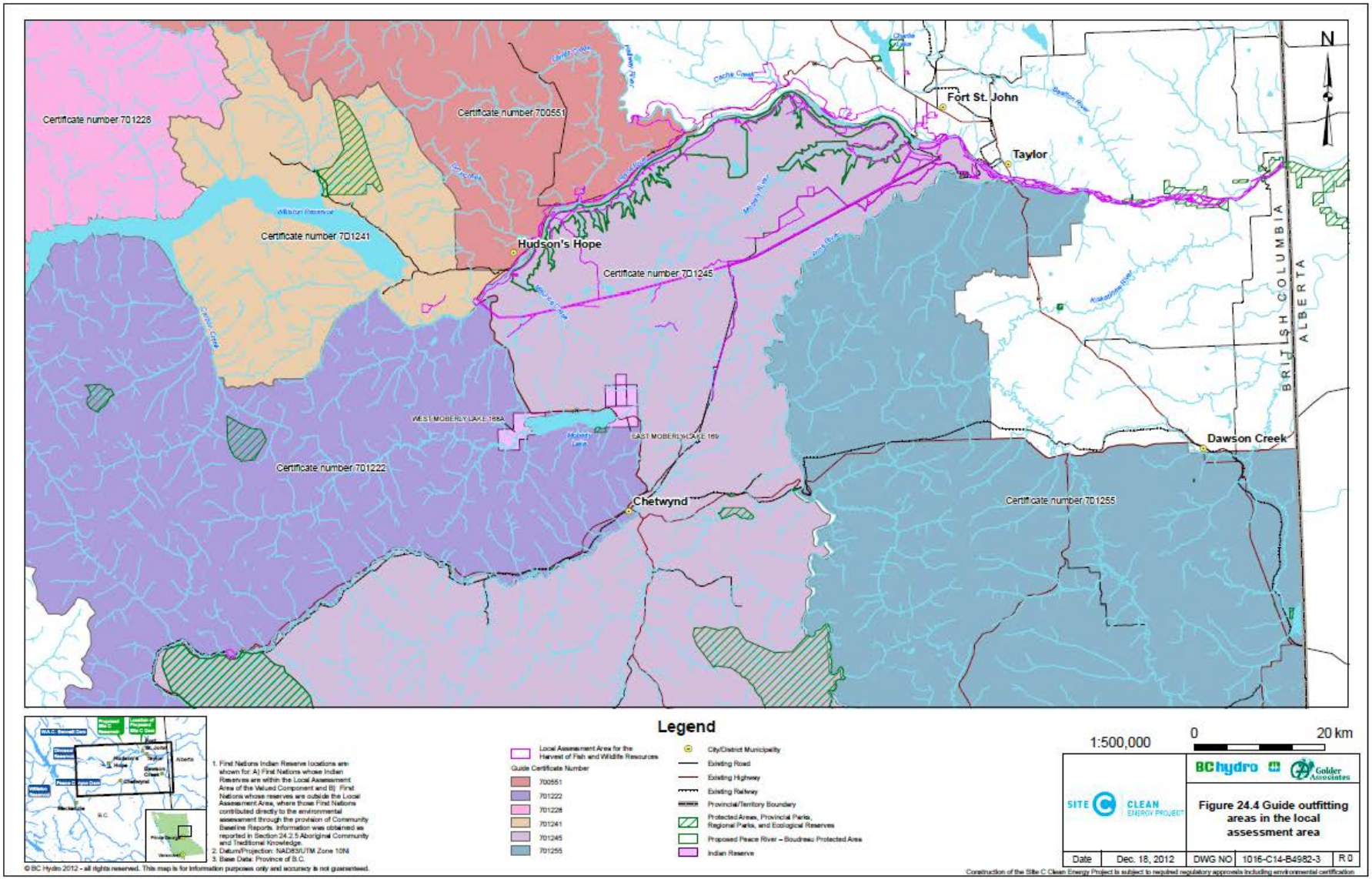
BC Hydro said one outfitter had a license of occupation for a hunting camp within the Project footprint. This outfitter told the Proponent that 40 to 50 percent of his hunts occur adjacent to the Peace River. Another outfitter said the valley is a good area for hunting as far as Maurice Creek, across from Hudson's Hope. Three cabins were identified within the LAA and one is in the inundation area. Figure 13 illustrates guide outfitting areas in the LAA

The main species harvested from 2006 to 2010 by outfitters within the full tenured areas that overlap with the LAA, included whitetail deer (156), black bear (102), elk (100), mule deer (66), moose (56), mountain goat (8), grizzly bear (7), lynx (1), and cougar (1).

BC Hydro said outfitters believed that traffic detours or access restrictions resulting from construction would adversely affect guide outfitting hunting experiences for their clientele and would reduce their operations and revenues. The outfitters were concerned about the increased competition for resources through greater access in the LAA and RAA, and the diminished wilderness experience due to visible industrial activities or the need for or exposure to motorized access. Some said forestry and the oil and gas industry have already disturbed their guiding areas "to the point where few untouched hunting areas remain".

BC Hydro estimated the percentage of the guide outfitter territories affected in the LAA would range from less than 0.1 to 1.4 percent. It said about 97 percent of the Project activity zone and the area within the reservoir impact lines are located within two outfitters' territories. It said up to three cabins and a hunting camp would either be lost or have to be relocated. The Proponent concluded that no effects were expected on harvest volumes of ungulates and large carnivores because the change in harvest areas is very small compared to the total guiding areas.

The Proponent said there would be no potential effects during operation with respect to guide outfitters areas, infrastructure, harvest volumes, or operations and revenue. It did not expect Aboriginal participation in tenured guide outfitting operations would change.



Source: EIS, Volume 3, Section 24

Figure 13.Guide Outfitting Areas in the Local Assessment Area

BC Hydro proposed mitigation measures to support recreation shoreline, boating access and water-based navigation and communication regarding areas and road closures. As for supporting the availability of harvestable species, BC Hydro refers to proposed measures for wildlife resources. It would mitigate effects on guide outfitting activities through discussions, and, where appropriate, would discuss compensation agreements with the affected tenure holders. The Proponent does not expect residual effects and therefore no determination of significance was done.

9.1.4.2 Views of Participants

High Prairie Outfitters and Tracks BC, a hunting, guiding, and outfitting operation, identified themselves as the largest tenure holder affected by the Project. It said that, “there's no other place in the world that grows white tail, elk, moose, grizzly bear, black bear to the size and mass in conjunction with the unspoiled wilderness that British Columbia is renowned for.” The organization holds tenure for the oldest base camp on a river used by guide outfitters. If the Project proceeds, this base camp along with the spring and mineral lick found near the camp would be lost. They said over 90 percent of the Project footprint was within their tenure. They noted that they were not satisfied with BC Hydro’s attitude, offer, and negotiation.

They also raised concerns over the potential for disruption and impact on their tenure and related commercial activities, as a result of hunting activities from Project workers. It worried that about the availability of preferred animals hunted by their clients or the ability of the populations to rebound if they declined. It said the large carnivores at the core of their operations (black bear and cougar) were not considered as valued components. It was also concerned about the area’s ungulate population; a major part of its marketing is that the area has the best unspoiled cultivated genetics.

Horseshoe Creek Outfitters Ltd. was identified as another outfitter in the area that indicated it would be affected from the relocation and construction of Highway 29 for the Project.

FLNRO said the *Wildlife Act* has no compensation mechanism for guide outfitters. Where there is an impact between two tenure holders, they rely on those stakeholders to work together to come to a common understanding as is done with trappers.

In response to High Prairie Outfitters and Tracks BC’s concerns, BC Hydro referred them to the comment made at the hearing by the Ministry of Jobs, Tourism and Skills saying the development of Site C would not be expected to have a meaningful impact on guide-outfitter businesses. BC Hydro committed to work with this outfitter.

9.1.4.3 Panel’s Analysis

Concerning High Prairie Outfitters and Tracks BC, the Panel understands that BC Hydro determined that 1.4 percent of the area they use in the LAA would be affected by the Project. However, the northern boundary of the land of their certificate number indicates that it is located on the Peace River from Taylor to below Maurice Creek, south-west of Hudson’s Hope (Figure 13). It appears to the Panel that the 1.4 percent affected is the area of the tenure that borders the river and would impede their river use. As their representative said, over 90 percent of the Project’s footprint would be in their tenure. Furthermore, almost the entire Project footprint overlaps with the tenures of two outfitters.

As for species harvested, the Panel notes that harvests are mainly ungulates but include large carnivores as well. The Panel takes note that for the four tenures overlapping with the LAA, 102 black bears were reported harvested by their clients over a four-year period, yet the indicator for

carnivores in the wildlife resources assessment was grizzly bear, which exhibits different behaviour. Moreover, BC Hydro did not examine cougar and Canada lynx because they had a low interaction with the LAA or the Project would not result in changes in the populations. The Panel agrees with High Prairie Outfitters and Tracks BC that there is a lack of appreciation and assessment with respect to commercial activities of outfitters and the preferred species of their clients. As indicated previously, lynx are also animals trapped for their furs.

The mitigation measures proposed for water-based navigation and shoreline access cover only the period after the filling of the reservoir. Therefore, there would be effects caused during the construction period and the first two-years or reservoir stabilization due to restricted boat launch access and navigation on the river during the eight-year construction period and the one- to two-year period of reservoir stabilisation. Accessing the river will become more challenging during this period for guide outfitters.

The percentage of an area lost for trapping opportunities or guide outfitter activities does not represent the real loss in terms of location of activities. Participants said the areas that would be affected by the Project, during construction and operation, are primary to their activities.

BC Hydro based its judgment of non-significance on the presence of available resources and the expectation that there would be no changes to harvested populations. The Panel disagrees partly with this statement. The territories of two outfitters and trappers are located in the Project activity zone and would be affected by the construction activities in a significant way.

The Panel concludes that, if the Project proceeds, some tenured trappers and outfitters would be adversely affected by the construction and operation activities of the Project. If the Panel's recommendation is implemented, this effect would not be significant.

The Panel is aware that compensation with trappers and outfitters are negotiated between parties without a legal set of rules as found in the property expropriation process.

RECOMMENDATION 21
The Panel recommends that, if the Project proceeds, fair compensation should be offered to tenured trappers and outfitters for long term losses.

9.1.5 Access to Harvested Species

BC Hydro assessed the potential changes in use of harvesting areas by looking at changes in use of hunting and fishing areas and changes in the number of local anglers and hunters during construction.

9.1.5.1 Proponent's Assessment

BC Hydro estimated changes in use of harvesting areas due to direct, indirect and, induced population changes resulting from the Project. The number of licensed anglers for the first five years of construction would increase to 416, which according to BC Hydro is a 3 percent increase above baseline or an average of 69 anglers per construction year. Because the workforce requirement would start declining in Year 6, this number is expected to decrease by 293, mainly during Years 7 and 8. The net change in licensed anglers during the construction period would be 123, or an average annual increase of 15 anglers.

BC Hydro expected the number of licensed hunters to increase by 265 by Year 5, which is also a 3 percent increase above baseline. That number is then expected to decrease after Year 5, down to 185 hunters over the last three years of construction. Therefore, the net change in licensed hunters during the construction years would be 80 hunters, or an average annual increase of 9.

BC Hydro did not consider this increase an adverse effect and said it is an objective of the Fish, Wildlife and Habitat Management Branch of FLNRO to increase participation in fishing and hunting at a provincial level. As a result, the Proponent considered that no mitigation measures were warranted.

BC Hydro discussed improvements to the road system and the building of temporary access roads, which would offer better access to hunting and fishing territories. The increased accessibility stemming from the Project, according to BC Hydro, would be positive. However, most of the Project roads are temporary and would be decommissioned following construction, either through reclamation and restoration to their pre-existing service level or through inundation by the reservoir. The Project access road would remain, but BC Hydro said it is already an accessible area for the public. It proposed discussions to be held with stakeholders, applicable agencies, and First Nations to determine if enforceable restrictions could be put in place or if there would be an opportunity to decommission other roads in the area.

BC Hydro committed to implement management policies to appropriately manage good behaviour on and off the work site and to require that contractors offer awareness training, adopt codes of conduct and monitor behaviour for all workers.

9.1.5.2 Views of Participants

The North Peace Rod and Gun Club, High Prairie Outfitters and Tracks BC, and Treaty 8 Tribal Association expressed concerns over competition with an influx of predominantly male workers and the resulting pressures that this may cause on hunting resources in the area.

Considering that this influx of workers on hunting resources could be significant and result in ungulate population declines, the North Peace Rod and Gun Club suggested it would warrant adjustment of the hunting regulations, as is done in other parts of the country for such situations. At the hearing, FLNRO confirmed that changing hunting regulations would probably not result in an increased moose population, and this was therefore not a reasonable option.

Saulteau and West Moberly First Nations voiced their concerns over the opening of hunting and fishing areas through the creation of Project access roads. Representatives of non-Aboriginal local and regional hunters had similar concerns. Figures 14 and 15 (see Section 9.6) illustrate the proposed and existing access roads in the Project area.

Members of West Moberly First Nations said that, even if the access roads were gated, it would not restrict hunting in the Peace-Moberly Tract because the advancement of hunting equipment has allowed greater access without access roads. When questioned at the hearing, BC Hydro said they do not have the right to lock or fence access roads without the agreement of the Crown. It also discussed the possibility that Ministry of Transportation and Infrastructure (MOTI) would take over ownership and maintenance of the Project access roads but said MOTI is not prepared to assume such responsibility for the long term.

9.1.5.3 Panel's Analysis

The Project is forecasted to increase hunters and anglers, on average, approximately 3 percent over the eight-year-construction period. This is a small number and a temporary situation. However, the Panel believes that comparing the influx of licensed anglers and hunters to baseline numbers of 2007 (latest year available) does not give sufficient information to assess whether there would be a need for catch and bag limit changes. There is no doubt that wildlife resources would be subject to additional pressures and that there would be increased competition for the resources as a result of the Project.

As for new access roads, the Panel understands that temporary ones would be decommissioned unless MOTI, a community, or a municipality takes over their ownership or responsibility for maintenance. The Panel believes that keeping some of the access roads would provide advantages in terms of better access to traplines, easier access to RAA territories, and the possibility of building new camps and cabins. The disadvantages could include the presence of more competition for resources, a possible rise in poaching, vandalism, thefts of cabins, loss of tranquility and increased pressure on all wildlife resources. Having better access could lead to a more specialised type of hunting, with activities more concentrated in time and space. These aspects were not studied by the Proponent to support its statement that the Project would offer easier access to hunters and anglers and would be a benefit.

The Panel concludes that more information is needed to assess the effects of the Project on harvest of wildlife resulting from an influx of workers from outside the Peace region and the opening of the territory by the construction of new access roads and the improvement of the road system.

RECOMMENDATION 22
The Panel recommends that, if the Project proceeds, BC Hydro must determine, in collaboration with applicable agencies, stakeholders and Aboriginal groups, what enforceable restrictions can be put in place with respect to the Project access road and which existing roads in the vicinity and new roads built during construction should be decommissioned.

9.1.6 Cumulative Effects Assessment

9.1.6.1 Proponent's Assessment

The Proponent determined that potential adverse residual effects on harvest of fish and wildlife were expected and conducted a cumulative effect assessment. The Proponent determined that the Montney Gas Play would likely have a positive effect on road and trail access and therefore no residual effects were expected from this project. For harvest of fish, the Proponent said no other projects would have effects in the LAA that could combine with the effects of Site C. BC Hydro said other reasonably foreseeable projects such as mines, pipelines, and wind projects could affect access to hunting areas. As for application of oil, gas, water, range, and other land tenures, it said that, because they were a continuation of existing baseline conditions that harvest of fish and wildlife already interacts with, no residual effects were expected.

BC Hydro concluded that population changes in the RAA due to other projects' workforce could increase the use of harvesting areas during Project construction and operation. However, it said the assessment of Project effects on harvesting areas already considered the population

projection for the region. Therefore, no further assessment of cumulative effects of changes in the use of harvesting areas was carried out.

The Proponent determined that during construction hunting would be displaced from the LAA to the RAA. This effect could combine with similar effects of other foreseeable projects in the RAA and result in cumulative adverse effects on access to hunting areas.

BC Hydro noted that its proposed mitigation measures for the effects of the Project and similar measures by other proponents would help attenuate effects on access to hunting areas.

The Proponent concluded that the cumulative effects were not considered significant because they would not result in a reduction of bag limits within the LAA managements units.

9.1.6.2 Views of Participants

Guy Lahaye from the North Peace Road and Gun Club said fishing and hunting opportunities had been dramatically reduced as a result of the two existing dams. He said the unstable conditions on the Williston reservoir and the poor fish species choice and production of both existing reservoirs were not favorable for fishing. He said persistent bank sloughing of the Williston reservoir, massive losses of habitat and wildlife populations, as well as dust effects on animal life expectancy have impeded hunting in these areas.

Treaty 8 Tribal Association and British Columbia Provincial Government Natural Resources Sector Agencies suggested that the LAA include those proposed new unaffected and accessible areas where BC Hydro said anglers and hunters could adapt to for hunting and fishing, and that additional pressures on hunting and fishing in those areas be evaluated as part of the assessment.

9.1.6.3 Panel's Analysis

A cumulative effects assessment on harvest of fish and wildlife should consider effects of past, existing, and future projects in the RAA on access to harvest and harvestable species combined with effects of Site C, particularly because BC Hydro acknowledged that hunting in the LAA would be displaced to the RAA. For harvest of fish, the Proponent should have determined how fishing opportunities and harvestable species have been impacted and would be impacted by other projects in the RAA, rather than assessing the effects of other projects on the LAA.

The same should have been done for harvest of wildlife and effects to traplines and guide outfitters activities because of the noted displacement.

The Panel disagrees that land tenures and the Montney Gas Play would have no residual effects on harvest. While access may be improved in some cases, other areas would become restricted and any additional development would have effects on resources and possibly increase harvesting pressures.

The Panel believes that change in bag limits is not the only factor that should be considered in the determination of significance. Availability and accessibility of harvesting sites, traplines and areas used by guide outfitters should also be taken into account in determining significance.

As mentioned in previous chapters, the Panel believes that participants have demonstrated that the region has been impacted and is still being impacted by anthropogenic developments, including the two existing dams, which most likely had negative impacts on harvest. Foreseeable projects combined with Site C would also further reduce harvesting opportunities. The Panel notes that the Province has not lowered the catch and bag limits despite regulations

which have likely increased hunting opportunities in the RAA over the last three decades. These seem to indicate that past and existing effects on harvest are not significant despite the level of land disturbances. However, the Panel is aware that the region is continuing to develop and that pressures on harvest will increase with every new project. Depending on the level of development approved in the future, effects on harvesting could become significant. The Panel trusts that the Province will monitor the situation closely and act accordingly to maintain sustainable harvest.

The Panel agrees with BC Hydro that the cumulative effects on harvest of fish and wildlife would not be significant.

9.2 AGRICULTURE

9.2.1 Proponent's Assessment

The Proponent's assessment evaluated four potential effects to the agriculture valued component (VC): loss of agricultural land, effects on individual farm operations, changes to agricultural economies, and changes to local food production and consumption.

9.2.1.1 Loss of Agricultural Land

BC Hydro stated that the Project would permanently occupy 6,469 hectares (ha) of Classes 1-7 land, of which approximately 3,816 ha are Classes 1-5 (capable of cultivated use). Of the agricultural land base permanently affected by the Project, most would be due to the Site C reservoir (4,523 ha), the reservoir erosion impact line (1,373 ha), and other Project components (573 ha). The loss of improved Classes 1-5 lands due to the Project would represent 18.7 percent of such lands within the Peace River valley, 0.1 percent within the Peace agricultural region, and effectively zero percent within the province. Considering higher capability Classes 1 and 2 (improved), the permanent land loss due to the Project would represent 20.5 percent of such lands within the Peace River valley, 2.4 percent within the Peace agricultural region, and 0.6 percent within the province.

There is no Class 1 land in the Project activity zone. There are 2,601 ha of Class 2 (unimproved) capability in the Project activity zone of which 318 ha is privately owned and the rest is either Crown Land or owned by BC Hydro. Permanent losses would include an estimated 541 ha of currently cultivated land and 1,183 ha of land within current grazing licence or lease areas.

Limited effects related to water table rise were anticipated because the majority of cultivated lands are located more than 1 metre above the reservoir levels.

9.2.1.2 Changes to Farm Operations

More than 70 percent of the more agriculturally capable lands within the Project activity zone are Crown lands. Of the remainder, BC Hydro owns more land than is currently under private ownership. Almost two-thirds of the agriculturally capable lands are within the Agricultural Land Reserve (ALR). Of the areas to be lost having high and moderate utility, approximately 45 percent was identified as Crown land, 35 percent as owned by BC Hydro, and 20 percent as privately owned.

A total of 34 farm operations of various sizes would be affected by the Project. Potential adverse effects to these farm operations could include:

- temporary and permanent loss of land and resulting loss of crop production and pasture capacity;
- changes to grazing tenures and resultant loss of livestock carrying capacity;
- loss of farm infrastructure (buildings, farm utilities, and other improvements);
- loss of irrigation and livestock watering facilities;
- changes to local groundwater and agricultural drainage;
- changes to access routes to farm properties and to areas of agricultural activities within farms;
- changes to livestock movement; and
- severance of farm properties.

The Proponent determined that 14 of these farms would permanently lose some cultivated land. BC Hydro was not able to calculate the permanent loss of cultivated land for five farms. Approximately 541 ha of currently cultivated lands are within the Project activity zone (PAZ). The three operations that would experience the greatest effect would have approximately 18, 58, and 62 percent of currently cultivated land remaining. A further three operations would have between 80 and 89 percent remaining, and three operations would have between 90 and 99 percent remaining. Nine operations would experience a permanent loss of grazing land. Losses would range from 0.003 to 72.5 percent of the total area. Five of those tenures would lose less than 5 percent of the total tenure area.

9.2.1.3 Changes to Agriculture Economies

BC Hydro calculated the future loss of economic activity as a result of the Project using several conservative assumptions. Future agricultural land use within the PAZ but without the Project was assumed to be 1,666 ha of cultivated land and 3,477 ha of grazing land. All of this potential land would be lost with implementation of the Project.

BC Hydro calculated the net present value of the foregone agricultural production, over the next 100 years, using social discount rates of 3.5 percent for the first 50 years and 2.5 percent for the next 50. It determined the foregone agricultural production at between $13 million and $31.5 million, with the base case estimated at $22.3 million.

9.2.1.4 Changes to Local Food Production and Consumption

The effect of the Project on regional self-reliance was anticipated to be low to non-existent because there has been, prior to 2012, little or no vegetable or fruit cropping in the PAZ except for home gardens. Accounting for population growth, BC Hydro anticipated that if the Project proceeds, there would be more than adequate land outside of the PAZ to meet self-reliance needs for at least the next 100 years. Of the 9,778 ha rated as having high agricultural utility outside of the PAZ, 6,606 ha have an unimproved capability of Classes 1 and 2, and 3,172 ha of Class 3. The Proponent reported that there would be no residual effects to the ability of the region to be food self-reliant in commodities that can be produced in the region.

9.2.1.5 Cumulative Effects

The permanent loss of agricultural land is a residual effect, after taking into consideration proposed mitigation measures, because the lost land cannot be replaced. BC Hydro determined

that the only project or activity that would overlap spatially with the agricultural land local assessment area (LAA) was one application for an agricultural tenure for grazing. The area of this application was considered in the assessment of grazing tenures. The Proponent said the adverse effects related to the permanent loss of agricultural land do not have spatial and temporal overlap with residual effects of any other current or reasonably foreseeable projects or activities, and therefore no further assessment of cumulative effects related to agriculture was conducted.

9.2.1.6 Mitigation Measures

To mitigate the lost value of agricultural economic activity, BC Hydro proposed a $20 million Agricultural Compensation Program to support projects in the region, in addition to the implementation of farm mitigation plans for those agricultural operations that are directly affected by the Project. BC Hydro also proposed to monitor climatic factors relevant to further irrigation improvement decisions that may be proposed under the agricultural compensation fund.

To mitigate effects on individual farm operations during construction and operation of the dam, BC Hydro proposed to develop farm-specific mitigation plans to avoid or reduce impacts on agricultural land and operations, developed in consultation with the owner and/or operator. During Project operation, BC Hydro would implement monitoring to assess site-specific changes due to reservoir creation that may affect farm operations, where such Project effects are not already addressed under agreement with BC Hydro.

BC Hydro would design monitoring programs to confirm if a Project-related change had occurred, specify the adverse effect on agricultural operations, and determine appropriate mitigation measures. Specific monitoring plans would include plans to monitor changes in wildlife habitat and associated crop or feed storage for agricultural operations within 5 km of the reservoir, changes to humidity within 1 km of the reservoir to evaluate effects on crop drying, and changes to groundwater elevations within 2 km of the reservoir.

Additional mitigation measures proposed for other Project components can be found in Appendix 9.

9.2.1.7 Proponent’s Conclusions

With respect to the agriculture valued component, BC Hydro noted that the Project would cause effects including the temporary and permanent loss of agricultural land, some of it of high quality, and changes in individual farm operations. It might also cause changes in the local microclimate that could affect agriculture, and change local food production and consumption.

BC Hydro stated that its agricultural compensation plan and individual farm plans would enhance regional production and replace the lost agricultural earnings of the affected farms. For this reason, BC Hydro considered the Project’s net effect on agriculture not significant.

9.2.2 Views of Participants

Numerous participants engaged on this topic in the public hearing and before. The potential losses to agriculture and the farming way of life were central to the concerns of many participants, local and otherwise.

Participants said the lands that would be lost were unique, citing a microclimate and soils that could support market gardening and hence regional self-reliance, even in the face of potential

economic disaster. They noted that the bottomlands were exceptional and not to be compared with upland areas. They claimed that there could be no “compensation” for the loss of such lands. Mitigation through a new fund was criticized for vagueness, and mitigation through designating new lands as being under Agricultural Land Commission (ALC) protection was seen as creating no new agricultural land.

Participants agreed with BC Hydro’s assessment that the loss or degradation of agricultural land would negatively affect local farmers, but they said that their means of earning income and entire way of life depend wholly on the agriculturally productive land. Local communities demonstrated a strong connection to the land through the foods that are produced on those lands. One participant even brought his market produce to the hearing. Farmers noted that losing land would result in a degraded rural sense of place or community connection to the land through farming.

A common concern forwarded by participants about climate change, both globally and locally, led to the idea that food security would take on much greater importance in coming years, and that the current use of land for agricultural purposes was a poor indicator of future value. Thus BC Hydro’s assessment of the Project’s effect on agriculture was considered to be inaccurate and short-sighted. Participants said the effect was indeed significant.

Wendy Holm, presenting for the Peace Valley Environmental Association, said that future value was understated in the Proponent’s assessment because too high a discount rate was used in the calculations. She felt that Lord Stern’s 1.4 percent would more fairly represent value. Participants raised other methodological issues, such as BC Hydro’s use of a novel “utility rating” for lands and its choice of scenarios for future agricultural development.

Some participants said the current land use estimate was modest because of the effects of the 1957 Flood Reserve and the threat of expropriation, which discouraged investment, and because of BC Hydro’s continuing land purchases, which had the effect of depressing prices and fragmenting the land base.

9.2.2.1 Agricultural Land Reserve (ALR) Considerations

The Minister announced by letter to the Chairman of BC Hydro, about five and a half months into the Panel’s eight-month process, that there would be no need for the ALC to consider an application to exclude some 2,775 ha of Classes 1-7 land from the ALR for the Project, the largest exclusion in the 40-year history of the Reserve, because it would duplicate the environmental assessment review. Joan Sawicki, a former Speaker of the Legislative Assembly and Minister of Environment, Lands and Parks, asked the Panel to write to the ALC, as it had written to the British Columbia Utilities Commission on another topic, to ascertain what its process and criteria would entail were it to retain jurisdiction. After consideration, the Panel did.

In the response from the ALC, it noted that an ordinary landowner proposing that land be excluded from the ALR would be required to go through a rigorous application process, including a lengthy formal application, posting of signs, advertisements, a public information meeting, possibly a hearing, and a decision by the Commission. The proposal might also require local government approval. The Commission noted other factors it would take into account including:

- Will the proposal benefit agriculture?
- Is the proposed use supportive of agriculture or in conflict with it?

- Will the proposal permanently damage the physical capability of the land for agricultural use?
- What effect would the proposal have on existing or potential agricultural use of surrounding lands?
- Would the proposal create conflicts in terms of noise, dust, odours, trespass, etc.?
- Would the proposal generate demand for urban-type services such as sewer and water?
- Would the proposal necessitate construction of new roads or widening of existing roads?
- Does the proposal include any measures to reduce potential impact on surrounding lands?
- Can the proposal be modified or should conditions be imposed to reduce potential negative impacts?
- Does the proposal meet the regional and community planning objectives for the area?
- Given a documented need for the proposal, can it be accommodated outside the ALR?
- What are the recommendations of the local government, advisory committees, and other stakeholders?

9.2.3 Panel's Analysis

The Panel understands from BC Hydro's assessment that production from the Peace River bottomlands is small and is certainly not important in the context of B.C. or even the region. Currently farmed portions of the PAZ are estimated to produce about 0.2 percent of regional gross farm receipts. It has potential, to be sure, but its unique and irreplaceable contribution would be for those labour-intensive crops like vegetables, which are not remotely practical in a labour-short region. Production of these high-value, labour-intensive crops from lands not in the Flood Reserve downstream of Site C is negligible. The Panel does not believe that the lands that would be affected by the Project would produce different results.

Some participants argued, however, that the future is uncertain, that imports may falter, and that populations are rising but the quantity of arable land worldwide is falling. In this regard, the Panel heard from many participants on the importance of food self-reliance. Under these circumstances, the loss of 1,666 ha of moderate- and high-utility land is intolerable to these participants, especially where they see alternative ways of generating electricity.

From the Panel's straightforward comparison of earning potential in the next several decades, the highest and best use of the Peace River valley would appear to be as a reservoir. Considerations not taken into account in this conclusion include optionality (the fact that becoming a reservoir is not easily reversed, whereas continuing as farmland preserves the option of the alternative), diversity (of agricultural production as well as wildlife populations), and heartbreak (for residents who would be displaced from the land of their dreams).

The present value of the agricultural production foregone was predicted to be $22 million (range $10 million to $31.5 million), using low social discount rates (SDR). These values might be higher (or the low SDR justified) if there were a food crisis in the coming decades, but the Panel finds no evidence for such a crisis. The current annual value of crops from the portion of the valley that would be inundated is but $220,000. While this may be due in part to the continuing threat of expropriation, the more important reasons are labour costs and the availability of cheap produce from elsewhere. Only if the future holds a radical end to current cheap food prices and a breakdown in interregional and international trade would higher figures become credible. The proposed $20 million agricultural investment fund, to be spent on improvements outside the inundation zone, is generous by comparison.

The Panel concludes that the permanent loss of the agricultural production of the Peace River valley bottomlands included in the local assessment area of the Project is not, by itself and in the context of B.C. or western Canadian agricultural production, significant. The Panel further concludes that this loss would be highly significant to the farmers who would bear the loss, and that financial compensation would not make up for the loss of a highly valued place and way of life.

With respect to the exemption from a review by the Agricultural Land Commission, the Panel notes that an assessment such as is undertaken by the Commission is not a direct overlap with the mandate of this Panel. The Panel notes that, while the factors outlined by the ALC were not developed for the Project, it is fair to say that were the Commission to be seized of this issue it would not take its decision lightly, or quickly.

BC Hydro undertook a cumulative effects assessment based on the permanent loss of agricultural land being an adverse residual effect. BC Hydro found that the only project that would overlap spatially with this residual effect of the Project was an application for a grazing tenure that was already included in the consideration of grazing tenures in the agricultural assessment.

The Panel agrees with BC Hydro that the Project would not cause cumulative effects on agriculture.

9.3 EFFECTS ON OTHER RESOURCE INDUSTRIES

The Proponent assessed the potential for the Project to adversely affect the oil and gas, forestry, and mineral and aggregates sectors.

9.3.1 Proponent's Assessment

9.3.1.1 Oil and Gas

BC Hydro noted that the Project activity zone (PAZ) would occupy a negligible 0.11 percent of the total petroleum and natural gas tenure area in the Peace River Regional District. Access to land would not be affected by the Project because the Peace River–Boudreau Lake proposed protected area would exclude all surface access for new drilling activity on the south bank of the Peace River. In addition, advances in directional drilling technology mean that the Project would not limit access to potential methane resources under the reservoir. Easier accessibility due to the development of Project infrastructure, including roads, was considered a beneficial effect for the oil and gas industry.

Spectra Energy's water intake in the Peace River is just south of Taylor. BC Hydro determined that Spectra Energy (which did not take part in the Panel process) may experience adverse effects if increases in sedimentation during construction, and in sedimentation and water temperature during Project operation, affect its operations. BC Hydro stated that, although physical changes to in-river sediment and temperature have been characterized, it has not been confirmed if these changes would lead to an adverse effect on Spectra Energy's operations. With appropriate monitoring and mitigation, no residual effects would be expected.

9.3.1.2 Forestry

The PAZ would overlap a relatively small amount of the timber harvesting land base. The total of some 410 ha accounts for less than 0.02 percent of the industry's regional land base. BC Hydro determined that because of the negligible land effect, there would be no effect on the allowable annual cut or the licence quotas held by industry to harvest Crown timber. A portion of area-based woodlot licence overlaps with the PAZ, but BC Ministry of Forests, Lands and Natural Resource Operations would make suitable replacement land available. The Proponent concluded that there would be no adverse residual effects on forestry associated with the Project.

The established timber mills in the region have the capacity to process the merchantable timber associated with the volumes produced from clearing the Project site. The Proponent reported that the Project would not be expected to change overall harvest trends in the region, as the annual fibre requirements of mills are more commonly influenced by market prices for products.

The PAZ would overlap four old-growth management areas that were established to achieve biodiversity targets for each timber supply area in the province. The BC Ministry of Forests, Lands and Natural Resource Operations would address the loss of old growth through the application of existing procedures that would result in fully mitigating the potential Project effects so that biodiversity targets would continue to be met.

The Proponent reported that no residual effects are anticipated for forestry.

9.3.1.3 Minerals and Aggregates

The Proponent stated that, during Project construction, mineral exploration activities could be limited in temporary Project areas. Site C reservoir filling would permanently preclude existing and potential mineral and aggregate use. However, the record of exploration in the LAA shows no sustained effort, and the geological characteristics of the LAA are not favourable for most valuable minerals, except for coal. The record of mineral exploration shows limited evidence of valuable deposits. Consequently, the probability of reduced access to undiscovered mineral potential as a result of the Project would be low.

Three Ministry of Transportation and Infrastructure (MOTI) pits (Peace View, Tompkins, and Riske Pits) would be affected by the Project. MOTI's Del Rio Pit is located in the transmission line corridor and would remain a gravel source to the Ministry after the Project was completed. The Portage Mountain quarry would remain a BC Hydro quarry for future use in maintenance of Hudson's Hope Shoreline Protection and the Bennett Dam as required, and would be potentially available to MOTI. The 85th Avenue Industrial Lands would be remediated based on the Official Community Plans of the local governments.

MOTI also holds seven sand and gravel reserves that overlap the LAA. Except for flooded areas, the Proponent determined that the Project would have minimal effect on the Ministry's access to the deposits. MOTI would also continue to use the Wuthrich and West Pine Quarries during construction. Following Project construction, surplus materials in the Wuthrich and West Pine quarries would be available to MOTI for further development.

The surplus material, estimated at 2.9 million cubic metres from the West Pine, Wuthrich, and Portage Mountain Quarries, would be a beneficial effect. BC Hydro proposed to negotiate a memorandum of understanding with MOTI to compensate for material used by the Project and to maintain material availability for Ministry operational needs. In addition, as the Project would be largely self-sufficient in aggregate use, with little reliance on private sources, it would not

disrupt the local aggregate market. The Proponent concluded that no residual effects are anticipated following the proposed mitigation measures and no cumulative effects are anticipated.

9.3.2 Views of Participants

During the public hearing, no one raised issues related to the effects of the Project on the oil and gas industry; however, many participants noted that the oil and gas industry has been present in the Peace region for many years and that oil and gas activities alone have a large footprint in the region.

Participants said this large and rapidly growing footprint included exploration, production, and transport. Participants shared maps of varying scales that demonstrated that, in addition to thousands of seismic lines and individual wells, each with its own pad, access road, and collector pipeline, a number of major transmission pipelines and their compressor stations are expected to traverse the region.

The City of Fort St. John said it had a well-established relationship with the oil and gas industry. Noting the low regional unemployment, the City said that the industry invests significant resources in training members of the Fort St. John community.

No one raised material issues regarding effects of the Project on forestry.

With respect to aggregates, the City of Fort St. John expressed a lack of confidence in BC Hydro's finding that the City would not experience lowered availability and higher prices in accessing aggregate resources, given the region's predicted rapid growth and development. The City felt that the Proponent should be responsible for locating, securing, and providing to the City a nearby long-term aggregate supply at competitive prices.

9.3.3 Panel's Analysis

The Panel agrees with the Proponent that the Project would have a negligible effect on the oil and gas industry. The monitoring and mitigation proposed related to overlap with Spectra Energy would eliminate any specific residual effect that the Project may have on that operation. In any case, the Panel understands that the Project would be unlikely to increase the existing sediment load downstream of the dam in the Peace River (Section 4.1.1.3). Water levels are unlikely to have an effect because there would be no change.

Likewise, the Panel agrees that the Project would have negligible effects on the forestry industry. Merchantable timber from the PAZ may slightly increase the wood supply for a brief period.

For minerals and aggregates, even taking into account the buoyant demand for these materials in a rapidly developing region, the Panel notes that glacial till overlying sedimentary rocks and abutting strong rock resources to the west is a fortunate endowment, and agrees that the Project's effects on regional supply would likely, on net, be financially beneficial.

The Panel concludes that the Project would have negligible effects on the regional oil and gas, forestry, and mineral and aggregate industries.

Cumulative effects, however, are another matter. The unemployment rate in the region is low, and it therefore appears that the Project could be competing with other resource industries for the same scarce skilled labour during its construction phase (see Section 10.1). The Panel believes this has the potential to drive up costs for the Project and resource industries.

Much more seriously from an environmental point of view, the cumulative effects of the oil and gas, forestry, aggregates, and hydroelectric industries are straining the capacity of the region's natural resources to support future generations with the same degree of environmental services now being exploited by present generations. The Panel's discussion of environmental cumulative effects as a result of the Project combined with others is discussed in other chapters of this report and Section 13.4.

9.4 TRANSPORTATION

The Project would use, develop, or improve roads to move people, equipment, goods, and materials to and from construction and operational sites. This section examines potential ground transportation issues caused by the Project.

9.4.1 Proponent's Assessment

To assess the effects of the Project on transportation, the Proponent used potential increases in traffic delays and collisions as the key indicators. The assessment was based on the results of the Project Traffic Analysis report which measured the anticipated increase to existing and future traffic without the Project and compared that with the modeled traffic generated by Project construction and operation. The analysis also measured the operation of the various roadways without the Project traffic and compared that baseline with the modeling of the operation of the various roadways with the additional traffic generated by the Project, generally characterized by an analysis of the delay expressed in seconds per vehicle. The analysis formed the basis of the Proponent's estimated increase in delays per vehicle, changes in level of service (LOS), and changes in safety of the existing road system that would be used during Project activities.

The Proponent completed several additional sensitivity analyses at the request of the City of Fort St. John, including residential traffic routing scenarios.

The effects of the Project on the transportation indicators were assessed by taking into account the potential for change in the following key aspects:

- Road transportation in the local assessment area (LAA) proposed for the Project;
- The need to develop and use regional road transportation routes for the Project;
- Specific transportation plans proposed for the Project;
- Local road forecasts; and
- Population, workforce accommodation, and shift schedules.

The effects assessment focused on road transportation because the Project's use of rail and air would be within the existing capacity and infrastructure. Therefore these transportation modes were not assessed.

The assessment of Project-related effects on transportation in the region was segmented into effects during construction and during operation.

9.4.1.1 Construction Phase

During the Project construction period, Highway 29 North, Highway 29 South, Jackfish Lake Road, and the north bank minor roads would likely experience the following:

- Minor traffic delays;
- Decline in the LOS on some roads and at some intersections; for example, in Hudson's Hope, trucks carrying rip-rap and other off-site material for either the Highway 29 realignment or the shoreline protection construction would slow traffic, and potentially impede egress at properties in the vicinity of Canyon Drive and Clarke Avenue;
- Potential for impeded egress at properties on some roads;
- Increase in frequency of collisions; and
- Potential safety risks to pedestrians and cyclists.

Highway 97 North and Highway 97 South would likely experience minor traffic delays and changes in LOS including:

- Highway 97 North at Old Fort Road, with delays of up to seven seconds per vehicle for southbound traffic turning left onto Highway 97;
- Highway 97 North at 100th Street, with delays of two seconds per vehicle for southbound traffic turning left onto Highway 97, and one second per vehicle for westbound traffic turning left onto 100th Street;
- Highway 97 North at 85th Avenue, with an eight-second increase in delay for drivers turning left from Highway 97 onto 85th Avenue; and
- Highway 97 South, with minimal delays on access to Tim Horton's near Highway 97 in Chetwynd.

The Project is also predicted to increase the frequency of collisions on Highway 97 North and Highway 97 South, particularly at major signaled intersections.

9.4.1.2 Operation Phase

BC Hydro said the formation of the reservoir may have localized potential temperature change effects. Therefore, climate data were collected to support an analysis of potential effects during operation on road safety due to changes in fog. This analysis was undertaken along roadways adjacent to the reservoir and the river downstream. The permanent upgrades to Highway 29 were also assessed in the context of road safety.

Due to the model's limitations, the Proponent said it could not predict with certainty what the effects of a 118-hour increase in fog would be on driving visibility, driving conditions, and overall road safety where Highway 97 crosses the Peace River at Taylor, in the adjacent low-lying stretches of the highway in the valley at Taylor, and in the ascent out of the valley on the south Taylor hill.

9.4.1.3 Mitigation Measures

BC Hydro would implement several measures during construction and operation to mitigate potential traffic delay and safety effects resulting from the Project. Mitigation would not be

required on Highway 97 North or South due to sufficient highway capacity and, for the recent four-lane enhancement of Highway 97 North near Fort St. John. Mitigation measures would also not be required in Hudson's Hope, due to low volumes of background vehicle and turning traffic.

Given the moderate level of uncertainty in the traffic modeling results and the predicted changes in fog hours at the Taylor Bridge, monitoring could be implemented to determine actual traffic operation and the effectiveness of mitigation measures. Additional detail on the planned mitigation measures is provided in Appendix 9.

9.4.1.4 Determination of Significance

BC Hydro said that mitigation and forward planning to deal with the predicted increase in traffic volumes would limit adverse effects, but increases in traffic delay would remain and, on some routes, the number of collisions would increase and be a residual effect.

The Proponent said residual effects on transportation would be significant if the effects were adverse, the magnitude moderate or high, the geographic context local or regional, the frequency continuous, the duration long-term, the effects irreversible, and the social context moderate or high resilience.

The change in traffic delay was based on a change in LOS expressed in seconds of delay, based on traffic operation definitions where the LOS 'A' represents little delay and LOS 'F' represents much delay. The six LOS were divided into 10-second to 25-second increments, where seconds of delay progressively increase as LOS degrades, for signalized intersections, and into10-second to 15-second increments for stop-control intersections. A reduction of two or more LOS was selected to indicate a moderate effect. For all road segments assessed, the Proponent said that, in a peak hour of the peak construction year, average traffic delays were anticipated to reduce the LOS by one level, and increases in traffic delays would be less than 10 seconds for all traffic movements. The magnitude of the effects was therefore considered to be low.

The Proponent indicated that at LOS 'E' the Ministry of Transportation and Infrastructure (MOTI) would continue undertaking improvements. That is, LOS 'E' is when traffic reaches a point of unacceptable congestion or capacity. The Proponent said the LOS is only one of the criteria the Ministry uses that would trigger an improvement. Sometimes MOTI will make improvements to a road or intersection before it reaches that LOS, or may also accept a condition where level of service at 'E' persists. Other criteria that MOTI may apply to determine how it would address the LOS could include safety performance, improvements, and consideration of part of a larger capital plan.

With respect to the other characterization criteria, the overall residual effects of the Project on transportation would be adverse, within the LAA (local), reversible, and medium in terms of duration because the effects on change in road traffic delays were expected only during the construction period.

The Proponent's analysis indicated that a change of 5 percent represents the normal variability in the annual collision frequency. This was confirmed with the assessment of collisions within the Peace region and for the province as a whole. Thus, an increase in 5 percent of the expected annual collision frequency was selected as the magnitude threshold between a low and moderate residual effect.

Road safety during construction was anticipated to be somewhat reduced on most roads within the LAA, but would be well within the normal variability of annual collision frequency in the LAA.

On Highway 29 North and Old Fort Road, implementation of mitigation measures and construction of road improvements were expected to increase road safety in the long term.

Furthermore, BC Hydro said benefits from Project-related road and highway infrastructure improvements would last much beyond its completion. For all the reasons stated above, the Proponent considers the adverse residual effects on transportation as not significant.

9.4.1.5 Cumulative Effects

The Proponent included future major development projects in the road transportation outlook used in the effects assessment. Therefore, the residual Project effects of transportation already account for overlaps and interaction with these projects. An assessment of cumulative effects was not undertaken because the Proponent said it would represent a double-counting of Project residual effects.

9.4.2 Views of Participants

Local municipalities had concerns about the scope of the traffic assessment. They requested an additional assessment of traffic issues within the communities, including effects related to indirect and induced employment, and changes to the average daily and peak-hour traffic during the summer. Hudson's Hope had concerns about the effects on Canyon Drive, Clarke Avenue, Beattie Drive, and Highway 29 being used as major haul routes for rip-rap, road construction aggregate, and bridge materials during construction. Likewise, the City of Fort St. John identified its areas of special traffic-related concerns. These transportation routes within the municipalities present additional safety and traffic volume concerns that were not assessed.

The municipalities said heavy hauling would cause deterioration of the road beds and surfaces, and the increased traffic levels will cause noise, dust, and other disturbances. All these concerns were cited in the context of the rapid expansion of industrial activities in the region, mainly the oil and gas sector, and the related transportation issues and booming population.

The District of Taylor did not attend the hearing but provided written comments related to traffic safety and the increased fog that is expected to occur with the Project, particularly at the Taylor Bridge, which crosses the Peace River. As stated in the Environmental Impact Statement (EIS) and confirmed in the Proponent's final comments, modeling predicted a potential annual increase of 8 hours of normal fog and 118 hours of heavy fog at the Taylor Bridge. Because of uncertainties of the models on microclimate, the Proponent proposed to monitor during construction to develop a baseline and to continue monitoring through Years 0-4 of operation, or until the changes in fog could be confirmed. It also proposed to install enhanced lighting throughout the stretch of Highway 97 through Taylor and changeable message boards.

Local municipalities requested that the Panel recommend that the following requirements of BC Hydro be included in Project approval:

- Establish an agreement with the City of Fort St. John on the location, scope, timing, and responsibility for the implementation of intersection and roadway improvements related to the Project; and
- Establish an agreement with the City of Fort St. John on a comprehensive Traffic Monitoring and Mitigation Plan that would ensure that actual transportation conditions in the city boundaries are assessed during the construction period and that unforeseen impacts would be adequately addressed on an on-going and timely basis.

Citing continued effects from the construction and operation of the previous hydroelectric facilities on the Peace River, municipalities said the Proponent and governmental agencies should be responsible and accountable to further assess, mitigate, and compensate for the Project-related and cumulative impacts with respect to transportation, including upgrades in civic infrastructure.

Concerns were raised by some participants, including a staff member from the Visitor Centre in Hudson's Hope, and the Ministry of Jobs, Tourism and Skills Training about potential disruption of resident and visitor traffic along transportation routes under construction, such as the Highway 29 realignments. In response, BC Hydro said the Traffic Management Plan would include communications for residents and tourists about construction activities and potential traffic delays. The Proponent said most of the new highway bridges and segments would be located away from the existing highway, permitting construction to take place with little effect to existing traffic.

Dr. Charl Badenhorst, on behalf of Northern Health, said the motor vehicle accident hospitalization rate per thousand is considerably higher in northeast B.C. than the rest of the province. Dr. Badenhorst also said the region's motor vehicle accident death rate is "sky high" compared to the rest of B.C.

9.4.3 Panel's Analysis

The Proponent's transportation modeling was conducted according to best practice. The Panel agrees with the Proponent that the Project activities during construction would cause small increases in traffic volumes. However, the Panel is concerned by the increase in traffic delays, particularly with respect to left turns at some intersections and the potential consequent safety effects.

In the context of MOTI's decision criteria for addressing LOS, including safety concerns, the Panel is concerned that the vehicle collision rates and victim collision rates between 2002 and 2011 for the LAA are higher than the regional and provincial rates, even without the effects of the Project. The City of Fort St. John described numerous safety-related challenges associated with Highway 97 and on local streets as the region experiences major increases in traffic resulting from the current industrial boom. Increased traffic associated with the Project would likely exacerbate these issues if additional local and provincial resources were unable to considerably reduce collisions in the area. The Panel received no indication from local or provincial agencies that they have plans or sufficient resources in place to address the current and future traffic safety issues.

The Panel disagrees with the Proponent's conclusion that Highway 97 has sufficient highway capacity and the recent four-lane enhancement of Highway 97 North, near Fort St. John, eliminates the requirement for additional mitigation measures with respect to safety. The Panel finds that three intersections in the City of Fort St. John would need monitoring to address issues where the LOS or safety may worsen, namely Highway 97 at Old Fort, 100th Street, and 85th Avenue.

Because of uncertainties associated with the microclimate model results for fog at Taylor Bridge and the potential impact on driving visibility, conditions, and safety, BC Hydro said there is a need for monitoring the situation. The Panel agrees that monitoring is needed.

The Proponent concluded that the adverse residual effects were not significant because the Project would bring further improvements to the road system as a whole. The Panel disagrees with this statement to the extent that:

- The Proponent's road improvements do not address the City of Fort St. John's three intersections named above, and only address Highway 29 realignment, Jackfish Lake Road, and the north bank minor roads;
- The mitigation measures proposed for Hudson's Hope would have to be proven as being effective; the same would apply for the measures proposed for the Taylor Bridge.
- Because the collision rates in the last decade for the LAA are higher than the regional and provincial rates without the effects of the Project, any decrease in the LOS causing traffic delays may exacerbate road safety.

The Panel agrees that the Project's effects are limited in time, reversible, and local.

The Panel concludes that the traffic at some places on Highway 97 is already dangerous, and during the period of construction, the Project would add to that, but there would be no residual effects after the construction period. If the Panel's recommendations are implemented, this effect would not be significant during construction.

The Panel also agrees that there is no need for a cumulative effects assessment because the Proponent accounted for the long-term industrial growth trends in its effects assessment of the Project.

The Panel notes that the Proponent's final comments indicated it completed several sensitivity analyses at the request of the City of Fort St. John, including local residual traffic routing scenarios. The Proponent submitted that it is collaborating with the City, its consultants, and the Ministry of Transportation and Infrastructure (MOTI) to develop a city-specific traffic monitoring and mitigation plan. The Proponent committed to assessing actual transportation conditions during the construction period, when unforeseen impacts would be addressed on an ongoing and timely basis.

The Panel insists on the importance of monitoring at locations that may have changes in LOS or safety. If monitoring indicates a Project-induced effect, the Proponent should take action and determine sufficient funding for mitigation, in collaboration with MOTI, local municipalities, and stakeholders.

The same monitoring process and issue response would apply if it is proven that mitigation of the Project-induced transportation effects is unsuccessful at Hudson's Hope and Taylor Bridge.

Considering participants' concerns about potential disruption of resident and visitor traffic for several years along transportation routes under construction, such as the Highway 29 realignments, it would be necessary to minimize delays and nuisance, particularly for visitors. During the summer, travellers visit northern B.C. as part of the Alaska Highway tour, a major tourist attraction. Related issues are described further in Section 9.7.

Although BC Hydro said there would be little effect to the existing traffic, the Panel considers it important to address potential traffic delays along Highway 29 and the construction nuisance

caused by dust, smoke, and noise. Dust, smoke, and noise are assessed as potential effects on human health in Section 11.1.

RECOMMENDATION 23
As proposed by BC Hydro, the Panel recommends that, if the Project proceeds, it must establish a current baseline of fog occurrences at Taylor Bridge and its approaches in Taylor, as well as follow-up monitoring during the first years of operation to evaluate the magnitude of any changes as a result of the Project.

RECOMMENDATION 24
The Panel recommends that, if the Project proceeds, BC Hydro must conduct monitoring of the Level of Service and road safety. Monitoring and a follow-up program shall focus on the following locations:

- Highway 97 at Old Fort Road in Fort St. John,
- Highway 97 at 100th Street in Fort St. John,
- Highway 97 at 85th Avenue in Fort St. John,
- Canyon Drive in Hudson's Hope,
- Beattie Drive in Hudson's Hope, and
- Clarke Avenue in Hudson's Hope.

RECOMMENDATION 25
The Panel recommends that, if the Project proceeds, BC Hydro's Traffic Monitoring and Management Plan and associated work schedules must be prepared, subject to safety considerations, to minimize delays and nuisance caused by the realignment of Highway 29, particularly during peak visitor periods.

9.5 AIR NAVIGATION

9.5.1 Proponent's Assessment

The Project has the potential to change the local climate, including air moisture levels and temperature, because of the change from a river to reservoir. These climate changes could cause an increase in fog in the area. BC Hydro examined visibility changes in terms of monthly and annual number of hours of fog occurrence. Fog frequency and density were evaluated at the locations of the seven BC Hydro climate stations close to the Project reservoir, at North Peace Regional Airport, and at Taylor Bridge.

The combined total of clear hours with visibility greater than 20 km and hours with visibility 10 km to 20 km was predicted to be reduced by 15 hours over the year at the North Peace Regional Airport, while the number of hours with visibility in the range of 1 km to 10 km was predicted to increase by 8 hours. The number of hours of poor visibility (less than 500 m) was predicted to increase by 6 hours per year at the North Peace Regional Airport with the addition of the reservoir.

The Proponent concluded that local climate model results and statistical analyses showed the reservoir's influence on water vapour and temperature, and by extension fog, was negligible.

The Project was not expected to have an adverse effect on aviation visibility due to changes in fog at the North Peace Regional Airport.

9.5.2 Views of Participants

Both Transport Canada and North Peace Regional Airport representatives considered the aviation assessment approach appropriate for evaluating potential Project-induced fog. However, other participants had concerns about the methods of climate modeling of fog, as well as the potential impacts of increasing fog at the airport. For example, the City of Fort St. John said, that in order to more accurately determine the possible impacts of fog on the airport, it would be essential to have at least monthly data and preferably data from a model that is calibrated from airport observational records to reproduce actual conditions. The City requested that the Panel require the Proponent to engage experts to interpret the increase in fog in order to determine what mitigation measures are necessary to ensure that the current levels of service at the airport are not compromised.

Neil Thompson provided an extensive presentation of potential Project-induced effects of fog and cumulative effects of industrial development that have resulted in changes to fog and ice near the airport on air navigation. Mr. Thompson also provided potential mitigation measures to address these navigational concerns.

BC Hydro responded to comments about fog at the airport, saying that its consultants conducting the study had worked with Transport Canada and North Peace Regional Airport representatives to discuss the assessment approach and that any changes to microclimate at the airport would not be statistically significant, thus mitigation measures were not proposed.

9.5.3 Panel's Analysis

The Panel agrees with the Proponent's interpretation that any potential effects on air navigation as a result of increased fog at the North Peace Regional Airport would likely be negligible.

The Panel concludes that the Project would not result in significant adverse effects on air navigation.

9.6 WATER NAVIGATION

9.6.1 Proponent's Assessment

Based on key issues raised during consultations with Aboriginal communities, the public, and government agencies, BC Hydro conducted its assessment of the Project's effects on navigation, focusing on four categories.

- Change in navigability and navigational use;
- Change or presence of navigational hazards in the waterway;
- Changes that result in restrictions to navigation, their rationalization, and the approach to public and navigational safety use; and
- Changes to Shaftesbury and Tompkins Landing ice bridges.

BC Hydro's analysis considered the effects on navigational issues listed above without distinguishing between Aboriginal and non-Aboriginal populations. BC Hydro assessed effects within a local assessment area (LAA) and regional assessment area (RAA) that include the Project activity zone downstream to Peace Island Park, and the Shaftesbury and Tompkins Landing ice bridge and ferry crossings. A significant effect would be determined if the magnitude was high, the geographic extent local or regional, the duration long-term, and social context not resilient. Figures 14 and 15 indicate the location of the proposed works, navigational use restriction areas, and existing and proposed major boat launches.

9.6.1.1 Change in Navigability and Navigation Use

The construction and operation of the dam and the associated restricted access zones would be a permanent barrier to navigation. The Project area would also have temporary restrictions during construction. Debris booms would be placed within this restricted navigational zone above the dam site, at the mouth of the Moberly River, and in construction Year 2, a boom above this zone at Wilder Creek. The debris booms would operate for several years during freshet, depending on the duration of reservoir clearing. BC Hydro stated that navigation past the temporary debris booms would be likely, subject to final design safety precautions. Navigation upstream and downstream during construction on the Peace River would continue from existing access points.

At the start of construction, BC Hydro would apply for a restricted navigational zone on the Peace River where it would conduct in-river and shoreline works such as shoreline excavation, blasting, cofferdam and dam construction, extending approximately 2 km upstream and 1.5 km downstream of the dam site. After filling, this restricted zone would be limited to a permanent upstream forebay safety boom and a 3 km downstream restricted navigational zone. Restrictions would also be required along the Moberly River, where temporary debris booms would be placed, and at Wilder Creek, approximately 12 km upstream.

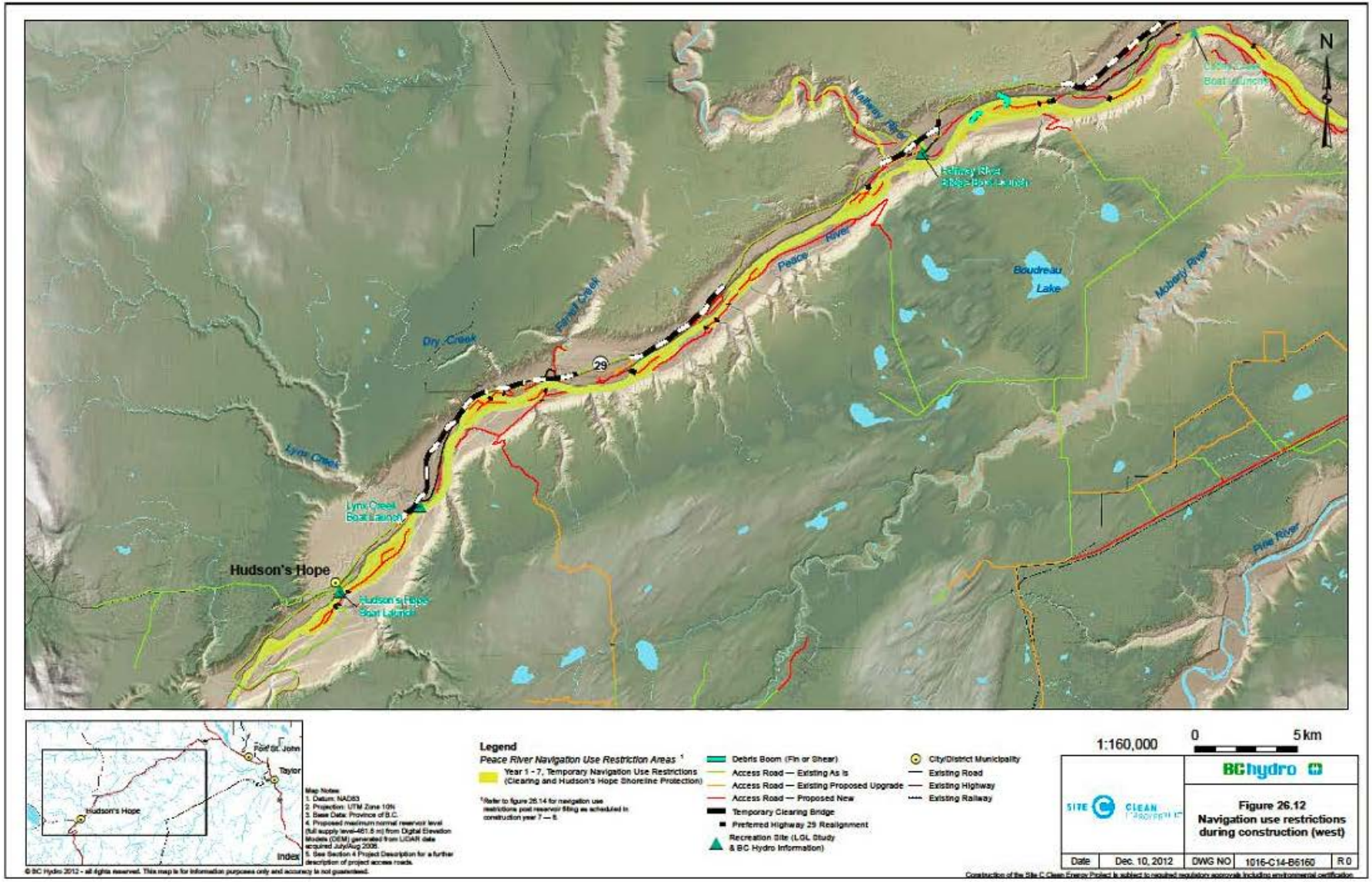
BC Hydro committed to maintaining access in the Project area until construction activities impact safety and usability. BC Hydro said there would always be at least one boat launch upstream of the dam open at all times during construction to ensure access for navigation. After reservoir filling is completed, BC Hydro noted that existing boat launches within the Site C reservoir area, including Halfway River, Lynx Creek, and Hudson's Hope ferry landing, would become permanently unavailable. In Year 5 of construction, the Hudson's Hope boat launch would be closed. Access to the Lynx Creek and Halfway River boat launches may be affected by temporary closures due to the Highway 29 realignment construction and clearing activities and both launches would be closed in Year 7 and reopened in Year 2 of operation. The launch at Halfway River would be replaced by a new location at Cache Creek also about the same year.

Access to the water would continue to be impacted until the new boat launches are opened for use on the reservoir. During the hearing, BC Hydro said it plans to construct the boat launches prior to filling the reservoir to promote early availability once filling is complete. These boat launches would consider the predicted erosion impact lines and that downstream access to the river would be unaffected through construction and operation. During operation, BC Hydro stated that reservoir access is anticipated after the first or second year of reservoir filling, dependent on reservoir conditions, slope stability, and debris management.

In response to participants' concerns that boat launches with the existing dams are not usable because of the water levels and that responsibility for these launches had been downloaded on

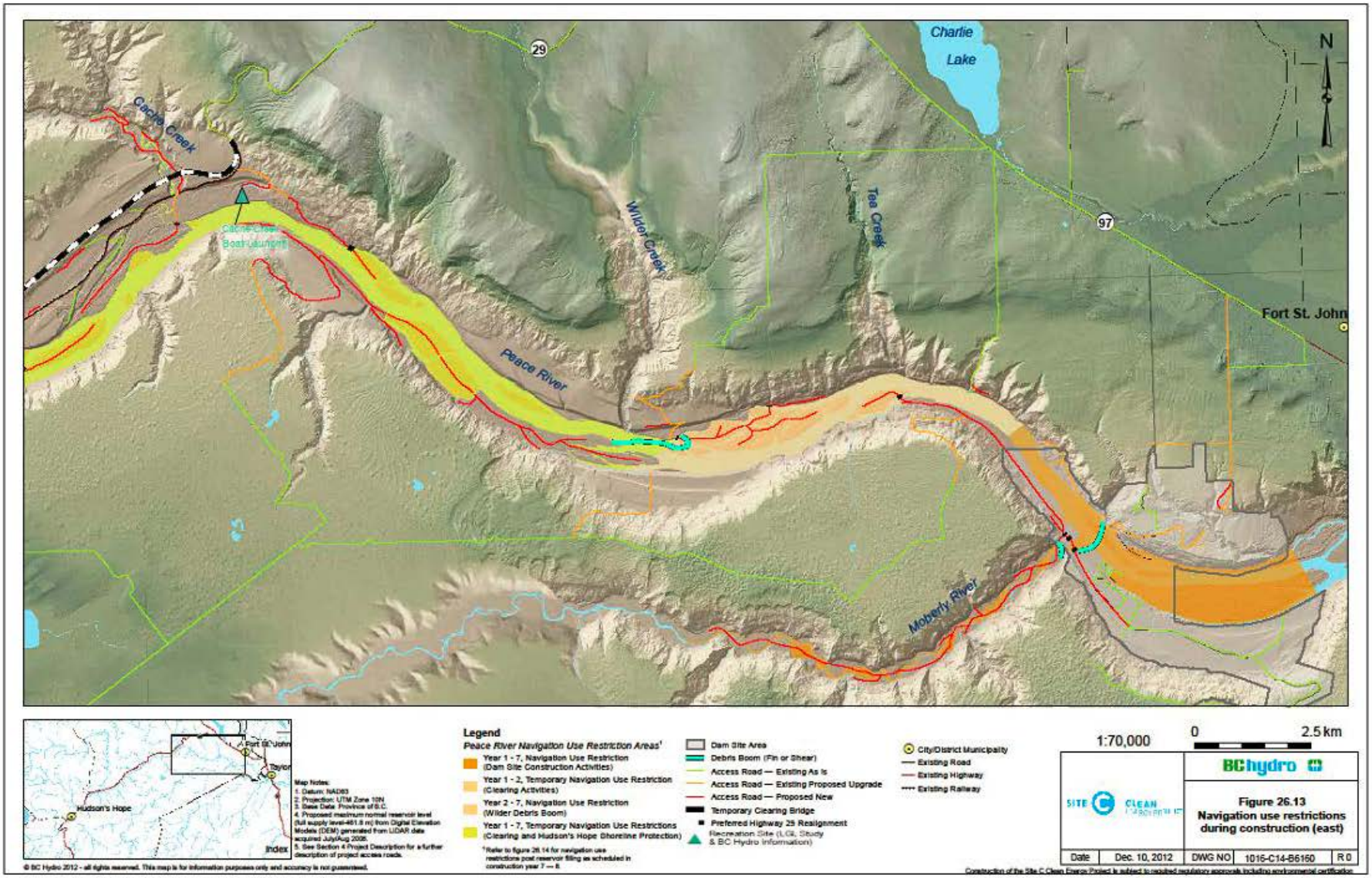
the Municipality of Hudson's Hope, BC Hydro clarified that it would be responsible for the construction, operation, and maintenance of the boat launches.

BC Hydro said filling of the reservoir was scheduled to occur in the fall, outside of the high season for navigation, but effects during filling may occur depending on the exact construction schedule. Once completed, the rising water levels resulting in mobilization of shoreline and woody debris may temporarily affect navigation upstream of the dam but fluctuating water levels would not be expected to have an adverse effect on navigability and navigational use.



Source: Modified from BC Hydro EIS, Volume 3, Section 26

Figure 14. Navigation Use Restrictions During Construction (West)



Source: Modified from BC Hydro EIS, Volume 3, Section 26

Figure 15.Navigation Use Restrictions During Construction (East)

BC Hydro said that, during operation of the Project, there would be limited difference in water level fluctuations compared to existing conditions and that the minimum downstream flow of 390 cubic metres per second (m^3/s) would be sufficient to support downstream navigation. BC Hydro said the minimum flow would be exceeded 70 percent of the time and would occur generally at night when the demand for electricity is low. BC Hydro provided surface water profiles from the Project to the B.C.-Alberta border under a range of downstream tributary flow conditions as further evidence that adequate depth and a continuous channel would exist to accommodate navigation. Water management during operation was noted to not affect navigability and navigational use.

BC Hydro assessed sedimentation as a factor that may affect navigability of waterways flowing into the reservoir and predicted that sedimentation would occur during operation in all of the affected tributaries, especially the Halfway River. It provided the river profiles for these water bodies and explained that the profile depths and estimated speeds of flow demonstrated that any deposition of sediment would be unlikely to affect navigability and navigational use.

BC Hydro said the Project would add to the existing flow regulation on the Peace River and shift the regulation point further downstream. It concluded that the main effect on navigability and navigational use would be at the dam site and decrease further away from the Project, because the flow and water level changes were expected to be minimized with the influence of tributaries into the river.

9.6.1.2 Change or Presence of Navigational Hazards in the Waterway

BC Hydro said floating debris in the river and on the proposed reservoir could be a boating safety concern. It said that mitigation measures proposed, including a Debris Management Plan and a boater hazard communication plan, installing a debris boom, and clearing shoreline vegetation, would manage the hazard, and it did not anticipate adverse effects. It also noted that the clearing strategy in the proposed reservoir of trees and vegetation exceeding 455 m elevation would provide at least 5 m water depth of clearance and eliminate boating hazards.

BC Hydro said the reservoir would not likely be drawn down below the operating level of 461.8 m, but in this event, hazards to navigation could include the tops of submerged standing trees and shoals. It noted that a hazard assessment would identify specific navigational hazards associated with that drawdown and concluded there would be no adverse effects because a drawdown to this level would take approximately 15 days, providing adequate notice to the public.

In response to concerns about quickly rising submerged trees, BC Hydro said this generally occurs only in reservoirs where no or minimal clearing is undertaken in advance of filling. It said that these were unlikely to occur with the Project because reservoir and shoreline clearing would reduce the volume of submerged trees and debris booms and removal of floating debris would prevent it from becoming submerged.

The Proponent said the design of the Highway 29 bridge crossings would mitigate any adverse effects on navigation, considering the future navigational use of the reservoir and including preliminary specifications for vessel clearances. BC Hydro proposed 8 m as a minimum clearance at Halfway River, but said this structure could accommodate a higher clearance. As a result of these considerations, the replacement of Highway 29 bridges would not cause an adverse effect on navigability or navigational use, nor create a hazard to or interfere with navigation.

The crossings of the Peace Canyon reservoir and the Moberly River by the transmission line would require approval from Transport Canada, and BC Hydro said safe clearances have been determined in consultation with the Department. Therefore, it concluded that the transmission line clearances would not cause an adverse effect on navigability or navigational use, nor create a hazard to or interfere with navigation.

9.6.1.3 Changes that Result in Restrictions to Navigation

Restrictions during construction, designed to ensure boater safety would result in adverse effects on water-based navigational users in these areas. BC Hydro said these restrictions would be requested for one year post-filling to account for any anticipated shoreline erosion and landslide potential. Specific areas of restriction that may impact navigational users include the mouth of Lynx Creek, the mouth of Farrell Creek, and the mouth of Halfway River opposite the historic Attachie Slide.

These navigational restrictions would be lifted after the second year, pending monitoring of reservoir shore conditions. BC Hydro further identified areas downstream of Wilder Creek and Moberly River that could be restricted for a slightly longer time depending on debris management.

9.6.1.4 Changes to Shaftesbury and Tompkins Landing Ferries and Ice Bridges

Shaftesbury and Tompkins Landing were two areas of navigational infrastructure that BC Hydro considered in its assessment. It determined that the Project could cause a potential shift in the formation of ice downstream that may impact the relative operating periods of the Shaftesbury ferry. As a result of this change, it predicted that, on average, the ferry operations may extend from 4 days to 2 weeks longer into the fall. However, the total number of crossing days for the ferry and ice bridge combined would not change, since the number of ice bridge days would decrease but the number of open water days would increase. BC Hydro concluded that there would be no changes at the Tompkins Landing Ferry.

BC Hydro stated that there would be no adverse effect on navigation at these locations.

9.6.1.5 Mitigation Measures

BC Hydro described several key mitigation measures that would support navigability and navigational use if implemented during the Project construction and operation phases on the reservoir. The main mitigation measure included a Public Safety Management Plan and other communications to notify the public about changes to navigability, navigational use and access, the presence of hazards, the location of navigational restrictions, and the availability of alternative access points. BC Hydro would also communicate this information through signage near the construction site.

BC Hydro said mitigation measures proposed for the adverse effects related to outdoor recreation would also mitigate effects on navigation. These measures included the funding of a Navigation and Recreation Opportunities Plan to encourage recreational use of the reservoir and a Community Recreation Site Fund to support development of new shoreline recreation, and technical support to outdoor recreation providers and submerged vegetation and debris management would be provided.

In response to concerns by Aboriginal groups related to mitigating potential adverse effects of the Project on navigation that may impact access to hunt and trap, BC Hydro proposed consultation with Aboriginal groups on clearing plans and protocol, and development of a

communications program to inform harvesters of planned or unplanned events related to construction activities that may affect hunting opportunities or access. BC Hydro said it is committed to resolving outstanding concerns of Aboriginal groups.

9.6.1.6 Proponent's Conclusion

BC Hydro concluded that there would be an adverse effect on navigation at the dam site because water-based navigation within the restricted navigational zones would no longer be permissible at this location.

Based on its surveys, BC Hydro said jet boating occurred most frequently between Peace Island Park and the Pine River, downstream of the proposed dam site. It found that most users operated on a round-trip basis and had their own truck and trailer for launching and transport. It also found that jet boat use of the Halfway River for hunting is common. BC Hydro's survey of vessels transiting the dam site, conducted between June and early-September, observed approximately 1.3 boats per day. No ongoing commercial navigation on the waterway was known.

BC Hydro concluded that, although there would be adverse residual effects on navigation due to the permanent restriction of navigation at the dam site, these effects would not be significant. It characterized the magnitude as low and the geographic extent as local because boaters would still be able to access areas upstream and downstream of the dam site. BC Hydro said boaters would be able to adapt to new conditions by planning their trip in a manner that would not require transit past the dam site.

9.6.1.7 Cumulative Effects

Adverse cumulative effects on navigation were not found to be significant in the Proponent's assessment because there are no other water-based projects within the RAA. It further noted that the Project does overlap in time and space with recreational activities in the RAA. However, there are no cumulative adverse residual effects of those activities combined with the Project on water-based navigation.

9.6.2 Views of Participants

Transport Canada (TC) said the Peace River and many of its tributaries have been deemed navigable under the *Navigable Waters Protection Act* (NWPA) including the Pine, Moberly, and Halfway Rivers. TC said it would be responsible for issuing an approval with conditions under the NWPA for Project components that may impact navigation of these waterways, should the Project be approved. TC said these conditions would be enforceable during and post construction. In order to proceed with approvals containing the required conditions, TC would require additional information from BC Hydro. BC Hydro responded that it would provide the requested information during the approvals process.

Based on the information that it had received, TC said construction and operation of the Project would result in "a substantial interference" to navigation. Substantial interference means that the "proposed work will significantly change the way vessels pass down a navigable waterway or may make passage dangerous to the public". TC confirmed that the information collected by BC Hydro demonstrated that vessels do transit the proposed dam site, that there is navigation on the Halfway River and limited navigation on the Moberly. Several members of Aboriginal communities spoke about their travel routes by boat up and down the river and along nearby tributaries within the RAA. However, a book submitted by Arthur Hadland, *Prophecy of the Swan*, noted that Alexander Mackenzie's voyage upstream on the Peace River in the summer of

1793 required that he portage 19 km around the Peace Canyon in order to reach the Finlay and Parsnip Rivers. The book also noted that these “turbulent waters” led to the naming of the Rocky Mountain Portage House near present-day Hudson’s Hope. The Mayor of Hudson’s Hope, Gwen Johansson, explained that this location was the head of navigation on the Peace River historically, and that the existing rapids that blocked navigation further upstream were drowned when the Peace Canyon Dam was built.

TC said it is unclear about the level of restriction that BC Hydro is requesting and would request more information from the Proponent to assist with the development of the terms and conditions of the NWPA approval. TC recommended that navigation be maintained through construction upstream of the dam site. BC Hydro responded to TC’s recommendations and stated that the public and worker safety risks associated with public access through the active construction site outweigh the navigational benefit of keeping it open to the few that would like to view construction of the dam. A public viewing area on the north bank would be constructed for this purpose.

TC understood that the mitigation proposed by BC Hydro was appropriate for the loss of existing boat launches, but was not appropriate for the loss of vessel passage. TC recommended a portage system be put in place as mitigation to allow users to transit the dam site. Based on reported use, monitoring done, and information presented by BC Hydro to date, TC believed that the amount and type of traffic would not warrant a lock structure in the dam, as was considered for other proposed hydroelectric projects in Canada. However, the City of Fort St. John expressed concerns that the information provided by BC Hydro regarding navigational use was not accurate because it did not account for boating during the fall big game hunting season. BC Hydro said the portage system suggested by TC was not warranted, based on the assessment of 1.3 boats per day frequency, and would not likely be used.

TC asked BC Hydro to provide navigability over the Wilder Creek debris boom to allow access to the river between the boom location and the dam site through the use of a specially designed segment to allow the typical jet boat to pass over. BC Hydro responded that further design work would be needed, but that it was working to accommodate the request and that once it considers final design and safety, it could design the booms to be navigable.

TC highlighted relayed the concerns of Aboriginal groups on navigability. Aboriginal groups had raised concerns related directly to harvest and access to hunting and trapping areas. They explained that the river was used to reach hunting and fishing territories along the Peace River and its tributaries, but also to visit family members or sites of cultural importance. Dene Tha’ First Nation noted that BC Hydro’s assessment of impacts to navigation did not appropriately consider access to preferred locations to exercise rights and the ability to transmit culture. It and others noted that the proposed mitigation measure of constructing more boat launches may actually create more impacts because it would increase access for recreational anglers, thereby creating more pressure on fishing resources and fishing areas. Aboriginal groups also noted that opportunities to access these sites have been lost since the building of the previous dams. Duncan’s First Nation said the existing operations on the river have “fundamentally changed the relationship of how Duncan’s First Nation people have interacted with the river in comparison from the past and today.”

Despite BC Hydro’s assertions that submerged trees would be unlikely to rise and impact navigation, TC maintained that this could occur in areas where clearing is not possible. TC said this would most likely occur during the first year post inundation period, when navigation would already be restricted, and further assessment of risks to navigation would be done after the first year post inundation period. Diane Culling, a participant at the hearing, stated that stories of “log

rockets" from dislodged debris on the Williston reservoir were myths, but that floating debris and deadheads were hazardous to navigation.

TC supported BC Hydro's proposed clearing strategy and considered 5 m of subsurface clearance adequate for the anticipated vessel traffic on the proposed reservoir. TC understood that BC Hydro would complete a hazard assessment identifying specific navigational hazards in the event that drawdown occurs. TC agreed that 15 days is appropriate notice to advise the boating public of any hazards or restrictions.

TC said there other project works may be subject to NWPA approvals. It said the new bridges along Highway 29 would not cause a significant adverse effect on navigability or navigational use, nor create a hazard to or interference with navigation as long as the recommended clearance envelopes were adopted and any terms and conditions of the NWPA approvals were adhered to. In discussions with BC Hydro, TC expressed concern over leaving the existing Halfway River and Farrell Creek bridges because of the potential effects on navigation due to sediment flows down the Halfway River and Farrell Creek areas.

TC noted that fish compensation works could have a potential impact on navigation, but without specific information on the fish and fish habitat compensation plan and associated waterway details, it could not draw conclusions on potential effects to navigation and/or navigability of the waterways where they are placed.

Effects on navigation related to other works, such as erosion protection works, temporary bridges, boat launches, and replacement of water intakes/outfalls, were noted to be potentially mitigated and avoided through specific terms and conditions of NWPA approvals and would therefore not cause significant adverse effects on navigation.

TC agreed with BC Hydro's assessment that there would be no adverse indirect effects on navigation for the ferries at Shaftesbury and Tompkins Landing. However, the government of Alberta expressed concern that the proposed design minimum flow could adversely affect crossings at these locations during the fall when tributary inflows are low. Little Red River Cree Nation and the Métis Nation of Alberta Region 6 were also concerned that the formation of the ice bridge at Shaftesbury would be delayed and, for the latter, would restrict access to lands for traditional purposes.

TC noted that Aboriginal groups had concerns related to the exclusion of the Peace Athabasca Delta (PAD) in the environmental assessment, and said that navigability in the PAD is important to traditional use activities and general recreational use. TC said that Aboriginal groups are particularly concerned with the potential impacts to navigation in the PAD during low flow periods. First Nation groups in the vicinity of the PAD said sometimes the river is too low to navigate. Athabasca Chipewyan First Nation and Mikisew Cree First Nation said their members have faced numerous navigational challenges in the PAD since the Bennett Dam was constructed due to low water levels. They also presented evidence of additional impacts resulting from higher winter flows on the Peace River due to BC Hydro's upstream regulation of the Peace River.

9.6.3 Panel's Analysis

The Project would consist of constructing a major permanent structure that would block navigation on the Peace River. In addition to the effects of the dam site itself, BC Hydro determined that restricted navigation on the waterway would occur during construction for a period of approximately one year. The navigational use restrictions during construction would

impinge current navigation at the requested locations; however, the Panel understands that BC Hydro has reduced the level of restrictions originally requested. BC Hydro's updated proposed restrictions are 1.5 km downstream of the dam and 2 km upstream during construction. BC Hydro would also ensure at least one boat launch upstream of the dam site remains operational at all times during the construction phase as recommended by TC.

The Panel recognizes BC Hydro's commitment to construct the new boat launches prior to filling the reservoir. However, the Panel realizes that two would be blocked until deemed safe for navigation, as per the request of TC. The new boat launches at Lynx Creek and Hudson's Hope would open in Year 2 of reservoir operation and the new boat launch at Cache Creek would open between Year 2 and Year 5.

Although BC Hydro proposed other mitigation measures to alleviate the effects of the Project on navigation, the Panel believes that the construction of new boat launches and ensuring that they are available as soon as possible is the only mitigation measure that is designed to mitigate effects. The other proposed mitigation measures, such as plans, funds, and technical support, would be helpful in encouraging navigational users to adapt to the new conditions of the river if construction proceeds, but do not reduce the significance of effects. For some Aboriginal groups, it may even elevate the impact due to increased access to hunting and fishing areas.

The Panel takes note that BC Hydro has already consulted with regulators, including TC and regional and local governments, as to future locations of boat launches. Moreover, when consultations were done on the outdoor recreation valued component, the public indicated where they would like to see these launches. Based on further technical examination by BC Hydro, none of the sites were retained because locations would have to take into consideration stability of the banks of the reservoir and future impact lines.

BC Hydro's concept of the social context being resilient does not correspond to what the Panel heard at the hearing, particularly from Aboriginal groups. The Panel also has some difficulty in understanding the characterization of users as resilient considering BC Hydro completed no social analysis to verify the adaptability of users. The Panel believes that some users would not be able to adapt to new conditions based on how they interact with the river, for example, Aboriginal users who travel up and down the river for spiritual purposes or elders who currently access the river without a truck.

The Panel agrees with BC Hydro that there would be an adverse effect on navigation at the dam site because water-based navigation within the restricted navigational zones would no longer be permissible at this location. However, the Panel disagrees with BC Hydro's assertion that when construction ended, the waterway would be unaffected in terms of navigation.

The Panel notes TC's submission that the Project would consist of "substantial interference" at the dam site and that this definition hinges on matters of public safety or on changes to the way vessels pass down a waterway. The Panel heard from members of Aboriginal groups, and received confirmation from TC, that participants do go up and down the river and traverse the dam site. The Panel believes that for these users the effect would be significant and cannot be mitigated.

The Panel concludes that the Project would have adverse effects on navigation use of the Peace River but that they would not be significant because the river would still have be navigable above and below the dam site. The Panel further concludes that the loss would be significant for the small number of people who traverse the dam site.

TC requested that certain information be brought to the attention of the Panel. The Panel understands from BC Hydro that this information would be dealt with between these two parties during the approval process. TC also noted in its written submission that the recommendations would "assist with the development of the terms and conditions of the NWPA approval." In the understanding that the formal approval process would require the production of the necessary information, the Panel will not forward those recommendations made by TC. However, the Panel fully supports the requests made by TC for information needed on navigational restrictions and their overall impact and justification to public and Aboriginal use of the Peace River during the 7- to 8-year construction period, including clearing of debris and during reservoir filling and operation.

The Panel agrees with BC Hydro that it would be unreasonable to request the installation of a portage system for a 1.3 boat per day frequency. The Panel also acknowledges that building such a system would not be technically feasible.

The Panel is comfortable with the assessment of navigational hazards and floating debris. It believes that navigation around the debris booms is important and understands that BC Hydro would consider this in future discussions with TC and any risks to navigation after the first year post inundation period would be mitigated.

TC requested further information regarding the fish habitat compensation plan prior to permitting to allow for discussion on navigational implications. Although it is common practice to not develop the compensation plan until after receiving approvals, the Panel notes TC's concern that the compensation plan for fish and fish habitat could cause additional effects on navigation, depending on the form of compensation chosen.

The Panel understands from the Proponent's and TC's assessments of navigational effects of the Project at Tompkins Landing and Shaftsbury Crossing that no impacts to navigation would occur because the regulated flow would not change. The assessment concluded that, at Shaftsbury Crossing, the number of crossing days by ferry would increase and the number of ice bridge days would decrease; no changes are anticipated at Tompkins Landing. The Panel is confident in this assessment but cannot determine the potential effects on Aboriginal people consequent to the reduction of ice crossing days nor their delay in the season.

9.6.3.1 Cumulative Effects Assessment

The Panel heard the challenges raised by the Aboriginal groups as they related to the PAD. The Panel recognizes that they are happening now, likely caused by climate change, water withdrawals in the Athabasca River, dredging and weir construction in the PAD, and possibly regulation effects of the two previous dams, but would not be exacerbated by Site C. As concluded in Section 3.7.3, the Panel does not believe that the Project has an adverse residual effect on the water flows to the Peace Athabasca Delta (PAD), and therefore a cumulative effects assessment of the Project in combination with other past or future physical activities carried out on navigation in the PAD is not required in this environmental assessment.

The Panel recognizes that this Project pushes the flow regulation of the Peace River further downstream from the existing dams. The Panel understands that the adverse residual effects of the Project on navigation, which the Panel determines to be significant for the small number of people that traverse the dam site, stems from the fact that it is a permanent structure that impedes the ability to traverse the dam site.

Participants spoke of the impacts of the two previous dams to traveling up and down the river, and that the Project would create an additional impediment to navigation. Aboriginal groups recounted how they used to travel from the Parsnip and Finlay Rivers through the (now) Williston reservoir and down the Peace River. Although a portage was always necessary to avoid the previously existing rapids in the area now occupied by the Peace Canyon Dam and the Dinosaur reservoir, water-based navigation was possible from the Rockies to the Alberta border and beyond. Transport Canada confirmed that a navigable river may have sections not suitable for navigation.

The Panel accepts that another dam would further impede navigation on the Peace River. However, the Panel concludes that, because a lengthy portage was necessary even before construction of the two previous dams, the addition of a third dam does not result in a cumulative effect on navigation.

The Panel concludes that there would be no cumulative effects on navigation of the Peace River if the Project proceeds.

9.7 OUTDOOR RECREATION AND TOURISM

The Peace River valley is rich in history. The Alaska Highway is one of the factors that contributed to the opening of the Peace region to tourism and outdoor recreational activities. Hudson's Hope is recognized as the birthplace of guide outfitters in British Columbia. Rocky Mountain Fort site, built in 1794, was the first European settlement east of the Rockies. Although marginally visited compared to British Columbia's major attractions, the valley offers activities such as sport fishing, hunting, camping, canoeing and kayaking, cultural, wildlife and landscape touring, and visits to hydropower sites. In this section, the Panel will examine the potential effects of the Project on outdoor recreation and tourism.

9.7.1 Proponent's Assessment

BC Hydro assessed the Project's potential to adversely affect outdoor recreation activities during construction and operation by considering changes to managed and unmanaged outdoor recreation sites, trails, parks, and the Peace River and Boudreau Lake proposed protected areas. The assessment for potential effects on tourism infrastructure during construction considered effects on visitor centres, tourist accommodations, and tourist attractions. During operation, the Proponent used the same aspects for its assessment but added regional visitor levels.

Consultation with the public, Aboriginal groups, and government agencies identified issues, concerns, and interests that guided the scope of the outdoor recreation and tourism assessment.

9.7.1.1 Construction Phase

Taking into consideration proposed mitigation measures, the Proponent said there would be an adverse residual effect on outdoor recreation and tourism infrastructure during construction. Construction activities, specifically Site C reservoir preparation and filling, would result in 14 managed and 14 unmanaged recreation sites being permanently unusable. In addition, one campground on private property west of Cache Creek would be directly impacted by the Highway 29 realignment. The current shoreline of Alwin Holland Park would also be unusable for a short time during reservoir filling; however, the Proponent noted that funds would be provided to the District of Hudson's Hope for improvements to shoreline access.

The Project would also directly affect one tourism facility on private property and one hunting camp at the Site C dam site. Use levels in Peace Island Park would increase during construction, because access to other affected recreation sites on the Peace River would be restricted, including access to the Hudson's Hope boat launch (closed in Year 5) and the Lynx Creek and Halfway River boat launches (closed in Year 7 or just before reservoir filling).

Mitigation would eventually replace and enhance outdoor recreation infrastructure in the local assessment area (LAA) after reservoir filling. However, access restrictions on the Site C reservoir during construction would represent an adverse residual effect on outdoor recreation.

The Proponent said visitor and recreation user experiences along the Peace River between Hudson's Hope and Bear Flat would be altered, because construction would transform the setting from a river to a reservoir. The use of the Peace River would be restricted, the viewscapes would be altered from the agricultural-natural setting that now exists, and some outdoor activities would no longer be undertaken.

No commercial recreation tenures issued through the government's Adventure Tourism policy would be affected. BC Hydro plans to enter into agreements with the private property owners and the one commercial recreation business with Crown tenure, as appropriate, and no residual effects on tourism businesses were anticipated.

During construction, the Proponent said there would be a beneficial effect on levels of outdoor recreation use and regional tourism visitors, because new demand and spending on outdoor recreation and tourism infrastructure services would be generated by the Project. Business travel would increase, as would the volume of visitors coming to the area to stay with in-migrant friends and relatives.

9.7.1.2 Operations Phase

Although access to some parts of the Site C reservoir would be restricted, access to other sections of the reservoir, such as the west end, would be available for recreation and visitor use soon after reservoir filling. Usage levels of Peace Island Park would likely increase due to users seeking nearby recreational opportunities. New infrastructure would be constructed after debris clearing and slope stability monitoring in the first two years following reservoir filling. Water-based recreation opportunities were expected to increase on the reservoir compared to the base case, because the reservoir could support a greater variety of boats.

Overall, the Proponent determined that effects on recreation and tourism infrastructure during operation would be positive. It said the Project would result in a moderate increase in outdoor recreation use levels and would not place undue strain on existing recreation infrastructure in the Peace River Regional District.

9.7.1.3 Mitigation Measures

To address changes in outdoor recreation and tourism infrastructure during construction, BC Hydro committed a Community Recreation Site Fund to support the development of new shoreline recreation sites on the Project reservoir and on the Peace River and tributaries downstream of the dam site to the Alberta border. Because the dam construction may draw tourists to the area, BC Hydro would also provide south and north bank viewpoints of the dam construction. The north bank viewpoint would be permanent.

The Outdoor Recreation Mitigation Plan specifies opportunities for recreation infrastructure on the Site C reservoir, and provides direct support to other recreation providers in the region. Mitigation measures would partially mitigate effects on outdoor recreation and tourism infrastructure, but not the effects of the loss of 28 managed and unmanaged sites, and associated access closures and restrictions, that occur over the construction period and the early years of operation.

To support long-term planning for the new environment, BC Hydro would fund the development of a Navigation and Recreation Opportunities Plan. This process would enable interest groups to understand, plan for, and optimize new recreation opportunities created as a result of the Project

9.7.1.4 Determination of Significance

The Proponent said it anticipated a residual effect for outdoor recreation and tourism infrastructure as a result of construction activities. Outdoor recreation and tourism use is widespread across the region, due to opportunities created through the placement of transportation, parks, and activity infrastructure. BC Hydro determined there would be a significant effect if the Project altered access to recreation and tourism infrastructure in a way that reduces recreation use below baseline case conditions in the Peace River Regional District over the long term and proposed mitigation would not offset changes to baseline case conditions.

BC Hydro would provide replacement of boat launches and day use areas in the Site C reservoir, and would implement measures to support the District of Hudson's Hope and other community groups in developing new reservoir recreation infrastructure and sites. The Proponent said adverse effects on recreation infrastructure would be low in magnitude, and would affect site-specific areas within the local assessment area. For short periods during construction, or while new infrastructure is being developed, some recreation opportunities would be reduced. However, BC Hydro said the outdoor recreation experiences and opportunities available to residents and visitors would increase in the long-term because the reservoir would provide new recreation opportunities. Recreation users were expected access other recreation areas in the Peace River Regional District during construction. The Proponent said the residual effect on recreation and tourism during construction would not be significant.

9.7.1.5 Cumulative Effects

The Proponent said the only registered active project that would overlap spatially with the Project in the Outdoor Recreation and Tourism LAA is the Montney Gas Play, which would have a positive effect on road and trail access in the LAA. Therefore, the Proponent concluded there would be no cumulative adverse residual effects on recreation and tourism infrastructure in the LAA.

Applications for *Land Act* tenures, new oil and gas facilities, and forestry harvest plans and

tenures would overlap spatially with the Project activity zone and reservoir impact lines, but the Proponent said these would represent a continuation of existing baseline conditions. Oil and gas facilities approved by the Oil and Gas Commission are already included in the consideration of the Montney Gas Play. Range tenures issued by BC Ministry of Forests, Lands and Natural Resource Operations (FLNRO) represent a continuation of grazing activity for the region's livestock sector. Similarly, harvesting plans are typically a licence to cut regularly, issued under the terms of a licensee's forest tenure. Because outdoor recreation and tourism already interacts with these activities, the Proponent concluded there would be no residual effects in the LAA.

Population changes in the RAA due to the workforce requirements of reasonably foreseeable projects could increase demand for recreation in the LAA during the construction and operation phases of the Project. However, population projections for the region that were used in the assessment on demand for recreation consider the population effects of reasonably foreseeable projects. Therefore, the assessment of residual project effects considered the cumulative population effects of reasonably foreseeable projects during the construction and operation phases of the Project. Based on this, further assessment of cumulative effects of changes in recreation use levels and tourism visitor levels was not carried out.

9.7.2 Views of Participants

The Panel received information on outdoor recreation activities and tourism products related to existing and future business opportunities and tourist attractions in the region and the Project's potential impacts on those.

9.7.2.1 Existing Opportunities in Northern B.C. and in the Peace Valley

Information provided by the Tourism Branch of the Ministry of Jobs, Tourism and Skills Training said B.C. offers a competitive advantage over other places for the following reasons: it is a welcoming safe place; has untamed but also sophisticated areas; contains spectacular natural beauty; is a unique mosaic of culturally rich and vibrant communities; and can provide exceptional experiences. Specifically, northern B.C.'s tourism brand is focused on unspoiled landscapes and natural habitats and is aligned with the idea of Super Natural British Columbia.

The Tourism Branch identified specific tourism assets in the Peace region including touring, adventures, fishing, skiing, events, and golf. Northeast B.C. products are the Alaska Highway, local communities, outdoor adventure opportunities, and camping; local area products are scenery, parks, trails, wildlife viewing, and heritage assets. Within the Peace area, the Alaska Highway traveller was identified as the most critical visitor market. Tourists visit the Peace River valley, historical sites, and museums on their way to the Yukon or Alaska. The BC Ministry of Forests, Lands and Natural Resource Operations said visitor centers at hydroelectric facilities are definitely tourist attractions.

The Tourism Branch said the B.C. tourism industry generates $13.4 billion, annually, and northern B.C. generates 8 percent of this ($1.1 billion dollars). The North Peace Economic Development Commission said tourism in the north and south Peace is valued at $165 million annually. The existing tourism market in the Peace region is small but has a definite potential to grow.

According to the Tourism Branch, half of the tourists visiting northeast B.C. are Canadian and are mainly from Alberta and British Columbia. Americans also visit, coming mainly from Alaska, California, and Washington. Tourists also come from Germany and Switzerland. The typical

tourist in northeast B.C. is a leisure traveler (not travelling for business), over 55, and rarely tours with children. The peak season is May to September. Tourists are interested in sightseeing, nature viewing, visiting relatives/friends, hiking, and historical sites. Alaska Highway travellers are first priority for the Tourism Branch because they generate the most revenue for the local communities.

The 2005 study conducted by the Northern Rockies Alaska Highway Tourism Association asked travelers to list three unique and interesting characteristics for northern B.C. Scenery was the most popular response, followed by wildlife, history, and hospitality.

Although the Tourism Branch said there was no eco-tourism, outdoor recreational businesses, or guide outfitters in their listings it said that this did not mean that none are in the area; just that they are not accessing the marketing available through the Branch. Several guide outfitters participated in the assessment and attended the public hearing.

FLNRO said guide outfitters consider themselves to be sustainable resource use tourism businesses. The Tourism Branch said it has started working with guide outfitters to provide marketing support through the Experiences B.C. program. Guide outfitters are viewed as part of tourism in B.C. because they often attract high-end clients from outside the region.

North Peace Economic Development Commission said the majority of tourism in the Peace region is business related. A 2005 study conducted by the Northern Rockies Alaska Highway Tourism Association estimated over 300,000 visitors each year travel through the region. The Alaska Highway was noted as the major feature drawing tourists. Guide outfitting in the region was also noted to be in high demand for hunters from North America and internationally. The North Peace Airport’s exponential growth in passenger movements in 2013 has resulted in more competitive fares, which have made tourism operations in the region more accessible.

Tribal Chief Logan and Ken Boon said historical, agricultural, and cultural sites in the valley could form a structure to build tourism opportunities on. Highway 29 was discussed as a popular destination for a scenic drive with wildlife viewing opportunities, in addition to hunting, fishing, photography, bird-watching, and hiking. The Peace River valley was highlighted as an integral part of the existing circle route through Dawson Creek, Chetwynd, Hudson's Hope, Fort St. John, and Taylor. It is promoted as an attraction to travellers on the Alaska Highway trail, providing opportunities for businesses along the route.

Wayne Sawchuk operates an equestrian eco-tourism business for travel in the back country. He operates north of the Peace River, not actually within the Peace valley. His business attracts tourists from other parts of B.C., Canada and around the world. He confirmed that groups such as Tourism B.C. and Northern B.C. Tourism offer some assistance for eco-tourism.

Participants said areas of the LAA, for example Watson Slough, are popular birding locations and promoted by Tourism B.C. Ebird, a real-time, online birding checklist program launched in 2002 by the Cornell Laboratory of Ornithology and the National Audubon Society has listed Watson Slough as a birding “hot spot” in British Columbia.

9.7.2.2 Potential Project Effects

The Tourism Branch said the Project would not have an impact on any existing tourism-related river-based businesses. As for travellers in the region, it does not expect a change in clientele with the Project as a venue.

A number of participants expressed the local and regional importance of the existing recreation

and tourism infrastructure and opportunities in the Project area. Some felt that the Project's beneficial changes to outdoor recreation and tourism as described by BC Hydro were not beneficial. That is, the outdoor recreation opportunities that accompany the existing river setting were of greater value than those that would be supported by the reservoir setting. Mr. Peck of the Hudson's Hope Historical Society explained that the associated mitigation measures would not replace the current multitude of river-based opportunities. He also said that they could no mitigate the experiences for some of the residents of that valley who "can jump in a canoe and get out in the river and go down the river. Reservoir-based recreation will be totally different."

Many participants stated that a reservoir is not a lake. One said naming reservoirs as lakes is misleading, for instance the Williston and Dinosaur Lakes. He said that on a river, there are many opportunities to access the shoreline, while on Williston and Dinosaur reservoirs, access points are limited due to fragile shorelines.

One participant said the reservoir would be unsafe during winter because of flow regulation. From past experience, Mr. Kabush, a member of the Moberly Lake Community Association, said the reservoir in winter would be of limited recreation use. He said that it would be a trap for wildlife and people on ski-doos.

Treaty 8 Tribal Association questioned if people can afford to purchase boats to access the reservoir, given that activities previously carried out on the shoreline would not be possible on the reservoir shore, such as fishing. In response, BC Hydro said a jet boat would not be required to undertake fishing activities on the reservoir, which would support a wider range of small craft than the current river.

Mr. Paul Gevatkoff, representing South Peace Oilmen's Association, said there is currently no public access to the river between Hudson's Hope and Fort St. John and the reservoir would allow the public to access where currently there is none. In response, Arlene Boon, a resident at Bear Flat, said that they allow public access for fishing, hunting, canoe launch, and take out through their private land.

Transport Canada had concerns about the effects of the Project on navigation for tourism and recreational purposes, including adequate access to the river during construction and the reservoir during operation, and overly confined navigational restrictions during construction and operation. These concerns are addressed in Section 9.6.

The District of Taylor indicated that the loss of river access would lead to an increased use of Peace Island Park during and following construction.

The Outdoor Recreation Council of B.C. produces an annual Endangered Rivers List of B.C. rivers, which it considers to be most threatened from a recreational and environmental perspective. It is based on submissions received from supporters of the Council's group members as well as others in the province. The Peace River has been on the list since 2008. In 2013, the Council received over 200 submissions related to the Project and the Peace River. The concerns submitted by the recreating public regarding potential loss of outdoor recreation and other social opportunities included: detrimental impacts to fishing opportunities (changes in species available); degradation of canoeing, kayaking, and paddling opportunities; loss of hunting and trapping opportunities in the valley; loss of wildlife viewing and bird-watching opportunities; loss of camp sites in the reservoir area and islands in the river; flooding of fossil sites; loss of prehistoric sites with dinosaur footprints; flooding of the Rocky Mountain Fort site; and destruction of one of the most visually attractive and much-visited B.C. landscapes in the province.

Concerns were also expressed regarding the effects of the Project on the values associated with the proposed Peace-River Boudreau Lake Protected Area, including tourism and outdoor recreation values.

9.7.2.3 Potential Effects on Business

Hudson's Hope Historical Society said that the Hudson's Hope Historical Museum gets about 6,000 visitors each year. The strategic plan for the museum identifies the potential to increase that number through infrastructure improvements; however, there are concerns that the Site C impacts would interfere. Many visitors make the day trip to or through Hudson's Hope to enjoy driving the Peace River valley. The Society anticipated a decline in visitors due to the reservoir clearing and road construction because the alternate route via Dawson Creek would likely be selected by tourists rather than Highway 29. It disagreed with BC Hydro's view that construction would not prevent tourists travelling through Hudson's Hope.

The Society said outdoor recreation brings many museum visitors to the Peace River valley. It said BC Hydro's proposed mitigation to attract boaters through the construction of boat launch facilities at the reservoir would likely draw potential visitors to the museum. It requested support for development of features and exhibits that could potentially enhance a museum experience and partially offset access challenges.

Katherine Burseth provided her first-hand experience working at the Hudson's Hope Visitor's Centre, where she has heard many comments about the region's beauty. She said many tourists are not interested in touring one of the existing dams; they are interested in the valley and its unique features. She said that if the Project proceeds, Hudson's Hope would become a "backwater community" and that visitors would not want to come to the area.

BC Hydro said sport fishing would remain popular because the reservoir would offer increased opportunities. However, the North Peace Rod and Gun Club said there was little evidence to support future success of sport hunting. Most of their clients are regional and local hunters. There is an elite clientele for out-of-Province hunters. FLNRO did not provide any information on the challenges or continued success of this type of clientele.

High Prairie Outfitters and Tracks BC and Horseshoe Creek Outfitters Ltd. are two guide outfitting operations that would be affected by the Project. Horseshoe Creek Outfitters Ltd. said it draws international tourists to the region who have commented on the beauty of the area.

9.7.2.4 Cumulative Effects

Participants said the cumulative effects assessment focused on potential contributors at the local assessment area scale, whereas an appropriate assessment should identify effects from past, existing, and future projects on outdoor recreation and tourism opportunities within the RAA and evaluate the Project's contribution to this effect at the regional level.

Ken Boon, a resident of the valley, said the two previous dams had a "tremendous impact on tourism that could have taken place in the Rocky Mountain Trench section" and is now flooded.

9.7.3 Panel's Analysis

9.7.3.1 Change from a River to a Reservoir

Participants said there are a number of lakes in the area but the Peace River offers unique recreational experiences. The Panel asked about the difference between a lake and a reservoir

and the safety of users of a reservoir, assuming that conditions were like those of natural lakes. Testimonies were to the effect that a reservoir is not a lake and participants felt very strongly that reservoirs and lakes did not offer the same kinds of experiences to recreational users.

BC Hydro said the following outdoor activities would be supported by recreation sites in the LAA: camping, hiking, fishing, snowshoeing, boating (jet and other), birding, shoreline leisure, cross-country skiing, picnicking, dogsledding, and hunting. The Panel recognizes that these are the same outdoor activities that are available currently in the area.

The Panel understands that the region offers the lifestyle of a semi-rural area that attracts residents who can work and recreate in the same area. Residents see the advantages of being able to work and practice outdoor interests close-by, enjoying the river, the surrounding wildlife, and the natural beauty of the valley. Recreation is easily accessed by residents.

The Panel notes that since 2008 the Peace River has been on the annual list of B.C.'s most threatened rivers. The Outdoor Recreation Council of B.C. indicated what outdoor-recreation and other social opportunities would be potentially lost if the Project proceeds. The list represents input from supporters of the Council's group members as well as others in the province.

The Panel disagrees with BC Hydro that a reservoir can replace a river for recreational and tourism purposes. It would present a different environment offering different activities associated with a reservoir, not a river.

9.7.3.2 Potential Loss of Business and Opportunities

As pointed out by Treaty 8 Tribal Association, it is not clear what would be the effects on people without a powerboat (i.e. those that currently use shoreline access points to swim, fish, harvest plants/berries, or launch a canoe/kayak). The reservoir would have limited shoreline access, except for the three new boat launches and other foreseeable shoreline areas to be developed, which may result in congestion or avoidance of activities. This may affect tourism and recreational opportunities in the area. BC Hydro said people would have to adjust; however, for the Panel, there is no indication that these effects have been assessed.

The Panel considers that the loss of historical sites; the major changes to the landscapes; the limitations to wildlife viewing and bird-watching opportunities; the degradation of canoeing, kayaking, and paddling opportunities; and the loss of informal camp sites and RV sites would all contribute to the loss of the valley's attraction for tourists and outdoor enthusiasts. Other destinations offer these activities, some closer to urban centres. Because the valley is not a destination but mostly a stop-over, reduced diversity of its products and services can only result in rendering more fragile an already vulnerable market.

The Panel believes, if the Project goes ahead, that there would be a need for a renewed promotion of the valley because the current attractions present in the natural landscapes of a river, the presence of wildlife, and the access to heritage sites, would be altered. BC Hydro left the evaluation of historical sites to the Heritage Resources valued component. The Panel feels that it is an integral part of the attraction of a valley tour, en route to other destinations. Some valued sites would be lost to flooding, such as the Rocky Mountain Fort and the Rocky Mountain Portage House. These sites are discussed further in Section 12.1.

Considering the main stream of tourists through the area, the Panel believes that people would still go to Alaska and the Yukon and the area would still have business travellers due to natural resource development in the area, with or without Site C.

The Panel believes that, for individual operations, such as High Prairie Outfitters and Tracks BC and Horseshoe Creek Outfitters Ltd, there would be impacts as a result of the Project. However, other outfitters in the region, that have a similar clientele, would not be impacted by the Project and that tourists could still generally conduct the activities offered in the region by outfitters. However, the Panel considers each outfit offers unique products and that all should be encouraged.

FLNRO confirmed that the hydroelectric facilities and their visitor centres are attractions. Since BC Hydro was only proposing a viewpoint, the Panel feels that the viewpoint would have to be aligned with a marketing and promotional campaign for the region to obtain a plus value to other existing tourism products.

BC Hydro has proposed funding to encourage recreational opportunities once the Project is in operation. BC Hydro's current mitigation plan also includes funding to open new recreational sites. At present, the Panel can only wonder about the success of a potential local and emerging new tourist industry following the Project and believes that BC Hydro should consider conducting a market study to assess the potential success of the different opportunities proposed. However, the Panel believes that, while the opportunities for recreation would change, proposed mitigation would alleviate effects to tourists and recreational users. The Panel encourages BC Hydro to work with affected business owners to help them adjust to the new opportunities the reservoir may bring. The recommendation proposed by the Panel in Section 12.1.3 may help businesses like the Hudson's Hope Museum in this case.

Some managed and unmanaged RV sites and campsites with river access and boat launches would be unusable during construction and would all be closed for reservoir filling. The duration of this effect is long-term if the effects last beyond the construction phase. Even if some recreational facilities would be built in the future, the existing ones are gone forever.

People who used recreation sites rendered unusable by construction activities would need to go elsewhere to continue these activities. The Panel understands that BC Hydro's mitigation is designed to address this.

The Panel concludes that the construction period would have an adverse effect on outdoor recreation activities associated with the Peace River, but this effect would not be significant.

9.7.3.1 Cumulative Effects

The Panel disagrees that land tenures and the Montney Gas Play would have no residual effects on outdoor recreation and tourism in the region. While access may be improved in some cases, other areas would become restricted and any additional development would have effects on the opportunities for and the quality of outdoor recreation and tourism activities.

As mentioned in previous chapters, the Panel believes that participants have demonstrated that the region has been and is still being impacted by anthropogenic developments that most likely reduced the potential for outdoor recreation and tourism activities. Foreseeable projects combined with Site C would also further reduce outdoor recreation and tourism opportunities. The Panel notes that the region offers a variety of outdoor recreation and tourism opportunities and that while these experiences would change on the Peace River, opportunities for outdoor recreation and tourism would remain. The mitigation measures proposed for the Project effects would also alleviate some of the cumulative effects on this VC.

The Panel concludes that the cumulative effects on outdoor recreation and tourism would not be significant.

10 COMMUNITY LIFE

This chapter discusses how the Project may affect local community life, including potential adverse effects of the Project and potential benefits. The Project may affect demographics, housing, community infrastructure and services, labour markets and the balance of local government revenues and expenditures due to the influx of the Project-related workforce. The benefits of the Project for local governments and regional economic development are also discussed in this chapter.

10.1 POPULATION AND DEMOGRAPHICS

The Proponent stated that the Project demand for skilled labour during construction would exceed the local labour supply, resulting in an in-migration of workers that would change the local population and demographics.

10.1.1 Proponent's Assessment

The Proponent assessed the potential for the Project to affect population and demographics.

- Labour market predictions were used to assess demographic changes in the Peace River Regional District and specifically the City of Fort St. John;
- A modest out-migration of Aboriginal people from First Nations communities to non-Aboriginal communities in proximity to the Project was foreseen.

Although the projected population during construction would be above that forecast by BC Statistics, BC Hydro predicted that the annual increment would be positive in the first six years of construction (i.e. net in-migration) and negative (i.e. net out-migration) thereafter. Absolute change in the population was predicted to peak in Year 5 of construction, equivalent to a 2.2 percent (3.6 percent for Fort St. John) increase over the base case, a variability that the Proponent said would be comparable to the last decade. The magnitude for Fort St. John would be considered moderate because it is expected to receive a higher proportion of new residents; however, growth would only be slightly above its expected population growth without the Project.

BC Hydro stated that all effects would be reversible after construction. Because the area is a diversified economy with population growth rates comparable to the province, BC Hydro noted that if workers and their families stayed in the region or Fort St. John after construction, it would not be a Project-related effect but would be attributable to other economic or social causal factors, such as taking local employment.

The Proponent concluded that the probability of Project-related adverse effects on population and demographics was low because of the predicted high in- and out-migration levels and the numerous major development and construction projects in the region. BC Hydro could not accurately predict residual population effects on Aboriginal peoples and First Nations communities as a result of the Project. Although local procurement and employment opportunities may serve to maintain on-reserve populations, there may be some out-migration to be near the new opportunities.

Migration flows were noted as important because they dictate the timing of demand for community infrastructure and services. Although the local assessment area (LAA) population would increase temporarily with the Project, annual in-migration would not exceed the extreme

net migration levels between 1998 and 2006. Similarly, after the construction phase, out-migration is expected to be lower than recent levels.

The determination of residual effects was based on a comparison of the Project's labour requirements with historical and expected population and demographic trends from Statistics Canada and BC Stats. Cause-effect relationships between changes in the labour market and population are well understood and suitable for quantitative modelling. However, the Proponent acknowledged that there was uncertainty about where workers choosing to live in the LAA would actually reside. Further, BC Stats population forecasts were not available at a municipal level. Therefore, the confidence in this assessment and its predicted outcomes were medium.

The Proponent concluded that the Project's effect on population would not be significant for the following reasons:

- The population would change from baseline conditions, but the peak changes in Year 5 of construction and variability between 2014 and 2022 would not exceed recent experience in the LAA or Fort St. John. Fort St. John experienced a 13.8 percent growth between 2006 and 2011, equivalent to a 3.3 percent annual increase.
- The peak population effect attributable to the Project in Fort St. John would be 3.6 percent, but the duration of that peak would be measured in months, not years.
- The net effect of the Project on population would be to advance growth—by about two years in the LAA, and three years in Fort St. John—that is already forecast.

BC Hydro said that the mitigation measures proposed for the Labour Market, Housing, and Community Infrastructure and Services valued components (VCs) would mitigate population effects for Aboriginal and non-Aboriginal populations.

10.1.1.1 Cumulative Effects

The Proponent said that the Project would act cumulatively with any project that would affect the population in the LAA during the construction period. Population projections consider growth resulting from the anticipated expansion of economic and employment activity for the region.

The forecasted net in-migration included in the baseline forecast is about 400 persons per year. BC Hydro suggested that the cumulative effects of economic activity in the region, drawing permanent population to the LAA, are incorporated into BC Stats population forecasts for the Peace River North and Peace River South local health areas. Therefore, the Proponent concluded that an assessment of cumulative effects was embedded in the effects assessment for the Project. Additional consideration of projects in the Project Inclusion List for potential cumulative effects on population and demographics would likely result in double-counting; thus BC Hydro did not undertake a cumulative effects assessment.

10.1.2 Views of Participants

Treaty 8 Tribal Association requested the Proponent to further support its assessment of population and demographics by: a) identifying relevant case studies of the effects of large-scale construction projects, including hydroelectric development projects, on relatively small population regions; and b) providing a summary of impacts predicted and encountered, lessons learned, and any recommended mitigation and monitoring measures identified in the literature. Its rationale was that relatively small communities, particularly Aboriginal ones, in the region of the Project, would likely experience much greater cumulative effects of the Project than identified in the assessment. Further, it stated that the Proponent failed to consider the Project

effects on demographics, where the influx of primarily young male workers would likely result in especially adverse population dynamics.

The City of Fort St. John submitted that the Proponent's population projection in the Environmental Impact Statement for impacts upon the City was not reasonable and did not include the "shadow population" that occurs with large infrastructure projects. The City said that it was unreasonable to base the assessment of impacts to the City on a single, probably inaccurate, population projection. The City proposed that, because important socio-economic effects would be determined by actual workforce demographics and settlement patterns, a range of population scenarios should have been used to evaluate Project impacts. The City recommended that the Proponent be required to regularly monitor and report on actual Project workforce size, residency, and demographics.

10.1.3 Panel's Analysis

The Panel understands that the Project would increase the local population modestly during the construction period. The demographics of those migrating to the region to work on the Project would likely mirror other natural resource development projects (i.e. in-migrants would primarily be young, single males with considerable disposable incomes). While this would be most representative of the direct Project workforce, the indirect workforce would likely be more balanced, and would seek accommodation in the community as opposed to in the work camps. The Panel believes that BC Hydro's modelling was competent, and could easily be extended by the City to create different scenarios for sensitivity testing.

As suggested by the City, the Proponent could monitor the numbers of workers and demographics of the in-migrants to the region as a direct result of the Project during construction. However, it would be impossible for BC Hydro to determine the specific numbers and characteristics associated with indirect and induced employment as it would have no right to ask non-employees for information. Furthermore, the concurrent expansion of other resource development activities would also contribute to population change, generating an attribution problem that would be difficult to resolve.

Regardless, the more important consideration is how the population increase and demographic changes would affect local activities and demand on social services in the region. These related effects are considered below.

The Panel concludes that population effects would be primarily limited to the construction phase of the Project, when modest increments to the local and City population would occur. Because most of these effects would be limited to the construction phase, the Panel concludes these effects would not be significant.

While the Panel does not offer any recommendations related to population, it does include recommendations to address the resulting socio-economic effects elsewhere in this report.

10.2 HOUSING

10.2.1 Proponent's Assessment

BC Hydro assessed the effects on housing in the Peace River Regional District (PRRD) and in nearby Aboriginal communities by taking into account potential changes in the following key aspects:

- Existing demand for housing, with specific reference to the City of Fort St. John;
- Effects of the Project on the labour market and hence on population and demographics, used to assess the incremental effects on housing; and
- Specific plans by BC Hydro to provide worker accommodation for all direct workers at the Site C dam site, with the ability to scale up the capacity if required.

The Proponent concluded that housing effects would result from direct workers who would live in the community (and not in the on-site camps) and from in-migrants taking indirect and induced employment opportunities in the local assessment area (LAA). The Proponent estimated the total increase in households to be 133 in the first year of construction, peaking at 713 by Year 5, and declining to 226 in the final year of construction before returning to non-Project conditions. It predicted incremental growth to be greatest in Year 1 and Year 5. The Proponent estimated that 90 percent of in-migrating workers would choose to reside in the North Peace, mainly in Fort St. John, the District of Taylor, and Area C of the PRRD.

10.2.1.1 Owned Housing

The Proponent said that if the employment period was more than one year, people would choose to purchase housing. In the Fort St. John area, the increased demand for owned housing was estimated to average 155 residences from 2014 to 2022, with a peak demand of 233 units in 2019 (Year 5). The number of available houses would average 288 during the construction period, with an estimated 292 in 2019. The Project effect on the owned housing market was expected to be positive, as it would create more balanced market conditions. Moreover, the Proponent concluded that Official Community Plans in all communities indicated subdivision space would be available to accommodate expected growth. Conditions that might signal a potential housing shortage during Project construction (i.e. low inventories, low listing activity, and low levels of new building activity) were not projected to be evident in the Fort St. John area or the PRRD.

10.2.1.2 Rental Accommodations

Given the variability in the rental housing vacancy rate over the last five years, a low-vacancy period, resulting in a rental market imbalance, would likely occur during the course of Project construction. Unlike the owned market, the rental market would be vulnerable to rent pressures if vacancy rates were below nine percent. Based on the Proponent's analysis, there would likely be apartment shortages, indicating potential adverse Project effects on rental prices. This effect would apply to both Aboriginal and non-Aboriginal renters in Fort St. John.

10.2.1.3 Temporary Accommodations

The Proponent indicated that there would be sufficient temporary accommodation to handle Project demand, which could serve as a contingency option should shortages occur in the apartment rental market. As such, there would be no adverse effects on the temporary accommodation market.

10.2.1.4 Non-Market Housing

Increased demand and possible shortages would be expected for low-income families, the homeless, and those needing transitional housing. Given the size and public awareness of the Project, the Proponent predicted an increased number of people coming to the region, resulting in a higher demand for emergency and transitional housing facilities in the City of Fort St. John during the construction phase. With the expansion of bed availability with the redevelopment of Cedar Lodge by the Salvation Army, shortages of emergency and non-market housing may not occur. The Proponent believed the Project would not have an adverse effect on non-market housing.

10.2.1.5 Mitigation Measures

The Proponent proposed on-site and off-site mitigation measures for effects to housing, including worker transportation where numbers warranted. Details are provided in Appendix 9.

Even with the application of mitigation measures, the Project would likely create a rental unit shortage and contribute to an imbalanced market, an effect concentrated in the City of Fort St. John. Project demand for rental housing that causes the apartment vacancy rate to move below 4 percent for more than six months would be considered by the Proponent to be a significant adverse effect. The Proponent concluded that it is uncertain whether the threshold vacancy rate would be exceeded. Yet, in consideration of the anticipated short duration and low magnitude, the Proponent further concluded that the Project effects on housing would not be significant.

10.2.1.6 Cumulative Effects

The base case projections for labour market and population include the future effects of major development projects in the region. The Proponent stated that residual project effects of housing already account for overlaps and interaction with these projects, and therefore reflect potential cumulative effects. Thus, the Proponent did not undertake an assessment of cumulative effects on local housing because that would represent a double-counting of Project residual effects.

10.2.2 Views of Participants

The City of Fort St. John identified housing for the construction workforce as an issue of major importance. Considering the cumulative impacts from other natural resource development activities in the region, the City said it is already challenged in addressing numerous housing market issues and that the Project would exacerbate them. The City felt that the Proponent had not sufficiently addressed these current and ongoing cumulative effects on housing. In general, the City felt that BC Hydro was underestimating the Project impact on the housing market, including home ownership, affordability, the rental market, and temporary accommodation. The City noted that the Project, coupled with the potential for other major industrial projects in the region, could result in serious housing challenges in the foreseeable future.

The City pointed out that, within its highly constrained boundaries, there was only enough land for a few years of supply of new housing. It hoped BC Hydro would assist in persuading the provincial government to act on the City's request for a boundary expansion.

The City of Fort St. John also felt that BC Hydro should encourage the construction workforce to live in existing communities rather than in temporary camps outside the municipalities. The aim would be to reduce the number of transient workers and foster a workforce that would be committed to living in the Peace region. The City proposed that the Proponent develop only one

temporary worker camp, not two, and locate it within city limits to maximize potential long-term benefits to the community. The City also said the housing units that the Proponent would fund was an arbitrary number and not reflective of the amount required to fully mitigate the effects of the Project on housing availability and affordability. The City said this number could only be determined through monitoring of housing for the duration of the Project construction.

Treaty 8 Tribal Association (T8TA) said the Project effects on housing would likely be more significant for Aboriginal people, both on- and off-reserve, something the Proponent had not adequately addressed. Aboriginal groups noted that BC Hydro's housing analysis was based on a general market perspective rather than the impact on poorer, marginalized, and vulnerable sub-populations, which, in the PRRD, disproportionately consists of Aboriginal people. T8TA also said the potential for housing pressures in Fort St. John, due to in-migration and inflation, could force people to move back to home reserves and exacerbate pressures on reserve housing and increase homelessness for Treaty 8 First Nations.

Some landowners who would be displaced as a result of the Project submitted that the Proponent's approach for mitigating property loss would be insufficient. The Proponent's approach was to compensate owners based on fair market value. Affected landowners noted that important non-market factors associated with housing were not incorporated into this compensation.

10.2.2.1 Municipal Recommendations

Local municipalities requested that the Panel recommend the following requirements of BC Hydro related to housing concerns:

- Develop new housing analyses using alternative population forecasts developed by the City, and present these results and new mitigation measures to all communities affected. This should be the first requirement placed on BC Hydro, and the following ones reviewed in the context of these new forecasts.
- Prepare a plan for minimizing impacts on the rental market such as availability, affordability, and livability.
- Work with the City in developing innovative, energy-efficient housing and neighbourhood planning to encourage the best use of the City's limited land-base for residential development.
- Develop mechanisms, including shift arrangements and worker housing compensation packages, to ensure that the majority of the construction workforce lives in temporary camp accommodations.
- Provide more direct involvement in the provision of ownership and rental housing.
- Continue the dialogue that began in early 2013 and follow through on its commitment to work with a local organization and provide 40 mortgage-free new housing units in Fort St. John.

10.2.3 Panel's Analysis

Evidence from other places experiencing rapid growth due to resource development activities shows that local inflation of housing prices, and cost of living generally, is highly likely. For Project workforce and oil patch employees, these increases would be offset by the typically high wages earned. However, there is a danger that present residents at the lower end of the income distribution might experience real difficulties.

Considering the mitigation commitments presented by BC Hydro to address housing issues related to the Project, the Panel is satisfied that there would not be significant adverse effects on housing solely as a result of the Project.

However, what concerns the Panel is the potential for significant cumulative effects on the housing market resulting from the labour demands of the Project combined with those of other major activities in the region. Housing can become so scarce and expensive that those whose wages are not directly tied to resource development sectors, such as teachers, medical practitioners, other essential social service providers, and lower-wage workers or disadvantaged populations, can find themselves unable to afford suitable accommodations.

The Panel considers that the limited availability of land for community development in Fort St. John is already generating a housing affordability problem. The Proponent, along with other corporate developers, would need to work with the City of Fort St. John to find effective solutions, but the problem is not theirs alone.

The contrast of the City boundaries with the expansive boundaries of Hudson's Hope could not be more striking.

RECOMMENDATION 26
The Panel recommends, regardless of whether or not the Project proceeds, that the Province give sympathetic attention to an extension of Fort St. John's municipal boundaries so that contiguous urbanizing areas, plus a reserve, are brought within the planning, service, and taxation ambit of the City's government.

10.3 COMMUNITY INFRASTRUCTURE AND SERVICES

10.3.1 Proponent's Assessment

The Proponent determined that interaction between the Project and community services and infrastructure would be expected during the Project construction phase, due to:

- Changes to population associated with direct and indirect workers and their families living in local communities (primarily Fort St. John and area) and the new demand created for community infrastructure and services; and
- Change in demand from the on-site camp workforce's use of community infrastructure and services.

In addition, the Project was predicted to displace specific existing local government infrastructure along the Peace River.

The Proponent assessed Project-related effects on local community infrastructure and services only for the construction phase. The Proponent indicated that there would be negligible direct use of infrastructure and services by the Project workforce during operation and there would be no further physical changes to infrastructure after inundation that could not be addressed with standard measures.

The results of the assessment of the Project on population and demographics were used to evaluate the potential to adversely affect community infrastructure and services, taking into account potential changes to the following key aspects:

- The demand for, or provision of, health and social services emergency, education, and community services and facilities (including recreation and leisure facilities, solid waste management facilities, sewer and water infrastructure);
- Specific displacement or effects to infrastructure, such as sewer and water systems; and
- The demand for services and facilities on Aboriginal peoples and communities on- and off-reserve.

The Proponent expected the Project would create additional demand in areas where there are currently wait-lists to access health and social programs and services, and where Northern Health experiences challenges in recruiting health care specialists. However, the Proponent planned to provide services in its work camps to reduce demand. Otherwise, adaptive management currently in place in northeast British Columbia to address the recent rapid population growth there was expected to function well. In other words, Northern Health and other area service providers would experience effects similar to those resulting from major development projects in oil and gas, forestry, and mining in recent years.

The increased demand on the region's community infrastructure and services would happen, even without the Project. BC Hydro predicted that the Project would advance the expected population growth and the associated increased demand on infrastructure and services by approximately two years.

Each service area has specific governance and funding structures. For example, education, health, and social services were described as primarily provincially funded, whereas sewer, water, and fire services were noted to be funded primarily at the local government level. Policing is funded by all three levels of government. Population increases induced by the Project that would affect provincially funded services would be met by provincial budget planning. The provision of forecast and actual labour information specific to the Project would help these agencies plan for the projected increases. For example, Northern Health would be expected to plan for increased service levels in consideration of Project-related new permanent residents and on-site workforce.

The Proponent said that advancements such as the First Nations Health Authority are addressing existing conditions in Aboriginal communities, which in any case are not the result of the Project. The Proponent noted the potential for Impact and Benefit Agreements with Aboriginal groups as a means for these communities to address their Project-related infrastructure issues. The Proponent committed to continue working with Northern Health and other provincial agencies to plan for and support the provision of services in local communities, including mental health services. It also committed to building health services at the Project site and worker camps.

While recognizing that planning for education resources and facilities in the province is the domain of the Ministry of Education, the Proponent committed to working with School District (SD) 60 to help it plan and adjust to anticipated changes in the school-age population and related matters. At the request of SD 60, the Proponent also made two years of funding available to local school districts, including Peace River North SD 60, Peace River South SD 59, Fort Nelson SD 81, and First Nations Chalo School, to provide for a career counselor to keep youth in schools and to facilitate their transition into the workforce and trades training.

Project-induced population increases would also result in a higher local tax base, which would support local governments in increasing service levels. The Proponent would continue discussions with local governments on agreements that would include consideration and mitigation of specific Project-induced effects on their communities. Where the Project would displace or impair the functioning of municipal infrastructure, appropriate measures would be implemented to maintain the functionality of these systems, including emergency, education, and community services and facilities. For example, the Proponent committed to remediating the 85th Avenue borrow pit site to enable its future use as light industrial land, as the City of Fort St. John requested. The Proponent also committed to discussing disposition of the property with the City.

Project effects on policing would be based on population, as well as the Project's increased use of roads and the presence of the camp population. The Proponent would provide additional funds to support incremental policing requirements; to that end, an arrangement has been made with E Division of the RCMP to second an experienced planning officer for a year. The Proponent stated that mitigation measures to address Project-induced effects on community infrastructure and services would also address related issues identified by Aboriginal groups.

In consideration of the proposed mitigation of effects, the expected population growth in the region without the Project, the limited duration of Project-induced effects, and Northern Health's experience in managing recent similar changes in demand for health and social services, the Proponent concluded that the adverse residual effects on community infrastructure and services would not be significant.

10.3.1.1 Cumulative Effects

The Proponent noted that the cumulative effects of projects drawing permanent residents to local communities are incorporated into BC Stats population forecasts of the North Peace and South Peace Local Health Areas by including population from specific known projects. These forecasts are used by service providers and account for continued growth in the region for the foreseeable future due to economic activity of the Project. As such, the Proponent stated that an assessment of cumulative effects on community infrastructure and services was embedded in the effects assessment for the Project. Additional consideration of other projects for potential cumulative effects would result in double-counting, and therefore the Proponent did not undertake a separate cumulative effects assessment on community infrastructure and services.

10.3.2 Views of Participants

Northern Health and local municipalities described how recent major development projects in oil and gas, forestry, mining, and energy caused considerable population growth, both resident and transient, in the region and ongoing challenges in adequately meeting the rapidly increasing demands on community infrastructure and services. The City of Fort St. John said the large increase in resident and transient populations already strains their health, policing, and emergency services and associated infrastructure.

Ms. Penny Gagnon of the Fort St. John Child Development Centre said the number of clients that it served increased from 771 in 2011 to 1,208 in 2013 but that there had not been an appreciable increase in staffing levels. She said that the short- and long-term impacts of Site C on non-profit services in Fort St. John were not known and that BC Hydro has underestimated the number of children and families the Project would bring. She said that child and family services were already strained in the region, and that as a non-governmental organization, there was a danger of this essential service being overlooked by official agencies.

The City of Fort St. John did not accept the Proponent's conclusion that "no monitoring or follow-up is required" and suggested that an ongoing independent monitoring program be implemented to gauge changes in effects on community infrastructure and services during the Project construction. The City suggested that a condition of the Project advancing should be that the Proponent would provide sufficient funds to support local community services if the independent monitoring determined the need.

Regarding the 85th Avenue Industrial Lands, the City of Fort St. John recommended that the Proponent be required to develop a reclamation plan, including appropriate grades, servicing, road network, and accessibility from adjoining roads, to the satisfaction of the City and Regional District. The City also recommended that the Proponent be required to return the land to the market (by lease or sale) for light industrial development as soon as practicable after it is no longer required for Project construction.

The City disputed the Proponent's view that increased local tax revenues would cover Project-related growth in community service and infrastructure demands. The City provided an analysis of the portion of increased costs that would not be recoverable from taxation or user fees applicable solely to the Project-related population growth, together with a determination of costs that should therefore be paid by the Proponent.

The City iterated the Proponent's assessment that "own source taxation to local government would increase" to cover growth in community infrastructure and service demands but found that was inaccurate. The City provided an analysis of what portion of the costs would not be recoverable from taxation and user fees applied to the Project-induced population growth, as well as a determination of costs that need to be compensated by the Proponent.

The City noted that the Project's effects on the local microclimate might result in increased stress on municipal infrastructure, citing, as examples, increased extreme precipitation events overloading storm and sewer systems, or increased fog hours affecting local road and air transportation. The City submitted that microclimatic effects on City services and infrastructure costs due to the reservoir operation must be monitored and mitigated, if detected.

The Electoral Area 'C' of the Peace River Regional District (PRRD) identified additional specific mitigation measures to address concerns of its residents about adverse effects that the Project would have on community infrastructure and services.

All municipalities and rural communities in the PRRD argued that an agreement between the Proponent and the local communities would be required as a condition of the Project being approved. This agreement should include specific mitigation and compensation efforts to address the concerns about the Project resulting in additional stress on community infrastructure and services that are considerably challenged to meet growing demands. Several municipalities and the PRRD promoted the concept of a Peace River Basin Trust (based on the Columbia Basin Trust model) to develop and deliver programs and initiatives that support the long-term economic, social, and environmental well-being of the region impacted by the existing Bennett and Peace Canyon Dams and the Site C Project.

School District 60 raised concerns about increased pressure on the school district's capital and operating demands that the Project may induce.

Treaty 8 Tribal Association (T8TA) said that the assessment of Project effects on community infrastructure and services did not reflect the magnitude of potential adverse changes specific to Aboriginal groups, both off- and on-reserve. For example, T8TA requested that the Proponent

assess the potential for a large influx of young men into a relatively small community to affect the health, safety, and quality of life of Aboriginal people both on- and off-reserve.

Aboriginal groups noted that the mitigation measures to address Project effects on community infrastructure and services have not adequately addressed specific concerns of Aboriginal communities. Moreover, it was noted that there is strong evidence, from Treaty 8 First Nations' experience and that of many other Aboriginal groups, that reduced cultural practices and ability to meaningfully practice Aboriginal and treaty rights can, and in many cases does, lead to cascading significant adverse impacts at the societal, culture group, family, and individual level. These can lead to considerable demands on health and social services. Treaty 8 Tribal Association said that the Proponent did not include a consideration of these cascading effects on Aboriginal well-being in a meaningful way, despite the extensive information submitted about reliance on the land by the Treaty 8 First Nations for socio-cultural well-being, and evidence of high vulnerability of the nations to further social and cultural loss.

10.3.3 Panel's Analysis

The Panel agrees that population growth as a result of Project construction would increase demand for community infrastructure and services. Given the funding provided in municipal agreements, timing remains a potentially outstanding issue for ensuring certain capital improvements to community facilities and infrastructure are in place before the Project-induced population growth occurs. For the City of Fort St. John, a major challenge would be its limited lands available for development of community infrastructure.

Aboriginal Affairs and Northern Development Canada is unlikely to provide funds in a timely way, and the *Indian Act* imposes difficulties regarding the raising of own-source revenues for community infrastructure and services. BC Hydro said during the hearing that Impact and Benefit Agreements with Aboriginal groups can include measures to address health and social service issues arising from the Project. In this circumstance, these agreements would be particularly important in mitigating potential effects on community services and infrastructure for Aboriginal groups.

For impacts to First Nations communities as expressed by Aboriginal groups, the Panel believes that the effects from population increases on their services would likely depend on how many migrate to live on-reserve. The Panel believes this is likely to be a small number.

With respect to concerns raised by the City of Fort St. John, the Panel believes that there would be a modest growth in local population as a result of the Project, which would have an inherent increase in demand on infrastructure and services, but that, with the mitigation measures BC Hydro has proposed and the forward-thinking of the region with respect to expansion, this increase is manageable.

The Panel has no evidence that the microclimate effects of the Project on municipal services would be likely or even measurable in the sense of being distinguishable from normal variations or general climate change. The Panel determines that microclimate effects would not be a residual effect as a result of the Project.

The Panel expects that, similar to the agreements entered into for other municipalities, the City of Fort St. John and BC Hydro will come to a consensus on Project-related impacts to the City.

The Panel concludes that the general stress on community infrastructure and services caused by the Project could be managed with sufficient resources. The Panel is confident that mitigation in the form of additional resources would be provided by BC Hydro and appropriately managed by the communities (including municipalities) such that effects would not be significant.

RECOMMENDATION 27
The Panel recommends that, should the Project proceed, BC Hydro be required to include in its agreement with the City of Fort St. John expenses for Project-related costs of child and family welfare services.

10.4 EMPLOYMENT, LABOUR MARKETS AND LOCAL RESIDENTS

The potential labour supply for the Project would be Canadian workers with the required skills and occupational training. Labour demand corresponds to the number of skilled positions at the required time to build and operate the Project, plus supplier demand (indirect) and consumer (induced) activities supported by Project expenditures.

10.4.1 Proponent's Assessment

The Proponent assessed the potential for the Project to affect the labour market considering the following:

- The Project's need for labour relative to the expected availability and types of skills of the persons in the local assessment area (LAA) defined as the Peace River Regional District plus the Northern Rockies Regional Municipality, together known as the Northeast Development Region;
- The indirect project employment calculated using the British Columbia Input-Output Model; and
- A comparison of the Project labour requirements against the baseline and forecast local labour supply and demand by skill category where the data are available.

These changes were assessed with respect to the construction phase only, as the Project's effects on the labour market during operation were predicted to be negligible. Mitigation measures were proposed to address potential imbalances in the labour market induced by the Project.

Project construction would require qualified persons to meet volume, skill, and scheduling requirements. The labour force in the LAA has most of the skills that suit the Project's trade needs. However, forecasts indicate that, due to the continued expansion of natural resource development activities in the region, there would likely not be a sufficient supply of suitably qualified individuals. BC Hydro predicted that this could affect businesses in the LAA who could lose workers to the Project, or who could face increased competition for hiring or retaining workers. Labour shortages could also slow construction of the Project and increase its costs, as well as the costs of other projects in the region.

To address the challenges of meeting the Project's own labour demand, the Proponent suggested the following measures:

- Recruiting workers from outside the region, and
- Enhancing the local labour market participation rate and skill level of the population in the LAA, primarily through training and skills development, including specific programs focused on Aboriginal people.

The Proponent noted that unemployment rates in the Aboriginal sub-market have been historically higher. The increased demand for labour stemming from the Project's construction phase, combined with training and skills development programs, would be aimed at providing new opportunities for Aboriginal persons in the region. However, the Proponent acknowledged that targeted measures would be needed to provide a fair and equitable pathway to accessing these opportunities.

The Proponent concluded that, with the implementation of the proposed mitigation measures, the Project would maintain balance (or not exacerbate an imbalance) in the local labour market and would offer fair and equitable access to Project employment opportunities for the Aboriginal labour force in the Project area. Therefore, BC Hydro concluded that the Project would result in no adverse residual effects and might enhance local skill profiles and labour participation rates, including those of the Aboriginal population in the Project area.

A cumulative effects assessment was not conducted as no residual effects were anticipated, and no monitoring or follow-up was proposed.

10.4.2 Views of Participants

Treaty 8 Tribal Association (T8TA) noted that the Proponent's aggregation of the general population in its assessment, rather than disaggregation of Aboriginal and non-Aboriginal people, resulted in an inaccurate depiction of the present socio-economic status, including employment capabilities of Aboriginal people in the region.

Treaty 8 First Nations (T8FN) said that it is unlikely that the Proponent's proposed mitigation measures would do more than provide a very small increase in the number of T8FN members who are able to take advantage of the employment and economic benefits of the Project. T8FN believed that the mitigation plans would be inadequate to even marginally "level the playing field" for employment and procurement competitiveness for regional Aboriginal peoples. For example, the training and educational supports for Aboriginal people provided by the Project, though an improvement over the historical efforts made by BC Hydro, would be insufficient to overcome the current systemic barriers to employment of Aboriginal people. In general, T8FN said Aboriginal people are less likely to have the educational backgrounds, employment history, training certifications, capital for investment, transportation, and business experience to take advantage of Project opportunities when compared with their non-Aboriginal counterparts. Aboriginal groups maintained that there is little evidence that the Proponent's mitigation measures would facilitate meaningful long-term economic development opportunities for Aboriginal people. Without proper mitigation, including appropriate supports from the provincial and federal governments to address the systemic training, education, and employment barriers, the Project would likely contribute to a continuation of persistent socio-economic deficits for both on- and off-reserve regional Aboriginal people.

Treaty 8 First Nations said that the long-term operational employment opportunities associated with alternative energy portfolios would likely be considerably greater than those of the Project and that these long-term employment opportunities were their priority. T8FN stated that short-term construction jobs are already plentiful in the region with current natural resource developments, jobs that are prone to boom-and-bust cycles and typically do not provide

dependable, sustainable economic benefits for Aboriginal people. T8TA said that the provision of only 75 operations jobs, of which only 25 would be located in the region, would not address the need for long-term employment identified by the First Nations. The employment from the Project would consist almost entirely of short-term labour, service, and contracting positions with subcontractors to large civil engineering firms with no real long-term skill development or sustained employment for T8TA members.

The Peace River Regional District and local municipalities submitted concerns regarding the considerable uncertainty surrounding the potential for cumulative effects on most valued components (VCs) and the ability of regulators and agencies to effectively address the rate of development in the region. They noted that this uncertainty translates into a difficulty to forecast future labour market and employment conditions. As a result, they claimed that the Proponent's assessment would likely not be accurate, and absent any monitoring and adaptive mitigation plans in place to address employment and labour market issues, there would be considerable risk to the residents in the region of not accruing the potential employment benefits of the Project.

Municipalities and Aboriginal groups frequently noted their continued skepticism that the mitigation measures to address the issues related to the Project-induced effects on the labour market would result in positive outcomes for long-term employment and economic benefits to the communities in the region. While municipalities recognized the potential construction-related benefits, the primary concern was that the Project would contribute considerably to a regional short-term boom in labour demand without resulting in more sustainable and stable employment levels that communities need.

10.4.3 Panel's Analysis

The Panel notes that, due to the rapid expansion of natural gas and other resource extraction industries in the region, there are currently abundant local employment opportunities. As noted by participants, the region is competing in the same labour pool as that found across northern B.C. and Alberta. Labour shortages are common, and finding qualified workers in many employment sectors is difficult. Local businesses are thriving, and an increasing diversity of goods and services benefits both consumers and job-seekers.

If the Project is to produce any beneficial outcomes for the local labour market, the Proponent would need to pay careful attention to ensuring local Aboriginal and non-Aboriginal people were well-trained and well-placed before contractors posted positions. A considerable challenge to ensuring local residents were meaningfully employed through the Project activities stems from whether the Proponent could work with provincial and federal governments in a timely manner to ensure the educational and training supports are accessible to those who wished to pursue these positions. If the Proponent and government agencies are not able to set up appropriate supports in time, then most jobs would likely be filled by recruits from out of the region with little benefit to local residents.

In reaching its conclusions on employment, labour markets, and local residents, the Panel considered the following factors to be relevant:

- The current unemployment rate in the region of 3.6 percent.
- The overlap in demand for trades from the oil sands, coal mining, gas well development and servicing, pipeline construction, and transportation.
- A large new project in the region requiring many workers from other parts of the country.

- The active measures proposed by BC Hydro to train local, especially Aboriginal, people.

The Panel concludes that the Project would further tighten a labour market where the unemployment rate is only 3.6 percent, and that it is in everyone's interest to ensure that local Aboriginal workers are as well-equipped as possible to compete in that market.

The Panel further concludes that, with the implementation of the proposed mitigation measures, there should be no significant adverse effects on the labour market.

RECOMMENDATION 28
The Panel recommends that, if the Project proceeds, BC Hydro must work with training institutions to focus on employment in indirect and induced sectors for Aboriginal workers, as these jobs are likely to be longer lived than those related strictly to construction.

10.5 LOCAL GOVERNMENT REVENUE

The Project's use of, or effects on others' use of, land, services, and infrastructure could affect local government revenues and expenditures. Positive changes in local government revenues and expenditures are valued by local residents. Federal and provincial governments would also receive revenues in the form of income taxes, consumption taxes, or water rentals, some of which may be transferred to local governments.

10.5.1 Proponent's Assessment

BC Hydro assessed the potential effect on local government revenues and expenditures during Project construction by considering how the demand for local government services and infrastructure would be influenced by the timing and magnitude of Project-related activities. These factors reflect population increases (see Section 10.1) and the ability of local governments to raise new revenue. In addition, the physical change to land use would affect existing property taxes as well as costs to develop local infrastructure.

The Proponent used the British Columbia Input-Output Model to assess the economic impact of the construction and operation of the Project and to evaluate potential population changes in local communities, focusing on Fort St. John. The potential population increases and changes to local employment participation rates caused by the Project during construction were then used to derive potential changes to local government revenue and expenditures.

As noted in Section 10.2, the Proponent recognized that Project workers would come to the area and might choose to live in the local communities, despite the availability of rooms in the construction camps. Others would settle in local communities, primarily Fort St. John and the surrounding area, during construction to fill indirect and induced positions. Local governments may experience increased costs related to meeting the demands of new residents and Project workforce camp populations. BC Hydro stated that infrastructure might be overloaded, leading to increased local government expenditures, and identified mitigation measures to address these effects.

BC Hydro stated that new residents in local communities would add to property tax revenues. Increased taxes paid to local government by supplier and induced industries would also improve

revenues. The Proponent indicated that most of the increase in local government taxation revenues would accrue to the City of Fort St. John where the majority of the Project-induced population growth was expected to concentrate.

Private land that would be inundated by the Project would result in a small loss in the assessable property tax base at the time of reservoir filling. These lands would then no longer require municipal services. The Proponent agreed to provide $160,000 to the District of Hudson's Hope to address this land loss.

BC Hydro concluded that no adverse residual effects on local government revenue would be anticipated following mitigation.

10.5.2 Views of Participants

The City of Fort St. John argued that BC Hydro did not complete sufficient analysis to identify and quantify the direct financial impacts that would be experienced by the City during construction of the Project. The City disagreed that there would be no net costs, even with the proposed mitigation measures. Each of the municipalities and the Peace River Regional District (PRRD) submitted a number of concerns and possible approaches to addressing the potential financial impacts of the Project on the community. Most concerns were related to the costs associated with the growth and demand for community infrastructure and services.

The City of Fort St. John stated that it would expect the Proponent to provide the City with a mandatory annual grant-in-lieu to help offset increased servicing costs associated with accommodating the construction and operation workforce, as well as other Project-induced effects. The Proponent replied that its Agreement with the PRRD aims to address many of the fiscal concerns noted by the City of Fort St. John and other municipalities. The benefits that would accrue from this Agreement would be in addition to any taxes and payments-in-lieu of taxes that may be paid by BC Hydro to municipalities in relation to the Project. The benefits would also be in addition to community-specific agreements that may identify mitigation measures for specific effects of the Project as determined by the Environmental Assessment Process.

The City concluded that the mitigation measures proposed by the Proponent would rely on detailed monitoring, management, or mitigation plans that have not yet been developed. The Proponent committed to "working with" or "consulting" the City in preparing these plans. The key outstanding issues for the City were the limited information on these plans, how the City would be engaged in developing them, and that the considerable risks to the City be monitored, managed, and mitigated effectively. Accordingly, the City proposed alternative frameworks as conditions of Project approval to ensure these issues were resolved and risks were minimized. A critical component of these frameworks included an independent monitor to ensure all Environmental Assessment Certificate conditions (including City interests) were monitored and managed, and effects mitigated as committed, in addition to BCEAO's Compliance and Monitoring Program and monitoring required by permitting agencies.

T8TA and other Aboriginal groups questioned the Proponent on why affected Aboriginal governments were excluded from the analysis of impacts on local government revenues and expenditure.

The District of Hudson's Hope said it felt helpless in decisions that were taken far away. It stated BC Hydro's acquisitions of property prevented effective development or planning within the District, and many of the resulting damages cannot be mitigated. The District recommended

appointing an independent monitor who would have wide-reaching powers over Project-related and other activities, including access to substantial funds. It further noted that B.C.'s "separate policy" for grants-in-lieu for Hudson's Hope was already seriously inequitable, and would be perpetuated. Although there have been discussions regarding the District's asserted adverse Project-related impacts, no agreement had been reached with BC Hydro.

10.5.3 Panel's Analysis

In reaching its conclusions on local government revenues, the Panel considered the following factors to be relevant:

- Grants-in-lieu of taxes are not determined by the recipient municipality, as would be the case with property taxes, but instead are set by the provincial government. Separating taxing responsibility from spending authority can lead to distortions.
- While local government revenues would increase, there could be problems with timing. Preparations for the influx of workers would need to be taken before they arrived. Borrowing for this purpose without a clear sense of future revenues would be a risk municipalities would properly seek to avoid.

The Panel understands that detailed negotiations are underway between BC Hydro and affected municipalities currently. Information provided during the hearing indicated that all parties are aware of the issues and working to resolve them.

The Panel concludes that revenues to be received from existing sources, together with payments contemplated in negotiations between the Proponent and local governments, would generally be sufficient to maintain current service quality levels. Several such agreements are already in place. No significant adverse effects are foreseen, nor are cumulative effects.

The Panel further concludes that the negotiations of Impact and Benefit Agreements with local affected Aboriginal groups would generally be sufficient to maintain current service quality levels both on- and off-reserve.

Related conclusions and a recommendation are provided in Section 10.3.3 of this report.

10.6 REGIONAL ECONOMIC DEVELOPMENT

The Proponent defined the valued component, Regional Economic Development, as "the change in areas of the economy such as business competitiveness that contribute to a region's overall economy and standard of living."

10.6.1 Proponent's Assessment

The Proponent asserted that a portion of the Project's total capital spending for labour, equipment, goods, and services would accrue to local businesses and contractors. Procurement practices and economic conditions during the Project construction phase could result in new regional companies being created or existing companies expanding to become more competitive in Project-related activities. Regional companies were noted to potentially further benefit from the expanded capacity, new skills, and innovations developed as a result of the

Project, due to displacing services from outside the region or by exporting their services outside the region.

BC Hydro stated that a key issue for industry would be being able to understand the type and value of contract opportunities expected to be undertaken for the Project. The main concern identified was the extent to which local businesses and contractors would have a fair and equitable opportunity to obtain contracts associated with the Project. As such, the Proponent assessed the potential for the Project to affect regional economic development by taking into account how the Project may result in changes to:

- Project contract opportunities in the local area during construction, and
- Project contracting requirements compared with the regional and Aboriginal business and contracting profile, capabilities, and capacity.

Project expenditures included direct expenditures by the Proponent on major work packages that would be subject to company and Project procurement practices, and spinoff business activity that would not be subject to or controlled by the Proponent. With regard to the former expenditures, the Project's general requirements for business contracting during construction were set out for each of the Project component areas.

The Proponent anticipated that the Project would have positive effects on regional economic development during construction, as opportunities would be created for businesses and contractors directly involved in Project construction, and for those involved in industries and activities that would benefit from indirect and induced expenditures.

The Proponent recognized the concerns identified by Aboriginal groups regarding procurement opportunities and stated that comprehensive planning was needed to identify and remove discrimination in procurement and award policies and procedures. BC Hydro stated that effects of social and historical barriers and challenges need remedying through targeted measures, and that appropriate representation of Aboriginal suppliers should be planned for throughout the Project during its construction phase.

The Proponent stated it would continue to implement its business participation strategy and outreach initiatives to update the regional business community, including Aboriginal businesses and contractors, on the status of the Project, and inform and engage the business community on future Site C opportunities. Its targeted application of its Aboriginal Contract and Procurement Policy to the Project and opportunities to register with BC Hydro's Aboriginal Business Directory would facilitate the participation of Aboriginal businesses. Activities under this program included set-asides, direct awards, select tenders, and the inclusion of Aboriginal content in bidding documents. Where identified by Aboriginal groups as an interest, BC Hydro would consider commitments respecting capacity building, education, and training for Aboriginal participation in Project labour market opportunities. These efforts would help to ensure equity in Project procurement and supply for Aboriginal businesses in the area.

The Proponent concluded that the Project would increase business procurement opportunities for local companies during construction of the Project. Direct expenditures by BC Hydro during construction would amount to $1.7 billion in B.C., with an estimated $170 million accruing to regional contractors, including Aboriginal businesses in the area. Another $324 million in indirect and induced output would accrue to regional businesses. Effects were not assessed for contracting during operation, as the annual expenditures for this phase would be low relative to the regional economy and would, therefore, be negligible.

The leading beneficiaries would be suppliers in the following industries: construction, transport, finance, insurance, real estate, rental and leasing services, manufacturing, wholesale trade and operating, office, cafeteria, laboratory supplies, and professional, scientific, and technical services. However, companies in all industries in the local economy would be affected.

BC Hydro has proposed actions relevant to the whole regional population, and others specifically relevant to Aboriginal peoples in the region. A full list of mitigation measures proposed is contained in Appendix 9.

10.6.2 Views of Participants

Information and written submissions provided by participants during the public hearing suggested that some parties were looking forward to the increased revenues to local businesses as a result of the Project. Others feared the disruption of the peaceful rural lifestyle that would result from the Project's changes to the Peace River valley.

As described in Section 10.4, Aboriginal groups said that the level of the Proponent's commitment to Aboriginal job and contract opportunities would be unlikely to make a substantial contribution to Aboriginal persons' ability to take advantage of the proposed regional economic benefits of the Project. Treaty 8 Tribal Association (T8TA) said that, while the proposed Project would offer potential benefits in terms of training, employment, and contracting opportunities, the short duration of these opportunities and the lack of long-term employment was not consistent with the economic development objectives of the First Nations. According to T8TA, the alternative portfolios for the Project provided greater long-term economic development opportunities, and greater potential for equitable sharing of benefits for the Treaty 8 First Nations and other Aboriginal groups across the province.

The City of Fort St. John suggested several areas where efforts to support regional economic development could be enhanced:

- Reconsider the development of a permanent bridge connection linking the north and south banks of the Peace River at the Site C dam site to enhance economic benefits to the region by ensuring efficient movement of goods and services, and provision of a secondary route to the Alaska Highway, which can experience closures at locations such as the Taylor Hill;
- Enhance skills training in some non-trade areas where there is anticipated to be much employment generated as a result of dam construction (i.e. finance, insurance, general business, good-host/customer service, and other program areas). This would help to achieve the community's objective of maximizing local procurement of goods and services;
- Support skills development in areas relevant to other primary industries in the region—forestry, oil and gas, and agriculture—in order to promote economic stability and diversification;
- Reconfirm commitment to local hiring, including implementing a program targeting employees with local mailing addresses; and
- Identify specific steps to be taken by BC Hydro in areas such as research, training, and innovation to enhance Fort St. John's standing as B.C.'s Northern Energy Capital. This would include working with the City, Northern Lights College, University of Northern BC, senior government, and the private sector to establish an Energy Innovation Centre in Fort St. John.

10.6.3 Panel's Analysis

The Proponent listed actions to enable more equitable economic development opportunities associated with Project construction for Aboriginal businesses and contractors. Specifically, the Proponent has offered to help build capacity, education, and training associated with Aboriginal participation in Project opportunities. No specific commitments to employment in the operational phase were made in the EIS as amended, but from the hearing, it seems clear BC Hydro would be eager to hire qualified Aboriginal workers on a permanent basis.

The Panel believes that the region is well-served by national and local financial institutions. Investment capital is not likely to be a constraint on small business expansion. It would seem that the constraints on economic development would more likely rest with skills availability rather than demand or access to capital.

Federal and provincial training and skills development programs are often slow to respond to fast-developing economic opportunities, yet they are key to local job-seekers and businesses who want to take advantage of opportunities presented. Every effort is needed by governments, in collaboration with local training and educational establishments like Northern Lights College, to anticipate the timing of requirements and to adjust their offerings accordingly.

The Panel concludes that there would be excellent opportunities for new and existing jobs and businesses during the construction phase.

As stated in sections above, many, perhaps most, of the opportunities presented by the Project would flow to Canadians outside of the region. To a considerable degree, the claimed regional economic benefits would represent a transfer from other parts of the province.

The measures BC Hydro contemplates to improve the competitiveness of Aboriginal resources are commendable, but a broader effort by senior governments is also required.

11 HUMAN HEALTH

In this chapter, the Panel examines the health effects of the Project and their significance, taking into consideration mitigation measures, and the cumulative effects that would likely result from the Project in combination with other past, present, or future projects or activities. The potential for human health effects as a result of the Project may be associated with changes in air quality, water quality, noise and vibration, electric and magnetic fields (EMF), and methylmercury levels in fish.

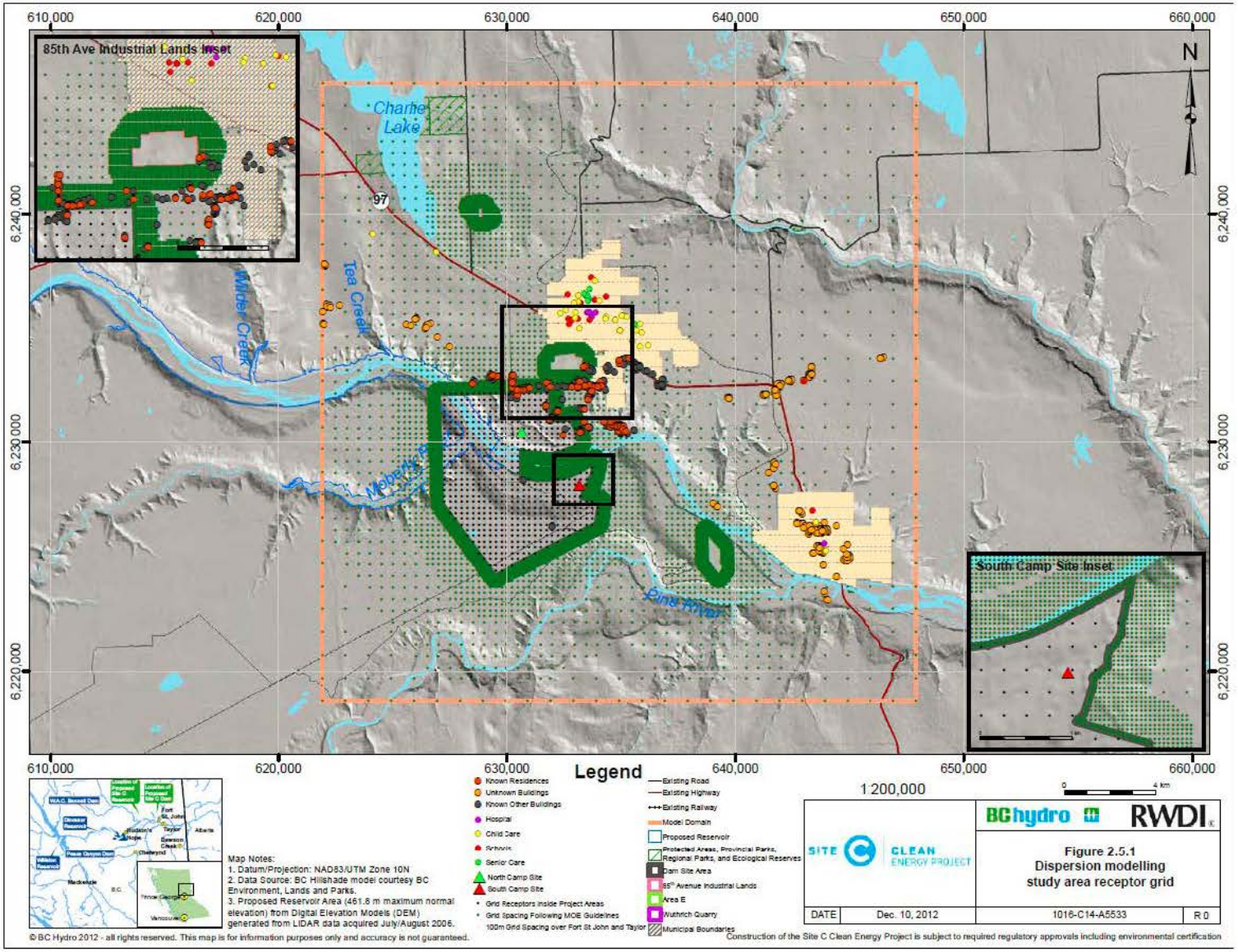
The Proponent's local assessment areas (LAAs) for human health was based on the technical study area boundaries for air quality, water quality, noise, electric and magnetic fields (EMF), and the mercury human health risk assessment, combined with locations of human receptors of concern. BC Hydro defined human receptors as individuals, population groups, or communities residing in or visiting the LAA that could be exposed to contaminants of potential concern. Sensitive receptors were considered to be those with potential for increased health risk and were identified based on physical/behavioural characteristics (i.e. age, existing health vulnerabilities, consumption of local foods), permanent residence, use of habitation sites, and presence of a potential exposure pathway according to Health Canada's guidance. The human health assessment applied a process of contaminant screening, human receptor screening and identification, exposure pathway screening, and exposure assessment to identify the potential effects of the Project on human health.

11.1 AMBIENT AIR QUALITY

The main air quality legislations in British Columbia are the *Environmental Management Act* and the *Waste Discharge Regulation*. Ambient air quality objectives and standards for criteria of air contaminants (CAC) provide guidance for environmental protection and air quality decisions. The BC air quality objectives and standards (BCMOE 2009) are established for the maintenance and improvement of health. The Canada-wide standards for particulate matter (PM) and ozone include standards, guidelines, objectives, and criteria for the protection of human health (CCME 2006).

11.1.1 Proponent's Assessment

BC Hydro's study of air quality calculated representative background concentrations for the dispersion modeling study area at representative receptors by following the BC guidelines for air quality dispersion modeling (BCMOE 2008). Receptor sites are illustrated in Figure 16.



Source: BC Hydro EIS, Volume 2, Appendix L, Figure 2.5.1

Figure 16. Dispersion Modelling Study Area Receptor Grid

Additional receptors were identified at the worker camps and private buildings. Sensitive receptors, representing vulnerable populations such as schools, and child, seniors, and health care facilities were also included. Maximum ambient concentrations of CAC and dustfall were measured for baseline considerations. Changes in ambient air quality were estimated for the worst-case scenario based on the predicted quantity of emissions and the proximity of sources to residences. Various locations were considered:

- Construction of the Site C dam, generating station and spillways, Wuthrich Quarry, 85th Avenue Industrial Lands, and Area E;
- Site C reservoir during preparation and filling;
- The construction of the transmission line to Peace Canyon;
- Quarried and excavated material development; and
- Construction access road development and Highway 29 realignment.

BC Hydro then assessed the potential to adversely affect human health by comparing predicted results to objectives and baseline levels. BC Hydro predicted exceedances at some receptor locations for total suspended particulate (24-hour), and PM_{10} (24-hour), and $PM_{2.5}$ (24-hour and annual). For total suspended particulate, the background level was determined to be 26 micrograms per cubic metre (µg/m^3), the objective is 150 µg/m^3 based on visibility, and the predicted exceedance would occur at the north campsite. For PM_{10}, BC Hydro said the background level is 26 µg/m^3. The objective of 50 µg/m^3 for PM_{10} would be exceeded at one residence, non-residential buildings, and the north campsite. $PM_{2.5}$ would exceed the 24-hour objective of 25 µg/m^3 at non-residential buildings, the north campsite, and the south campsite. Annual $PM_{2.5}$ of 8 µg/m^3 would be exceeded at non-residential buildings and the north campsite. BC Hydro said objectives for PM_{10} and $PM_{2.5}$ were health based.

BC Hydro estimated exceedances to potentially be present during the following activities:

- Construction Access Road Development and Highway 29 Realignment: at known residences and in First Nations habitation use areas in proximity to Highway 29 there is a potential for these exceedances to affect human health.
- Quarries and excavated material development: although West Pine is an existing site, there is the potential for exceedances of PM objectives to affect human health at a residence located 1.5 km from the quarry boundaries. Otherwise, ambient concentrations of CO, NO_2, and SO_2, PM and dustfall would increase relative to baseline, but remain below ambient air quality objectives. Exceedances of B.C. air quality objectives for PM would occur within approximately 1 km of site boundaries and decrease rapidly further out.
- Site C reservoir preparation and filling: ambient air concentrations of PM would increase relative to baseline during clearing. CO, NO_2, and SO_2 would also increase if vegetation debris is burnt. Any exceedances that would occur with burning would potentially affect human health at the known receptor locations.
- Site C dam, generating station and spillways, including Wuthrich Quarry, 85th Avenue Industrial Lands, and Area E: The highest predicted concentrations in exceedance would occur in the vicinity of Wuthrich Quarry in an area where there are no known sensitive receptors. Some exceedances would also occur along the construction boundary for Area E and near the Peace River close to the dam site construction boundary, where there are no known receptors.

For the construction of the transmission line to the Peace Canyon Dam, there would be minimal increases in air quality parameters and exceedances would not occur at identified receptor sites. Effects on human health were not anticipated.

The Proponent concluded that, with mitigation, no residual effects of air quality on human health were anticipated, and monitoring would be designed and implemented to monitor the effectiveness of mitigation measures.

11.1.1.1 Mitigation Measures

BC Hydro proposed several management plans to reduce emissions and ensure that exceedances of ambient air quality objectives do not occur. These plans would include a Smoke Management Plan that would meet the requirements of the BC Open Burning Smoke Control Regulation. It would identify efforts to reduce open burning activities and the best management practices to minimize the effects of burning activities on the environment and the public. BC Hydro suggested measures such as transporting non-merchantable wood near Hudson's Hope, Fort St. John, and Taylor to special incineration sites, or burning wood along Highway 29 and the transmission line in mobile burn boxes. For disposing of wood waste near areas with a population density over 200 people per square kilometre, considered primary smoke sensitivity (PSS) zones, burning would be constrained to within 10 km of PSS zones. For these areas, other methods were studied, such as forced air burning of non-merchantable wood in large steel containers and landfilling.

In addition, BC Hydro proposed several mitigation measures to be employed at the dam and generating station site to reduce total suspended particulates and particulate matter. To manage PM exceedances at the proposed camp site locations, BC Hydro intended to conduct a monitoring plan that would include the confirmation of the emission source locations and detailed air quality modelling. Details on the proposed mitigation plans can be found in Appendix 9.

11.1.2 Views of Participants

Environment Canada considered the information presented by the Proponent to evaluate air quality effects as satisfactory, but said that the Proponent did not assess conditions during operation, when fugitive dust entrainment could occur during dry periods due to wind erosion from exposed areas. Health Canada also said open burning and incineration from clearing activities were estimated to contribute most of the emissions of fine particulate matter, but these emissions were not included in BC Hydro's air quality assessment for human health.

Health Canada said First Nation habitation use areas were identified in the vicinity of the dam site, such as cabins and hunting and fishing camps, but a quantitative assessment of predicted changes to ambient concentrations of CAC at these habitation use areas was not conducted. In response, BC Hydro said that an exclusive land tenure around the dam site would be applied for and the perimeter would include the majority of habitation areas mentioned. Therefore, consideration of those use areas was accounted for in the analysis.

For habitation use areas outside this perimeter, BC Hydro would seek information from Aboriginal groups through pre-construction surveys because the information provided to date on location, nature, frequency, and timing of habitation use, had limitations in quantitatively assessing potential changes in ambient air quality parameters and possible effects on health at these locations. If they are located within the air quality assessment area, they would be added to the human health receptor list. If they are located in areas with predicted ambient air quality exceedances, they would be subject to mitigation measures designed for effects of air quality on health.

The City of Fort St. John expressed concern regarding the emission of dust associated with the 85th Avenue Industrial Lands, specifically, that the identification of sensitive receptors was not correct. BC Hydro confirmed that the monitoring results for the corrected locations indicated no exceedances at the 85th Avenue Industrial Lands or at the sensitive receptor locations.

Non-merchantable vegetation is the biomass that does not meet the merchantability description of FLNRO. Its biomass equations were applied by BC Hydro to calculate the total stand biomass, to be derived in oven-dry tonnes and then converted to cubic metres (m^3). BC Hydro has estimated the non-merchantable biomass within the Project activity zone to be 1,636,000 m^3. All non-merchantable wood and debris would be removed within the dam construction site, quarries, Highway 29 realignment, and proposed access roads but not the transmission line corridor, estimated to be 1,188,000 m^3. Most of the clearing would be done in Year 1 for the dam site and in Year 4 for the reservoir.

The City of Fort St. John said BC Hydro had no practical plan to get rid of non-merchantable timber other than burning. In response, BC Hydro said it had a three-fold approach of reducing the volume to be burned, reducing the smoke that would be produced, and reducing the effects on humans from any smoke. Furthermore, BC Hydro said that it is in negotiations for “innovative uses of non-merchantable timber” that could divert up to one-third of the wood waste from conventional disposal methods. BC Hydro committed to determine the timing and location of burning in accordance with Open Burning Smoke Control Regulation, the Smoke Management Plan, atmospheric conditions, and in consultation with specialists from the Ministry of Forests, Lands and Natural Resource Operations (FLNRO).

Northern Health said that, based on current scientific literature, particulate matter (PM) follows a linear no-threshold model with respect to human health effects, and any increase can have potential impacts on human health. BC Hydro did not treat PM in this manner. The assumption that the provincial objectives are a threshold for health was carried throughout the human health section of the Environmental Impact Statement and Northern Health said the approach is not supported by current scientific literature. Northern Health said the human health section should note that the objectives and guidelines for PM are not a threshold for health effects, and that being below the objective, or similarly to being above, does not necessarily identify whether health or residual effects would occur.

Given the above, Northern Health recommended the following measures:

- Detail what actions will be taken during construction, regular operation and maintenance to minimize emissions associated with the Project to as low as reasonably achievable as opposed to below the applicable objectives and guidelines;
- Strive to meet the annual Planning Goal for $PM_{2.5}$ of 6 micrograms/m^3 (as opposed to the Objective of 8 micrograms/m^3);
- Clearly acknowledge and identify the difference between health impacts and the applicable objectives when discussing air quality health mitigation, management, residual effects, and cumulative effects in the health assessment;
- Follow the federal principles of “Continuous Improvement” and “Keeping Clean Areas Clean”; and
- Provide details of the air quality monitoring program.

11.1.3 Panel's Analysis

The Panel agrees that the method used by BC Hydro is generally satisfactory; aspects requiring attention are discussed below.

In addition to BC Hydro's determination of potential exceedances at receptor locations, the Panel considers that the objective of 1.75 milligrams per decimetre squared per day (mg/dm^2-d) for dustfall could be reached at residence 38 because the predicted result of 1.2 mg/dm^2-d is close to the objective. The same applies with some receptor groups where the $PM_{2.5}$ and PM_{10} background values or predicted effects are already close to the objectives. Monitoring should be done at these locations to verify the predicted results. The Panel notes that the Proponent did not present any effects assessment on human health during operation and believes that monitoring should be done for the first two years of operation.

With respect to the 85th Avenue Industrial Lands, the Panel is satisfied that the material coming from there would not be a significant source of dust, and understands that the conveyor would be covered. Furthermore, the air quality monitoring station installed by BC Hydro to collect baseline data and to measure the PM levels during construction would enable BC Hydro to implement any mitigation measures in the event of exceedances.

Health Canada, Environment Canada, and the City of Fort St. John expressed issues regarding the open burning and incineration associated with clearing activities. The Panel agrees with BC Hydro that, because burning would occur in different areas, according to season, atmospheric conditions, and areas of works, it would have been difficult to include this activity in the air quality modeling. Based on the information provided, even if up to one-third of the total amount of non-merchantable biomass can be diverted into innovative uses, the Panel believes there is still a considerable quantity left for burning, close to the City of Fort St. John. According to the BC Ministry of Environment, exposure to wood smoke can cause serious illness based on a 1993 report released by the Provincial Health Officer. Chemicals and fine particulates in wood smoke can make people quite sick, and even cause death. Illnesses include coughing, runny nose, asthma, and the aggravation of lung and heart problems. It is clear to the Panel that wood smoke can cause health effects.

The Panel notes that the BC Open Burning Smoke Control Regulation (OBSCR) is still under review. In anticipation of potential changes to the OBSCR, the Panel understands that BC Hydro would develop a Smoke Management Plan for Project burning activities. In line with Health Canada, the Panel supports BC Hydro's efforts to reduce open burning activities. However, monitoring on burning that does take place would have to be done in order to advise vulnerable populations, such as small children, elders, asthmatics, and people with compromised lung functions of any appropriate precautions that should be taken.

Standards and guidelines are important managerial tools. However, the Panel considers that, according to World Health Organization, with current scientific evidence no guidelines for PM would lead to complete protection against health effects. Northern Health quoted BCMOE's statement that "no safe health thresholds have been identified." The Panel recognizes the need for continuous efforts to improve air quality and keeping baseline levels below established thresholds. The Panel also notes that the BC air quality objectives and standards were established for the maintenance and improvement of health and not only for its protection.

The Panel notes that once final locations of emission sources are confirmed, BC Hydro plans to conduct additional air quality modelling at the dam construction site. It also plans to place three additional particulate matter monitoring stations at the two workers camps and one in Hudson's

Hope at the shoreline protection site. The Panel views this monitoring as an important aspect in confirming the results of the assessment.

The Panel concludes that, if the Project proceeds, there is a potential for health effects from a degradation of air quality in the region of Fort St. John, Taylor, Hudson's Hope and for Aboriginal groups using areas close to the construction activities of clearing and burning, the construction of access roads and the realignment of Highway 29. The predicted results would have to be confirmed through monitoring and the mitigation measures adjusted, if needed. These effects could be overcome with proper mitigation. If the Panel's recommendation is implemented, there would be no residual effects.

RECOMMENDATION 29
The Panel recommends that, if the Project proceeds, BC Hydro must:

- Add monitoring at sensitive receptor groups locations to the monitoring plan for dust and smoke.
- Prolong the monitoring proposed for the construction period into the first two years of operation for particulate matter and dustfall. In case of exceedances, appropriate mitigation measures must be implemented.
- Identify places of high Aboriginal group use and develop mitigation measures should adverse effects be predicted at those locations.
- Ensure procedures are developed to warn and protect sensitive populations in cases of exceedance.

11.2 POTABLE AND RECREATIONAL WATER QUALITY

Drinking water sources in the LAA are found in Hudson's Hope, Taylor, and Fort St. John. There are also 48 registered and 7 non-registered drinking water wells within 2 kilometres of the reservoir that could be affected by the Project. BC Hydro said that First Nations communities' water supply does not come from potentially affected surface water or groundwater sources.

For recreational water use, a survey indicated that swimming occurs in the Pine River, in the Peace River between the Site C dam site and the Alberta border, and at the confluence of both rivers.

11.2.1 Proponent's Assessment

Changes in potable and recreational water quality were evaluated during the first 10 years of operation. With respect to surface water, a number of drinking water quality parameters would change as a result of the Project; however, changes would not result in exceedance of drinking water quality guidelines or recreational water use guidelines. BC Hydro concluded that contact with or consumption of water from the Site C reservoir and from downstream tributaries would not pose a health risk, and no effects on human health are anticipated.

With respect to groundwater, approximately 55 identified water wells are along the Peace River adjacent to the proposed reservoir, 6 of these would be submerged as a result of inundation, and would be properly decommissioned. The remaining wells would experience an increase in water level of 1 to 10 m, location dependent, but quality of the groundwater within the well or the well operation would not be affected. Groundwater quality could be affected if either a flooded

septic field or a contaminated site is in close proximity to operating water wells. If this were to occur, there would be the potential that groundwater quality would exceed drinking water quality guidelines and result in potential effects on human health.

11.2.1.1 Mitigation Measures

BC Hydro's proposed plans to monitor and mitigate the risk of groundwater quality exceeding drinking water quality guidelines during operation and potential groundwater contamination are outlined in Appendix 9.

BC Hydro concluded that, with mitigation, no exceedances of potable or recreational drinking water quality guidelines and no residual effects on human health are anticipated.

11.2.2 Views of Participants

Health Canada said there is some uncertainty about whether any surface water or groundwater sources used by Aboriginal communities would experience changes during inundation. Health Canada suggested that, if impacts to these water sources are identified in relation to the Project, then appropriate mitigation measures should be implemented to maintain drinking water quality. A mechanism to work with the Aboriginal community to conduct monitoring should be considered. Health Canada recommended that the Emergency Response Plans include means to manage the potential contamination of drinking water sources and initiate immediate communications with those impacted.

The City of Fort St. John obtains its water from a well field approximately 12 km downstream of the proposed dam. BC Hydro indicated that this water is obtained from bedrock, but the City clarified that water is obtained from a shallow and potentially fragile point-bar sand and gravel aquifer. The City of Fort St. John said this aquifer is subject to high surface water interaction; therefore, it may be impacted by water quality changes associated with changes in the Peace River. The City of Fort St. John's water treatment system may be affected by changes in surface water quality impacting groundwater quality. Additionally, changes in river water levels could affect the supply well operations and water quality. The City of Fort St. John also had concerns regarding potential physical degradation of the aquifer and water supply in relation to long-term flow changes downstream and catastrophic failures.

The City expressed concerns about the potential for contaminants leaching into its water supply from the City landfill and flooded septic systems. In response, BC Hydro said the Groundwater Protection Plan would involve the monitoring of potential groundwater contamination and, if required, identifying appropriate groundwater protection measures. This would be done through private well sampling and include monitoring the quality of Fort St. John's drinking water sources. BC Hydro indicated that it is prohibited from publishing the locations of wells that may be affected by a flooded septic field or contaminated site; however, it identified the following mitigation measures:

- Prior to reservoir filling, building infrastructure, groundwater wells, and septic tanks or fields at properties within the proposed inundation area would be decommissioned to reduce the potential for affecting groundwater quality for existing water well users.
- Prior to reservoir inundation, further investigation and, as warranted, site remediation, would be conducted on potentially contaminated properties and on properties where residual pesticides and herbicides may be present at concentrations of concern.

The District of Hudson's Hope had concerns regarding its sewage lagoons located adjacent to the proposed reservoir. First, it said changes in reservoir water levels may impact the stability of the lagoons. Second, it said the groundwater level is expected to rise in response to the filling of the reservoir, which would reduce the distance between the sewage lagoon and groundwater. This reduced distance may not allow for adequate treatment of the wastewater in the lagoons. The District requested Monitoring to ensure the integrity of the lagoons and the functionality of wastewater treatment.

The Government of Alberta indicated that the proposed design minimum flow of 390 cubic centimetres per second (cm^3/s) in normal and event operations could cause undue risk to Alberta infrastructure. It indicated that low water levels could force communities to shut down their water intakes. It noted that the infrastructure in Alberta has been designed, constructed, and operated accounting for historical normal operation flows from the Bennett and the Peace Canyon Dams.

The District of Taylor had concerns regarding potential changes to water downstream with respect to its drinking water source wells on an island in the Peace River. These concerns have been accommodated through an agreement between the District of Taylor and BC Hydro.

11.2.3 Panel's Analysis

BC Hydro indicated that changes in surface water and groundwater quality as a result of the Project are not anticipated to exceed potable or recreational drinking water quality guidelines.

Six of the 55 wells would be decommissioned permanently. Moreover, there is the possibility that groundwater quality could exceeds drinking water quality guidelines if either a flooded septic field or a contaminated site with impacted groundwater is in close proximity to operating water wells.

The Panel understands that under common law, an occupier of land would be liable in nuisance if it caused damage to or interference with the use and enjoyment of another's property. Generally, a public authority would be liable only if the damage or interference suffered were "unreasonable." However, section 31of the *Hydro and Power Authority Ac*t provides that BC Hydro cannot be liable in nuisance. As a result, unless it were negligent, BC Hydro would not be liable for an adverse impact of the Project on a well. Although, BC Hydro agreed to pay for the loss of functionality of systems at the hearing, there was no indication that, in the case of the lost wells, it would provide compensation.

The Panel disagrees with BC Hydro that there would be no effects on individual wells. There would be a risk of exceedances of drinking water quality guidelines for a number of wells. If the Panel's recommendation is implemented, there would no residual effects.

RECOMMENDATION 30
The Panel recommends that, if the Project proceeds, BC Hydro must monitor potentially affected wells, starting as soon as Project approval is received. Monitoring must be done twice a year for 10 years. If any changes are observed the owners must be informed. If any functionality problems such as poor water quality or low yield result from the Project, BC Hydro must work with the well owner(s) to provide an alternate source of potable water.

Additionally, mitigation measures to prevent leaching from contaminated sites and septic fields as proposed by BC Hydro should be initiated prior to inundation.

For the City of Fort St. John's and the District of Taylor's supply water wells, the Panel agrees with BC Hydro that exceedances of drinking water quality guidelines are not anticipated.

The Panel approves of the collaborative efforts of the City of Fort St. John and BC Hydro with respect to the City's drinking water.

The Panel notes the concerns of municipalities and the Government of Alberta about the risks to the functionality of their water supplies or waste water treatment systems. With respect to the City of Fort St. John's landfill, the Panel notes that BC Hydro would implement its proposed mitigation measures for contaminated sites prior to inundation. Follow-up monitoring should be implemented during operation to ensure no degradation in water quality occurs.

The District of Hudson's Hope had concerns regarding its sewage lagoons located adjacent to the proposed reservoir. Changes in reservoir water levels may impact the stability of the lagoons, and the expected elevated groundwater could reduce the functionality of the wastewater treatment. The Panel understands that BC Hydro would monitor these effects and mitigate as required. In particular, BC Hydro states that the Hudson's Hope shoreline protection would be designed to address the potential for erosion at the sewage settling ponds. The Panel further notes that mitigation plans would be updated as monitoring requires.

Alberta had concerns regarding water availability due to the proposed design minimum flow of 390 cm^3/s. This flow rate may cause undue risk to Alberta infrastructure including community water intakes. The Panel has made recommendations to address the potential effects and uncertainties in Section 3.1.3.

11.3 NOISE AND VIBRATION

11.3.1 Proponent's Assessment

British Columbia has no province-wide regulations or guidelines regarding acceptable noise and airborne vibration for sensitive human receptors or the environment. BC Hydro's evaluation was based on the methods and criteria outlined by the BC Oil and Gas Commission (BCOGC). The requirements of the method proposed by Health Canada were considered with respect to the identification of noise-sensitive human receptors. BC Ministry of Transportation and Infrastructure (MOTI) guidance for highway noise mitigation was reviewed for sound level guidance for Highway 29 traffic noise. Blasting noise or airborne vibration was evaluated based on the US Office Bureau of Surface Mining and the Ontario Ministry of the Environment,

although the latter was found to be more stringent; therefore, it was used to compare benchmarks against the calculations of airborne vibration from blasting for the Project.

Changes in noise and vibration were considered during the construction phase for the Project, with a focus on Year 3 and Year 5 when there would be the highest concentration of construction activity with most equipment on-site. Predicted daytime and nighttime noise levels at receptors resulting from dam site activities during these years were evaluated. Specific activities included: excavation and material movements; concrete batching; pile driving; blasting; fabrication yards; and construction camps. Sound power levels for equipment used on-site during Year 3 and Year 5 would range from 88.6 decibels (dBA) to 129.8 for daytime and 88.6 dBA to 125.2 for nighttime, with hydraulic hammer pile driving at 103.2 dBA for daytime only. Figure 17 presents the location of the noise receptors used.

Results of the modelling were provided for the predicted ambient sounds levels, predicted cumulative sound levels, and changes in ambient sound levels. These were compared to the permissible sound level (PSL) guidelines. Exceedances are predicted for one residence during the daytime in Year 3, and for several residences during the daytime and nighttime in Year 5.

Health Canada considers that the human perception of changes from a current ambient noise to a cumulative sound level is an important point in appreciating public reaction to noise. When applying recommended sound level limits, for instance to a residential land use development, increases in sound above recommended sound level limits in dBA will indicate the magnitude of the noise problem and if noise control measures or action need to be taken. Generally, sound is considered perceptible if the change in noise level is greater than 3 dBA; if it is between 6 and 10 dBA, it is perceived as a doubling of the sound; if it is above 10 dBA, control measures are recommended.

For Year 3, a change in the level of sound was predicted during the day but not at night at one residence, and day and night at the two workers camps. For Year 5, the predicted changes in sound level would be present at several residences and both the workers camps, day and night.

BC Hydro clarified that WorkSafe BC is the authority that has jurisdiction over the health and safety of workers in work camps. It does not impose outdoor sound level limits but regulates sound exposure for workers, and has jurisdiction over exposure of workers in camps. BC Hydro committed to comply with any requirements that WorkSafe BC imposes and work to manage the potential for sleep disturbance by outdoor noise sources. According to BC Hydro, control of indoor noise can be achieved partially through control of outdoor noise, but also through the type of camp structures used, such as insulated walls and double-glazed windows. BC Hydro believes that these measures would result in workers not being woken 10 or more times a night.

BC Hydro conducted a worst-case scenario modeling for noise for the Wuthrich Quarry, considering that it was representative of quarries and borrow pit sites within or close to the technical study area. The results indicated that sound generated by quarrying and blasting activities was expected to comply with available guidelines at the 1.5 km technical study area boundary. Project effects were expected to occur only within this boundary.

For clearing, BC Hydro considered that a single worst-case location scenario would not be representative because of schedule variability or progression of the works. A general approach was used to evaluate noise levels at any receptor. The model established an expected minimum area where all equipment was to be present. The model then analyzed noise levels at set distances from activities, as well as at specific receptor distances. Results confirmed BC Hydro’s conclusion that sound generated by clearing activity in the reservoir may result in noise levels at receptors that exceed the BCOGC daytime guidance of 50 dBA for remote areas within

500 m of the activity but are contained within the technical study area. Changes in ambient sound levels would range from 8.6 to 23.8 dBA, needing special measures. BC Hydro concluded that receptors located less than 50 m from the activity zone would require a specialized management plan.

For Highway 29, sound would be generated along the length of the highway from Year 2 through Year 6 when highway realignment and bridge construction take place. BC Hydro said that, because this type of work occurs along the highway, a single worst-case location would not be representative of all receptors.

The model approach used established an expected minimum area or zone where all equipment was expected to be operating. Modelling was then done on this generic work area and noise levels were analysed at set distances from the activity as well as at specific receptor distances. These distances were used to estimate the maximum amount of noise that may be received at the receptor when highway construction activity occurred at the closest point. BC Hydro noted that this approach identified the expected worst-case condition at a receptor and would be used to determine where control programs may be required. Noise levels would be compliant with BCOGC guidelines at about 500 m from the cut or fill and grading activity. Changes in ambient sound level would vary according to the receptor and the distance, and results could be 26.6 dBA at ground zero and 10.5 dBA at 78 m. Results indicated that receptors within 50 m of the activity zone would require a specialized management plan.

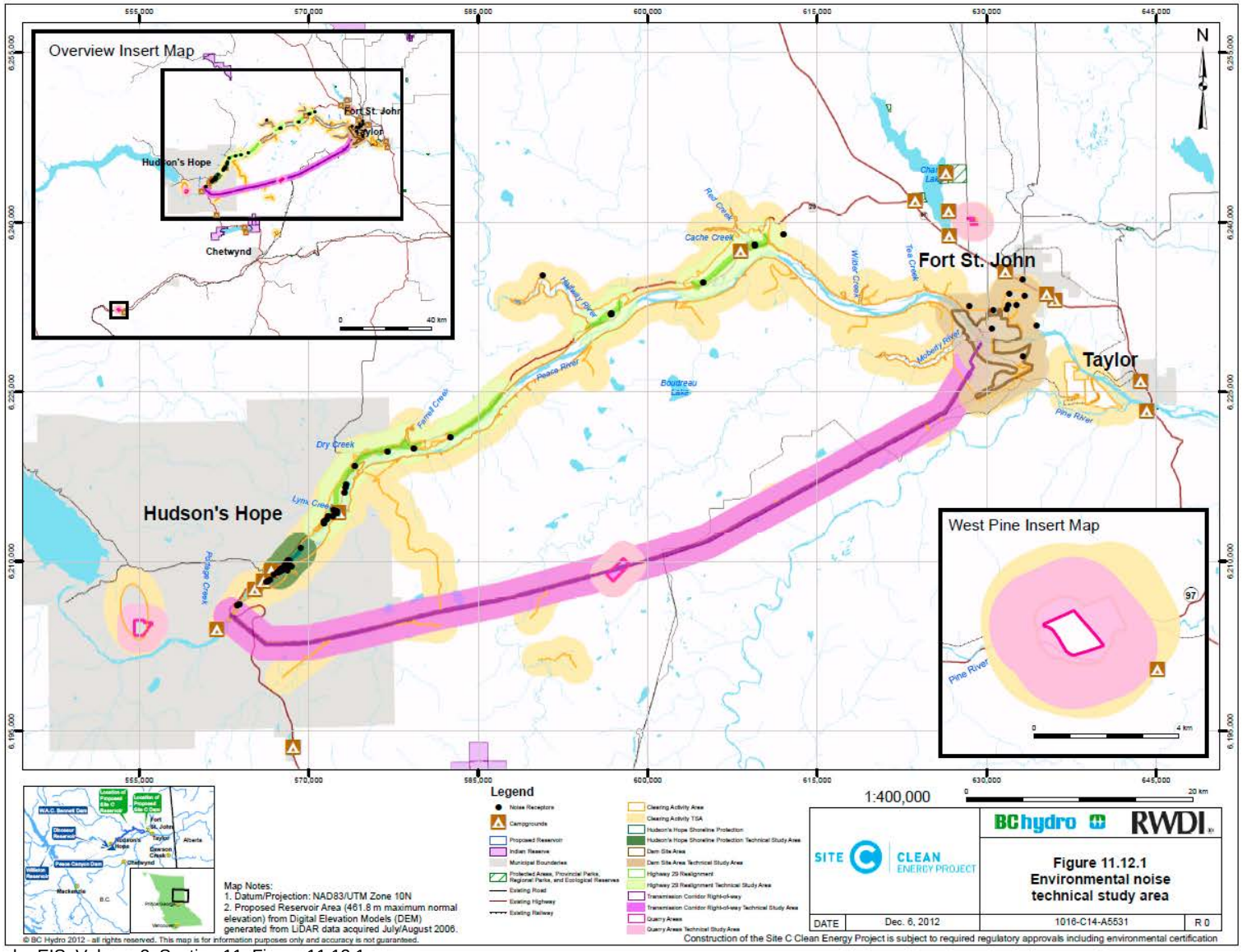
Highway 29 traffic noise during the construction phase was also considered with a worst-case scenario at Year 7. Results indicated that changes in sound levels would be 3.2 dBA and less or barely perceptible.

For the transmission line construction, two scenarios were evaluated to cover the tower foundation construction activity and the helicopter usage for tower erection. Modelling was conducted for the receptors near Hudson's Hope. The results indicated that, for the tower construction, no changes in noise levels were greater than 3 dBA. For the helicopter noise analysis, the potential changes in noise levels would depend on the locations and time duration of the hovering and landing, and the relative height of the helicopter when hovering.

The results indicated that noise management may be required if transmission line towers were within 100 m of receptors for hovering and 400 m for landing. No habitations were identified within the Project activity zone.

During operation of the transmission line, a corona noise or line hum greater than the existing one would be audible, an estimated sound level of 51.1 dBA that would diminish below 40 dBA at 200 to 250 m. Fieldwork would have to determine if there were habitations inside this zone that would be impacted.

For the Hudson's Hope shoreline protection works, changes in noise levels at receptors were expected with the berm construction, which would be immediately adjacent to the community itself. Four representative locations were selected for the analysis. The results indicated that noise levels in the community may exceed the BCOGC daytime guidance by up to 10 dBA; and changes to ambient sound levels would vary from 6.8 dBA to 14.6. BC Hydro recognized that exposure to such a situation or to changes more than 3 dBA would have to be controlled through a management plan.



Source: BC Hydro EIS, Volume 2, Section 11, Figure 11.12.1

Figure 17. Environmental Noise Technical Study Area

Exceedances of guidelines for noise levels would potentially occur during construction of the following Project components: the Site C dam site, generating station and spillways (including 85th Avenue Industrial Lands); Site C reservoir preparation and filling (including Hudson's Hope Shoreline Protection); transmission line to Peace Canyon; quarried and excavated materials source development; Highway 29 realignment; and access road development.

Exceedances of noise guidelines with the potential to affect human health at receptor sites are associated with the following Project components and activities:

- Quarry and excavated material source development at 85th Avenue Industrial Lands – till excavation, loading, and conveyor;
- Site C reservoir clearing activity and shoreline protection at Hudson's Hope – clearing activities during the daytime and off-road heavy equipment;
- Construction of Highway 29 new alignment and bridges – off-road heavy equipment and generators; and
- Construction of the dam.

11.3.1.1 Mitigation Measures

The Proponent proposed a Noise and Vibration Management Plan that would include mitigation measures to reduce noise levels at receptor locations. It would outline measures to reduce noise (i.e. traffic scheduling to reduce bunch up, no engine compression brakes, no free swinging tailgates, equipment state, communication plans with residents). With respect to clearing activities, a notification plan would be developed for residents within 500 m of the activity. A specialized management plan would be created for receptors within the activity zone or less than 50 m from the activity.

Activities associated with the Hudson's Hope shoreline protection may warrant temporary vertical noise barriers in residents' yards. The Proponent agreed at the Hearing that a few residences closer to the dam site may warrant similar extra measures. A noise monitoring plan would be developed to verify the effectiveness of measures in place and adjust as required.

For bridge construction activity, temporary barriers and/or portable enclosures or walls would be implemented to mitigate noise levels at receptor locations where exceedances would occur. A notification plan would be implemented, informing residences of the expected schedule and duration of construction activities and noise events.

As for workers camps, health regulators have requested building requirements to protect the sleep of the workers. A noise monitoring plan would be developed to monitor and verify the effectiveness of measures in place and be adjusted as required.

Details of these measures are provided in Appendix 9. Implementation of these measures would reduce noise levels at receptor locations to meet guidelines. BC Hydro concluded that with mitigation no residual effects were expected.

11.3.2 Views of Participants

The City of Fort St. John acknowledged that using a conveyor to transport till material from the 85th Avenue Industrial Lands to the dam site would reduce heavy truck traffic on public roads, resulting in less noise and dust. The City also recognized that, after discussions with BC Hydro, the Proponent is committed to establishing monitoring stations for baseline information for air quality and noise on and around the 85th Avenue Industrial Lands. However, in its request for

independent monitoring, the City submitted a list of several elements referring to uncertainties remaining with respect to future potential impacts of the Project. Among these issues, the City said more specific noise contour diagrams should be prepared for sensitive lands and routes in Fort St. John.

The District of Hudson's Hope had a concern with respect to major haul routes for riprap, road construction aggregate, and bridge materials intersecting the main town site. It said increased traffic levels would cause noise, dust, and other disturbances.

Some Aboriginal groups had concerns that the construction noise could scare animals away from the area.

11.3.3 Panel's Analysis

The Panel considers that only monitoring would confirm the predicted results and what measures would be required, including reduction or exclusion of certain nighttime activities at the dam site.

With respect to clearing activities, the Panel agrees with BC Hydro's conclusion that receptors located less than 50 m from the activity zone would require a specialized management plan. However, as Health Canada noted, "communication" to residents is not equivalent to community consultation, whereby resident feedback may be used to adjust construction schedules and activities to minimize noise impacts, where feasible. The Panel considers that the implementation of a notification plan should be based on community consultation rather than individual needs. To inform residents of the expected schedule and duration of construction activities and noise events is a basic courtesy, but it is not considered by the Panel as mitigation to reduce noise levels.

Realignment of Highway 29 would be done over a four-year period. Although short periods of works are foreseen, predicted noise levels were high at some receptors and would also require a management plan.

BC Hydro noted that the World Health Organization (WHO) recommends criteria to be applied with respect to indoor noise levels of 30 dBA for continuous sound and 45 dBA for events or short-term increases (WHO 1999). However, the Proponent did not specify if those levels have been used for the planning of the workers camps. Considering the effects of noise on health in relation to sleep patterns and resulting physiological conditions, the Panel considers the measures taken which only ensure workers are not woken 10 or more times a night, as BC Hydro's sound specialist said at the hearing, were presently inadequate. Furthermore, there is no BC regulation or guidelines for noise levels in workers housing.

Some activities would also produce impulsive noises from cofferdam installation and bridge construction. BC Hydro said that pile driving occurs through Year 5 and its repetitive impulsive sound can be intrusive, particularly if it is dominant. The Proponent underlined that the sound level contribution of the pile driving only is noticeably lower than the overall site contributions. Other equipment used on-site would have higher sound power levels, such as cranes and haul trucks. The sound produced by the latter is not considered as sharp sound pressure peaks occurring in a short interval. Yet BC Hydro did not consider the amount of sound coming from pile driving as dominating other construction noise or background sound levels. If that is so, the Panel considers that the level of noise heard by residents close to the dam site could be intrusive and disturbing. Furthermore, the Panel wants to underline a day-and-night eight-year

construction period is not a temporary one. The relocation of the affected residents for some part of the duration of the works should be considered.

The Panel concludes that there are predicted exceedances of the BC Oil and Gas Commission guidelines and changes in sound levels at some receptors - above 5 dBA at one residence and above 10 dBA at worker camps. If the Panel's recommendation is implemented, there would be no residual effects.

RECOMMENDATION 31
The Panel recommends that, if the Project proceeds, BC Hydro must:

- Design a work and noise management schedule that allows an uninterrupted eight hour sleep schedule for workers; and
- Manage Project noise to provide quiet enjoyment to residents, even if it means temporary relocation

11.4 ELECTRIC AND MAGNETIC FIELDS

11.4.1 Proponent's Assessment

The Proponent considered changes in electric and magnetic fields (EMF) during the operation phase of the 500 kV transmission lines. EMF levels were calculated for the proposed 500 kV transmission lines at average conductor height. Magnetic fields were calculated at maximum load under normal operating conditions.

BC Hydro calculated electric and magnetic field levels for the 500 kV transmission lines and compared them to the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and the International Committee on Electromagnetic Safety (ICES) guidelines. The Proponent determined that no exceedances would occur for magnetic field levels, and, particularly, the strengths would be very low. However, BC Hydro predicted small exceedances (5.39 kilovolts per metre [kV/m] versus 4.2 of ICNIRP guidelines and 5.0 of ICES guidelines) for the electrical field levels on the right-of-way (ROW) that may cause small shocks to ungrounded persons who touch grounded objects and vice versa. However, because people do not spend a substantial amount of time in the ROW, adverse health effects associated with exposure to electric and magnetic fields were not anticipated.

11.4.1.1 Mitigation Measures

Given that predicted EMF levels are below both the ICNIRP and ICES guidelines and that few known human receptors are located within LAA, mitigation was deemed not required by BC Hydro. In compliance with the British Columbia Utilities Commission, BC Hydro would continue to review the current status of research regarding the potential for health effects from exposure to EMF, including changes in guidelines developed by the WHO, ICNIRP, ICES, Health Canada, and other relevant agencies. BC Hydro would also continue to disseminate public information on EMF.

11.4.2 Views of Participants

Health Canada supported activities that would help mitigate potential public concerns surrounding exposure to EMF, including monitoring of post-construction EMF levels near human receptor locations, and to communicate the results to concerned communities.

First Nations expressed concerns regarding potential impacts from exposure to electric and magnetic fields (EMF).

Northern Health said only monitoring would ensure actual values were in line with predicted values. They recommend that BC Hydro test the actual EMF levels, once the Project is operational, to ensure they are in line with predicted values prior to determining whether there is a need for ongoing monitoring or not.

11.4.3 Panel's Analysis

The LAA and RAA for the assessment of electric and magnetic fields contained habitation areas considered by BC Hydro as human receptor locations near the existing Hudson's Hope's substation connection. First Nations habitation sites were also identified near the extension of the corridor for the future 500 kV transmission lines. These locations were not specifically assessed by BC Hydro with respect to human health risks associated with electric and magnetic fields.

The Panel asked participants to identify the precise locations of First Nations habitation sites and their use. The Panel was provided with little detail on these locations, how they are used, and for what duration. This leads to the conclusion that fieldwork is required to determine if any of these habitations would eventually be in or adjacent to the future transmission line corridor. The same conclusion would apply for human receptor locations near the existing Hudson's Hope's substation connection.

It is understood that the predicted values are not expected to exceed exposure limits. However, as indicated by Northern Health, exposure can only be confirmed through testing of the actual EMF levels once the Project is operational. Health Canada also supported monitoring and communication to concerned groups, particularly Aboriginal groups.

BC Hydro predicted that EMF exposure limits would not be exceeded at the right-of-way edge of the corridor, based on international exposure guidelines of the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and the International Committee on Electromagnetic Safety (ICES). Health Canada noted that the objective of the guidelines is to ensure that exposures to EMF do not cause electric currents or fields in the body that are stronger than the ones produced naturally by the brain, nerves, and heart. However, there is an international debate on magnetic fields and their association with occurrences of cancer, especially leukemia and the Panel understands that the ICNIRP guidelines do not consider that.

The Panel notes that Health Canada monitors scientific research on EMF and human health. However it does not provide guidelines for exposure to EMF because there is no conclusive evidence of any harm caused by exposures at levels found in Canadian homes and schools, including those just outside the boundaries of power line corridors. It also does not consider that any precautionary measures are needed regarding daily exposures to EMF at extremely low frequencies. Health Canada acknowledged BC Hydro's commitments to continue reviewing the current status of research on the potential for health effects from exposure to EMF and to continue disseminating information to the public on this matter.

BC Hydro's assessment indicated there would be small exceedances to the electrical field levels on the right-of-way that may cause small shocks to ungrounded persons who touch grounded objects and vice versa. This is not considered to be harmful; however, the Panel reckons that the public should nevertheless be informed.

The Panel agrees with BC Hydro's conclusion that no adverse health effects associated with exposure to electric and magnetic field are expected.

For the reasons discussed above, the Panel considers that, if the Project proceeds, there is a need to recommend level testing and communication of the results to concerned communities.

RECOMMENDATION 32
The Panel recommends that, if the Project proceeds, BC Hydro must measure post-construction electric and magnetic field levels at the right-of-way edge where habitation sites exist and communicate the results of occupants. If monitoring determines an exceedance of the International Commission on Non-Ionizing Radiation Protection guidelines (4.2 kV/m) at a habitation site, BC Hydro must provide the necessary resources for relocation.

11.5 METHYLMERCURY IN FISH

As noted in Section 3.6, increases in methlymercury are inherent in creating new reservoirs. Through the process of bioaccumulation described in that section, humans and fish-eating wildlife can be exposed to methylmercury which can result in health problems.

11.5.1 Proponent's Assessment

Operation of the Site C reservoir would result in potential increases in methylmercury concentrations in all levels of the aquatic food chain, the highest occurring in predatory fish. Changes were considered during the operation phase, specifically during Years 3 to 8, when methylmercury was predicted to peak in fish. It would then return to baseline levels within 20 years.

With respect to routes of exposure, in addition to fish consumption, BC Hydro acknowledged that methylmercury concentrations may increase in fish-eating birds and mammals in the Technical Study Area. Because BC Hydro's data indicated that people do not commonly consume fish-eating wildlife from the Technical Study Area, the assessment of country foods was limited to methylmercury exposure via fish consumption.

The Mercury Human Health Risk Assessment focused on the potential risks associated with consumption of bull trout and rainbow trout, because available data indicate that of the fish most commonly consumed by humans, these species would be the most abundant during the first decade of Project operation. Additionally, of all trout species, bull trout have the highest baseline mercury concentrations. The assessment was based on the forecasted peak methylmercury concentrations in fish, which was conservatively estimated at four times the baseline concentrations. A value of two times the baseline methylmercury concentrations in fish was used to conservatively represent the peak concentration in fish downstream of the dam. Risk would be the highest at the peak (Years 3 to 8) and would be expected to decrease once the peak has been reached.

Results of the assessment indicated that commonly consumed species of fish could be eaten by even the most sensitive age group at least twice a week without exceeding Health Canada's provisional tolerable daily intake (pTDI) for methylmercury. Comparing these results to the reported baseline consumption frequencies of fish caught in the LAA (based on Duncan's First Nation's Country Food Questionnaire and Horse Lake First Nation's Country Food Harvest Survey), it was anticipated that people would not be required to change the frequency of consumption of fish that are caught from the LAA.

BC Hydro noted that fish is highly nutritious, and consumption has been shown to protect health and promote healthy development. Avoiding fish consumption due to a perceived heath risk could result in negative health effects. The solution to fear and uncertainty regarding the consumption of fish from the reservoir would be to conduct monitoring and provide effective communication to communities regarding safe fish consumption. BC Hydro indicated that it would consult with Aboriginal communities, Northern Health, and the First Nations Health Authority prior to developing a long-term mercury monitoring plan.

BC Hydro said in its closing response that if provided with consumption information from Aboriginal groups, it would incorporate that in developing tailored health fish consumption advice for each community (this may involve the consideration of fresh vs. dried fish). BC Hydro does not anticipate collecting more data.

11.5.1.1 Mitigation Measures

A monitoring program would be initiated to monitor methylmercury levels in commonly consumed fish species to identify changes in concentrations. It would be developed with input from Aboriginal groups and other stakeholders to identify species, fish size, and preferential fishing locations. The proposed methylmercury monitoring framework would:

- Monitor mercury concentrations in the surface water column, in sport fish species and in lower trophic level biota;
- Monitor at several locations upstream and downstream of the proposed dam site and in some tributaries;
- Monitor during construction (first year following diversion and partial flooding and two year later, just prior to inundation) and operation (first, third, sixth, and tenth year following inundation and every five years thereafter until fish mercury concentrations have stabilized at a new baseline concentration); and
- Communicate monitoring results to the public.

If the monitoring results indicated changes in mercury concentrations higher than predicted, a human health risk analysis may be required to determine if the monitored mercury concentrations would necessitate a fish consumption advisory to avoid exceedance of pTDI of mercury. If monitoring and risk analysis results indicated a potential health risk related to the consumption of fish obtained from the LAA, information would be provided to responsible regulatory authorities for supporting fish consumption advisories. Any consumption advisories would be designed and implemented in accordance with federal and provincial procedures for issuing fish consumption advisories. Advisories would be issued using good practice including: culturally appropriate communications to Aboriginal groups; mechanisms to receive and respond to inquiries from local communities in regards to the advisories; and a collaborative monitoring process with Aboriginal and other communities.

No adverse residual effects on human health are expected with the BC Hydro's mitigation and monitoring program integrated with an effective communication program.

11.5.2 Views of Participants

Health Canada expressed some concern regarding the representativeness of the data BC Hydro selected to represent country food consumption patterns for Aboriginal groups located near the Project. BC Hydro used the First Nations Food Nutrition and Environment Study (Chan et al., 2011) to understand BC First Nations' dietary trends. Health Canada said this study does not represent the consumption patterns of all First Nations who are likely to consume fish from the Project area. Even though food questionnaires and surveys completed for the Duncan's First Nation and Horse Lake First Nation were used to inform the fish consumption frequency in the human health risk assessment; however, these groups are located more than 100 km downstream from the Project. Consumption patterns can differ from group to group; therefore, more reliable data obtained directly from potentially affected communities is preferred. Health Canada acknowledged BC Hydro's commitment to incorporate country food consumption data from Aboriginal groups into the long-term monitoring plan as the data is made available to them. Health Canada said additional dietary information, especially from the Treaty 8 First Nations near the proposed reservoir, would provide a better understanding of actual consumption patterns.

Health Canada pointed out the importance of accurately representing the size of the fish being consumed. BC Hydro used an average mercury concentration in fish tissue to estimate the maximum servings per week that could be safely consumed; an acceptable practice if the sizes of the fish with average concentrations are those being consumed. Health Canada recommended using a higher mercury concentration if there was uncertainty in the representativeness of using average mercury concentrations.

Health Canada supported the use of the adult average serving size (163 grams) in the absence of more-site specific data; however, it highlighted the fact that a "serving size" may not be equivalent to a "meal size." A meal may comprise more than one serving. Large portion sizes may limit the maximum number of fish servings per week as presented by BC Hydro. Health Canada suggested that consumption limits be communicated in grams per week or month rather than servings per week or month. It also recommended guidance should include what a gram of fish is equivalent to (i.e. 75 grams of fish is ½ cup) in order to make the communications more user-friendly.

Health Canada said using more representative consumption data would allow for the testing of BC Hydro's conclusion that "it is anticipated that people will not be required to change the frequency of consumption of fish caught in the LAA."

Duncan's First Nation said they do not eat fish from the Peace River; however, BC Hydro used the food consumption data from this group to inform the mercury human health risk assessment. Other groups closer to the Project indicated that they eat fish from the Peace River and more frequently than assessed. McLeod Lake Indian Band said its members may be consuming meat and fish as often as every day. Councilor Willson of the West Moberly First Nations was concerned about all of his family consuming exclusively fish during their camps, every day for two to three weeks at a time.

Health Canada provided suggestions for the design of a methylmercury monitoring program. These included means of collecting representative data through collaboration with Aboriginal communities to enable meaningful sampling of the appropriate fish species and fish size in areas where groups harvest fish. The spatial extent of the sampling program should include tributaries used by Aboriginal groups. It was also recommended that fish-eating wildlife be included in the monitoring program to cover those species consumed by Aboriginal groups.

Health Canada highlighted the importance of involving local Aboriginal communities and the First Nations Health Authority in the design, implementation, management, interpretation and communication of results from the methylmercury monitoring program for country foods.

West Moberly First Nations conducted a study of the mercury concentrations in bull trout in the Crooked River (March 2013). The tissue analysis found that the levels of mercury in the bull trout fish were elevated above the significant threshold for use by the community. Chief Willson claimed the results of the tissue analysis demonstrated a serious problem with the level of methylmercury in bull trout that migrate from the Bennett Dam into the Crooked River. He found this fact concerning, given that there is a possibility that other runs of bull trout that members of First Nations traditionally harvest in the territory, such as those in the Parsnip River, have elevated levels as well.

First Nations reported that Health Canada had used notices in weekly country newspapers, such as the Hudson's Hope that are not read by First Nations, despite Health Canada's statutory responsibility for on-reserve health matters.

Health Canada acknowledged the concerns of Aboriginal groups regarding the perception of increased risk and lack of trust in traditional food sources that may lead to avoiding these sources and switching to commercial sources. This may have an impact on nutritional value of their diet. Health Canada agreed with Northern Health's recommendation to maintain open lines of communication with communities and other agencies to allow issues or concerns with potential impacts to human health to be addressed as proactive as possible.

Health Canada suggested the Panel consider recommending that BC Hydro work with all levels of government to communicate information to Aboriginal groups and others regarding potential fish consumption advisories and other health related bulletins or information as may be necessary.

11.5.3 Panel's Analysis

The Panel agrees with Health Canada that there is a need for more representative fish consumption data. BC Hydro has committed to incorporate country food consumption data from Aboriginal groups into the long-term monitoring plan as the data are made available to them.

Regarding fish consumption data used by BC Hydro in the Mercury Human Health Risk Assessment, the Panel concludes there are no reliable data available at this point.

Reliable data are required to test BC Hydro's conclusion that "it is anticipated that people will not be required to change the frequency of consumption of fish caught in the LAA".

RECOMMENDATION 33
The Panel recommends that, if the Project proceeds, BC Hydro must work cooperatively to obtain site-specific data from Aboriginal groups. The dietary information to be collected from potentially impacted groups should include:

- Species and size of fish caught for consumption;
- Location where fish are caught for consumption;
- Consumption of fish by age group;
- Parts of fish consumed;
- Fish preparation methods;
- Fish meal sizes by age group;
- Fish meal frequency; and
- Other relevant consumption information (e.g. events where consumption is higher over a short period of time such as a camping event).

BC Hydro should make an effort to ensure data is current until mercury concentrations stabilize at the new baseline value.

The Panel concludes that only monitoring of the fish in the reservoir and the consumption habits of the people would provide an adequate base for the development of effective mitigation measures for methylmercury.

RECOMMENDATION 34
The Panel recommends that, if the Project proceeds, the monitoring program must require the collaboration of Health Canada and include:

- Involving local Aboriginal communities and the First Nations Health Authority in the design, implementation, management, and interpretation and communication of results from the methylmercury monitoring program for fish;
- Collecting representative data through collaboration with Aboriginal communities to enable meaningful sampling of the appropriate fish species and fish size in areas where groups harvest fish. The spatial extent of the sampling program should include tributaries used by Aboriginal groups; and
- Working with all levels of government to communicate information to Aboriginal groups and others regarding potential fish consumption advisories and other health-related bulletins or information as may be necessary.

The Panel believes that an advisory (if needed) is not adequate mitigation for potential health effects associated with fish consumption in the LAA. Additionally, there is a perceived risk regarding fish contaminated with methylmercury that may lead to the avoidance of fish from the LAA as dietary sources. Moreover, the Panel believes that BC Hydro's table indicating the maximum number of fish servings per week that can be consumed pre- and post-inundation methylmercury peak is not easily understood. Furthermore, it does not provide any useful guidance to those people eating more than one species of fish.

RECOMMENDATION 35
The Panel recommends that, in the event that Health Canada determines a consumption advisory is needed, the Chief Medical Officer of Northern Health must be notified by Health Canada. The advisory should be designed and implemented in accordance with federal and provincial procedures for issuing fish consumption advisories. It should be issued using good practice including:

- Culturally appropriate communications to Aboriginal groups;
- Mechanisms to receive and respond to inquiries from local communities in regards to the advisories; and
- A collaborative monitoring process with Aboriginal and other communities.

RECOMMENDATION 36
The Panel recommends that, if the Project proceeds, effective communication with Aboriginal communities and other stakeholders is required by Health Canada whether an advisory is needed or not. This should include:

- Communication of the results of the Mercury Human Health Risk Assessment, including guidance for people consuming more than one species of fish and how they can continue to eat multiple species without exceeding the provisional tolerable daily intake for methylmercury; and
- Communication of consumption limits in grams per week rather than servings per week. Further guidance should be provided as to what a gram of fish is equivalent to in order to make the communications more user-friendly.

11.6 OTHER PARTICIPANT VIEWS RELATED TO HUMAN HEALTH

Participants indicated that mental health was not included in the human health assessment. It was specifically pointed out regarding mental health impacts on Aboriginal people in response to the changes caused by the Project (e.g. loss of culture). Northern Health discussed this issue in terms of community health impacts. Peace River Regional District Directors Area B and C also pointed out the stress caused by the Project on people in the area that may have negative health results, particularly those that may be expropriated or heavily impacted by the Project.

Treaty 8 Tribal Association and Saulteau First Nations had concerns about Project effects on the health and well-being of Aboriginal people. Saulteau First Nations highlighted that social and cultural impacts lead to the loss of identity, and because identity is often tied to the land, the loss often results in substance abuse and can lead to injury and death. It was indicated that more cultural programs are required to address these types of issues.

Treaty 8 Tribal Association (T8TA) highlighted that the in-migration associated with the Project would further pressure an already strained health system that Aboriginal people have a hard time accessing. It indicated that, due to limited health care resources, Aboriginal people often do not receive timely treatment or are limited to treatment via emergency room visits. There are challenges to attracting and retaining qualified health professionals in communities. BC Hydro's mitigation measures would not address the issues associated with the in-migration effects of the Project. BC Hydro is primarily relying on government (i.e. Northern Health and RCMP) and local service providers to deal with the effects of population increase with little or no financial support.

In response, BC Hydro said that impact benefit agreements can include provisions for Aboriginal groups to address such social issues as better access to health services, social services, and housing, as noted in Section 10.3. The Proponent's representative, Ms. Jackson, said "If the

Treaty 8 First Nations wished to negotiate with BC Hydro toward an impact benefits agreement, such funds would be available for their purposes in targeting the needed improvement areas, should they wish to use them in that manner."

11.7 PANEL'S OVERALL ANALYSIS ON HUMAN HEALTH

The Panel received information from participants regarding human health that were not included in BC Hydro's human health assessment. The Panel recognizes that some of these issues are outside the Proponent's competence and responsibility, but there may be consequences related to the Project that need to be pointed out and addressed.

According to BC Hydro, human health effects are not anticipated as result of the Project with the implementation of the mitigation and monitoring proposed. It is important to note that this conclusion was based on modeled or predicted data. There is uncertainty regarding what actual measured values for the media discussed above would be and how effectively the mitigation measures would work.

BC Hydro compared predicted levels to the appropriate objectives, standards, and guidelines and indicated that, with mitigation, there would be no exceedances; therefore, no residual Project effects. The Panel believes there may be additive effects of changes in different media occurring simultaneously (i.e. increased noise in addition to reduced air quality) and these were not assessed. Where predicted values are near but below the regulatory levels, there should be careful monitoring, noting that people who experience high noise levels may also be likely to experience degraded air quality and these effects would be additive. These additive effects may be stressing for some people and may be of particular concern during some of the construction periods in areas close to the dam site and Hudson's Hope shoreline protection area. For instance, the Panel has determined that at least one residence would experience exceedances for noise and air quality.

The Panel concludes that some homes close to the construction of the dam and in Hudson's Hope shoreline protection activity area would experience an increase in noise combined with a degradation of the ambient air quality.

RECOMMENDATION 37
The Panel recommends that, if the Project proceeds, where monitoring indicates that homeowners are experiencing serious nuisance as a result of the Project, BC Hydro be required to mitigate those effects, up to and including relocation if necessary.

The Panel agrees with the Proponent that there would be no significant adverse effects on human health taking into account the mitigation measures proposed by the Proponent and the Panel recommendations.

Because the Proponent concluded that there were no residual effects anticipated there was no requirement for it to conduct a cumulative effects assessment on the human health valued component. The Panel found that the effects of the Project may not be mitigated completely and the actual results must be confirmed through monitoring. Therefore a residual effect from the

Project potentially remains and may interact with residual effects from other past, existing or future projects in the RAA.

For the production of methyl-mercury, the Panel takes note that mercury contamination from the Williston reservoir has decreased and returned to baseline levels, therefore it would not combine with the methylmercury predictions of the Project.

The Panel recognizes that current measurements of ambient air quality present a combination of what exists at present, which may be left over from the past in terms of particulate matters and dust. For future projects BC Hydro's evaluation in the area indicates that oil, gas and forestry may contribute to air and noise effects, as well as any projects and activities in the City of Fort St. John. The Panel determined that no residual effects would occur with the Project, therefore no cumulative effects assessment is required with respect to air quality.

For EMF, the Panel determined that there are potential residual effects to be confirmed through monitoring. In this case, cumulative effects are not expected.

With respect to water quality, the Peace River Environmental Society of Alberta, Natural Resources Canada, the Government of Alberta and Mike Rudakewich shared concerns on the cumulative impact of natural and anthropogenic influences downstream, including Site C. The Panel acknowledges the uncertainties that lie downstream due to changes in hydrology as a result of the Project. The Panel has proposed an adaptive management plan which could determine if any effects occur. Should effects occur, they may combine with other influences of water quantity and quality and will require future assessment and possibly mitigation.

Because of the uncertainty in the assessment, the Panel concludes that there is no need at present to do a cumulative effects assessment on health indicators but that one may be required once effects are confirmed through monitoring.

12 HERITAGE RESOURCES

In this chapter, the Panel assesses the effects of the Project on physical heritage, cultural heritage, including intangible heritage, and visual resources.

12.1 PHYSICAL HERITAGE

This section includes the review of paleontological sites and locations containing fossils, archaeological sites, or physical evidence of past human activities and historical sites as defined by the B.C. Archaeology Branch 1998. This section also incorporates information based on the Proponent's interviews with local and regional historical societies, museums, other organizations, and local residents.

12.1.1 Proponent's Assessment

BC Hydro conducted an assessment of the potential for the Project to adversely affect heritage resources by considering changes to the following key aspects:

- Changes to resource integrity
    - Disturbing heritage sites and features
    - Disturbing elements essential to the heritage character or features
    - Disturbing artifacts, features, human remains, and fossils
- Changes to resource accessibility
    - Hindering or increasing access to sites and destroying contextual information
- Other relevant considerations raised by Aboriginal groups

BC Hydro assessed the effects of the Project on paleontological, archaeological, and historical sites, objects, and features within the local assessment area (LAA) and the regional assessment area (RAA). The LAA and the RAA were denoted by the same boundary and were the areas where direct and indirect disturbance was likely to occur. BC Hydro stated that these areas were used for the assessment because heritage sites are fixed in space and the Project would not have an effect on heritage sites beyond these limits.

BC Hydro noted that potential effects on heritage resources could occur directly as a result of surface and sub-surface disturbance as well as inundation and operation of the reservoir. Indirect effects were stated to possibly occur as a result of increased public access. BC Hydro noted that there would be no interaction of the Project with heritage resources downstream of the dam site because of the limited change in flow regime as a result of the Project.

BC Hydro initiated a heritage program in 2010 that involved consultation with agencies and Aboriginal groups on site identification and a field inventory to collect baseline data. BC Hydro said that some fieldwork would still be required for components such as access roads, quarries, a transmission line tie-in at Peace Canyon Dam, existing infrastructure that needs to be relocated, private lands, and a possible human burial site. BC Hydro committed to completing this work prior to the start of construction.

12.1.1.1 Paleontological Resources

Fieldwork conducted in 2011 and 2012 identified a total of 173 paleontological sensitivity areas in the LAA: 26 Class I, 113 Class II, and 34 Class III. Class I areas were described to be the

most important locations because they may contain unique fossils in situ, abundant and diverse specimens, good preservation level, and multiple time depth representation. This may result in potential educational or commercial opportunities. Class II and III areas were categorized as sites of moderate or low importance, with lower preservation and abundance and higher disturbance than Class I sites. Locations where significant clusters of fossils were found were placed in 11 fossil complexes. Observed and collected fossil types from these locations in the LAA included: ammonites and other molluscs, fish scales, fragmented plants, algal individuals, dislodged dinosaur teeth and vertebrate bones, possible dinosaur and other tracks and trace fossils, and jellyfish impressions. BC Hydro noted that field inventory is still required at some of the potentially affected sites.

12.1.1.2 Archaeological Resources

In assessing the effect of the Project on archaeological resources, BC Hydro conducted an extensive archaeological program including approximately 70,000 shovel tests. From this field program, BC Hydro identified a total of 296 archaeological sites, to date. These identified sites comprise 38 Class I and 210 Class II areas. BC Hydro noted that Class I and Class II sites that could not be avoided through the Project design would be considered for data recovery. This would include three archaeological site complexes containing high densities of Class I and II areas, namely Wilder Creek–Jim Rose Prairie, Cache Creek–Bear Flat and, Cache Creek–Watson Slough.

BC Hydro used a model to determine erosion potential which indicated the sites that would be the most and least susceptible to erosion. The Proponent used it to predict the effects on archaeological and historical sites associated with filling, commissioning, and operation of the reservoir.

BC Hydro stated that some fieldwork is still required in some areas of potential disturbance and that some ground truthing with elders and First Nations may still be conducted. BC Hydro noted that the *Heritage Conservation Act* permit contains a number of days for this purpose. Should specific sites be identified by First Nations through this process, BC Hydro committed to update the archaeology model to reflect the additional specificity.

In response to concerns about a previous permit infringement during geotechnical fieldwork, BC Hydro stated that it has changed field practices with respect to surface and subsurface disturbance and will ensure that no decisions would be made in the field without consultation.

12.1.1.3 Historical Resources

BC Hydro recorded 42 historical sites within the LAA: Of these, 9 Class I, 21 Class II, and 8 Class III. The remaining sites could not be classified.

Rocky Mountain Fort and Rocky Mountain Portage House were identified as Class I historical sites protected by the B.C. *Heritage Conservation Act*. BC Hydro stated that it would consider them for systematic data recovery (excavation) to expose and identify additional architectural details and to gather a sample of artifacts. BC Hydro explained that previous excavations at Rocky Mountain Fort were not oriented toward data recovery.

BC Hydro recorded five historic period human graves at two locations in the LAA. These two locations are protected by the B.C. *Heritage Conservation Act*, and are identified as Class I historical sites, meaning that they have heritage significance, good integrity, and are in good condition. Although BC Hydro noted that it has received traditional land use studies from First Nation groups, they do not contain the specificity to identify specific burial locations. BC Hydro

committed to offering ground truthing days with elders and First Nations during pre-construction to confirm any burial remains. BC Hydro noted that, with respect to burials and human remains, it would be required to comply with protocols outlined in the *Heritage Conservation Act* and the *Burials and Cremations Act*.

12.1.1.4 Mitigation Measures

The approach described by BC Hydro to mitigate potential effects to heritage resources includes a combination of avoidance, effect reduction or minimization, documentation, systematic data recovery, monitoring, and compensation-in-kind. This approach is generally applicable to Class I and II sites. Class III areas would not be considered by BC Hydro for further mitigation work beyond adherence to established chance find procedures. It stated that the proposed mitigation strategy would aim to reduce adverse effects on heritage sites and to provide a positive effect by recovering data that adds to the knowledge of paleontology, prehistory, and human use of the LAA over time. It further said that, while the effects of Project activities on paleontological, archaeological, and historical resources would be similar, the mitigation measures would differ for each. Details are provided in Appendix 9.

BC Hydro noted that, in the absence of specific legislation, these measures would be consistent with best practices for mitigating effects of the Project on paleontological resources. For archaeological sites that the Project could not avoid, including work in the three high-density areas, BC Hydro would consider wide excavations and systematic data recovery, and determine additional mitigation measures in consultation with Aboriginal groups and the B.C. Archaeology Branch during permitting.

BC Hydro proposed mitigation measures for Rocky Mountain Fort, including relocation, systematic data recovery, capping, monitoring, and compensation-in-kind (replication). Prior to construction in areas with potential burial grounds, mitigation would be established in accordance with legislation and in consultation with stakeholders, for instance, the descendants of the deceased.

BC Hydro stated that all of the artifacts that have been collected will go to the Fort St. John Museum, the named repository in the permit issued for undertaking that work. The artifacts would be fully catalogued prior to delivery to the museum. BC Hydro conceded that artifacts recovered may also be of interest to several different centres. As a result, BC Hydro said that it would work with these centres and has already engaged with Hudson's Hope Museum, the Fort St. John Museum, and the Tumbler Ridge Paleontological Centre to discuss their involvement in the heritage and mitigation programs. In response to the presentation by the Hudson’s Hope Historical Society, BC Hydro noted that protected artifacts have been placed in facilities authorized by the B.C. Archaeology Branch and that any facility, including First Nation communities, can seek to become an approved repository.

Further mitigation measures would include scheduled monitoring of the reservoir for shoreline erosion in the first five years. The need for additional monitoring would be evaluated after the fifth year. In the event of low reservoir occurrences for scheduled and unscheduled maintenance, emergency salvage and systematic data collection of exposed resources would help to mitigate the potential effects of erosion and the unauthorized collection of heritage materials.

12.1.1.5 Determination of Significance

BC Hydro stated that the process for determining significance of effects to heritage resources depends on the value of the site and the mitigation strategies to offset the effects, combined

with follow-up monitoring and mitigation. BC Hydro noted that significant effects should only occur when the applicable legislation is not followed or when unforeseen effects occur that cannot be mitigated to applicable standards.

BC Hydro concluded that alterations could occur to heritage resources where sensitivity was determined to be of high, moderate, and low heritage value. Implementing site-specific mitigation measures may offset the adverse effect or create a beneficial effect through collection and curation. BC Hydro noted that the B.C. Archaeology Branch would determine whether planned alterations and mitigation strategies were acceptable for archaeological and historical sites, and that the residual effects would need to be mitigated before the Project could proceed. BC Hydro concluded that the magnitude of effects would be low or moderate, depending on heritage value, and that the residual effects of the Project on heritage resources would not be significant.

12.1.1.6 Cumulative Effects Assessment

BC Hydro conducted a cumulative effects analysis within the LAA and concluded that no other foreseeable projects would overlap with the Project. As such, BC Hydro did not identify any cumulative effects.

12.1.2 Views of Participants

Participants expressed concerns with the assessment conducted by BC Hydro, including thoroughness and completeness of the field studies. First Nation groups, in particular, were frustrated with the effects assessment for physical heritage resources and the proposed mitigation measures.

Their main source of frustration stemmed from the effects presumed from the Bennett and Peace Canyon Dams. Hudson's Hope Historical Society noted that there has already been extensive loss of physical heritage sites, materials, and knowledge due to the construction of these dams, combined with the recent increase in shale gas and coal exploration. The McLeod Lake Indian Band also reported the loss of "an enormous quantity" of prehistoric and historical archaeological and First Nations' heritage resources as a result of the Bennett Dam and its reservoir.

Chief Willson of West Moberly First Nations asked BC Hydro if it had established mitigation for the loss of these sites. BC Hydro responded that it has been consulting Treaty 8 groups about those losses, but had not yet received particular information about respecting those grievances. Chief Willson stated concerns that if BC Hydro did not yet understand the effects of its previous operations on the local First Nations, it may not have fully accounted for effects related to the Project.

Many participants, including Aboriginal people, expressed concerns that the area that would be inundated by the Project contained artifacts and graves. Métis Nation British Columbia identified four burial sites located near the proposed reservoir on the shores near Hudson's Hope. Duncan's First Nation identified three burial sites located downstream of the proposed reservoir, northeast of Manning on the west bank, and stated concerns that the fluctuation in water levels during release periods would affect these graves. Aboriginal participants spoke of respecting the past of their ancestors and feared that, if not cared for properly, they would become dislodged and float to the surface.

Other participants noted concerns about the loss of specific sites to flooding or other construction activities. The Métis Nation British Columbia stated that the loss of the Rocky

Mountain Fort would be particularly troubling for many Métis in the region. Hudson's Hope Historical Society recommended that mitigation plans be focused on impacts to this site. The Society also noted that construction of other Project components could impact historical sites from the early 1900s, including a ferry landing for a paddle wheeler and a historic portage trail.

Karen Aird, an archaeology consultant for West Moberly First Nations, noted that the Peace River region was important for physical heritage due to the wide range of known travel routes. She stated that cultural records revealed a high frequency of prehistoric material residue such as flakes, projectile points, and scrapers. She claimed that these sites, even small sites, were highly significant for scientific and cultural reasons. The McLeod Lake Indian Band stated that the loss was not necessarily of the site itself, but of knowledge that would add to the understanding of routes used by Aboriginal people migrating through North America in prehistoric times.

Ms. Aird detailed a few recently uncovered deeply stratified sites near the Peace River. She stated that in order for these sites to be documented and studied, West Moberly First Nations would require an intimate knowledge of the landscape and additional time, due to the labour-intensive nature of these sites. Her concerns with the construction of the Project revolved around the direct loss of undocumented and perhaps highly significant sites and indirect loss through the inability to access remaining archaeological sites for identification, documentation, and understanding. She also expressed concerns about opening up access to sites that could be looted.

Hudson's Hope Historical Society suggested that efforts be made to identify, document, preserve, and interpret the historical resources potentially affected by the Project. A few participants noted that when artifacts are moved, the historical significance of the sites and the connection to them are lost. Organizations that favored salvaging the artifacts, should the Project proceed, noted that they had limited resources to house and display recovered artifacts. Two participants said that artifacts found at the Peace Canyon Dam went to Drumheller or Toronto because those facilities were able to take them.

Hudson's Hope Historical Society said their museum has limited storage for new artifacts, but it recently became an authorized repository and would not want to be overlooked as a repository. Some First Nation participants noted that had been no consultation on artifacts found during construction of the previous dams or during field surveys for the Project. There was some discussion by several participants that recovered artifacts should be returned to the appropriate First Nations for storage.

BC Hydro's response was that protected artifacts are placed in authorized facilities and any organization or First Nation community could work with the B.C. Archaeology Branch to develop such facilities.

12.1.3 Panel's Analysis

The Panel acknowledges concerns of interested parties about the modeling conducted by BC Hydro. The Panel believes that conducting over 70,000 shovel tests and collecting two years of data constitute best practice. The Panel is satisfied that this extensive modeling would provide an appropriate indictor of the level of effects that would likely occur should the Project proceed. It is understood that not all data is required for this stage of environmental assessment, and the Panel acknowledges BC Hydro's commitment to continue data collection in the areas noted. The Panel notes that BC Hydro committed to update the archaeology model to reflect additional specificities once the field program is complete.

The Panel agrees with the general proposal of BC Hydro to mitigate potential effects to heritage resources, first by avoidance, then by effect reduction, and lastly, by artifact recovery, with compensation as needed. Where avoidance of archaeological sites is not possible, the Panel is reassured that BC Hydro would be required to mitigate effects in consultation with the B.C. Archaeology Branch during permitting and that the branch would determine whether planned alteration and mitigation strategies are acceptable. Furthermore, the Panel is comfortable that mitigation work in the three high-density areas would be determined in discussions between BC Hydro and the B.C. Archaeology Branch and Aboriginal groups. The Panel has confidence that the Archaeology Branch will set appropriate measures because the *Heritage Conservation Act* is binding. The Panel views this approach to mitigation as “as good as possible.”

The Panel understands that, as part of the issued permit, a number of days would be allocated for fieldwork with Aboriginal groups. The Panel is satisfied with BC Hydro’s commitment that the ground truthing days with elders and First Nations during pre-construction would confirm any burial remains, and that in such cases, BC Hydro would be required to comply with protocols outlined in the *Heritage Conservation Act* and the *Burials and Cremations Act*. The Panel acknowledges that BC Hydro is already hiring First Nation members to this end and encourages continuation of this practice. The Panel strongly encourages Métis community members to participate in these ground truthing days to identify any of their burial sites that the Project may disturb.

However, the Panel notes that there is no provincial oversight to ensure appropriate mitigation for paleontological resources.

Although the Proponent expected no downstream effects, sites had been previously identified in the downstream area. The Panel considers it important that BC Hydro set up monitoring for the first years of operation.

With respect to the determination of significance, Class I sites are defined as sites that have heritage significance, have good integrity, and are in good condition. The Panel considers that, for Class I sites that would be permanently lost, the magnitude of the effects should be characterized as high because the heritage resource is of high value, by definition. The Panel disagrees with BC Hydro that residual effects would be adverse, in this case, but not significant.

The Panel agrees with participants who stated that removing an artifact from its location removes some of its heritage value. It appears to the Panel that, despite the implementation of mitigation, only avoidance would result in an elimination of effect, and there would be a loss of many Class I sites in the LAA regardless, should the Project proceed. The Panel agrees with the North Peace Historical Society, the Hudson’s Hope Historical Society, and the City of Fort St. John that, although mitigation could recover these artifacts, much of the historical significance of the sites and the connection to them would be lost.

This is especially true for sites that are already protected under the B.C. *Heritage Conservation Act*, such as Rocky Mountain Fort and Rocky Mountain Portage House. The proposed mitigation program of relocation, systematic data recovery, capping, monitoring, and compensation-in-kind (replication) for these two sites is praiseworthy, but even if done according to artful best practices, it would result in the loss of their historical significance.

The Panel concludes that effects on any Class I sites are significant because of the high magnitude and the irreversibility of effects. This conclusion takes into account the proposed mitigation measures by BC Hydro.

The Panel concludes that residual adverse effects on physical heritage resources caused by the Project would be adverse and significant.

The Panel agrees that the recovery and display of affected heritage resources would provide some benefit to their disturbance and would alleviate some concerns from participants about losing the historical knowledge. However, as noted above, the benefit is dampened by the extraction of the resource from its historical significance. Furthermore, if these resources are transported outside of the region for catalogue and display, their historical significance is even further diminished. The Panel acknowledges BC Hydro's commitment to work with local institutions in their mitigation planning; however, the Panel heard from these organizations that they have neither the credentials nor the resources to care for these artifacts.

RECOMMENDATION 38
The Panel recommends that, if the Project proceeds, BC Hydro must monitor reservoir erosion during occurrences of low reservoir levels and investigate, according to the requirements of the Archaeology Branch of the Ministry of Forests, Lands and Natural Resource Operations, any potentially new-found sites and carry out emergency salvage.

RECOMMENDATION 39
The Panel recommends that, if the Project proceeds, BC Hydro must conduct monitoring of shoreline erosion downstream (for approximately 2 km) as part of its chance find procedures to determine if physical heritage resources are affected. The Panel recommends that BC Hydro undertake this monitoring for any spills from the Project reservoir, for a period of 2 years.

RECOMMENDATION 40
The Panel recommends, if the Project proceeds, that BC Hydro must continue its collaboration of First Nations and the Métis Nation British Columbia, for the days committed on ground truthing for the identification of any burial sites that the Project may disturb.

RECOMMENDATION 41
The Panel recommends that, if the Project proceeds, BC Hydro must provide sufficient funds to local accredited facilities in close proximity to the Project to curate and display the recovered resources. The Panel further recommends that these funds be provided only to facilities that agree to work with Aboriginal groups on the display and curation of those artifacts.

12.1.3.1 Cumulative Effects Assessment

BC Hydro conducted its cumulative effects assessment on the basis that a particular site was affected by the Project, combined with past, present, and reasonably foreseeable projects. The Panel disagrees with this approach and views the assessment of heritage resources more broadly.

Participants in the hearing underlined that the Peace River was a route used for over 10,000 years and that the river contained many heritage resources not known or discovered. Those

participants said that paleontological, archaeological, and historical sites have already been lost with the construction of the existing upstream facilities and claimed that this loss was significant for scientific and cultural reasons.

The Panel is swayed by the argument and believes that, based on the historical information provided about the river and the number of Class I sites in the LAA, other areas along the river contained many sites that have been lost. The significance of the LAA indicates the value of the area and underlines the potential for past and future loss to culture and science.

The Panel concludes that the cumulative adverse effects on heritage resources would be significant.

12.2 CULTURAL HERITAGE

The *CEAA Reference Guide on Physical and Cultural Heritage Resources* defines cultural heritage as “a human work or a place that gives evidence of human activity or has spiritual or cultural meaning, and that has historic value. Cultural heritage resources are distinguished from other resources by virtue of the historic value placed on them through their association with an aspect(s) of human history.”

12.2.1 Proponent’s Assessment

BC Hydro recognized that the Peace River was designated as a Heritage River by the Province of B.C. in 1998, which established it as “a river managed for a variety of resource-based uses, including power generation, a critical cornerstone of the province's economy, while maintaining representative natural heritage qualities and recognising the historical heritage value of the river corridor to First Nations and non-aboriginal people.” BC Hydro noted that the landscape of this Heritage River comprises the Peace River itself, the valley, its associated benchlands and uplands, and a rural landscape characterized by farms within and outside the valley. BC Hydro stated that the construction of the Project is consistent with the establishment of the river as a Heritage River by the province and concluded that the landscape downstream of the proposed dam would remain unchanged and that the upstream landscape, while shifting from a river to a reservoir, would maintain the characteristic benchlands, uplands, and rural features already present.

BC Hydro recorded cultural heritage features of importance to residents and Aboriginal people, such as landscape features, aspects of settlement and interaction with the environment, developing economies, and building social and community life. BC Hydro also included in its assessment “changes in cultural uses of the land” by Aboriginal groups including place names, gathering places, teaching areas, ceremonial and sacred areas, and burial sites or sites that served a combination of uses. BC Hydro noted that, while an explicit assessment of intangible resources was not required, it was taken into account in the assessment on cultural and traditional uses of the land.

BC Hydro stated that most cultural use areas were located along the shore of the Peace River, with a higher concentration at stream confluences on the north shore. Several places reported by BC Hydro as having high cultural value within the LAA would be inundated, including: Attachie, Bear Flat; Farrell Creek; Bull Flats; Coffee Pot; Hudson‘s Hope (near Maurice Creek); Lynx Creek; Dry Creek; between Farrell Creek and the Site of Farrell; Moberly River to Fort St. John Historical site; and, Fort St. John Historical site. BC Hydro stated that, although adaptation

to the new landscape would be possible by Aboriginal groups, the success of such adaptation would require the return of conditions supporting both current use activities and concerns supporting broader cultural aims (teaching, ceremony, and other cultural uses). BC Hydro concluded that many identified sites of Aboriginal importance would not be affected by the Project.

For effects on non-Aboriginal cultural heritage, BC Hydro stated that rural farm heritage would continue because the majority of farms that are affected are only partially affected and can continue operations.

BC Hydro proposed various mitigation measures which are outlined in Appendix 9. Because the assessment on cultural heritage was undertaken with the assessment of current use of lands and resources for traditional purposes, these mitigation measures will be outlined there.

12.2.1.1 Determination of Significance

BC Hydro recognized that Aboriginal groups have indicated the Peace River holds spiritual and cultural value for them and that places that Aboriginal groups value and use for multiple purposes would be permanently changed or lost by the construction of the Project. BC Hydro identified three sites along the Peace River, Bear Flat, Farrell River, and Attachie that are of particularly high value for Aboriginal groups. BC Hydro said these sites would be permanently lost and access to them impaired through inundation. Because of the permanent removal of these places from the landscape, BC Hydro determined significant adverse residual effects for Doig River First Nation, Halfway River First Nation, Prophet River First Nation, West Moberly First Nations, Blueberry River First Nations, Saulteau First Nations, and McLeod Lake Indian Band (for the location at Attachie). The Proponent stated that adaptive response to these changes by Aboriginal persons is unknown.

12.2.2 Views of Participants

Several participants relayed the history of the area during the public hearing and referenced the fact that the Peace River was a designated Heritage River. Participants viewed this status as noteworthy. Participants explained that, pre-European arrival, the area was used heavily by Aboriginal people. European arrival coincided with the fur trade, and participants noted that the river was the route for fur traders and explorers such as Alexander Mackenzie and Simon Fraser, who came through the valley. Alexander Mackenzie established Rocky Mountain Fort in 1793 after his overland expedition near present-day Fort St. John, at the confluence of Moberly and the Peace Rivers. In 1805, Simon Fraser established Rocky Mountain Portage House near Hudson’s Hope, which is now a numbered heritage site. The Métis Nation British Columbia noted that the Métis people played an important role in establishing the series of forts built in that time. It noted that this history is critical to understanding the lived experience of the Métis. Métis Nation British Columbia explained that John Baptiste Boucher travelled with Simon Fraser for a number of years and was recorded as the first Métis to make a life in B.C. It was further noted that all Métis patronyms can be traced back to the fur trade. Hudson’s Hope Historical Society noted that one can look at the river and imagine Alexander Mackenzie, Simon Fraser, and David Thompson paddling on it more than 200 years ago. The Society postulated that it would be difficult to maintain that visualization should the Project be constructed.

Rachel Darvill spoke of what she calls “ecosystem services” along the Peace River. She described these as the activity, function, condition, or process of natural ecosystems that benefit and sustain human life, and that have value for people. She noted that these services rely on tangible aspects of the landscape, such as timber, fibre, food, and pharmaceuticals; intangible

aspects such as aesthetic views, recreational opportunities, and landscapes with scientific or educational value; and cultural aspects such as sense of place, historical cultural heritage, and healing. She noted that the largest ecosystem service hotspot was along the Peace River, extending from Hudson's Hope to the mouth of the Halfway River. Interest groups surveyed noted that this hotspot is used for both cultural and provisioning ecosystem services but that the top-three indicators were cultural (aesthetic or scenic values, recreational opportunities, and spiritual or religious values).

The Peace River valley was also described as "a special place" by Aboriginal groups. Tribal Chief Liz Logan noted that the valley was sacred for members of Treaty 8 Tribal Association and an important place where members gathered. West Moberly First Nations members noted that these places were important for teaching and the transmission of knowledge and culture. The Halfway River and its confluence (Attachie) with the Peace River (Attachie flats) were referenced by many participants as ancestral gathering places for Dane-zaa families, noting that it was still used today. Other key places recognized as gathering places included Farrell Creek, Lynx Creek, Bear Flat, Old Fort, and Taylor. Many participants at the Community Hearing Sessions presented videos and told stories demonstrating their attachment to the land and their connection to areas where they gather for spiritual activities. One voiced concerns that Aboriginal heritage, livelihood, way of life, and connection to the land would be wiped out and stated that this loss would have physical and mental impacts on the residents. She claimed that the existing upstream facilities had such impacts.

Tribal Chief Logan stated that the areas that would be impacted by the Project contain archaeological and heritage sites, spiritual sites, gravesites, and areas important for the practice of treaty rights. George Desjarlais, former Chief of West Moberly First Nations, underlined that a sacred site used for teachings and initiations near Hudson's Hope (the "singing rock") would be lost. He also expressed concerns that the Project would affect important sweat lodges.

The Métis Nation British Columbia identified cultural sites in a study area around the Peace River to be birth sites, burial sites, death sites, settlements, gathering places, and protection sites. It noted that places of gathering are generally associated with overnight sites where Métis meet on a semi-regular basis to hunt and gather or for cultural or spiritual purposes. These places were identified as important sites for solidifying, maintaining, and developing kinship networks. Along the Peace River, the Métis Nation British Columbia recorded many overnight sites with conglomerations appearing at the Project site, between Bear Flat and Attachie flats, downstream of Farrell Creek, at the confluence with Lynx Creek, and at Hudson's Hope.

Treaty 8 Tribal Association noted that the site 7B alternative to the Project would preserve more heritage sites important to its members because the landscape would be largely maintained. Furthermore, it noted that highly valued cultural sites at Bear Flat, Attachie, and Moberly and Farrell Creeks would be preserved.

Dr. Craig Candler, introduced by Treaty 8 Tribal Association, concluded that BC Hydro did not meaningfully assess intangible cultural resources as required by the EIS Guidelines in its assessment of the Project. He described intangible cultural heritage resources as being values, knowledge, skills, traditions, sharing, and maintaining relationships. He stated that these resources are not necessarily fixed to a particular geographical location, but are nonetheless critically important. Aboriginal participants also expressed concerns that intangible heritage sites had not been properly considered. Treaty 8 Tribal Association explained that values, knowledge of fishing areas, the use of medicinal plants, skills such as cooking and preparing hides, and sharing social relations were elements of critical importance to their Nations but were not addressed by BC Hydro.

Treaty 8 Tribal Association explained that water in general is sacred and vital to the cultural and physical survival of the Dane-Zaa people and that the impact of the Project on this had not been assessed. It further explained that the Peace River is a revered area where the dreamers made predictions about the future.

Aboriginal groups stated that the potential effects of the proposed Project on these intangible cultural resources would include:

- Impacts to areas or sites of high value for teaching, gathering, and transmission of current and traditional knowledge of the lands and natural resources through inundation and increased access to non-Aboriginal people;
- Permanent alteration of the Peace River valley as a known and highly valued cultural landscape for Aboriginal peoples; and
- Loss of a unique sense of place, well-being, and quality of life of Aboriginal peoples directly or indirectly resulting from degradation of intangible cultural resources.

Karen Aird, on behalf of West Moberly First Nations, also stated that there was a significant gap in information related to intangible cultural heritage. She advised that this gap needed to be understood and accommodated for and that successful methods of conserving intangible and tangible heritage resources associated with the Peace River region need to be determined. She noted the “inescapable fact” that, once a cultural landscape is removed or modified in an irrevocable manner, peoples’ relationships and memories associated with it are usually permanently lost or distorted.

12.2.3 Panel’s Analysis

The Panel, in its assessment, distinguishes between physical heritage and cultural heritage through evaluating a “thing” of heritage value or a “place” of heritage value. This is consistent with the *CEAA Reference Guide on Physical and Cultural Heritage Resources*, which notes that cultural heritage is distinguishable because of the spiritual or cultural value placed on it through association with an aspect(s) of human history.

BC Hydro recognized that some Aboriginal groups have indicated the Peace River holds spiritual and cultural value to them and that specific places that Aboriginal groups’ value and use for multiple purposes would be permanently changed or lost by the construction of the Project. BC Hydro recognizes that this effect cannot be mitigated and significant for Doig River First Nation, Halfway River First Nation, Prophet River First Nation, West Moberly First Nations, Blueberry River First Nations, Saulteau First Nations, and the McLeod Lake Indian Band. The Panel agrees.

Although the Métis Nation British Columbia acknowledged BC Hydro’s inclusion of their members, in documenting and highlighting Métis history, there was no determination as to whether effects of the Project on cultural sites for the Métis were significant. After hearing from the Métis Nation British Columbia, the Panel recognizes the high density of important Métis cultural sites that would be permanently affected by the Project. The Panel determines that the Project would result in a significant effect on these sites.

The Panel notes that the Peace River valley is a rich area for cultural resources. Furthermore, these cultural resources represent aspects of human history. As one participant noted, the river was a historic “water highway” used by First Nations, settlers, and trappers. The journal article submitted by Mr. Hadland referencing canoe voyages dating back to 1828 is only one of many references to the historical value of this area. Many participants spoke of the unique history of

the Peace River and, in particular, this reach of the river. It is made only more apparent by the physical heritage sites present on the river, such as Rocky Mountain Fort and Rocky Mountain Portage House, and the histories of explorers such as Alexander Mackenzie, Simon Fraser, and David Thompson. Participants demonstrated a strong attachment to this history.

Local residents in the hearing presented a strong social attachment to the valley and a sense of belonging to the landscape. Although most of the information the Panel received was anecdotal, the Panel takes particular note of Rachel Darvill's presentation, which states that the area of the Peace River extending from Hudson's Hope to the mouth of the Halfway River was the largest "ecosystem services" area in the watershed. She explained that, in particular, participants in her research "felt a strong sense-of-place" in this location and demonstrated a variety of uses. The Panel believes this research to be a good characterization of the value and attachment of the area that was echoed by participants in the hearing.

The Panel thinks that, over time, it may be possible for the various participants to adapt to new landscapes and create new places of cultural value. However, the existing historically valuable cultural sites would be permanently lost.

The Panel notes the apparent incongruity between the provincial definition of a Heritage River and the participants' views of what that definition should be. It was apparent that participants viewed the designation as affording some kind of protection to the area.

Based on the information presented by participants, the Panel would characterize this reach of the river as highly historical. The Panel recognizes that, if the Project were constructed, there would only be 62 km of this river left intact in British Columbia. The Panel believes that the continued transformation of river segments into reservoir degrades the historical value and has a cultural impact for people in the area. The Panel determines that the loss of the cultural places as a result of inundation, for Aboriginal and non-Aboriginal people, to be of high magnitude and permanent duration and be irreversible.

The Panel believes that the mitigation measures proposed by BC Hydro for physical heritage may help attenuate effects to cultural heritage but will not alleviate the Project's effects on the intangible cultural heritage for Aboriginal people.

For these reasons, the Panel determines that the effect of the Project on cultural heritage resources to be adverse and significant.

The Panel concludes that there would be significant adverse effects of the Project on cultural heritage resources for both Aboriginal and non-Aboriginal people.

12.3 VISUAL RESOURCES

Visual resources assessment considers the potential effects of a project on scenic resources. In this chapter, the Panel examines visual resources as part of its review of effects of the Project on rural and cultural landscapes.

12.3.1 Proponent's Assessment

BC Hydro evaluated the potential impact of the proposed Project on scenic resources and noted that the Project would introduce permanent visible features to the landscape, and would

therefore have the potential to affect visual resources within and around the Project activity zone. To evaluate the effect of the Project, BC Hydro evaluated:

- The visibility of Project components from selected receptor sites, and
- Predicted scenic values, using photomontages and assessed according to the *Visual Impact Assessment Guidebook* (BCMOF 2001).

BC Hydro conducted an assessment of the potential for the Project to adversely affect visual resources, in accordance with provincial standards and guidelines. Five receptor sites were selected as representative of the visual landscape in the Peace River valley. At the request of the Panel, BC Hydro also conducted a visual assessment from the perspective of a person on the water, by adding to the assessment three viewpoints of high cultural value (Farrell Creek, Attachie, and Bear Flat), accessible by boaters, and two additional sites that would have views of the potential dam site.

BC Hydro noted that the Project would introduce permanent visible man-made features into the landscape and would change the visible landscape from a river to a reservoir. BC Hydro predicted that the Project itself would be visible from receptor sites and may lower scenic values in some areas. Therefore, the Project was determined to alter the viewscapes from receptor sites in and around the Peace River.

BC Hydro explained that because visual resources contain an aspect of human perception of aesthetics (a “sense-of-place”), the experience of the visual landscape by observers is a key element in assessing the effects. BC Hydro also considered social context and the general level of disturbance to provide an understanding of the existing visual environment and of the ability of and readiness for people and communities to adapt to changes in the visual landscape.

Mitigation measures proposed by BC Hydro relate to the shoreline protection program at Hudson’s Hope, the Site C dam and worker accommodation camps. Details are provided in Appendix 9.

12.3.1.1 Determination of Significance

BC Hydro stated that the Project would introduce permanent visible features into the landscape when seen from viewpoints on land and water. It determined that the Project is predicted to be visible from receptor sites and would be a permanent change towards lower scenic values in some areas, through an increase to the amount of visible man-made disturbances in relation to base conditions during construction and operation. BC Hydro stated that the effect of the Project overall on visual resources would not exceed the general (historical) level of existing visible man-made disturbances (including industrial developments) in the LAA. It determined the social context to be previously disturbed by human development, as opposed to a pristine environment. BC Hydro further concluded that additional Project-related disturbance could be accommodated without changing the overall character of the visual landscape.

BC Hydro, therefore, concluded that the effects on visual resources would not be considered significant.

12.3.2 Views of Participants

During the Pre-Panel Stage, participants stated concerns related to general visual impacts and changes to aesthetics with construction of the Project. They also noted that flooding of the

valley would result in a loss of the river landscape and would change the scenic view opportunities.

Many participants presented vivid pictures of the Peace River valley to the Panel. These participants claimed that Highway 29, through the present valley, is one of the most beautiful drives in B.C. Residents of Hudson's Hope noted that many visitors take the road off the Alaska Highway to view the valley and were concerned that visitors would take an alternate route if the Project were to proceed. Hudson's Hope Historical Society claimed that many visitors comment on the scenic beauty of the valley when visiting the museum.

Some participants noted that losing the landscape view would result in a loss of visual cultural referents. Treaty 8 Tribal Association members indicated that members have a strong cultural connection to the Peace River and its valley, and that potential effects of altering the visual nature of this cultural landscape would include high anxiety, despair, and other possible adverse health outcomes.

12.3.3 Panel's Analysis

BC Hydro conducted the visual assessment according to best practices and provided a thorough and helpful evaluation of the Project pre- and post-construction. The Panel believes that this type of assessment is valuable in properly understanding the effects of the Project on visual resources.

The Panel also believes that the mitigation measures proposed by the Proponent represent best practices and include landscaping and camouflage of Project components.

BC Hydro characterized the Project as a "permanent change towards lower scenic values in some areas." The Panel agrees with this characterization. BC Hydro further stated that the Project would be acceptable because the landscape has been "previously disturbed by human development" and is not a pristine environment. The Panel understands that there is already considerable development in the valley but does not agree that this necessarily allows additional disturbance.

The Panel heard from many participants about the beauty of the Peace valley and how important the landscape was. Participants noted that they wanted to keep the river as it currently is. The Panel was presented with photographs and videos in support of these testimonies. The Project would represent a permanent change from a river to a reservoir and alter the visual landscape as a result.

The Panel recognizes that the change in landscape is at the essence of constructing the Project and that, aside from the mitigation proposed, it is an immitigable effect. The Panel believes that for some people, particularly residents that attended the hearing, this effect would be significant.

The Panel concludes that the effect of the Project on visual resources would be a significant adverse effect.

13 ENVIRONMENTAL PROTECTION AND MANAGEMENT

13.1 GHG EMISSIONS

Anthropogenic carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and other greenhouse gases (GHGs) are principally responsible for current changes in the global climate. The Project was assessed for effects related to its contribution of these gasses to the atmosphere. For an evaluation of the effects of climate change on the Project, see Section 13.2.

13.1.1 Proponent's Assessment

BC Hydro provided information regarding the expected GHG emissions for the Project. To determine the net emissions as a result of construction and operation of the Project, BC Hydro estimated the current GHG processes in the Project area, both captures and releases, and compared these to the GHG emissions predicted with the Project. BC Hydro determined the significance for Project-related GHG effects considering the direction, magnitude, geographical extent, frequency, duration, reversibility, context, and level of confidence of the estimated GHG emissions. In consultation with the CEAA guidance document *Incorporating Climate Change Considerations in Environmental Assessments: General Guidance for Practitioners*, BC Hydro concluded that a significant adverse residual effect of the Project on GHGs would occur if the release of GHGs was either medium or high magnitude.

BC Hydro believed that evaluating generating facilities by their emissions per unit of energy generated (g CO_2e/kWh or grams of carbon dioxide equivalent per kilowatt hour) was an important relative measure when evaluating the potential climate warming impact of a project. As such, BC Hydro determined that the maximum net emissions of the proposed reservoir operation, over the 100-year lifespan of the Project, would be approximately 58,200 t CO_2e/year, with an additional emission of approximately 52,128 t CO_2e/year for fuel use during construction. BC Hydro explained that the maximum net emissions from the Project would represent 0.2 and 0.01 percent of provincial and national emissions, respectively. On the global scale, it noted that these net emission rates would represent 0.002 percent of the net anthropogenic emissions (5.5 to 6.3 billion t CO_2e/year).

Because no clear quantitative threshold for GHG emissions is defined in federal and provincial regulations, BC Hydro used a qualitative definition to determine significance. The Proponent concluded that the Project-related quantities of GHGs released to the atmosphere would be a small fraction of the provincial, national, and global emissions, and would be considered low, in terms of total emissions and emission intensity. As a result, BC Hydro found the effects of the Project would not be significant.

Additionally, BC Hydro noted that the electricity from the Project that would be used by BC Hydro's customers would avoid emissions associated with the alternative methods of meeting customer demand. BC Hydro estimated that the Project would avoid between approximately 34 and 76 million tonnes of CO_2 equivalent over a 100-year evaluation period. Table 7 outlines the emission intensity of Site C compared with other forms of generation.

BC Hydro proposed mitigation measures for GHG emissions, including reducing fuel use through, for example, using a conveyor for fill rather than trucks, and increasing fleet fuel efficiency. In the operational phase, there would be limited ability or capacity to apply mitigation measures. Instead, Project design would be focused on minimizing long-term conversion of land from current conditions.

Table 7. Emission Intensity – Site C Compared with Other Generation

Generating Facility Type	Range (g CO_2e/kWh)	Average (g CO_2e/kWh)
Tropical Hydroelectric	1,750–2,700	2,150
Modern Coal	959–1,042	1,000
IGCC (Coal)	763–833	798
Diesel	555–880	717
NGCC (Natural Gas)	469–622	545
Photovoltaic	13–104	58
Canada Boreal Hydroelectric	8–60	36
Wind Turbines	7–22	14
BC Hydro Site C (Tier 3—likely, with embedded carbon, fuel, and electricity use)	Not applicable	10.5

Source: adapted from EIS Table 15.11

BC Hydro conducted a cumulative effects assessment, having found adverse residual Project effects and determined GHG emissions would combine with other emissions in British Columbia and Canada. BC Hydro said that, although the Project's contribution to the atmospheric GHG burden would be small, once combined with the significant and ever-increasing GHG emissions worldwide and the consequent climate changes, the cumulative environmental effects of a change in GHG emissions as a result of the Project would be significant.

13.1.2 Views of Participants

Environment Canada (EC), in their written submission to the Panel, found the calculations of GHG emissions associated with construction and operation of the Project to be reasonable. EC agreed with the Proponent's determination that the adverse residual effects of the Project on GHG emissions would be low.

EC also agreed that the GHG emission intensity would be substantially lower than other electricity generation options, as supported by the 2012 special report of the Intergovernmental Panel on Climate Change, *Renewable Energy Sources and Climate Change Mitigation*.

At the public hearing, no other participants raised concerns about the Project's GHG emission contributions. However, during the Pre-Panel Stage, participants claimed that the Peace River valley currently acts as a carbon sink that would be lost if the Project were to proceed. Participants also noted that the Project would displace activities, such as agriculture, that are perceived to have a lower carbon footprint than a hydroelectric reservoir.

13.1.3 Panel's Analysis

The Panel believes that the question around the effects of GHG emissions is one of relative as opposed to absolute contributions. To that end, the Panel notes BC Hydro's conclusion that, over the approximate 100-year evaluation period of the Project, and depending on the precise mix of gas, coal, and renewables that would constitute the alternative, the Project would avoid large amounts of emissions into the global atmosphere.

The Panel concludes that the Project would produce more power per gram of CO_2e than any alternative (non-nuclear) over its lifetime.

BC Hydro concluded that the Project would be considered "low," in terms of the total emissions and emission intensity. This conclusion resulted in a determination of "not significant." The Panel notes that Environment Canada agreed with BC Hydro's assessment. Consequently, the Panel is comfortable that the assessment conducted by BC Hydro with respect to the Project's contribution of GHGs is accurate and that the Project-related emissions would be considered low.

The Panel agrees with BC Hydro that the Project's effects on greenhouse gases would not be significant.

According to the CEAA guidance document, *Incorporating Climate Change Considerations in Environmental Assessments: General Guidance for Practitioners*, "if the project's emissions are likely to be of only low intensity or volume, there may be no need to conduct further analysis."

BC Hydro concluded that global emissions of GHG are highly significant and therefore even a small contribution matters. The Panel understands this conclusion considering that GHG releases by the Project cannot be avoided or mitigated. However, the Panel notes that GHG emissions are a global issue, not a local or regional one. The Panel understands that, when a project has residual effects, a cumulative effects assessment is required. In this case, the Panel believes that the strict application of the cumulative effects guidance results in a "false positive," where a determination of significance was made that is neither correct nor needed. The Panel agrees with BC Hydro that emission intensity is important and likely to become more so with time.

The Panel notes that the GHG contributions of the Project constitute a 0.002 percent, a 0.2 percent, and a 0.01 percent contribution to the global, provincial, and national problem, respectively. The Panel considers this to be a negligible contribution, and therefore an assessment of cumulative effects is not required.

The Panel agrees with BC Hydro that the contribution of the Project to the provincial, national and global problem would not be significant.

13.2 EFFECTS OF THE ENVIRONMENT ON THE PROJECT

The Panel's Terms of Reference require it to conduct its assessment in accordance with the Agreement and the *Canadian Environmental Assessment Act, 2012* (CEAA 2012). Under CEAA 2012, section 19(1), the environmental assessment of the Project must consider any change to the Project that may be caused by the environment.

13.2.1 Proponent's Assessment

BC Hydro conducted an assessment of environmental factors that may affect the Project including:

- extreme weather events;
- seismic events;
- sedimentation;
- wildfire;
- flooding;
- drought;
- slope stability and mass wasting; and
- climate change.

These environmental factors could adversely affect the Project through: causing an accident or malfunction; delaying the Project in-service date by more than one year; interrupting service during operation; causing damage to infrastructure that compromises the safety of employees or the public; and/or causing damage to infrastructure that is not economically or technically feasible to repair.

13.2.1.1 Extreme Weather and Natural Hazards

BC Hydro assessed extreme weather events (wind, rain, ice, low temperatures) and resulting natural hazards (flood, fire, and drought) in order to determine their potential effects on the Project, should they occur. It identified extreme weather events that would potentially cause erosion, wave events, and damage to Project infrastructure, including the dam site, and stated they would also potentially affect the transmission line, the substation, the highway realignment, and the Hudson's Hope shoreline protection.

BC Hydro examined extreme changes in water availability as a result of floods or droughts and determined it would have mainly financial repercussions with respect to the ability to produce power. Extreme dry weather or drought would reduce the amount of water available in the reservoir for power production, but the storage capacity of the Williston reservoir could be used in these years. An increased occurrence of wet years would have an impact on the Project, but BC Hydro noted that the resulting change in generation of electricity would be beneficial. It also noted the occurrence of extreme floods during construction would have adverse effects on the Project if the cofferdams were overtopped during river channelization or diversion. Flooding during operation would be unlikely and would be appropriately prepared for in Project design.

BC Hydro explained that wildfires could pose a hazard to Project components including the dam, generating station and spillways, transmission line and substation, and roads. BC Hydro classified fire danger in the area as high and as very high in the area around Hudson's Hope.

13.2.1.2 Seismic Events

BC Hydro noted that it had recently completed a large and comprehensive seismic hazard analysis of their dams that provided site-specific ground motions for its 41 dams and Site C. BC Hydro stated that the seismic source model for the Project included the potential for earthquakes up to magnitude 7.6 to occur and that the Project would be designed to accommodate such an event (1/10,000 year ground motions); however, it confirmed that there

are no known active faults at the dam site and that the largest earthquake recorded nearby was a magnitude 5.4 event in 2001, approximately 70 km southeast of the dam site.

The Proponent described the performance of dams that have experienced earthquakes and stated that earthfill dams perform well in earthquakes, unless they are constructed of hydraulic fill or founded on loose soils. BC Hydro said the history of dam failures in other countries have generally been caused by liquefaction as a result of loose fills. The liquefaction assessment of the Project identified some thin discontinuous zones in the riverbed alluvium that could liquefy at low confining pressures that would not induce failure, but could cause some slumping at the upstream and downstream toe where the confining pressure is low. BC Hydro concluded that the dam would be constructed using design standards and lessons learned to ensure protection from unlikely seismic events.

BC Hydro determined that reservoir-induced seismicity would not be a problem because there was no evidence that it did or could occur in the region.

The transmission line, substation, roads, and the Hudson's Hope shoreline protection would be designed to handle earthquake events.

13.2.1.3 Terrain Hazards

BC Hydro assessed the potential effects of terrain hazards such as slope instability and sedimentation on the Project. It noted that slope instability and mass wasting would potentially adversely affect the Project through direct damage to Project components via landslides and indirect damage to Project components through shoreline erosion failure of a landslide. BC Hydro also noted that mass wasting events could result in landslide-generated waves or overtopping of the dam that could result in direct damage to infrastructure. The effects on the environment caused by dam breach are discussed in Section 13.3.

BC Hydro conducted a detailed study of the reservoir shoreline geology, an inventory and characterization of existing slopes and landslides, groundwater monitoring and modeling, shoreline erosion modeling, and slope stability analyses. These analyses indicated that the creation of the proposed reservoir would have limited impact on the overall stability of the high bank slopes but that some changes in erosion and slope stability would occur around the reservoir shoreline. Based on the slope stability analysis, BC Hydro generated four types of preliminary impact lines to characterize this potential hazard (flood impact; erosion impact; stability impact, and landslide generated wave impact).

BC Hydro indicated that the creation of the proposed reservoir would have limited impact on the overall stability of the high bank slopes because the critical failure surface for most potential landslides typically occurs above maximum normal reservoir level. However, BC Hydro noted that locations, such as the slopes opposite Lynx Creek and Farrell Creek and slopes downstream of Wilder Creek (including Moberly River), where current groundwater levels are low and/or fine or weak sediments would be located below the maximum normal reservoir level, may have decreased stability. Very small changes were also predicted for the slopes upstream of Hudson's Hope; however, BC Hydro noted that shoreline erosion would dominate the observed changes. At the dam site, BC Hydro determined that the north bank had a moderate to high likelihood of landslide following disturbance and the south bank had a low likelihood. BC Hydro concluded that appropriate slope stabilization methods at these locations would prevent potential slides that could have an adverse effect on the Project.

BC Hydro assessed six sites for their potential to generate landslides that would result in impulse waves if they entered the reservoir: the slopes opposite Lynx Creek, the slopes

opposite Farrell Creek, the slopes opposite Halfway River (near the 1973 Attachie Slide), the slopes between Halfway River and Cache Creek, the slopes opposite Cache Creek (Bear Flat), and the slopes opposite Wilder Creek. The assessment found that there would be some potential for landslide-generated wave impacts at elevations above the Flood Impact Line east of Lynx Creek and Farrell Creek, and on either side of Halfway River. Furthermore, it stated that while there would be some potential for landslide-generated waves at the other three study sites, because of the greater reservoir width and/or smaller predicted landslide source volumes, the predicted wave run-ups would not exceed the Flood Impact Line elevation. BC Hydro concluded that the diversion tunnels and the freeboards would be designed to sufficiently prevent a landslide-generated wave from overtopping the cofferdam during construction or the earthfill dam during operation.

Sediment could enter the reservoir from tributary flow, shoreline erosion, and landslides described above. BC Hydro predicted that the volume of sediment expected to enter the reservoir from these sources would be small and sedimentation of the reservoir would not have an adverse effect on the Project.

In response to concerns by several participants in the public hearing regarding sinkholes discovered at the Bennett Dam in 1996, BC Hydro noted that the sinkhole was discovered to be an area of lower compaction caused by a temporary survey marker during construction. Over time, the soil settled, creating a void or sinkhole. BC Hydro noted that it initiated an immediate and comprehensive response and successfully remediated the sinkhole by compaction grouting. BC Hydro said that monitoring demonstrated the dam continued normal operation. BC Hydro did not identify sinkholes as having a potential effect on the Project.

13.2.1.4 Climate Change

BC Hydro developed two climate change scenarios (2050s and 2080s) based on modeling provided by the Pacific Climate Impacts Consortium to predict changes in the environment. These scenarios were determined as averages from a selection of projections from global climate models. BC Hydro noted that climate change projections predict an increase in annual streamflows in the Peace River, an increase in precipitation that will fall outside the range of historical variability, and an increase in temperatures that will not fall outside the range of historical variability. Climate change in the direction of a warmer, wetter climate could affect the Project through changes to the generation of electricity and the magnitude of floods. BC Hydro concluded that the increases in Peace River streamflow as a result of climate change would be beneficial to the Project because it would result in an increase in generation capacity and that the current Project design would be able to accommodate predicted changes to the probable maximum flood.

13.2.1.5 Mitigation Measures

BC Hydro stated that the Project was designed to prevent adverse effects of the environment on the Project. Mitigation proposed for extreme weather events included using riprap on the upstream face to prevent erosion and providing sufficient freeboard to prevent overtopping of the dam. Ancillary facilities, the transmission line, and substation were also said to be designed to withstand extreme weather events. BC Hydro provided erosion protection measures to mitigate effects of extreme weather on the highway alignment. The dam site would be cleared during construction, and a vegetation-free buffer would be maintained to provide firebreaks.

BC Hydro proposed regular monitoring programs of the environmental components that may affect the Project, including:

- Monitoring of shoreline conditions, groundwater levels, shoreline erosion, and landslide activity;
- Seismic activity in the region; and
- Climatic conditions in the region.

Associated follow-up programs included a review and update of the impact lines following approximately five years of reservoir operation and inspection of the dam, structures, and generating facilities should seismic activity be detected. If a dam safety hazard is identified as a result of the environment, then BC Hydro would implement response procedures as outlined in the Emergency Preparedness Plan.

13.2.2 Views of Participants

Natural Resources Canada (NRCan) described the Project as being in a region of low seismic hazard that has been accurately characterized by the Proponent. The department confirmed that recent earthquakes in the region were not close to the Project location (70 km away in 2001 and 230 km away in 1986). NRCan noted that the Proponent's seismic hazard model had incorporated past, present, and likely future earthquakes and had adequately accounted for potential earthquakes by using the highest standards for earthquake design. NRCan also noted that the dam design, particularly the freeboard, had factored in the possible effects of seiches resulting from earthquakes. Additionally, NRCan noted that while liquefaction is an important factor in the design of earthfill dams, the Proponent had taken this into consideration.

NRCan explained that, in addition to natural earthquakes, anthropogenic disturbances can also cause earthquakes. One way earthquakes can be triggered is through reservoir-induced seismicity that can occur when the water increases the pore-pressure on pre-existing fractures beneath the reservoir. NRCan noted that larger dams tend to induce seismicity but that the probability of induced seismicity is extremely low for reservoirs less than 60 m depth, such as with the Project. NRCan confirmed that there had been no significant reservoir-triggered seismicity at the Bennett or Peace Canyon Dams.

Other means of induced seismicity described by NRCan include injection wells and hydraulic fracturing. NRCan concluded that BC Hydro's seismic hazard assessment adequately addressed questions on all types of potential induced seismicity and that the monitoring and project design were sufficient.

NRCan also conducted an assessment of possible landslides in the Project area. It described two categories of landslides: natural (triggered by water, seismic activity, or volcanic activity) and human-caused (triggered during construction by removing vegetation, loading top slopes, oversteepening slopes, excessive irrigation, etc.). NRCan said that individual slopes can be monitored for signs of movement and that mitigation measures, including slope stabilization, can reduce the effects. BC Hydro agreed, during the public hearing, that mitigation measures would be employed if monitoring landslide activity resulted in unforeseen impacts and confirmed that some of the measures demonstrated by NRCan would be appropriate.

NRCan noted that the Proponent had appropriately conducted the slope stability analysis and had established conservative impact lines. NRCan concluded that BC Hydro had adopted current standards and best practices related to slope stability for the Project.

Many participants referenced the instability of the soils in the area and cited, as evidence of that instability, the Attachie Slide of 1973 that blocked the river and deposited over 23 million cubic metres of detritus. Dr. Sandra Hoffman referenced other historical landslides in the Project area,

including: Cache Creek (1900), failure of the north bank at Taylor Flats resulting in a collapse of the bridge (1957), and a failure just downstream of the proposed dam site (1974). Dr. Hoffman noted that, while it was possible to build a dam at the proposed site, without exposed bedrock there may be some additional engineering challenges.

Dr. Hoffman and others also expressed concern about the determination of reservoir impact lines. She said that BC Hydro's methodology relied too heavily on reviewing and updating the impact lines post-filling. Several participants shared a photo of a cabin perched on the edge of the Williston reservoir as evidence that the impact lines BC Hydro predicted are not always realistic.

Dr. Carver, on behalf of Athabasca Chipewyan First Nation and Mikisew Cree First Nation, noted that the predictions about climate change by BC Hydro correctly reflected the modeled scenarios (i.e. an increase in temperature and precipitation), but asserted that global climate models are inherently conservative in nature. This conservatism combined with the accelerated pace of global greenhouse gas emissions result in large uncertainties in predicting climate change and potentially underestimating the effects. He postulated that if corrections to reduce the uncertainty were applied, climate changes forecasts would predict a significantly greater increase in global warming than currently predicted.

Environment Canada (EC) was the only participant that raised concerns about the effects of climate change on the Project. EC's main concern was that the discussion revolved around the median values. It noted that this approach did not adequately consider the inherent uncertainty in climate projection and that the range of projected changes (i.e. the minimum and maximum for the 23 simulations) may be more informative for impacts and adaptation applications than the median discussed. EC added that the extremes could be important in the potential impact to infrastructure and processes such as sediment transport.

13.2.3 Panel's Analysis

In arriving at its conclusions on effects of the environment on the Project, the Panel notes that BC Hydro considered a range of events that the Project may experience. The Panel determines that BC Hydro's assessment of the effects of the environment on the Project is sufficiently inclusive and that the modeling conducted is appropriate. In its evaluation, BC Hydro selected events and modeled a combination of worse than worst-case scenarios to determine their effects on the Project. In reviewing these scenarios, the Panel believes that these events are unlikely.

The Panel is confident in this finding because, apart from Environment Canada's concerns regarding the climate change assessment, expert departments were largely satisfied by the work of BC Hydro.

The Panel accepts that BC Hydro appropriately characterized the seismic hazard risk in the project area and notes that such risk is low. The Panel also agrees with BC Hydro's assessment on extreme weather events and natural hazards (fire, flooding, and drought).

The Panel acknowledges that many residents are concerned about slope stability. The Panel believes that slopes in the Project area are likely to mobilize as predicted by BC Hydro and confirmed by NRCan, but that the planned mitigation is adequate. BC Hydro has also proposed monitoring programs, and the Panel is assured that it would provide warning of any potential landslides that may affect the Project.

Climate change predictions based on the most recent global climate models indicate a general slow warming over the next 50 years, with resulting increases in precipitation and precipitation seasonality. Participants who spoke of climate change did not dispute this assessment. The Panel acknowledges that there is considerable uncertainty associated with predicting the effects of climate change, and even if BC Hydro had considered the range of projected changes as suggested by Environment Canada, the use of median values is informative enough for the purpose of this assessment. The Panel finds that the climate change model used by BC Hydro is sufficient to determine the effects of the environment on the Project.

The Panel believes that there are many aspects of Project design to accommodate changing environmental factors predicted by climate change. The Panel concludes that the Project design and mitigation measures proposed are reasonable to minimize potential adverse effects and that the Project has incorporated sufficient flexibility to manage greater than predicted levels of climate change. The Panel agrees with BC Hydro that if the climate changes as predicted, it would not result in much change to the Project; in fact, any effects would generally be positive.

The Panel concludes that the design of the Project adequately accounts for possible adverse effects of the environment on the Project.

13.3 ACCIDENTS AND MALFUNCTIONS

The Panel's Terms of Reference require the Panel to assess the environmental effects of accidents and malfunctions that may occur in relation to the designated Project. CEAA 2012 also requires that environmental effects of accidents and malfunctions be considered in the assessment of cumulative environmental effects if they are likely to result from the designated project in combination with other physical activities that have been or will be carried out. The Panel understands this to mean that the cumulative effect is likely, not that the accident or malfunction is likely. In the context of this assessment, the Panel considers the cumulative effect of multiple dam breaches occurring concurrently or consecutively.

13.3.1 Proponent's Assessment

BC Hydro conducted an assessment of the following accidents and malfunctions related to the Project:

- Dam breach;
- Release or spills of chemicals and hazardous materials;
- Containment of pond leakage or failure;
- Sediment control failure; and
- Fire and explosion

13.3.1.1 Dam Breach

To assess environmental effects of accidents and malfunctions, BC Hydro conducted dam breach analyses for the Project for the Stage 2 upstream cofferdam and the earthfill dam. It used these analyses to assess the consequences of dam failure by the characterization of a hypothetical dam breach and routing the resulting flood wave. BC Hydro identified two causes of dam breach: overtopping and dam failure. It considered two scenarios for failure of the Stage 2 upstream cofferdam: an overtopping with 50-year downstream tributary inflows and an overtopping with average June downstream tributary inflows. For failure of the earthfill dam, BC

Hydro considered two scenarios: a sunny day failure with mean annual flow and at maximum normal reservoir level and an overtopping failure during probable maximum flood, assuming blockage of all spillway gates and auxiliary spillway overflow with no powerhouse discharges.

BC Hydro's extensive investigations of the geology of the dam site over several decades informed its dam design to ensure that dam safety is maintained. BC Hydro adopted the highest Canadian Dam Association classification for this Project, which recommended that the highest inflow design flood and earthquake design ground motion be used in its design. BC Hydro noted that it had designed the Project to safely pass a probable maximum flood with a peak inflow of 19,300 cubic metres per second (based on a frequency of less than 1/10,000 of two consecutive storms with the equivalent of 84 percent of the mean annual rainfall in Fort St. John falling within four days). BC Hydro further explained that it had designed the Project to withstand a ground motion with a mean annual exceedance probability of 1/10,000 (potential earthquake of 7.6 magnitude). BC Hydro said that the annual exceedance frequency of a flood potentially damaging or overtopping the Stage 2 upstream cofferdam is approximately 1/600.

BC Hydro determined that a Stage 2 cofferdam breach could impact fish and fish habitat, vegetation, wildlife, current use of lands and resources for traditional purposes, agriculture, oil and gas infrastructure, harvest of fish and wildlife resources, navigation, visual resources heritage, and human health. BC Hydro determined that these would also be impacted by a breach of the earthfill dam, but on a larger scale. In addition, BC Hydro noted that a breach of the earthfill dam could also impact greenhouse gases, navigation, and community infrastructure.

Should an overtopping event be predicted, BC Hydro asserted that it would have approximately four days of notice to implement the emergency preparedness plans and evacuate potentially flooded areas downstream. Due to the proximity of Old Fort and Taylor and the resulting short flood arrival times, there would be limited time available for warning and evacuation for the sunny day failure. There would be additional time available for warning and evacuation downstream of the B.C.–Alberta border. For example, as referenced in the table above, the flood arrival times at Dunvegan and the Town of Peace River are about 10 and 16 hours, respectively, from the start of dam failure (Table 8).

Table 8. Inundation Modeling Results for the Sunny Day Failure Scenario

Location	Distance from Site C (km)	Initial Water Level [a] (m)	Max. Water Level (m)	Water Level Increase (m)	Flood Arrival Time [b] (hrs.)	Time to Flood Peaks [b] (hrs.)	Peak Flood Flow (m3/s)
Site C Dam	0	-	461.8	-	-	-	77,090
Old Fort	7	407.7	425.8	18.1	0.9	2.8	72,590
Taylor	18	403.3	418.2	14.9	1.5	3.9	64,500
B.C. – Alberta Border	62	380.0	402.3	22.3	3.8	9.0	46,370
Dunvegan	191	340.2	356.8	16.6	9.5	17.7	34,800
Town of Peace River	291	311.9	322.2	10.3	15.7	25.8	31,510
Carcajou	546	256.9	267.8	10.9	30.8	46.6	23,190
Fort Vermilion	726	247.4	254.0	6.6	42.2	73.9	14,300
Peace Point	1,031	212.3	218.1	5.8	73.5	111.1	11,730

Source: EIS, Table 37.18

BC Hydro stated that the failure of the dam is very unlikely and the failure of the Stage 2 upstream cofferdam is also unlikely, given the extreme flood and earthquake scenario for which it would be designed and given the rigorous operation, maintenance, and surveillance

requirements that would be implemented for the Project. BC Hydro noted that, nonetheless, these scenarios would be used to inform the emergency preparedness plans.

13.3.1.2 Other Accidents and Malfunctions

BC Hydro also conducted an assessment of accidents and malfunctions related to the release or spills of chemicals and hazardous materials, containment pond leakage or failure, sediment control failure, and fire and explosion. BC Hydro concluded that effects related to containment pond leakage or failure and sediment control failure would be negligible due to effective standard mitigation measures.

BC Hydro determined that an incident involving fire or explosion could affect vegetation, wildlife, current use of lands and resources for traditional purposes, and visual resources. An accident or malfunction related to the spill or release of chemical and hazardous materials could affect fish and fish habitat, vegetation, and current use of lands and resources for traditional purposes. The extent would depend on the magnitude of the event.

13.3.1.3 Cumulative Effects

In response to a request by the Panel, BC Hydro noted that a collective failure of the upstream dams would be highly unlikely because of the stringent design standard required by the Canadian Dam Association and the BC Comptroller of Water Rights. BC Hydro said that it was unable to provide more detailed information about failure of the existing dams because of the sensitive nature of that information. It confirmed that if the Project is approved, dam break analyses for the Bennett and Peace Canyon Dams would be conducted and emergency preparedness plans would be updated taking the Project into account.

BC Hydro said that a failure of the Bennett Dam resulting in a failure of the Project would increase the predicted flood levels and flows downstream of Site C by a small amount—that is, the flood caused by a failure of Bennett Dam would be increased only slightly by the subsequent failure of Site C. Additionally, BC Hydro noted that failure of the Peace Canyon Dam alone would be unlikely to result in a failure of Site C due to the large spillway capacity and freeboard.

BC Hydro indicated that it would work with Alberta Environment and Sustainable Resource Development if the Project proceeds to ensure it has all necessary information to address potential impact to downstream communities.

13.3.1.4 Mitigation Measures

BC Hydro noted that dam design was the main factor in mitigating accidents and malfunctions related to dam breach. It noted that the Project has had an established Technical Advisory Board, comprised of professional experts, which provided technical advice on the Project engineering and design. In addition, BC Hydro noted the following measures to mitigate accidents and malfunction:

- inflow flood forecasting and flood warning - using calibrated models to predict flood flows from hydrometeorological data and would therefore predict inflows to the Project. BC Hydro would have approximately four days of notice to implement the emergency preparedness plans and evacuate potentially flooded areas downstream.
- spillway gate reliability - appropriate design, operation, maintenance, inspection, and testing of flood discharge gate systems to attain and maintain reliability. High spillway gate reliability

was noted to materially reduce the risk of overtopping of the earthfill dam during a large flood.

- debris management - consistent with debris management on other reservoirs, debris would be contained and removed on the reservoir rather than passing through the spillway. This would prevent the spillway from becoming blocked and reduce the risk of overtopping.
- powerhouse operation - ability to provide additional discharge capacity and possibly draw down the reservoir prior to flood arrival.
- increasing cofferdam freeboard - adding temporary walls on the Stage 2 upstream cofferdam to reduce wave overtopping.
- surveillance and monitoring - to prevent failures due to piping, dam surveillance and monitoring pursuant to the operation, maintenance, and surveillance manual would occur.

BC Hydro would develop and implement Environmental Management Plans to reduce the likelihood or mitigate the potential occurrence of other accidents and malfunctions during construction and operation. The proposed plans are listed in Section 13.6 of this report. The emergency response plan would provide the framework for managing accidents and malfunctions during construction and operation.

13.3.2 Views of Participants

During the Pre-Panel and Panel Stage of the review, participants' concerns related to potential accidents and malfunctions focused almost exclusively on the possibility of dam breach. Downstream residents of the existing dams noted that although dam breach had a low probability of occurrence, it was still a concern. Residents appeared more concerned about the resulting effects of a failure of the Bennett Dam and the resulting failure of the Peace Canyon Dam and the Project than a failure of Site C alone.

Regarding the concerns of a cascading dam failure, Alberta Environment and Sustainable Resource Development recognized the unlikelihood of this occurrence but recommended that BC Hydro consider and analyze the impacts of such an event, create appropriate emergency preparedness plans, and share the results with Alberta before construction of the Project. Alberta further noted its understanding of BC Hydro's commitment to meet Alberta's dam safety concerns and emergency plans through continued communication and ultimately determined that it was satisfied.

Glen Davidson, Comptroller of Water Rights for the province of B.C., explained that the *Dam Safety Regulations* are a fundamental component of the *Water Act*, the legislation that would authorize the construction, diversion, storage, and operation of the dam. He noted that the dam safety program is extensive and is designed to minimize and manage risks to people, the environment, cultural values, infrastructure, and the economy associated with construction. Although major dams have failed elsewhere in the world, Mr. Davidson said that there has never been an extreme-consequence failure in B.C. He demonstrated that several steps occur after the review and approval of the preliminary design that involve reviewing the detailed design to ensure that targets are met and the sensitivity analysis is appropriate. It would also be reviewed in terms of relevant legislation, the Canadian Dam Association Guidelines, and the issued water license to ensure that the design could meet the conditions of these documents. Conversations would begin on operation and maintenance, emergency preparedness, and dam safety at this stage. Mr. Davidson assured the Panel that a number of checks, phases, and approvals would need to occur before the dam is constructed. He said that, after construction, the Proponent would be required to conduct inspections in accordance with its legal obligations and report to the Province annually on its state of compliance. In additional support, he noted that BC Hydro

is close to 100 percent compliance with its existing 41 dams in B.C. and that any issues with that compliance are considered minor in nature.

13.3.3 Panel's Analysis

BC Hydro assessed effects of several categories of accidents and malfunctions that may occur with the Project, accounting for the potential for both major and minor accidents and malfunctions. Based on probability of occurrence, the Panel recognizes that minor accidents and malfunctions are more likely than major accidents and malfunctions and that there appears to be an inverse relationship between consequence and likelihood.

The Panel is satisfied that BC Hydro has evaluated appropriate accident and malfunction scenarios as they relate to the Project. The Panel agrees that most mitigation for accidents and malfunctions is in the form of good project design and safe operation of equipment, combined with the development of Environmental Management Plans. The Panel believes that BC Hydro has appropriately mitigated any potentially likely significant adverse effects through project design and planned project management.

The Panel concludes that the effects of the Project from minor accidents and malfunctions are not likely to be significant and that BC Hydro has demonstrated appropriate diligence in its analysis and proposed mitigation.

Of the accident and malfunction scenarios BC Hydro assessed, the Panel heard from participants mostly about one: uncontrolled release of water from the Project and/or the existing dams upstream of the Project. The Panel understands the concerns shared by participants, considering the potential impact that a dam breach could have on them.

However, the Panel acknowledges that BC Hydro would be required to comply with the *Dam Safety Regulations* and obtain approval from the Comptroller of Water Rights. This process has been proven to be extensive and effective in minimizing risks associated with operating a major dam. The Panel is also reassured that the classification and design of the Project follow the highest standards of the Canadian Dam Association.

Furthermore, the Panel recognizes that BC Hydro is an experienced dam owner with an excellent record for dam safety and compliance and that no catastrophic dam failure has ever occurred in B.C. The Panel believes that, although unlikely, if a dam breach occurred, the effects would be high magnitude, long-term, regional in extent and would lead to a conclusion of adverse and significant environmental effects. The Panel believes this would also be true of any large-scale accident or malfunction, such as an explosion, that leads to widespread fire. However, the Panel recognizes that these accidents and malfunctions are not likely.

Although plans, such as operation and maintenance, monitoring and surveillance, and emergency preparedness and response plans, have not yet been prepared, the Panel understands that these would be required during the licensing phase of the Project, should it proceed. Given the Province's extensive experience with hydroelectric facilities and BC Hydro's existing facilities upstream, the Panel believes that the plans would be adequate. The Panel is confident in the abilities of the Province and BC Hydro to appropriately account for the warning and evacuation of residents in these emergency preparedness and response plans should a dam breach occur.

The Panel acknowledges that a cascading dam failure is a possible accident and malfunction scenario, although highly unlikely. The risk of a dam failure occurring at the Bennett or the Peace Canyon Dams is present irrespective of Project approval and construction, and a dam breach would cause significant effects by way of the same criteria for the Project. The failure of the Project would not result in the failure of either dam upstream.

As presented by BC Hydro, the incremental effects caused by the increase in flood levels and flows downstream of Site C in the event of an upstream failure would be small due to the lower volume of water in the Site C reservoir and the larger spillway capacity. Nonetheless, the cumulative effect would be significant.

The Panel concludes that a Site C dam breach would result in significant adverse effects, but that the probability of failure occurring is remote. The Panel further concludes that any effects of a cascading dam failure would result in significant cumulative effects, but that the probability of cascading failure is extremely remote.

BC Hydro said that it currently consults with the government of Alberta on the existing facilities and would continue this practice for the Project. The Panel expects BC Hydro to follow through on this commitment. The Panel recommends that this consultation include an analysis of a cumulative dam breach and communication and contingency plans.

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The Panel recommends that, if the Project proceeds, BC Hydro must conduct an assessment of the impacts of a multiple cascading dam breach and share the results of that study with the Government of Alberta and the authorities of the towns that would be affected. The Panel recommends that BC Hydro consult with Alberta and emergency management officials in both provinces on communication and contingency plans to address the potential occurrence of a multiple cascading dam breach.

13.4 CUMULATIVE EFFECTS ASSESSMENT

The Panel's Terms of Reference require an assessment of cumulative effects. Section 19 (1) (a) of CEAA 2012 requires the assessment of "any cumulative environmental effects that are likely to result from the designated project in combination with other physical activities that have been or will be carried out." To meet this requirement and to predict the cumulative effects of the Project on each valued component (VC), the Proponent assessed each VC where the Project would result in adverse residual effects.

The Panel has reviewed the assessment conducted by the Proponent on each VC and come to conclusions elsewhere in this report. This section reviews the methodology used by the Proponent.

13.4.1 Proponent's Assessment

To meet the requirements of the cumulative effects assessment, BC Hydro developed three cases: a baseline case, a future case without the Project, and the Project case. The baseline case showed the current status of the VC, which accounts for projects and activities that have been carried out. The baseline case was demarcated as September 5, 2012 to coincide with the

release of the Environmental Impact Statement (EIS) Guidelines and the assessment of effects and cumulative effects of the Project that had been developed by BC Hydro.

In response to suggestions from participants that the environmental assessment should consider a “pre-Bennett Dam” or a “pre-development” case, BC Hydro explained that it was not required because the effects of the past were reflected in the current baseline conditions. BC Hydro also noted that the results of a pre-development case would be unreliable because data was unavailable for this period. Numerous assumptions would have to be made to model pre-development conditions.

BC Hydro also asserted that the potential effects of those facilities were also not included because the future only contemplates two options: a future with Site C and a future without Site C. BC Hydro stated that conducting a pre-development assessment, considering the existing dams, would not be helpful in predicting what the future would look like with Site C.

BC Hydro stated that it did, however, consider the effects of the existing dams through the experience that it has gained from the previous facilities. It described these effects in a narrative.

In the narrative, BC Hydro acknowledged that the environmental conditions in the Peace River watershed have been influenced by a range of ongoing anthropogenic developments and environmental factors, both prior to and following the development of the upstream hydroelectric facilities. BC Hydro characterized changes upstream of the existing facilities as a conversion from a river valley environment to one composed of two separate water bodies. BC Hydro stated that there have been some changes in hydrology and biological conditions relative to that conversion.

BC Hydro said it has received complaints from several Aboriginal groups asserting that the creation and operation of the existing dams and associated reservoirs have negatively affected their communities and the exercise of their Aboriginal or treaty rights. BC Hydro currently undertakes a range of activities to avoid and manage the environmental effects of construction, operation, and maintenance of its existing facilities on the Peace River. BC Hydro has resolved grievances with three First Nations and is currently addressing others.

Considering that the existing baseline reflects the net residual effects to date of other past and existing projects and activities, including the existing upstream facilities, BC Hydro assessed the potential effects of the Project on each VC in the local assessment area (LAA). If the Project was not expected to have a residual effect on a VC, no cumulative effects assessment was undertaken. For any VC where the Project was determined to have an adverse residual effect, reasonably foreseeable projects and activities within the regional assessment area (RAA) were identified, including ongoing activities, such as oil and gas, forestry and other activities associated with existing land tenures. For some VCs, BC Hydro then determined if the residual effects of projects within the RAA were likely to overlap with residual effects of the Project within the LAA and result in a cumulative effect on the VC in the LAA. For other VCs, the Proponent assessed qualitatively whether the residual effects of foreseeable projects in the RAA, combined with the residual effects of the Project were likely to act cumulatively on the condition of the VC in the RAA.

BC Hydro concluded that five VCs would sustain residual effects from the Project, but no cumulative effects: Fish and Fish Habitat, Agriculture, Outdoor Recreation and Tourism, Navigation, and Heritage. BC Hydro stated that the residual effects of the Project on these VCs would be unlikely to overlap in time and space with the potential adverse effects of other projects and activities. Three VCs would experience cumulative effects that would not be

significant: Harvest of Fish and Wildlife Resources, Current Use of Lands and Resources for Traditional Purposes and Visual Resources. Vegetation and Ecological Communities and Wildlife Resources were expected to have significant cumulative effects; however, the effects were determined to be significant with or without the Project. BC Hydro also determined that the cumulative effects on GHGs would be significant.

13.4.2 Views of Participants

Comments were received from numerous participants during the Pre-Panel Stage, at the public hearing, and in final submissions regarding the cumulative effects assessment conducted by the Proponent. They focused on several topics including: methodology, choice of temporal and spatial boundaries, the exclusion of certain VCs because of a lack of residual effects, and resulting conclusions.

Many participants provided comments on the exclusion of the existing upstream facilities in the cumulative effects assessment. They stated that an understanding of the contribution to cumulative effects made by the existing facilities is important. Treaty 8 Tribal Association said the riverine hydrological processes and the complex morphology of rivers are landscape elements that are directly and extensively affected by hydroelectric development. It also said long-term habitat loss and conversion has occurred over a large portion of the watershed as a result of the upstream dams, and the consequences of these effects are not yet well understood. Parks Canada agreed and noted that incorporating the flow regulation and the impacts associated with the existing dams into the baseline presupposes that the impacts are acceptable. Mr. Ken Boon, on behalf of the Peace Valley Landowners Association, said one of the consequences of treating the cumulative effects of past developments as the “new normal” reflected in current baseline conditions is that it glosses over the gradual encroachments on the regional land base that First Nations and non-First Nations people have depended on.

Métis Nation British Columbia recognized that BC Hydro had included the upstream facilities in the EIS but had not acknowledged them in the cumulative effects assessment. It noted that to not include the compounding effects of these dams changes the definition and meaning of cumulative effects. T8TA, Smith’s Landing First Nation, and Athabasca Chipewyan First Nation and Mikisew Cree First Nation further commented that the effects of the existing facilities are ongoing and are not past effects that would be appropriately captured in the studies of existing baseline chosen by BC Hydro. They noted that the studies of the existing baseline would not provide the complete picture of the changes that have occurred already and that the incremental effect that the Project would have on VCs would be missed. Dene Tha’ First Nation agreed and said BC Hydro’s scoping methods are inconsistent with standard environmental assessment best practices. T8TA said it expressed these concerns because of what it believes has already been lost from the river basin as a whole. It explained that participants would like to understand what the condition of the environment may have been without incremental disturbances such as the existing hydroelectric developments.

Many members of the public also expressed concerns about the lack of consideration of the large impacts of the Bennett Dam, to which the incremental impacts of the Project were closely related and substantial.

In response to BC Hydro’s rationale that a cumulative effects assessment in relation to the existing facilities was not conducted due to insufficient and unreliable data, T8TA noted that historical information was available and should be used to recreate a picture of the ecosystem prior to the construction of the existing facilities. The historical rendering of the prior ecosystem could then have been applied to determine if cumulative effects of multiple projects and

activities would result. Participants noted, furthermore, that information was available through several sources (Water Survey of Canada's Historical Data & Station Information, Northern Rivers Basins Study, the Northern Rivers Ecosystem Initiative, the Mackenzie River Basin Board, and the Peace-Athabasca Delta Ecological Monitoring Program). Several Aboriginal groups also said they had traditional ecological knowledge for the "pre-Bennett era" that could have been used for this purpose.

Participants also expressed concerns about the cumulative effects of the Project at a regional level. T8TA said the Project would add to the numerous ecological, social, cultural, and economic effects of the existing projects currently experienced by Aboriginal peoples, and the consequent effects on land use and implications for Aboriginal and Treaty rights. It said that, at a regional level, this would constitute a spatial and temporal overlap in effects from multiple developments in the same region and that such an assessment was not meaningfully undertaken by BC Hydro or the Province.

T8TA used agriculture as an example, saying that "if agricultural lands are flooded (i.e. completely destroyed), this represents a net loss for agriculture forever, regardless of financial compensation, or increased production on unaffected lands. The EIS lists other projects, but states that they are not in the LAA and there is no spatial overlap with the proposed Project. Therefore any losses of agricultural land or productivity are not counted in the cumulative effects assessment. First, the RAA should be used for the cumulative effects assessment. According to the approach used in this EIS, if each project proposed in the RAA were to destroy a separate block of agricultural land, there would be no cumulative effects recorded as long as there was no spatial overlap. Overlap is irrelevant when lands (and habitats) are flooded or otherwise completely destroyed. Theoretically BC Hydro could obliterate all the agricultural land in the RAA, compensate the farmers, and have 'no significant cumulative effects.'"

Participants said, within the region, there was extensive industrial activity, and BC Hydro had not determined if those industries would affect the VCs which were predicted to be also affected by the Project. For example, the Métis Nation British Columbia noted hypothetically that if Métis heritage sites were highly impacted in the region due to other project development, then Métis Nation British Columbia would consider the remaining "intact and pristine" sites as more valuable. Referencing the extensive development in the region, Chief Bud Napoleon of Saulteau First Nations worried that Site C would be "the straw that broke the camel's back."

The Yellowstone to Yukon Conservation Initiative (Y2Y) had specific concerns about the use of a regional assessment to evaluate effects on wildlife. It stated that a cumulative assessment should also determine the impacts of projects on connectivity of habitats so that animals are able to move from one area to another. It noted that the RAA used by BC Hydro was not large enough for this purpose.

In response, BC Hydro clarified that it conducted a Project assessment and the Y2Y seemed to be discussing a regional assessment. BC Hydro said a regional study is not needed to conduct a project-specific cumulative effects assessment, and the absence of a regional study for a given area would not mean that a project-specific cumulative effects assessment for a reviewable project within that area could not be undertaken or is deficient. It further said that the RAA for the Project was chosen to include areas where there could be possible interactions with other developments in an effort to develop an understanding of the Project's contribution to those cumulative effects.

The provincial Ministry of Forests, Lands and Natural Resources Operations (FLNRO) said it had been developing a cumulative effects assessment framework to facilitate regional

cumulative effects assessment and management by the government. The Province was conducting three pilot projects to aid in the development of the framework; one of which was around the Dawson Creek Land and Resource Management Plan. The Province explained that the focus was on incorporating cumulative effects assessment into decision-making to mitigate risks through management responses. It said unintended impacts of cumulative effects can occur over time if one considers only project- or sector-specific effects. The pilot study uses a values-based approach to determine if a set of manageable values would be impacted positively or negatively by a decision and what the risk would be. The Province said the information collected would be available to proponents publicly so that they are still able to conduct their own project-based assessment. The government would then use the information provided in the project-based assessments in its values-based assessment of cumulative effects and provide guidance to proponents with respect to their projects.

13.4.3 Panel's Analysis

The Panel received numerous comments from participants regarding the methodology used by BC Hydro in its cumulative effects assessment. The Panel understands that the Proponent conducted its cumulative effects assessment in accordance with the EIS Guidelines issued by the federal Minister of the Environment and the BCEAO Executive Director for the Project, including the use of a narrative to describe the effects of the existing hydroelectric facilities. The Panel reviews a few consequences of this decision.

13.4.3.1 The Choice of Temporal Boundaries

A cumulative effects assessment requires an evaluation of the residual effects of a Project, followed by an evaluation of other projects that overlap spatially and temporally with those residual effects. The significance is then determined by evaluating the criteria in a similar manner to the evaluation of specific Project effects (e.g. magnitude, direction, duration, frequency, reversibility, geographic extent, context, probability and level of confidence). A discussion is typically provided if the Project is incrementally responsible for adversely affecting a component of interest beyond an acceptable point.

BC Hydro conducted an evaluation of the cumulative effects on each VC using a baseline that represented the existing effects of all projects, including the two existing hydroelectric facilities. It concluded that, for some VCs, there would be adverse cumulative effects and that some would be significant. For three VCs, BC Hydro predicted the cumulative effects as significant with or without the Project. The Panel feels that the conclusions of significance regardless of the Project's contribution are indicative of a threshold that has already been passed.

The Panel understands that the Proponent's methodology follows one of the "options" outlined in the CEAA *Cumulative Effects Practitioners Guide.* The chosen option allows for current conditions to be used as the baseline for the assessment. The rationale states that "the further back or ahead in time, the greater the dependence will be on qualitative analysis and conclusions due to lack of descriptive information (e.g. what conditions were like years ago or which other actions may occur in the future) and increasing uncertainty in predictions. For these reasons, in practice the scenario in the past often defaults to the year in which the baseline information is collected (i.e. current conditions) and the future extends no further than including known (i.e. certain) actions."

The EIS Guidelines stated that an understanding of the upstream facilities and of the mitigation measures employed may provide information that could be used to better assess the potential effects of the Project and the feasibility of the proposed mitigation measures. Indeed, the

Proponent used the narrative for this purpose. The Panel found the narrative useful in that it provided the context for past impacts. However, because the narrative, as outlined in the EIS Guidelines, was not intended to conduct “qualitative analysis and conclusions” for cumulative effects, it did not provide the Panel with a full understanding of past activities that cumulatively interact with present and future ones.

While the Panel understands that, according to the CEAA Operational Policy Statement, past or existing physical activities may be helpful in predicting the effects of a designated project, it is not the sole intent of assessing past or existing projects. The Panel believes that providing a narrative with no analysis or conclusions on the cumulative effects of the existing hydroelectric facilities does not suit the needs of a cumulative effects assessment.

In the hearing, the Panel heard that the effects of the existing hydroelectric developments, particularly the Bennett Dam, had a large impact during initial construction and operation. The Panel understands from participants and from the narrative provided by BC Hydro that some of those effects are ongoing. The Panel determined that some of these effects act cumulatively with the Project.

Participants also said the assessment should have considered effects using a pre-industrial baseline, which they defined as starting around 1950, before the construction of the Bennett Dam. The Panel considers that BC Hydro followed federal and provincial guidance on assessing cumulative effects. It understands that BC Hydro chose the existing environmental conditions as the baseline because the current conditions reflect impacts that have occurred in the past and may continue to affect the VC today. However, it became apparent to the Panel during the hearing that an assessment based on existing environmental conditions does not accurately reflect incremental effects on VCs.

The present developmental condition that lies behind the current and future fate of the ecosystems under review and the VCs that depend on them is a concerning one. The Panel recognizes that BC Hydro made a laudable effort to thoroughly review existing and future projects for its assessment of cumulative effects. However, the assessment excluded the Bennett and Peace Canyon Dams, which were also part of the anthropogenic development in the region that had environmental effects. The Panel agrees with participants who noted that the two previous dams should have been included explicitly in the cumulative effects assessment conducted by BC Hydro. The Panel believes that the assessment of cumulative effects would have benefited from evaluating the ongoing effects of the existing dams and from an evaluation of effects that have occurred in the past that may not be reflected in the current baseline (e.g. loss of riparian habitat).

In light of the information outlined above, the Panel considered the effects of the existing hydroelectric facilities as past and ongoing effects in its assessment of cumulative effects

The Panel disagrees with BC Hydro’s assertion that there was limited information available to conduct a cumulative effects assessment, particularly given the information from participants. The Panel received numerous testimonies from Aboriginal and non-Aboriginal participants about the effects of the Bennett and Peace Canyon Dams. This information was provided first-hand (by people who were alive at that time) or second-hand (by participants who learned of the effects from previous generations). The Panel understands that there is existing information in various formats such as air photos, environmental impact studies, research from various provincial and independent bodies, and historic maps of changing land tenure. With respect to missing biological data for plant species, fish and land animals, and their habitats, the Panel heard that there are anthropological studies done in the region, traditional knowledge passed on

for generations, and historical knowledge of their environment. Considering that participants were aware of information that could be used, the Panel believes that BC Hydro could have done more to provide the “qualitative analysis and conclusions” that are missing in the assessment.

The *Cumulative Effects Practitioners Guide* notes that the lack of information can result in uncertainty in the assessment, as BC Hydro correctly states. However, the Guide suggests empirical methods when considering such shortcomings. It notes that one can provide conservative conclusions or record data gaps and confidence in data quality as needed. The Proponent has done this for the determination of significance of VCs, and the Panel considers that this exercise could have been pursued with respect to cumulative effects.

13.4.3.2 Regional Scale Cumulative Effects

The purpose of a cumulative effect assessment, as described by guidance materials and referenced by participants in the hearing, is to evaluate changes induced by projects occurring in a regional area. The assessment is designed to consider the consequences of multiple projects, each possibly insignificant on its own, yet important when evaluated collectively.

The Panel understands that the Proponent has not used the same methodology for each VC. For some VCs, including heritage, agriculture, health and aspects of current use and harvest, BC Hydro assessed whether projects in the RAA would have residual effects overlapping with residual effects of the Project in the LAA rather than the RAA. For the remaining VCs, the Proponent assessed qualitatively the cumulative effects of the Project combined with the residual effects of other foreseeable projects in the RAA.

When asked by the Panel to present quantitative data on the incremental effects of the Project in the RAA for some VCs and the significance of those effects, the Proponent explained that it had collected limited quantitative information for the RAA and had limited access to quantitative information for other foreseeable projects.

As noted in the Cumulative Effects Practitioners Guide, although the total cumulative effects resulting from all projects in the RAA must be determined, a key task in completing a cumulative effects assessment is to identify to what degree the Project under review alone is contributing to the change in the condition of a VC. The Panel agrees and believes that the methodology used by BC Hydro makes it difficult to assess the project-related cumulative effects in this manner. The Panel was, therefore, forced to determine cumulative effects in a qualitative manner using the information provided by the Proponent and by participants.

Numerous submissions demonstrated that the region has experienced a great level of agricultural, silvicultural, and industrial development. The Panel also finds that the region expects a high rate of industrial development in the upcoming years as described elsewhere in this report. The Panel considers that it is not the responsibility of a proponent alone to evaluate the contribution of all effects of all projects in a region. For this purpose, the Dawson Creek Cumulative Effects Pilot Project, led by FLNRO, is an exercise in the right direction. The Panel believes that the mandate of the pilot should be extended to prepare an adequate regional baseline and determine regional thresholds that could be used by all proponents in preparing cumulative effects assessments in the region and by relevant authorities for management objectives.

The Panel concludes that, whether the Project proceeds or not, there is a need for a government-led regional environmental assessment including a baseline study and the establishment of environmental thresholds for use in evaluating the effects of multiple, projects in a rapidly developing region.

RECOMMENDATION 43
Given the rapid developments foreseen for northeast B.C., Ministers may wish to consider commissioning a regional baseline study and environmental assessment as a public good and a basis for planning and regulating all activities requiring review. Such a study would greatly assist future proponents in all sectors, notably oil and gas, forestry, mining and energy production.

13.4.3.3 Further Improvements Required in Cumulative Effects Assessment

Over the last years, there has been a growing interest in cumulative effects assessment with a significant number of publications and courses offered by Canadian universities on the subject. The International Association for Impact Assessment (IAIA) has also covered this topic in many ways. Consequently, different interpretations and methodologies have emerged outlining generally acceptable practices in cumulative effects assessment. The Panel believes that there is a need to assess the success and utility of the guidance documents available. Despite the good intention to conduct high-quality cumulative effects assessment, the Panel considers that there is a need for a more standardized process relying on a common code of practice.

In recent years, it seems that assessments have strayed from the intent of the *Cumulative Effects Practitioners Guide* and have followed their own guidelines for different reasons. For instance, the absence of reliable data for past projects has been a common excuse to shy away from assuming the responsibilities for assessing cumulative effects.

The Panel believes that the Canadian Environmental Assessment Agency has covered several decades of cumulative effects assessment and is in a strong position to evaluate the success of its guidance documents and their utility. As a result of what the Panel heard during this assessment, it would like to make the following recommendations for the Agency's consideration when reviewing its cumulative effects assessment guidance documents, including the updated operational policy statement:

- Explicitly state the definition and purpose of cumulative effects assessment;
- When offering different options to conduct the assessment, explicitly state when and how each option should be used. For instance, the options for establishing the past boundary presented in the *Cumulative Effects Practitioners Guide* should be contextualized and sustained with explanations and examples; and
- Clearly present the difference between the roles and responsibilities of proponents and governments in the preparation and management of cumulative effects.

Given that joint federal-provincial environmental assessments are a reality, Provinces should be consulted by the Agency on their needs, issues encountered, and expectations. Those comments should be incorporated into the review of the cumulative effects assessment documents. On the other hand, Provinces should work to establish proper baselines and

thresholds that can be used as reference catalogues for proponents, in a similar manner to what is being conducted for the Dawson Creek Pilot Project.

Because of the importance of cumulative effects assessment, the Panel concludes that there is a need to improve and standardize cumulative effects assessment methods.

RECOMMENDATION 44
Whether the Project proceeds or not, the Panel recommends that the Canadian Environmental Assessment Agency undertake, on an urgent basis, an update of its guidance on cumulative effects assessment, taking into account the views of the provinces.

13.5 CAPACITY OF RENEWABLE RESOURCES

The Panel's Terms of Reference requires the Panel to consider, in its assessment of the Project, the capacity of renewable resources that are likely to be significantly affected by the Project to meet the needs of the present and future generations. The Panel sees the definition of capacity of renewable resources as closely linked to the *Canadian Environmental Assessment Act, 2012* (CEAA 2012) definition of sustainable development. CEAA 2012 defines sustainable development as development that meets the needs of the present, without compromising the ability of future generations to meet their own needs. Biodiversity is a key aspect in maintaining productive ecological systems for the future.

13.5.1 Proponent's Assessment

BC Hydro defined renewable resources as natural resources that are replenished on an on-going basis, either naturally or by human action. The Proponent stated that these resources can be living and non-living and are used by people either consumptively (e.g. fishing, hunting, or forestry) or non-consumptively (e.g. recreational, activities, landscape viewing).

The renewable resources where BC Hydro concluded no significant adverse effects are agriculture, forestry, harvest of fish and wildlife resources, outdoor recreation and tourism, navigation, visual resources, and human health. Table 9 provides the valued components (VCs) where BC Hydro concluded that potential effects may occur as a result of the Project and their use (consumptive or non-consumptive). The resources that may have potential adverse effects are fish and fish habitat, vegetation and ecological communities, wildlife resources, and current use of lands and resources for traditional purposes.

The Proponent also evaluated the Project's beneficial use of renewable resources and identified this resource as water. It stated that, since 1968, surface water resources "have been used non-consumptively to produce renewable electricity for past and present generations, and will continue to produce electricity for future generations." BC Hydro said that the use of the same water by the Project as by the two existing hydroelectric facilities would allow the non-consumptive production of hydroelectric power that would provide substantial renewable electricity benefits to both present and future generations. BC Hydro also underlined that a commissioned climate study confirmed that, with predicted global climate change, Peace River would continue to have reliable inflows.

Table 9. Summary of Consideration of Renewable Resources

Valued Component	Resource Use, Consumptive (C), Non-Consumptive (NC)	Potential Significant Adverse Effects
Fish and Fish Habitat	Fishing (C, NC)	- Loss of Habitat due to construction of headpond and reservoir filling - Reduced fish health and survival due to sediment inputs from construction headpond and reservoir filling - Hindered fish movement due to obstruction to fish passage
Vegetation and Ecological Communities	Landscape viewing, plant gathering (C)	- Habitat alteration and fragmentation to certain ecological communities and rare plants
Wildlife Resources	Wildlife Viewing, hunting, trapping (C)	- Alteration and fragmentation of habitat for Yellow Rail (SARA-special concern, Red-listed), Canada Warbler (SARA-threatened, Blue-listed), Cape May Warbler (Red-listed), Bay-breasted Warbler (Red-listed), and Nelson's Sparrow (Red-listed).
Current Use of Lands and Resources for Traditional Purposes	Fishing, hunting, trapping, plant gathering for Aboriginal purposes (C)	- Changes to other cultural and traditional uses of the land during construction and operation

Source: Modified from BC Hydro EIS, Volume 5, Table 37.25

BC Hydro also said that the Project would have a benefit to sustainability and the environment, in that it would provide electricity at a low greenhouse gas (GHG) emissions intensity and enable additional low-footprint, low-GHG-emitting renewable projects over the long term. The Project would also complement other clean or renewable resources, such as wind and run-of-river hydro.

Each year, BC Hydro reports on its sustainability performance. Indicators for social and environmental aspects cover biodiversity, community investment, stakeholder engagement, and Aboriginal relations.

13.5.2 Views of Participants

Numerous participants claimed the importance of biodiversity, and expressed concerns over the loss of wildlife if the Project goes ahead. One participant stated that constructing the Project would not contribute to the development of a sustainable relationship with the natural world.

Wendy Easton, on behalf of the Canadian Wildlife Service, stated that the Peace River region lies in an ecological location at the northern extent of the Continental Divide where the Rocky Mountains split North America into eastern and western distributions. She stated that this fact, especially for an inland region, is why the region has such high species diversity, not only for birds but for insects and other species, such as freshwater fish.

The Yellowstone to Yukon Conservation Initiative (Y2Y) said that this river section is within the Yukon to Yellowstone wildlife corridor and that keeping it open and available was critical to allow wildlife to live in and travel through the region. Some participants noted that the Bennett and Peace Canyon Dams affected this corridor, and the Project site was the last part of the corridor. The Y2Y said that this corridor was critical on a continental scale to the health and genetic connectivity of wildlife populations.

When asked by the Panel if flooding the Peace River valley could seriously increase the barrier to wide-ranging animals, Dr. Clayton Apps, on behalf of the Y2Y, replied that the Project would not likely be a barrier to movement for many wide-ranging species; however, it may still have a population-level impact with respect to fragmentation. Dr. Apps' research demonstrated that

females are much less likely to cross a large reservoir than males, which could result in regionally specific sub-species that could theoretically lose some resilience to the larger population. Dr. Apps expected that regional human-use trends would further impact these species unless there was proactive conservation planning. Dr. Apps said that the first step in maintaining these species for future generations would be to properly characterize the existing impacts on these resources and species and identify what future impacts would likely occur given the current trajectory.

The Ministry of Forests, Lands and Natural Resource Operations (FLNRO) said that at least seven major habitat types for birds are represented in the Peace River reach, including agricultural fields, aspen parkland, banks and cliffs, north-facing cool forest, south-facing warm open slopes, gravel bars, and bottomland forest. Ms. Scheck, from the Ministry, said that these habitat types and associated vegetation communities provide the basis for the high biodiversity of breeding birds, approximately 150 in the Peace River reach. Along with birds, butterflies and plants were cited as two other examples of taxa with high biodiversity in the Peace River reach. Mr. Ken Boon, on behalf of the Peace Valley Landowners Association, cited the high biodiversity in the area as being reason to protect the Peace valley, in particular the north bank and the islands.

Donna Lynn Chapman, a private citizen from Roberts Creek, said that BC Hydro's assessment did not account for lost biodiversity and ecosystem services and functions within the valley and downstream of the Project. Dr. Petr Komers, speaking on behalf of Saulteau First Nations, also recommended that BC Hydro present sustainability thresholds and calculate when any given threshold will or has been reached. Ms. Chapman felt that monetary values should have been ascribed where losses would occur. Her understanding was that if these costs had been included, any feasibility of Site C would be untenable. Furthermore, she noted that the costs related to lost biodiversity would not be confined to residents of the Peace River valley, but would be borne by all British Columbians. She worried that the loss of biodiversity created a debt that would hurt future generations if the Project were to proceed.

The Province said its top priority was to ensure that harvested wildlife populations are sustained over time. However, some First Nations disagreed that the Crown has managed the wildlife populations to ensure a harvestable surplus. Lindsay Staples, a consultant for the Peace Valley Landowners Association, noted that a report of the office of the Auditor General of B.C. in 2013 audited biodiversity and gave the Province a "failing grade" with respect to managing an increasingly fragmented landscape in which biodiversity is dropping rapidly.

Mr. Staples recommended that the Panel adopt a sustainability framework in its analysis. It noted that the general purpose of a sustainability framework would be to protect and provide for viable futures for upcoming generations. He stated that the key question in this assessment was "are the people in a region or in a country overall going to be better off or not?" and likened it to an assessment of "trade-offs." Rachel Darvill, a Masters student, also said that sustainable management and conservation decisions in the watershed needed to appropriately weigh and consider "short-term interests" such as the Project with the long-term impact that these kinds of projects would have for future human generations and their well-being. Mr. Staples said that it was important to recognize the interdependence of social, economic, ecological, and other considerations in adopting a sustainability framework.

Dr. Faisal Moola, on behalf of the David Suzuki Foundation, said that "natural capital" is a term that describes natural and managed ecosystems, fields, farms, forests, and other ecosystems that provide important ecological benefits to local communities, such as flood control, pollination services, hunting and fishing opportunities, nutrient cycling, and other ecosystem services. He

said that several international agencies have urged policy-makers to carefully manage the global natural capital resources, considering that approximately 60 percent of these ecosystem services, including ones in Canada, are already degraded or are being used unsustainably. Ms. Darvill said that decision- and policy-makers should consider multiple interest groups and their values and uses of the land when evaluating impacts to these ecosystem services.

Participants, particularly from Aboriginal groups, stated that the conservation of biodiversity and existing resources in the area was important for future generations. Members of various First Nations spoke about the potential negative effects that the development of the Project would have on future generations, limiting their children, grandchildren, and great-grandchildren in continuing their cultural practices. These participants said that they are responsible for keeping the land for those future generations, a responsibility bestowed upon them by the Creator. Former Chief Garry Oker said that he wanted to leave behind a sense of identity for future generations as Dene people. Other members of Treaty 8 Tribal Association communities stated that it was already challenging to conduct cultural practices amidst the development in the region. Participants stated concerns that, because the Project would affect wildlife habitats and would result in decreased hunting opportunities, that there would be fewer opportunities to teach cultural traditions to future generations. Treaty 8 First Nations noted that ensuring cultural sustainability is very important to them.

Several participants said that the industry development in the area is already above the threshold of what is ecologically sustainable. Brian Churchill, a biologist and retired conservation officer, said that the region was already overstressed by cumulative industrial development that harmed the ecological values critical to sustainability. Reginald Whiten, an agrology consultant, said that land use planning conducted by the Province should consider the context of other projects in the area, when looking at the ability to sustain quality of life and resources. He feared that the planning process is designed to react to projects instead of plan for the future.

The Panel received close to 1,000 form letters that contested the Project because it would bring, among other things, the eradication of wetlands that support migratory birds and damage to remaining fish and wildlife.

13.5.3 Panel's Analysis

For the Panel, the context to assess the capacity of renewable resources is based on the *Canadian Environmental Assessment Act*, *2012* purpose to promote sustainable development. The Panel notes that Canada is also a member state of several international conventions and treaties that provide the framework for provincial, national, and international cooperation for the conservation and the wise use of natural resources.

The world's biological resources are recognized internationally to be vital to humanity's economic and social development, and as a result, there has been an increasing recognition that biological diversity is a global asset of great value to present and future generations. In parallel, the threat to ecosystems and species has never been so present and the growing rate of species extinction so alarming.

With these factors in mind, the Panel reviewed BC Hydro's assessment of the Project to potentially affect the capacity of renewable resources to meet the needs of present and future generations. The Panel agrees with the selected VCs by BC Hydro as being renewable (Fish and Fish Habitat, Vegetation, Wildlife, Current Use of Lands and Resources for Traditional Purposes, Agriculture, Forestry, Harvest of Fish and Wildlife, Outdoor Recreation and Tourism, Navigation, Visual Resources, and Human Health).

The Panel completed its assessment, considering effects on biodiversity and on sustainability. The Panel recognizes that an assessment under the Agreement and its Terms of Reference largely considers these two factors, and each chapter of this report covers the specifics of how renewable VCs are affected.

Overall, the Panel's assessment indicates a change in biodiversity for Fish and Fish Habitat, Vegetation, and Wildlife. For the renewable resources identified, the Panel also concluded that significant effects would occur in the long-term for Fish and Fish Habitat, Vegetation, Wildlife, Current Use of Lands and Resources for Traditional Purposes, Navigation, and Visual Resources. The Panel views this as an effect on the sustainability of these resources.

The Panel believes that the loss of biodiversity has a cost in terms of loss to world biodiversity and heritage. As brought to the attention of the Panel at the hearing by Ms. Chapman, it also has a financial cost.

Many different proposals were presented to pursue the conservation of biological resources of the province or to propose and implement proper planning that would entail their adequate use. The Panel supports and encourages such endeavours.

The Panel concludes that because of the significant adverse effects identified on some renewable resource valued components in the long-term, if the Project is to proceed, there would be diminished biodiversity and reduced capacity of renewable resources.

13.6 ENVIRONMENTAL MANAGEMENT PLANS, FOLLOW-UP AND MONITORING

13.6.1 Proponent's Assessment

The Proponent has proposed a set of Environmental Management Plans (EMPs) and commitments to conduct monitoring and follow-up responses for many valued components (VCs) in its Environmental Impact Statement (EIS). Each management plan and monitoring and follow-up measure would describe the applicable potential Project effects and clearly document all measures to be implemented and actions to be taken to mitigate those effects. The EMPs would also describe the worker qualifications and training requirements pertaining to the plan. Many of the EMPs and monitoring and follow-up measures would require consultation and input from Aboriginal groups, government agencies, and relevant stakeholders.

BC Hydro expects that implementation of the EMPs as outlined in section 35 of the EIS, and the follow-up programs described in Table 39.2 of the EIS, will be conditions of approval of the Project.

13.6.1.1 Environmental Management Plans

As described in section 35 of the EIS, each Environmental Management Plan (EMP) would follow a standard outline that will include: objectives; statutory requirements; BC Hydro policies; voluntary commitments; project's effects, mitigation and environmental protection measures; training and human resource planning; and monitoring and reporting.

For the construction phase, BC Hydro expects to submit detailed EMPs to regulators as a required component of permit applications. These EMPs would provide performance-based requirements to be met by contractors, and the contractors would be required to develop work plans to demonstrate how they would meet the requirements of the EMPs.

For the operation phase, the Site C facilities would be operated in accordance with BC Hydro system management practices, agreements, and policies. Maintenance would be done in accordance with corporate policies, procedures, and standards. Conditions of Project certification and approval would be included in operating requirements. Operations phase EMPs would be developed during Project construction and be complete prior to commissioning.

EMPs would be developed by professionals with relevant expertise. Federal and B.C. government agencies, local governments, in the vicinity of the Project, and Aboriginal groups would have the opportunity to review and comment on the draft EMPs as appropriate. Comments received during consultation and the EIS comment period would be considered in the development of the EMPs.

It is common for major projects to provide an EMP outline during an environmental assessment process, followed by the development of the detailed plans themselves during the regulatory or permitting process. This allows for the inclusion of the outcomes of the environmental assessment (EA) to be incorporated in the EMPs.

Finalization of proposed site-specific detailed mitigation measures would be confirmed with the framework of the EMPs and follow-up programs described in the EIS, and in the subsequent permitting phase, in consultation with the appropriate agencies and Aboriginal groups.

In response to the Panel's information requests, the Proponent provided additional details on some of the EMPs and mitigation plans identified in the EIS. This included, for example, further details regarding a conceptual fish habitat compensation plan to demonstrate key elements that would be covered in that plan.

EMPs that the Proponent has proposed are listed in Table 10

13.6.1.2 Compliance Reporting and Monitoring Plan

Compliance Reporting is outlined in section 36 of the EIS. Each contractor engaged for the Project would be required to retain one or more qualified Environmental Monitors who would have authority to stop work in the event of non-compliance with conditions, federal and provincial permits, management plans, applicable legislative requirements, and BC Hydro policies. The role of the Environmental Monitors would be to inspect, evaluate, and report on the performance of construction activities and on the effectiveness of environmental control strategies and mitigation measures. A detailed monitoring plan identifying the type and frequency of observations and data collection, methodologies to be employed, and protocols to be followed would be developed prior to commencement of activity.

BC Hydro would retain one or more Environmental Monitors who would have the same authority as the contractors' Environmental Monitors. It would also retain Environmental Officers who would inspect and evaluate the work of contractors' Environmental Monitors and to report to regulators.

Table 10. BC Hydro's Proposed Environmental Management Plans

Construction Safety	
Emergency Response	Traffic
Fire Hazard and Abatement	Worker Safety and Health
Public Safety	
Construction Environment	
Acid Rock Drainage	Hazardous Waste
Air Quality, incl. dust	Heritage Resources
Blasting	Ice
Clearing and Debris Management	Noise and Vibration
Communications	Soil, Site Restoration and Re-Vegetation
Contaminated Sites	Smoke
Erosion Prevention and Sediment Control	Vegetation and Invasive Plant
Fisheries and Aquatic Habitat	Waste, incl. reduction and recycling
Fuel Handling and Storage	Wildlife, incl. human-bear conflict
Groundwater Protection	
Operations Safety	
Emergency Response	Worker Safety and Health
Public Safety, incl. reservoir shoreline monitoring	
Operations Environment	
Hazardous Waste	Waste
Ice	Water
Vegetation and Invasive Plant	

Source: Modified from BC Hydro EIS, Vol. 5, Section 35

Further to the mitigation measures described above in the context of the Project's proposed Environmental Management Program, section 39 Table 1 of the EIS provides a list of mitigation measures that have been developed specifically to avoid or reduce the potential adverse effects of the Project on the VCs.

13.6.1.3 Follow-up Measures

Table 39.2 in the amended EIS provides a complete list of follow-up measures. Specific follow-up measures have been identified to address areas of uncertainty regarding the nature or extent of predicted adverse residual effects on a VC. Follow-up measures are also proposed to address uncertainty about certain mitigation measures. The follow-up measures are generally

based on the monitoring programs and include measures to mitigate any further effects that may be detected.

13.6.2 Views of Participants

In general, participants expressed concern that the details of EMPs and monitoring and follow-up programs were not available until the permitting stage and were not required as part of the Project EA decision. More specifically, participants were concerned about the effectiveness of proposed mitigation measures, how EMPs would address such uncertainty, and the exclusion of monitoring or follow-up programs for some VCs in light of this uncertainty. A common submission was that monitoring and follow-up programs may or may not fully mitigate effects that arise from the Project and that were not assessed in the EIS. The primary concern was that the effectiveness of such adaptive management efforts is uncertain and could result in further significant adverse effects that have not been defined in the EIS.

Aboriginal groups and stakeholders said the Proponent needed to be clearer and more descriptive in how and who it would consult in the development of more detailed EMPs and monitoring and follow-up programs. Participants suggested to the Panel that these consultation process details should be described as specific conditions, should the Project proceed.

Participants also expressed a need for the Proponent to commission an independent third-party environmental monitor to implement and direct the EMPs and monitoring and follow-up programs to better ensure effective responses to Project-induced and cumulative effects that arise during construction and operation. The role of an independent environmental monitor would include directing the resolution of disputes between the Proponent and interested parties in finalization and implementation of the EMPs and monitoring and follow-up programs.

Participants said it was not clear whether the costs of developing and implementing the EMPs and monitoring and follow-up programs were included in the Project cost or in addition to the estimated Project cost of $7.9 billion. Participants noted that the Proponent estimated $1.005 billion for “indirect costs,” for example, “Mitigation & Compensation.” Participants requested the Proponent to provide an estimate of how much of the $1.005 billion was to be applied for mitigation; a primary concern being that there was insufficient funds allotted to developing and implementing the EMPs and monitoring and follow-up programs, including further mitigation measures that may be required and not outlined in the EIS. Participants also submitted that the Proponent should provide an estimate of the costs of the EMPs and monitoring and follow-up programs, including potential mitigation measures that may arise, in order for the Panel to understand the full financial costs of the Project.

Participants were concerned about the ambiguous wording of many proposed mitigation measures in the EIS. They said phrases such as “when appropriate,” “where possible,” “where practical,” and “where feasible” allow the Proponent to easily decide not to implement those mitigation measures without any legal repercussions. The concern was that if the Proponent was not committed to mitigating effects as proposed in the EIS, the effective implementation of EMPs and monitoring and follow-up programs was also questionable. Participants requested the Panel recommend that monitoring and follow-up measures be legally enforceable conditions should the Project proceed.

13.6.3 Panel’s Analysis

Both the BC Environmental Assessment Office and the Canadian Environmental Assessment Agency have a compliance team and policies in place to enable monitoring of compliance with

Project conditions during construction and operation. Moreover, provincial and federal government agencies have resources to monitor compliance of conditions required through the review of required permits.

The B.C. Environmental Assessment Office's Compliance and Enforcement Program was developed based on leading practices of other jurisdictions and builds on the expertise and resources of partner compliance agencies, such as the Ministry of Forests, Lands and Natural Resource Operations, the Oil and Gas Commission, the Ministry of Environment and the Ministry of Energy and Mines. Field and administrative (i.e. desk-based) inspections are key components of the Environmental Assessment Office's approach to compliance oversight. In addition to Environmental Assessment Office staff, compliance staff in the Ministry of Forests, Lands and Natural Resource Operations and the Oil and Gas Commission is authorized to inspect projects under the *Environmental Assessment Act*. Working with partner agencies, the Environmental Assessment Office develops compliance inspection priorities and determines which projects will be inspected each year. Additional inspections may be conducted by the Environmental Assessment Office or partner agencies in response to complaints, to follow up on previous issues of non-compliance or if there is reason to believe a project may be out of compliance with environmental assessment certificate conditions.

Appendix 9 of this report provides a complete list of the Proponent's proposed mitigation measures and commitments noted during the public hearing. The Panel, in general, agrees with the measures proposed.

Subject to the recommendation below, the Panel is satisfied with the Proponent's environmental management, including its mitigation measures, monitoring programs, and follow-up programs.

RECOMMENDATION 45

The Panel recommends that, if the Project is to proceed, all recommendations of the Panel directed to BC Hydro and mitigation measures proposed by BC Hydro become conditions of Project approval.

14 PROJECT PURPOSE, COST, AND BENEFITS

"Purpose" is defined by the Canadian Environmental Assessment Agency's *Operational Policy Statement - Addressing "Need for", "Purpose of", "Alternatives to" and "Alternative Means" under the Canadian Environmental Assessment Act* as "what is to be achieved by carrying out the Project." It provides the context under which the Panel considers alternatives identified. This section also outlines the costs of the Project and the benefits as reported by the Proponent and participants.

14.1 PURPOSE OF THE PROPOSAL

14.1.1 Proponent's Assessment

According to the Proponent, "the Project is being proposed to meet three purposes: (1) to cost-effectively meet BC Hydro's forecast need for energy and capacity, (2) to meet forecast need in alignment with the provincial policy objectives of the *Clean Energy Act*, and relevant B.C. Government policy statements, and (3) to cost-effectively maximize the development of the hydroelectric potential of the Site C Flood Reserve which was established in 1957.

14.1.2 Views of Participants

Some participants, notably the Treaty 8 Tribal Association (T8TA), questioned the validity of objective (3), which seems to stem from the "two rivers" (Peace and Columbia) policy of the provincial government of half a century ago

Specifically, Philip Raphals, presenting for T8TA, pointed out if the purpose of the Project includes maximizing the hydroelectric potential of the Site C flood reserve, then there cannot be any alternatives, because no alternatives to meeting the energy and capacity needs maximize the hydroelectric potential. He referenced his participation in the Lower Churchill project Joint Review, where he advised the Panel to exclude maximizing hydroelectric potential from the purpose of the Project in order to allow for a broader consideration of alternatives to the Project.

14.1.3 Panel's Analysis

There can be no disagreement with the first two objectives identified by BC Hydro. The third, however, appears to be its own. The Panel cannot find this objective in the authoritative statement of B.C.'s energy objectives, the *Clean Energy Act* of 2010, unless it can be inferred from section 2(m): "to maximize the value, including the incremental value of the resources being clean or renewable resources, of British Columbia's generation and transmission assets for the benefit of British Columbia." The operative word is "value," which implies principally an economic judgment, and no mention is made of utilizing all the hydraulic resources of the Peace River. Part 2 of the *Clean Energy Act*, "Prohibitions," says in section 10 that these prohibitions do not include Site C, but no statements of intent follow the double negative.

If accepted, this third objective would tilt the scales heavily in favour of Site C as against any other supply possibilities. Because it would render nugatory much of this Panel's Terms of Reference, the Panel assumes this was not the intention of the two governments.

The Panel rejects, as a governing purpose, the maximization of the hydraulic potential of the Peace River.

This is not to say that Site C is unattractive. The Panel finds that BC Hydro's proposed dam would benefit hugely from the upstream storage and regulation, providing firm, seasonally modulated power for many decades beyond its amortization period. Provided its near-term costs are affordable, it would become a substantial addition to B.C.'s very long-term supply of low-cost "Heritage Hydro."

14.2 PROJECT BENEFITS

14.2.1 Proponent's Assessment

The Proponent identified important economic, environmental, and social benefits to B.C. and Canada as a result of the Project. Some would come from the low cost, low greenhouse gas (GHG) electricity generation provided by the Project, and additional benefits would come from economic development activities during construction and operation, as well as improvements to local recreation and infrastructure. As a result, according to the Proponent, the Project would leave local communities and the entire province better off.

14.2.1.1 Ratepayer Benefits

BC Hydro's customers would benefit from electricity rates that are among the most competitively priced in North America. These competitive rates result from historic investments in the Heritage hydroelectric system paid for by previous BC Hydro customers.

The Project is identified as unique in that costs decrease over time as debt is paid down and inflation reduces the relative cost of the depreciation expenses. With rate smoothing, the Project would expect to result in a small (~3 percent) increase to rates compared to alternatives for the first five years of operation, after which rates would be lower for the rest of its operating life.

BC Hydro claimed that ratepayers would also benefit from increased certainty in the cost of supply for the Project's operating life. The majority of the Project's revenue requirement would be established once construction was completed and the Project enters service. BC Hydro would be able to further improve cost certainty by fixing financing for 30 years at attractive rates.

By comparison, projects such as wind power were noted to have a lower operating life than the Project and would require replacement and significant rehabilitation after 30 years. Projects with fuel requirements such as gas-fired generation would also have a shorter operating life and be subject to volatility in fuel prices.

14.2.1.2 Economic Development Benefits

The Project would also provide benefits to economic development in the Northeast Development Region, the province, and the rest of Canada through spending during construction and operation. The Proponent noted that these benefits would come through increased gross domestic product (GDP), output, household income, and employment. Table 11 summarizes the benefits to economic development for the construction and operation periods.

Table 11. Economic Benefits of the Project

	Increase during construction (aggregate) $x10^6 except where noted	Increase during operation (per year) $x10^6 except where noted
Northeast Development Region		
GDP	132	0.4
Output	324	1.1
Household income	81	0.3
Employment	3,900 person years	99 person years
Provincial		
GDP	3,228	7.0
Output	3,016	13.5
Household income	2,232	4.9
Employment	29,300 person years	161 person years
Federal		
Imports from other provinces	580	1.8

Source: Modified from EIS, Volume 1, Section 7

14.2.1.3 Environmental and Sustainability Benefits

BC Hydro argued that the Project would be important in continuing B.C.'s legacy of low-GHG generation within the planning horizon and beyond. Even though all generation resources will produce some level of GHG emissions, the Project would deliver a higher amount of energy per unit of GHG than alternatives. Additional information on the GHG contributions of the Project compared to other potential sources of supply is outlined in Section 13.1.

The benefits of the Project to sustainability and keeping GHG emissions low would be realized through its capability to integrate other clean or renewable resources such as wind and run-of-river hydro. Electrical systems are limited in their capability to manage resources such as wind while maintaining system reliability, due to the intermittent nature of the resource. The Project would increase the amount of wind the system can reliably integrate.

While the Project is not being proposed for exporting energy, the energy surplus in its early years would allow BC Hydro to assist other jurisdictions, such as California, in managing an increasing level of intermittent resources such as solar or wind. This assistance could be provided irrespective of the net import/export position of BC Hydro compared to external jurisdictions. The dynamic capacity and storage would allow these external jurisdictions to integrate additional wind, solar, and run-of-river hydro, in turn lowering their GHG emissions and footprint of supply resources. BC Hydro's ratepayers would further benefit from the revenues associated with providing such a service.

14.2.1.4 Fiscal Benefits to Governments

The Project would provide benefits to all levels of government during construction through increased taxation revenues and to local and provincial governments during operation through taxation revenues and grants-in-lieu. Table 12 summarizes the benefits to government revenues for the construction and operation periods.

Table 12. Government Revenues

	Construction period, total $\$x10^6$	Operations period, annual $\$x10^6$
Local	40	5
Provincial	176	75-260
Federal	270	0

Note: reflects changes to water rental rates and the BC Hydro return on equity resulting from the November 26, 2013 Government Announcement, as well as the revenues to local governments expected under the Regional Legacy Benefits agreement.
Source: BC Hydro Response to IR# 22, CEAR #1624

The Peace River Regional District and its member communities signed a Regional Legacy Benefits agreement in June 2013. Under this agreement, BC Hydro would provide $2.4 million per year indexed to inflation beginning in Year 1 of Site C operation and continuing for 70 years. These funds would be allocated to the member communities using a formula determined by the District and its communities, and would provide lasting benefits as they see fit.

14.2.1.5 Benefits to Aboriginal Groups

BC Hydro noted its commitment to providing lasting benefits and opportunities to Aboriginal groups through the construction and operation of the Project. BC Hydro is willing to negotiate Impact and Benefit Agreements (IBAs) with First Nations that would be most affected by the Project. Potential components of an IBA could include cash, work and contract opportunities, Crown land transfers, and implementation of land protection measures or special land management designations.

14.2.1.6 Benefits to Local Communities

The Project is expected to leave the communities in the District better off upon its completion. The benefits to local communities were stated to include financial benefits, road safety benefits, and economic development benefits as shown in Table 13.

Table 13. Community Benefits

Area	Benefits
Peace River Regional District and the Peace region generally	• Revenues from legacy benefits agreement • Revenues from additional grants-in-lieu of taxes • Increased fishing opportunities on reservoir • Increase in water-based recreation opportunities due to greater potential access by a variety of boats • Enhanced recreation opportunities on the new reservoir. • Travel time savings and better road safety on Highway 29 • Community fund of $100,000 per year for eight years, to support non-profit organisations in the North and South Peace during Project construction • 2.9 million cubic metres of stockpiled construction material that would lower road construction costs for the Ministry of Transportation and Infrastructure. • $1 million to support trades and skills training at Northern Lights College, half of which would be dedicated to Aboriginal students. • BC Hydro participation in the Northeast Regional Workforce Table, which improves understanding of labour demand and supply in the northeast. • $100,000 for the Northern Opportunities Partnership over three years to aid in the continued attraction of new entrants into trades training. • $100,000 for the North East Native Advancing Society to support Aboriginal

	entry into trades training. • $184,000 for Northern Opportunities to support a school counsellor position in local school districts. • Improvement of the 85th Avenue Industrial Lands after BC Hydro's use; BC Hydro will provide $50,000 toward a Site Master Plan to guide future land use and development.
City of Fort St. John	• Revenues from legacy benefits agreement • Approximately 40 new housing units for use by BC Hydro's workforce and their families during construction, plus 10 new affordable housing units. After construction of the Site C project, all of the housing units would be available as affordable housing. • $1,000,000 per year during Project construction. As the City will not have to provide services to BC Hydro sites, these payments would be net revenue to the City during the construction phase. • North bank roads will have improved driving conditions and road safety, with increased shoulder width or paths for cyclists • Improvements in local transmission system reliability • New daycare spaces for community use • Donation of $200,000 to Salvation Army Northern Centre of Hope to support shelter and transitional beds • Donation of $25,000 to Skye's Place, a second stage housing program for women and children • Donation of $25,000 to Meaope Transition House for Women and children • Funds for the North Peace Museum
Hudson's Hope	• Revenues from legacy benefits agreement • Improved vehicle access to shoreline, berm and proposed day use recreation area and boat launch from upgrades to D.A. Thomas Road • Improved road safety from construction of paved brake check before grade on Canyon Drive, with potential for arrestor beds or runaway lanes. • New water supply infrastructure. • Funds for the Hudson's Hope Historical Society museum, to support their role in heritage mitigation by sharing the heritage history of the Peace River valley.
Taylor	• Revenues from legacy benefits agreement • Improved access to Taylor wells • Improved monitoring of Taylor wells, shoreline protection at well-sites, and reduction of sedimentation • Improvements in local transmission system reliability • New continuous street lighting on Highway 97 through Taylor, improving local road conditions and driving safety during fog conditions. • New Changeable Message Signs north and south of Taylor, and webcams operated as part of the provincial system, to provide regional highway information • Twenty new long-stay, serviced RV sites at Peace Island Park
Chetwynd	• Revenues from legacy benefits agreement • Construction of south bank dam viewpoint • Allocation of dedicated portion of the Community Recreation Site Funds for the south bank
Dawson Creek	• Revenues from legacy benefits agreement

Source: BC Hydro's Closing Submission, Table 10

14.2.1.7 Summary

BC Hydro concluded that while the Project could cause some significant residual effects, they are justified by (1) the public interest in long-term, reliable electricity to meet growing demand, (2) the employment, economic development, ratepayer, taxpayer, and community benefits that would result, (3) the ability of the Project to meet this need for electricity with lower GHG impact than other resource options, (4) the limited footprint of the Project, given its generation capability, using water already stored in the upstream reservoirs to generate over 35 percent of the energy from BC Hydro's largest facility with only 5 percent of the reservoir area; and (5), the

honourable process of engagement with Aboriginal groups and the potential for accommodation of their interests.

14.2.2 Views of Participants

The Panel heard various opinions on Project benefits. Some participants agreed with BC Hydro, citing the Proponent's view of the Project benefits. Others felt that the benefits identified by BC Hydro would not be benefits from their point of view, or that they would not outweigh the Project's adverse impacts.

Senator Richard Neufeld, a former B.C. Minister of Energy, Mines and Petroleum Resources and former MLA for Peace River North, highlighted the employment benefits during initial development and construction. He said that the Project would have the potential to provide regional advantages beyond the early stages that would stretch for many generations to come. He stated that local communities need to have a well-rounded understanding of the full potential of this Project so that they can make the most out of these opportunities.

Regional benefits were also stressed by Blair Lekstrom, another former B.C. Minister of Energy, who, in 2010, introduced the *Clean Energy Act*. He mentioned in particular the positive benefits associated with increased employment and tax revenue. Acknowledging the negative impacts that the Project would have on certain lands and families in the region, he suggested that compensation for lands taken should be more like double the appraised values than the "value plus 5 percent" formula in the *Expropriation Act*.

Philip Hochstein, of the Independent Contractors and Businesses Association, said that many local businesses would stand to benefit from the Project. He also emphasized the benefits to taxpayers in the form of additional revenues to all levels of government. He noted that BC Hydro's substantial commitments would also help generate economic benefits for First Nations.

Wayne Dahlen, a former mayor of Dawson Creek, said that, after weighing the pros and cons of the Project, he felt that it would be good not only for the Peace region, the province, Canada, and North America, but the whole world. He conceded that "a few will have to sacrifice for the greater good," but that, from his perspective, only a very small percentage would be negatively impacted. Gerry Lundquist, speaking on his own behalf, also said that the Project would result in changes to the landscape and that some people would need to be compensated, adding that the benefits of Site C would far outweigh the disturbances, as was the case with other hydroelectric projects in B.C.

Paul Gevatkoff, of the South Peace Oilmen's Association, pointed to the benefits of the Columbia River dams for southern B.C. He felt that this success should be brought to the north. Like others, he acknowledged that there would be adverse impacts; however, he felt that the sacrifice would be warranted. He said that benefits, in addition to power generation, would include flood protection, new fishery opportunities, new recreational opportunities, new industrial opportunities, and potential increase in water storage against future droughts.

Blair Qualey and Jim Inkster, of the New Car Dealers Association of B.C., said that the Project would benefit the association because of the growing interest in electrical vehicle use in the province.

However, other participants said that the people experiencing the negative impacts of the Project are not those receiving the benefits. Participants including Treaty 8 First Nations members, farmers, Peace Valley landowners, and environmentalists stated that they, and future generations in the region, would bear the costs of the Project, while the benefits would accrue to

distant, perhaps non-British Columbian, customers of BC Hydro. Participants noted that there would be some who would benefit financially and in the short term; however, those who would not benefit would be the ones who value the long-term benefits of the farmland, the environmental health, heritage, and wildlife of the valley, and the general well-being of being a resident. They noted that these costs would be especially difficult to bear considering alternative methods of power generation that could be used by the province, which would not be as destructive. D. Lynn Chapman said that most participants do not agree that the benefits would outweigh the impacts. She said that there are better solutions to meet energy needs and that BC Hydro has failed to recognize the unique and irreplaceable character of the Peace River valley. She said that the Peace River has borne enough of the burden of hydroelectric development for this province and should not suffer any further.

Sandra Fuchs, a member of Saulteau First Nations, said First Nations would not experience the financial benefits portrayed by BC Hydro. She spoke of her experience during the construction and operation of the upstream dams and how this has affected the reputation of BC Hydro. Aboriginal groups also said many short-term labouring jobs are already available in the region without the Project. Real benefit would lie in helping remove systemic barriers to Aboriginal employment and business creation, including training and educational opportunities to support long-term Aboriginal economic development objectives.

Timing was an issue for Randall Hadland. He said that building a project in advance of need would create adverse environmental and economic impacts prior to experiencing any benefits. He said that the financial benefits of the Project would be directly related to putting $8 or $10 billion of borrowed money into a project and claimed that such a significant investment into any other industrial or power generation projects would result in the same kinds of financial benefits.

Ken Forest quoted the official 2013 B.C. Agricultural Climate Change Action Plan, which was pointedly complimentary with respect to the unique market-gardening and fruit-growing potential of the Peace River valley. He called the employment benefits of the Project a red herring, saying that the jobs created would benefit only transient workers. Once construction was complete, only a handful of permanent jobs would remain. However, the Project would have displaced thousands of agricultural jobs over the coming decades.

John Locher, of Ethix Consulting, said that the Project benefits would mainly flow to large population centres in southern B.C. but that the negative effects would be felt elsewhere. He referred to those living close to the construction zone for eight years and how the Project benefits would not outweigh this impact. He stated that, during that construction period, the majority of the impacts would be negative (traffic, noise, dust, transient workers, and over-taxed local services). He noted that one potentially positive impact may be jobs for local residents or contracts for local businesses, but since the work would be publically tendered, there would be no guarantees of local employment or of local contractors being successful. He feared that the positive benefits may not be realized locally.

Mr. Locher also expressed concern regarding the financial benefits for the three local communities that would be permanently affected by the Project (Hudson's Hope and Electoral Areas B and C in the Peace River Regional District). He felt that the grant-in-lieu of taxes should be negotiated before construction starts to ensure that local residents would be adequately compensated for the permanent impacts.

Mayor Gwen Johansson of Hudson’s Hope said that there is no shortage of employment in the area with all the oil and gas activity and that there would be even more jobs available if planned projects proceed. She expressed concerns specific to the District of Hudson’s Hope, stating that

existing BC Hydro jobs in Hudson's Hope may be moved to Fort St. John if the Project proceeds. She said that it is difficult to see how the benefits of the Project for Hudson's Hope would extend beyond the short construction period. "Hudson's Hope looks to get a lot of disruption, a lot of lost land, and severely diminished quality of life for its citizens."

Terry Webster discussed the legacy community fund specific to the District of Hudson's Hope. He mentioned that BC Hydro and the Province of B.C. have a history of shortchanging the District on the issue of legacy funds and grants-in-lieu. Unlike other local governments, it did not receive legacy funds for the upstream dams. However, the District of Hudson's Hope would be receiving 10.99 percent of the funds while receiving 90 percent of the negative impacts. Hudson's Hope's share of the legacy fund would be based on population forever, he said, rather than on imposed cost. For this reason, the District of Hudson's Hope asked BC Hydro for a separate agreement, which was refused.

Grace Setsuko Okada quoted World Bank documents used to aid in its decision making: "Because of the severity of social impacts suffered by impacted people, a traditional cost-benefit analysis is not an adequate justification for the decision to build a large dam." She also read the following quote: "In too many cases, an unacceptable and often unnecessary price has been paid to secure benefits, especially in social and environmental terms, by people displaced, by communities downstream, by taxpayers and by the natural environment."

Many participants said that there were other economically competitive sources that did not create such huge environmental and social costs. These are discussed in Chapter 15.

14.2.3 Panel's Analysis

Beyond an abundant supply of firm power, BC Hydro noted economic benefits in terms of direct as well as enabled economic (GDP) growth; local, provincial, and federal government revenues; and regional economic benefits, including the employment of Aboriginal labour and other resources. While the Panel understands that these claims were required by the EIS Guidelines and were not the fault of BC Hydro, they are, in part, misleading.

As one participant noted, the real question is the difference between these results and the results that would have occurred if the capital had been invested in its next best alternative, or, in the limit, left in private hands for independent decisions about consumption and investment. The regional and local economic benefits—school taxes, grants-in-lieu, IBAs, side agreements with local governments and agencies, employment, etc.—are best viewed as geographically displaced payments. In the absence of the Project, an investment of $7.9 billion would have created returns of some sort in other places.

A partial exception to the displacement argument could be that the Project would have interregional distribution effects that society values and would be difficult to attain otherwise, such as Aboriginal employment. This is certainly a benefit of the Project, though it appears not to be one that local First Nations value much if it comes at the cost of flooding the valley.

The Panel views the more general alleviation of regional unemployment as a non-issue in a booming area with exceptionally low unemployment rates; indeed, it appears that most of the construction workforce would have to be imported from other parts of B.C. and Canada.

The Panel concludes that the Project must rest on its main claims - that it would supply electricity that B.C. customers need and would pay for, at a lower combination of cash and external costs than any alternative - and not on regional economic benefits.

14.3 PROJECT COSTS

14.3.1 Proponent's Assessment

BC Hydro has provided only a summary of construction costs, but asserted that the Project, including mitigation and other "soft" costs, can be completed for $7.9 billion, broken down as shown in the Table 14.

Table 14. Project Costs

Project Cost Breakdown	Cost Estimate ($10^6 nominal)
Dam and associated structures (earthfill dam, approach channels and RCC buttress, spillway, intakes and penstock, left bank stabilization, cofferdams, dikes and diversion tunnels)	1,790
Power facilities (powerhouse and switchgear building, stations and transmission)	990
Offsite works (Highway 29 relocation, access roads, clearing, land and rights)	530
Construction management and services (worker accommodation, construction management, and construction services	515
Indirect costs (development costs including sunk costs, regulatory costs, construction insurance, management and engineering, mitigation, and compensation	1,005
Contingency	730
Inflation	790
Interest during construction	1,550
Total construction and development costs (nominal)	**7,900**

Source: BC Hydro "Project Costs", Technical Memo, Table 1, p.4

14.3.2 Views of Participants

A number of participants expressed concern regarding the cost of the Project. Some worried that the intertwined finances of the Province and BC Hydro posed unacceptable risks to taxpayers. Others worried that the expense of Site C would cause electricity rates to rise, or that the Project's costs could affect taxpayers through a lowering of the Province's, and therefore BC Hydro's, credit rating.

Many participants had little confidence in the estimated cost of the Project, citing substantial overruns on other large projects, for example, the Northwest Transmission Line's 50 percent-plus overrun. Some felt that eventual decommissioning costs should be included. Others were simply unclear about what was included in the $7.9 billion figure, wondering whether it contained mitigation and compensation costs were included. In response, BC Hydro stated that the $7.9 billion included all expenses to complete the Project, including mitigation and compensation, but that decommissioning is not anticipated.

Some participants said the projected costs of Site C were understated by the failure to include sunk costs, and that this unfairly biased the analysis against alternatives.

14.3.3 Panel's Analysis

The Panel is unable to say whether these estimates are likely to be accurate. It notes, however, that BC Hydro has been working on this Project off and on for 35 years, that the technology is mature, that the work has been done to the standards of a Class 3 (-15 percent to +30 percent) estimate of the Association for the Advancement of Cost Engineering, and that the work has been reviewed independently by KPMG, a consulting firm. The cost estimate was completed in 2011, and allowances have been made for inflation until the in-service date.

Because BC Hydro has not built a project of this size for many years, the Panel feels that there is little corporate experience to draw on. When asked for its recent experience with smaller capital projects, BC Hydro noted that its average cost overrun on recent projects of more than $50 million was 3.3 percent, and for generation projects, was -0.3 percent. The Panel is encouraged by these results.

The Panel cannot conclude on the likely accuracy of Project cost estimates because it does not have the information, time, or resources. This affects all further calculations of unit costs, revenue requirements, and rates.

RECOMMENDATION 46
If it is decided that the Project should proceed, a first step should be the referral of Project costs and hence unit energy costs and revenue requirements to the BC Utilities Commission for detailed examination.

14.3.3.1 BC Hydro's Financial Condition and Risk to Taxpayers

A number of participants drew attention to the financial risks faced by ratepayers and, through the Provincial guarantee of BC Hydro debt, by taxpayers in general as a result of the Project.

The finances of BC Hydro and its owner, the provincial government, have been intertwined by the latter at the expense of the former. BC Hydro's present financial condition, with its immense deferral ("regulatory") accounts and absence of a real equity base, is a consequence of the Province's dividend policy, its discriminatory water rental rates, and its determination until recently to delay the sort of rate increases that would pay for these and other unfunded mandates.

The deferral accounts grew from $2.1 billion on March 31, 2011, to $4.4 billion two years later, aided by a transition to new accounting standards prescribed by the Province over the criticisms of the provincial Auditor General. The water rental rates have historically been much higher than those charged to other industrial water users, including Fortis, the private utility that serves the Kootenays. Hitherto, the Province has required a dividend equal to 85 percent of its earnings, calculated on the basis of what the BC Utilities Commission (BCUC) allows Fortis to earn on its equity. But BC Hydro has no real equity, so the payment must come from fictional ("deemed") earnings, reducing BC Hydro's ability to pay for sustaining capital expenditures, much less plan for anything new. The effect is to reduce the free cash flow BC Hydro has to support Site C,

thus requiring more borrowing, which exposes it and its owner to interest rate (and possibly exchange rate) risk.

In effect, the Province has been increasing the total of its direct and indirect debt while classifying BC Hydro's portion of it as being supported by rates it did not allow BC Hydro to charge.

On November 26, 2013, the Minister of Energy announced a series of reforms that should put BC Hydro into a more sustainable position over the next ten years. These include a paying-down of the non-Site C regulatory accounts; the elimination of the special BC Hydro-only third tier of water rentals starting in 2018; a reduction of dividends, also starting in 2018, until BC Hydro reaches a debt:equity ratio of 60:40; a budget for capital expenses before Site C, averaging $1.7 billion a year for ten years; a rate design review to encourage conservation; and a substantial hike in rates to pay for it all. The rate increases will total some 45 percent (nominal) between 2014 and 2023.

These plans will affect the government of B.C.'s long-term debt management plans, notably through foregoing $2 billion in income from BC Hydro over the coming decade, balanced by a lower borrowing requirement by BC Hydro. The Province and therefore BC Hydro enjoy a triple-A credit rating. According to the 2014 Budget (Table 15), B.C.'s forecast of debt shows continuing modest increases with no substantial change in its debt-to-GDP ratio. This is before the addition of the cost of Site C, whose construction would be financed mostly by provincially guaranteed debt, since BC Hydro is unlikely to have any but deemed equity until later. There is a risk that less-than-stellar debt management by the Province could cause its credit rating to slip a notch, which would entail an increase in the cost of B.C.'s total debt, not just BC Hydro's.

Table 15. B.C.'s Debt Growth is Forecast to Slow

	2008-9	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Total ($10^{9})	38	42	45	50	56	62	65[f]	67[f]	69[f]
Debt/GDP (percent)	19	21	22	23	19	19	18[f]	18[f]	18[f]
Debt/cap ($10^{3})	9	9	10	11	12	13	14[e]	14[e]	14[e]

[f] forecast; [e] estimated.

Sources: B.C. 2013 Financial and Economic review, Aug. 2013, p. 35; fin.gov.bc.ca/tbs/F&Ereview13.pdf; B.C. Budget 2014, Fiscal and Debt Summary

The Panel does not base any conclusions on the realization of this macro risk, as it is entirely manageable by a prudent B.C. government.

15 NEED FOR AND ALTERNATIVES TO THE PROJECT

The Panel is required to assess the purpose of the Project, the need for it, alternatives to it, and alternative means of carrying it out. Alternative means are discussed in Chapter 2. Cascade options are markedly more expensive means of utilizing the hydraulic potential of the Peace River and would only marginally reduce the environmental, social, health, and heritage costs. Changes to road, transmission line and work camp locations would increase costs without corresponding reductions in externalities.

Purpose has been dealt with in Section 14.1. The critical remaining topics are need and alternatives to the Project, which are the subject of this chapter.

The need for the Project is defined as the difference between forecast load and available resources. This requires an examination of the demand forecast and means of moderating that demand, addressed in Sections 15.1 and 15.2 below. The remainder of the chapter discusses supply alternatives within the constraints of public policy. As these severely reduce the options available to BC Hydro, the constraints are set out for the reader.

15.1 DEMAND

15.1.1 BC Hydro's 2012 load forecast and updates

BC Hydro's load forecasting methodology was based on "bottom up" forecasts for each of the major sectors, residential, commercial, and industrial. It used a combination of statistical, historical, customer interview, and judgmental methods to develop an understanding of the likely course of demand over a period of 20 years. For the Environmental Impact Statement (EIS), it used the middle of its 2012 load forecast array as required by B.C. Reg 245/2007. The forecast was slightly modified in the Evidentiary Update (September 13, 2013) and the Integrated Resource Plan (November 25, 2013).

According to BC Hydro, the 2012 load forecast was prepared in accordance with the BC Utility Commission's (BCUC's) Resource Planning Guidelines, using methods approved by the Commission, and following the policy guidelines in the 2011 B.C. government review. BC Hydro said it was a conservative forecast due to the use of rate increases that were larger than the government's recently announced rates, the exclusion of liquefied natural gas (LNG) demand, and the inclusion of only a modest amount (20 percent market penetration by the early 2020s) of residential electric vehicle demand. BC Hydro forecast load growth to be about 1 percent per annum for the next 20 years after the impact of rate increases and its demand-side management (DSM) target, which is close to other North American forecasts (averaging 0.85 percent) and is lower than historic growth.

BC Hydro said there is a need for energy in fiscal 2027 and capacity in fiscal 2019. However, if even the low LNG scenario of 823 gigawatt hours per year (GWh/year) and 100 megawatts (MW) occurs, this would advance the need for energy from fiscal 2027 to fiscal 2024. BC Hydro said it is not possible to perfectly match any resource's energy and capacity additions to forecast demand and "plan to the head of a pin." The 2011 government review noted that the BC Hydro load forecast was "well planned…accurate [and] reliable" and that variances between forecast and actual are low.

BC Hydro said it has an "aggressive" DSM target of 7.8 terawatt hours (TWh) (7,800 GWh) per year of anticipated energy savings and 1.4 GW of associated capacity savings by fiscal 2021.

BC Hydro said it is among the leading jurisdictions, including California public utilities, as measured by DSM spending as a percent of retail sales, and the DSM target is expected to reduce forecasted energy demand growth by 78 percent in fiscal 2021, well above the *Clean Energy Act* objective of at least 66 percent in fiscal 2021.

Table 16. BC Hydro Load Forecast with Low LNG and DSM 2, TWh/yr

Year	Gross	Low LNG	-ΔTheft	Opt^{zn}	DSM 2	Net 2
2012	56.8	0	0	0	0	56.8
2013	57.1	0	0	0	0	57.1
2014	58.7	0	0	0	1.9	56.8
2015	60.4	0	0	0.2	2.7	57.5
2016	61.9	0	0	0.2	3.6	58.1
2017	63.2	0	0.1	0.3	4.4	58.4
2018	65.8	0	0.1	0.3	4.9	60.5
2019	67.6	0	0.2	0.3	5.9	61.6
2020	69.1	0.8	0.3	0.3	6.8	61.7
2021	70.2	0.8	0.3	0.3	7.8	61.8
2022	70.8	0.8	0.4	0.3	8.2	61.9
2023	71.7	0.8	0.4	0.3	8.4	62.6
2024	72.7	0.8	0.5	0.3	8.9	63.0
2025	73.4	0.8	0.6	0.3	9.2	63.3
2026	73.8	0.8	0.6	0.3	9.6	63.3
2027	74.5	0.8	0.6	0.3	9.9	63.7
2028	75.5	0.8	0.6	0.3	10.2	64.4
2029	76.4	0.8	0.6	0.3	10.3	65.2
2030	77.4	0.8	0.6	0.3	10.5	66.0
2031	78.4	0.8	0.6	0.3	10.7	66.7
2032	79.5	0.8	0.6	0.3	10.9	67.7
2033	80.3	0.8	0.6	0.3	11.0	68.4

Years are BC Hydro fiscal years starting on April 1; **Gross** is forecast after line losses; **Low LNG** assumes house load only; **-Δ Theft** is theft reduction; **Opt^{zn}** is voltage and VAR optimization; **DSM 2** is current demand-side management plan; **Net 2** is demand after the foregoing.
Source: BC Hydro, "Electric Load Forecast," December 2012, Table 4.1, p. 21 and BC Hydro, "Questions of Clarification from the Joint Review Panel," March 3, 2014, Table 1

BC Hydro distinguishes among several definitions of demand, or load. The smallest number is the amount actually sold to customers. To this must be added line losses, theft, and various small adjustments for non-optimal voltage and frequency control. BC Hydro, following BCUC guidance, calculates demand management as a negative supply requirement and so reduces its gross demand by the amount it expects active demand management programs will yield. Table 16 shows the gross demand net of line losses for the integrated system in the first column. An increment of 823 GWh/yr is balanced by theft reduction and system optimization by 2024. The expected results from DSM 2 are captured in column 5.

Provincial hopes for a new LNG export industry have been growing throughout the Panel process. BC Hydro has been trying to accommodate developments in its forecasts, but it is still too early to conclude what the requirements might be. Accordingly, BC Hydro set out three widely differing cases. One, at 823 GWh/yr and 100 MW of capacity starting in 2020, assumed that electricity would not be used for compression or liquefaction, only for plant "house load." At the other extreme is a scenario that posited rapid expansion of the industry and a substantial use of electricity for the large compression and liquefaction loads. It ramped up to 6.6 TWh/yr and 800 MW. In between is an "expected" load, 3 TWh/yr.

On July 25, 2012, by Reg 234/2012, the government of B.C. exempted “facilities that liquefy natural gas for export by ship” from section 2(c) of the *Clean Energy Act*. LNG developers are now free to use their own product for liquefaction regardless of the greenhouse gas (GHG) consequences.

15.1.2 Views of Participants

Four participants cited inconsistent Provincial energy policy in establishing the need for the Project. There have been conflicting messages from the government: powering new homes, supporting the organic growth of the B.C. economy, supporting the LNG industry, and exporting power to California have all been featured at different times. The participants objected to building for export, interpreting BC Hydro’s testimony on January 23, 2014 to mean that it needs to sell its electricity to California.

Diane Culling, citing the authoritative Edison Electrical Institute, thought that BC Hydro’s load forecast seriously underestimated the potential of conservation. A January 2013 Edison report listed several factors that contribute to disruptive challenges to the electrical utility industry, including falling costs of alternatives, increasing focus on development of new distributed energy resource technologies, increasing customer regulatory and political interest in demand management, declining price of natural gas, slowing economic growth trends, and rising electricity prices. She cited obvious opportunities for cost-effective conservation and self-powering that could be observed locally in Fort St. John. The convergence of these factors is considered a potential game changer for the U.S. electric utility industry. As it becomes easier for ratepayers to get off the grid, it becomes necessary to increase the rates for the utilities’ remaining customers, which in turn provides increased incentive to get off the grid.

Philip Raphals, speaking on behalf of the Treaty 8 Tribal Association (T8TA), said the issue was not so much energy, for which the need was stated only in general terms. In reality, the problem that the Site C Project was intended to solve was BC Hydro’s need for additional capacity. But capacity could be provided, he said, with relatively inexpensive, focused investments.

Rick Hendricks, also of T8TA, said BC Hydro, consistent with good utility practice and previous BCUC decisions, planned to the mid-load forecast. Thus no portfolios were created or evaluated using the high- or low-load forecasts. But actual growth since 2007 has been substantially below the 2007 low-load growth scenario. The unusual economic events since 2007 are clear, but this experience suggests that forecasts are less reliable than believed, and that more attention should be paid to these low-load growth scenarios.

Several participants, including Dr. Marvin Shaffer of the Peace Valley Environmental Association, said that the need for Site C was due directly to the elimination of the Burrard Thermal plant, whose 6.1 TWh/yr of energy and 900 MW of capacity did not have to be retired completely. It could have been maintained for peaking and as a reserve against low-water years with appropriate investments and refurbishment.

15.1.3 Panel’s Analysis

BC Hydro’s forecasting methods did not differ substantially from best practices among utilities across North America. This forecasting, as revealed in the Evidentiary Update and in response to Panel questions, was professional and not “conservative,” in that it aimed to be high half the time and low half the time. BC Hydro, understanding the necessary uncertainties, has been forthright about some of the factors and judgments that can affect forecasts, including:

- The future economic growth in countries to whom B.C. exports products;
- The future incomes of BC Hydro's customers;
- Large, uncertain resource development prospects. For example, not just the course of natural gas development in B.C., but whether some of the producers, pipelines, and liquefaction plants might use grid electricity rather than gas itself. There are potential mining prospects within the planning horizon, and if they occur would require large blocks of power;
- The possibility that one or more of the mainline railroads might in future decide in favour of electrification for their mountain divisions, a possibility foreshadowed in the *Clean Energy Act;*
- The impact of progress with solar or geothermal technologies now regarded as uncertain, expensive, or immature;
- The possibility that some customers might install their own generating systems, going off-grid for some of the time and even producing a surplus for sale back to the grid (net metering);
- The rate of market penetration of electric cars, LED lighting, and other novel end uses that could raise or lower the demand for electricity; and
- The effects of rising prices on demand and the results of investment in demand management techniques.

The Panel concludes that BC Hydro's forecasting techniques are sound, but uncertainties necessarily proliferate in long-term forecasts.

15.1.3.1 LNG Development

One major uncertainty, as noted, is what the demand for electricity will be from the nascent LNG export industry. The timing of demand is still unclear, but it could start before 2020. Standard industry practice is to use gas turbines for compression and liquefaction. The choice is between self-powering or grid sourcing, a function of the relative prices of gas and grid electricity. BC Hydro said the purpose of BC Reg 234/2012 under the *Clean Energy Act* was "to make electricity supply from BC Hydro competitive with LNG developers using natural gas to meet their energy needs," but in fact the exemption appears to be only for liquefaction, not transmission. The mechanism for allowing BC Hydro to become competitive appears to involve BC Hydro using on-site gas turbines and clean grid energy in combination, thus somewhat lowering greenhouse gas emissions. The Panel expects compression loads would be borne by burning natural gas in turbines along the pipeline, a standard practice.

Liquefaction trains are generally electrically driven. The issue is whether developers would find generation using cheaper and more reliable than grid electricity. BC Hydro said that self-powering would not be in conflict with section 2(g) of the *Clean Energy Act*, and that developers' choices would not eat into its headroom of 7 percent "unclean" under section 2(c). It is hard to see how this would be so. First, the energy requirement for liquefaction is very high - 525 MW in one proposal, 700 MW in another - and there are reportedly more than a dozen proposals. Allowing plants to generate that much power by burning gas would make provincial (and national) GHG targets all but impossible to reach. In the case of B.C., those targets have the force of law. There is a plausible case that BC Reg 234/2012 may be inconsistent with the statute on which it depends, depending on the choices LNG developers make.

Second, if the power were to come from BC Hydro, many of the independent power producers' (IPP) renewable resources contemplated for development after the construction of Site C would have to be called into play before the dam could be completed. BC Hydro seems to be saying that because there is no evidence about how B.C. is doing on long-term GHG reductions (because the Province has not established sectoral limits to go along with its 33 percent reduction target), one can say that there is no impact. As for compression, it will challenge the "33 by 2020" (section 2.3 (g) (iii)) goal all by itself.

From the GHG perspective, shale gas released by fracking typically contains a good deal of CO_2, which is normally separated from the produced gas and released. Unless costly capture and sequestration is required by regulation, this practice will put further pressure on B.C.'s GHG targets.

The Panel concludes that it is unlikely that the transmission and liquefaction energy requirements of the new liquefied natural gas industry will be satisfied by any source except natural gas itself, and thus that BC Hydro's *Integrated Resource Plan* sensitivity scenario of "Low Liquefied Natural Gas" forecast is most likely correct.

BC Hydro's current estimates of LNG demand run from 823 to 6,600 GWH/yr, and the industry's plans will develop rapidly in the next few years. The power demands of this new industry are the biggest wild cards in the load forecast.

15.1.3.2 Load Forecasting

LNG is but one of the factors that make forecasting, especially over the long term, an heroic exercise. Forecasts are correct only by good fortune. BC Hydro initially made a modest allowance for resource development, some for electric cars, and none for railroad fuel-switching. Self-powering, going off the grid, or net-metering were not seen as having much impact on load forecasts despite what may be increasing financial incentives for end users. BC Hydro has provided plausible, though still arguable, reasons for its choices.

Historically, utility demand forecasts tended to overestimate the actual demand growth. BC Hydro aims for its forecasts to err evenly on both sides of actual, and claims that, in the relatively short run, the average forecast error has been less than 1 percent. The Panel notes, however, that the difference between sales forecasts and actuals from 2005 to 2011 were seriously askew in 5 of those 7 years, a period that included the unusual, but repeatable, recession of 2008–2009. The Panel further notes that the 2012 load forecast is substantially lower than 2011: by four percentage points, on average, for the 2013–2032 period. The difference is roughly half of what Site C would provide.

One factor affecting utility forecasting is a tendency to regard the costs of a too low forecast as greater than the costs of over-building to a too high forecast. Insufficient capacity is seen as calamitous: brownouts, rotating blackouts, or expensive emergency purchases from uncertain suppliers might result, and the regulatory, public, and political pressure might be very high. Recent experience in Newfoundland produced "language…that was quite elevated." Legislation reinforces this bias. Further, the consequences of producing a surplus may be positive, if it can be sold for more than it costs to produce. For a long time, this was generally true. But times have changed, and BC Hydro's expectation is that it might sell Site C surpluses for only about one-third of their costs, leaving B.C. ratepayers to pay for the rest.

BC Hydro has slightly modified its 2012 forecast, which was completed in late 2011, following the ministerial announcement of November 26, 2013, which set out a forecast of electricity price increases for the next decade. As noted, these are considerable: about 20 percent real over the next 5 years, perhaps 30-32 percent real over 10. Such large price increases can be expected to have a correspondingly large effect on demand. BC Hydro, in a March 2014 update, provided a revised forecast with slightly increased demand that was said to have resulted from the new prices being lower than previously embedded ones. “The changes to return on equity and dividend policy announced by the B.C. Government on 26 November 2013 produce lower rate increases of 21% over 20 years,” said the BC Hydro summary of February 3, 2014. These figures are presumably nominal and not expected to have much meaning, as their effect was to add only 275 GWh/year in the 2024-2033 period.

The Panel concludes that, basing a $7.9 billion Project on a 20-year demand forecast without an explicit 20-year scenario of prices is not good practice. Electricity prices will strongly affect demand, including Liquefied Natural Gas facility demand.

RECOMMENDATION 47
The Panel recommends that BC Hydro construct a reasonable long-term pricing scenario for electricity and its substitutes and update the associated load forecast, including Liquefied Natural Gas demand, and that this be exposed for public and Commission comment in a BC Utilities Commission hearing, before construction begins.

15.2 DEMAND MODERATION

15.2.1 Proponent’s Assessment

BC Hydro now forecasts that 7.8 TWh of 2021 gross demand would be met by demand-side management (DSM). That total would include a slight contribution from “natural conservation”—the things power consumers would do on their own, unaccelerated by active DSM programs. BC Hydro calculated the long-run elasticity of demand to be -0.57, of which natural conservation was -0.10; for every 1 percent increase in real price, total demand falls by 0.57 percent. BC Hydro further said gross demand in 2023 would be 71.7 TWh before DSM and price effects, and prices would rise about 30 percent in real terms.

Following standard BCUC guidance, BC Hydro produced its load forecasts without regard to the effects of price increases, rate structures, or active DSM programs to moderate demand growth. DSM programs and price effects were separately modelled and entered as a correction to gross demand. The forecast of net energy yields for the closely similar DSM options 2 and 3, which differ not in content but in expenditure devoted to them, is shown in Table 16 above. BC Hydro presented its DSM options in five packages of increasing uncertainty about deliverability, as shown in Table 17.

Table 17. Demand Moderation Options According to BC Hydro

DSM Options	Details
1	- 7,500 GWh/year (EIS) or 6100 GWh/year (IRP) of energy savings and 1,200 MW of capacity savings by 2021. - Developed explicitly to meet 66 percent of the forecasted load growth with DSM, which would be the minimum required to meet the CEA objective.
2	- Current DSM target - 7,800 GWh/year of energy savings and 1,400 MW of capacity savings by 2021. - Includes a broad range of codes and standards, rate structures, and programs targeting most market segments. Specific tactics include: 1) Codes and standards enacted, announced, or planned by the federal or provincial governments 2) Conservation rate structures in place or planned. These include the Transmission Service Rate (TSR) for large industrial customers, the Residential Inclining Block (RIB) rate for residential customers, a conservation rate structure for large commercial and small industrial customers in the former Large General Service (LGS) rate class, and a conservation rate structure for the Medium General Service (MGS) rate class. 3) Programs targeting residential, commercial, and industrial customer classes, e.g. refrigerator buy-back, Smart Meters, Power Smart Partner and Product Incentive Program. - Supporting expenditures have been reduced over the near term to conserve cash.
3	- 9,200 GWh of energy savings and 1,400 MW (EIS) or 8300 GWh and 1500 MW (IRP) of dependable capacity savings by 2021. - Considered a partial alternative to the Project. - This option would defer the need for the Project's energy output for two years (from 2027 to 2029). - Constructed to target more electricity savings by expanding program efforts, while keeping the level of activity and savings for codes and standards and conservation rate structures the same as Option 2. - Program activities would be expanded with increased incentives, advertising, or technical support to address customer barriers, thereby increasing participation.
4	- 9,500 GWh of energy savings and 1,500 MW of dependable capacity savings by 2021. - Includes new or more aggressive conservation rate structures, and significant government intervention and regulation in the form of codes and standards. - Large industrial customers would be exposed to a much larger extent to marginal cost price signals because the Transmission Service Rate would change from a 90/10 to an 80/20 split between Tier 1 and Tier 2 prices, thereby increasing the amount of energy consumption that is subject to Tier 2 pricing. Each industrial customer would need to meet a government-mandated, certified, plant minimum-efficiency level to take advantage of BC Hydro's Heritage BC Hydroelectric lower-priced electricity; otherwise, electricity would be supplied at higher marginal rates. - Commercial customers would be subject to efficiency-based pricing through either a connection fee tied to building energy performance, or an initial baseline rate structure for new buildings. Rate structures would be tied to a house or building's rated energy performance. - Represents a bridge to DSM Option 5 by including activities and pilot initiatives that would facilitate the market and social transformations targeted by Option 5 - Screened out: government and customer acceptance issues might arise from BC Hydro's reliance on an aggressive and untested combination of rate structures, codes and standards; significant delivery risk
5	- 9,600 GWh of energy savings and 1,600 MW of dependable capacity savings by 2021. - Aims to create a future scenario where buildings are net-zero consumers of electricity, with some buildings being net contributors of electricity back to the grid - Energy efficiency and conservation activities would be pervasive throughout society and ingrained in a business decision-making culture. This shift would be reflected through widespread district energy systems and micro-distributed generation, smaller and more

	efficient housing and building footprints, community densification, distributed workforce and hoteling (shared workspace), best practices in construction and renovation, efficient technology choices and behaviour, and an integrated community perspective (land use, zoning, multi-use areas). A carbon neutral public sector would contribute to the culture shift. For the industrial sector, a market transformation to certified plants would occur, supported with expanded regulation. - Fundamental shift in BC Hydro's approach to saving electricity, one that places much greater emphasis on government regulation and rate structures to change market parameters and societal norms and patterns that influence electricity consumption and conservation. - Considered as an alternative to the Project. - Implementing this option would reverse load growth over about a 20-year period such that there would be no need for new energy resources until 2031 - Screened out: government and customer acceptance issues would arise from BC Hydro's reliance on an aggressive and untested combination of rate structures, and codes and standards; significant delivery risk, especially with respect to capacity savings; could jeopardize BC Hydro's ability to serve its customers
DSM Capacity Initiatives	- Specifically target capacity savings - Industrial customer load curtailment: targets large customers who agree to curtail load on short notice to provide BC Hydro with capacity relief during peak periods. BC Hydro implemented a load curtailment program targeted at shorter term (one to three years) operational capacity needs in recent years, and customers have delivered as requested. - Capacity-focused programs: programs that use equipment and load management systems to enable peak load reductions to occur automatically or with intervention. Programs may involve payments for customer equipment and for participation in the program. Examples of capacity-focused programs include load control of water heaters, heating, lighting, and air conditioning. Delivery is uncertain. - On their own, these initiatives are not considered alternatives to the Project.

Source: EIS s. 5, DSM Technical Memo, Evidentiary Update, IRP sec. 3.3

In its November 2013 Integrated Resource Plan (IRP), BC Hydro announced a cutback in its DSM expenditures for 2016–2017 as a cash-saving measure, expressing an untested confidence that they could subsequently be ramped up to meet the level targeted for 2022.

15.2.2 Views of Participants

See the views of Diane Culling in Section 15.1.2. Many other participants mentioned the attractiveness of conservation and energy efficiency as alternatives to the Project.

15.2.3 Panel's Analysis

Utility best practice involves detailed consideration of demand management, including price level and structure effects, before creating new supply. This is the Legislature's instruction in the *Clean Energy Act* of 2010, which goes on to license the deliberate use of pricing mechanisms to achieve conservation and efficiency ends. BC Hydro practice is to choose a series of active DSM techniques sufficient to yield the energy savings required under the *Clean Energy Act* (and more), cost them, and add a non-empirical balancing factor for "natural conservation." BC Hydro's DSM strategy, in other words, assumed little response without direct and costly stimulus. Its planning mostly ignored general price effects but has the virtue that DSM measures can be shadow-priced for comparison with supply options.

The difference in yield between DSM options 2 and 3 is small, and both seem to run out of steam in their later years.

BC Hydro agreed in testimony that the sum of its active DSM and “natural conservation” was the equivalent of a price elasticity of demand of -0.57. This implied that gross demand in 2024 would fall (0.57 x 0.30 =) 17.1 percent from 72.7 TWh by about 12.4 TWh. Net demand in 2023 would thus be about 60.3 TWh, or 3.4 TWh more than at present: an average load growth of 340 GWh/yr, or 0.6 percent during the period when new DSM measures would be actively introduced.

Applying BC Hydro’s agreed elasticity to gross demand at the end of the forecast period in 2033 would require an estimate of the intervening increase in real prices, which has not been provided. A deceleration of the announced increases following the paying down of several deferral accounts is reasonable. However, capital maintenance and operating costs would not decline, and there would be a new capital expenditure of $7.9 billion for Site C, to be worked into rates once the Project became operational. Suppose that the total real rate increase between 2013 and 2033 is 50 percent, instead of twice the ~30 percent of the 2013–2023 decade. This would imply a net demand in 2033 of 65.4 TWh. Alternatively, elasticity would have to decline from the present -0.57 to -0.39 in the second half of the forecast period to produce the forecasted 68.4-68.8 TWh (Table 18), an unlikely result in a period of rising prices.

Electricity prices in B.C. have been low and relatively constant for a long time. Real prices in 2015 will only be at the level they were 40 years ago. In fact, for the period 1976-2009, prices in real terms were gently falling. Only the increase since 2009 has given the planners much to work with, and the sharp increases since then constitute a natural experiment. As well as the rate level, the rate structure changed slightly just as prices began their upward surge, so that residential consumers now pay the marginal rather than the average cost for consumption over 675 KWh/month. Arguably, both the mild 33-year decline and the increases of the last 5 years have been too small to change behaviour very much. After all, consumers first have to notice a change, and the changes have been small, on a small base.

This is now changing. Rates are now scheduled to rise more than 30 percent in real terms over the coming decade, and by perhaps lesser amounts from 2022 to 2032. Will this relatively large change be enough to get consumers’ attention and cause them to change their consumption patterns? In the U.S., there is evidence that rate changes in this range affect consumer behaviour, and may cause large commercial consumers to radically change their consumption. Such rates may also induce industrial consumers, especially at the point of choosing substantial investments in plant and equipment, to seek electricity-conserving alternatives.

BC Hydro was cautious about “natural conservation”—it has few useful numbers from the BC market—and about the deliverability of its DSM promises. Evidence from other jurisdictions varies widely (total elasticities from -0.1 to -0.7 in the literature sampled by the Panel), and BC Hydro argued that as a winter-peaking, hydraulically driven system, it cannot rely on evidence from the U.S. or other countries for planning purposes in B.C. BC Hydro characterized its current DSM plan—DSM 2 in Table 17 above--as “aggressive.” DSM 3 has the same elements as DSM 2, just somewhat more expenditure push. BC Hydro retreated from its previous DSM 3 to DSM 2 during its IRP discussions with the Province, apparently as a means of saving some $320 million between 2015 and 2022. DSM 4 and 5 are rejected based on “political acceptability,” though not enough detail is presented about their content, especially DSM 4, to justify that conclusion. None of the DSM alternatives take full advantage of the price level and structure alternatives expressly allowed in section 3(1)(b)(iv) of the *Clean Energy Act*. The plan was accepted by the B.C. government in the Integrated Resource Plan of November 25, 2013.

The Panel concludes that the demand-side management yield ought to at least keep up with the growth in gross demand, and therefore the potential savings from 2026 to 2033 may be understated.

Using BC Hydro's price elasticity of demand of -0.57, accepting BC Hydro's forecast of gross demand, and positing a real price increase of 50 percent from 2014 to 2033, the Panel concludes that net demand in 2033 is likely to be about 65 terawatt hours.

The Panel concludes that demand management does not appear to command the same degree of analytic effort as does new supply.

15.3 SUPPLY: ENERGY

15.3.1 Proponent's Assessment

BC Hydro selected potential supply alternatives based on its 2010 Resource Options Report, a database of 20-year options consistent with BCUC's Resource Planning Guidelines. Four groups of options were screened out from the beginning:

- Legislatively barred resources: Burrard Thermal, nuclear, imports, other large BC Hydro projects barred by the *Clean Energy* and *Fish Protection Acts*;
- Technically or economically infeasible resources: coal-fired generation with carbon capture and sequestration; wave, tidal, and solar power;
- DSM options 4 and 5; and
- DSM capacity initiatives: industrial load curtailment, other capacity programs.

For the remaining options, technical, financial, environmental, and economic development attributes were developed. The options examined were (cf. Table 20 below):

- Clean or renewable resources from third parties: on-shore and off-shore wind, run-of-river BC Hydro, biomass, municipal solid waste, geothermal;
- BC Hydro Resource Smart programs to gain efficiencies at existing BC hydro-electric facilities;
- Revelstoke Unit 6;
- Gordon M. Shrum Units 1-5;
- Pumped storage;
- Gas-fired generation (single-cycle gas turbines for capacity) or co-generation (combined-cycle gas turbines for energy) up to the 93 percent *Clean Energy Act* target; and
- DSM option 3.

Table 18. BC Hydro Load-Resource Balances, Low LNG and DSM 2, TWh/year (Energy) and GW (Capacity)

Year	Energy Supply	Net 2	Energy LRB	ELCC	Demand 2	R6 + GMS	LRB 2+
2012	60.5	56.8	3.7	11.4	10.3	0	1.1
2013	63.0	56.3	6.7	11.5	9.6	0	0.9
2014	57.9	56.9	1.0	11.6	10.7	0	0.9
2015	60.0	57.5	2.5	11.7	10.8	0	1
2016	60.5	58.1	2.4	11.1	10.9	0	0.3
2017	63.6	58.4	5.2	11.1	10.9	0	0.3
2018	64.1	60.6	3.5	11.1	11.1	0	0.3
2019	64.0	61.5	2.5	11.1	11.1	0	0.1
2020	64.1	61.7	2.4	11.1	11.2	0.7	0.6
2021	64.0	61.8	2.2	11.1	11.3	0.7	0.5
2022	63.7	61.9	1.8	11.1	11.2	0.7	0.6
2023	63.6	62.6	1.0	11.1	11.4	0.7	0.4
2024	63.6	63.0	0.7	11.1	11.4	0.7	0.4
2025	63.6	63.3	0.3	11	11.6	0.7	0.3
2026	63.6	63.3	0.3	11	11.6	0.7	0.2
2027	63.6	63.7	(0.1)	11	11.7	0.7	0.1
2028	63.5	64.4	(0.9)	11	11.9	0.7	(0.1)
2029	63.4	65.2	(1.8)	11	12	0.7	(0.2)
2030	63.4	66.0	(2.6)	11	12.2	0.7	(0.5)
2031	63.5	66.8	(3.3)	11	12.4	0.7	(0.7)
2032	63.5	67.7	(4.2)	11	12.6	0.7	(0.9)
2033	63.5	68.4	(4.9)	11	12.7	0.7	(1)

Energy Supply is BC Hydro's presently committed supply in TWh/yr; **Net 2** is from Table 16; **Energy LRB** is the energy load-resource balance in TWh/yr; **ELCC** is electrical load carrying capacity in GW; **Demand 2** is net demand after DSM 2 including low LNG; **R6 + GMS** is Revelstoke 6 and Gordon M. Shrum capacity additions in GW; **LRB 2+** is the remaining capacity balance in GW
Source: BC Hydro, "Questions of clarification from the Joint Review Panel," Tables March 3, 2014

A number of assumptions were common to the late-2013 assessment of all portfolios, including:

- The load-resource balance (LRB) was based on the 2012 load forecast with no LNG load: low LNG would bring the balance point for energy back to 2024 and for capacity to 2022.
- The electricity and gas long-term market scenario was based on the spring 2012 price forecast by Ventyx, a consultant.
- The current BC Hydro DSM target (DSM 2) was used in every portfolio.
- The cost of alternatives was based on 2013 IRP data, using a real weighted average cost of capital (WACC) of 5 percent for BC Hydro and 7 percent for independent power producers.
- WACCs were used as a surrogate for social discount rates.

In its initial analysis, BC Hydro compared Site C with similar-sized blocks of power (5.1 TWh/yr, 1.1 GW of capacity). The blocks were a "clean generation portfolio" and a "clean plus thermal generation portfolio." The former was composed of wind, run-of-river, and biomass, with pumped storage providing capacity but consuming energy. The latter used the clean portfolio but substituted single-cycle gas turbines up to the 7 percent limit for pumped storage for capacity. BC Hydro noted that using gas headroom in this way would deplete its capacity as a contingency resource, a value not fully represented in the block analysis.

Additionally, in the 2013 IRP, DSM 3 was evaluated as a partial alternative to the Project. However, a clean plus thermal plus DSM 3 block turned out to be financially inferior to Site C plus DSM 2.

Based on the portfolio analysis, BC Hydro believed that the Project would provide the best combination of financial, technical, environmental, and economic development attributes and is therefore a preferred option to meet the need for energy and capacity within BC Hydro's planning horizon. Compared to both the clean portfolio and the clean plus thermal portfolio, Site C plus DSM 2 had sufficiently superior characteristics that no quantitative weighting of the attributes of other portfolios was conducted. The preferred portfolio was estimated to cost $110/MWh.

BC Hydro presented a summary of some of the environmental attributes of allowable alternatives. Run-of-river and other smaller hydroelectric projects always flooded some amount of valley bottoms. Wind power presented visual challenges but had a small landscape footprint. The gas-based alternatives had encountered siting problems in the past, and produced GHGs at a rate fully half that of coal; in addition, their exhaust gases could compromise air quality, especially in confined valleys. Municipal solid waste had similar problems and produced more GHGs per unit of electricity.

BC Hydro counted as firm supply the 48.2 TWh of energy from its Heritage Hydro system that would be generated under average water conditions of the 1970–2000 period. Amounts above that level would be non-firm and available for domestic or export sale, and would lower amounts that would have to be generated from natural gas.

15.3.2 Views of Participants

Many participants commented about the optimal use of gas both within and beyond the 7 percent headroom.

- In BC Hydro's alternatives analysis, said one, BC Hydro failed to consider how single-cycle gas turbines, an important capacity source, could provide the backup capability that the Burrard plant used to provide. This could be done very economically.
- BC Hydro's assessment considered that it would run the gas turbines at an 18 percent capacity factor, said another, although this type of plant could run at 90 percent or higher. The difference between 90 and 18 percent in the clean plus thermal blocks would result in 3.7 TWh of energy. However, since BC Hydro's analysis did not recognize the backup capability that would also allow increased reliance on non-firm resources, BC Hydro would be buying high-cost energy in these blocks. This resulted in exaggerated costs of the clean plus thermal portfolio.
- One participant felt that Site C was preferred, in BC Hydro's submission, because of the severely restricted role of the single-cycle gas turbines. There was, he felt, a more cost-effective alternative than Site C, namely a single-cycle gas turbine strategy for the required capacity, and for firming up more non-firm BC Hydro and spot-market purchases. BC Hydro would not be producing any more energy from the gas turbines than necessary, and on average, that would be within the cap because, in most years, BC Hydro could use available non-firm Heritage Hydro, filling any gaps with opportunistic purchases of spot-market energy, which all forecasts say would be the lowest cost source of energy for the system.
- Others felt that co-generation (combined-cycle gas turbines) would be a more cost-effective alternative than Site C. The costs of mitigation would be much less. Also, losses associated with Site C that cannot be mitigated, such as loss of agricultural land, would be avoided.

Participants highlighted the radically reduced footprint of a co-generation facility compared to Site C.

- As an example, participants cited the Shepherd Energy Facility in Calgary, whose energy and capacity are comparable to Site C, and provided a comparison between this facility and Site C. For Site C, the unitized energy cost (UEC) is indicated to be $110 per MWh, but for Shepherd, even including the cost of gas, it is $30 per MWh. This type of facility would offer huge economic benefits over Site C in terms of preventing rate increases.
- CO_2 from a co-generation plant could be used in other industries, but GHGs such as methane released by reservoirs cannot be captured.

Some participants tied the need for Site C to the decision to phase out Burrard, or to provide power for the LNG export industry. They were led to the conclusion that the capital, environmental, and social costs of flooding the valley were needed only to replace the fully functional, if tired and obsolescent, Burrard Thermal plant.

Ken Boon, a farmer at Bear Flats, noted that the 1983 BCUC decision included the finding that BC Hydro should investigate alternative sources of energy, specifically geothermal energy. And in 1991, BC Hydro was advised to investigate the use of natural gas. But “we’re back here now 30 years later and still talking about a dam.”

Two participants wanted to know what BC Hydro’s next firm energy sources would be after Site C and whether those sources could be used in place of Site C.

Since Site C would rely on the stored water of the Williston reservoir, the assessment of impacts should consider the effect of constructing that facility on GHGs, and whether Site C could be called “clean.”

The Treaty 8 Tribal Association (T8TA) considered the sites identified in BC Hydro’s alternative means assessment to be alternatives to the Project. T8TA’s analysis of the alternative sites included multiple criteria similar to those of BC Hydro. This analysis identified Site 7B as having the potential to be a viable alternative to the Project location. Site 7B had been considered by BC Hydro as part of a two-dam cascade; however, T8TA considered Site 7B as one dam. Site 7B was not considered by BC Hydro as it did not meet the objective of using all the hydraulic head of the Peace River in B.C.

T8TA saw Site 7B as advantageous, given its size and the load-growth uncertainty, noting that it would produce 25 percent of the power of Site C, creating a smaller surplus. Its other advantages included reduced flooding, stronger geology, a smaller reservoir, a location upstream of the Halfway River, reduced downstream impact due to flow changes, less flooding of tributaries, reduced impacts to fish and wildlife, and better protection of traditional land use. T8TA noted that additional study would be required. However, this alternative substantially reduced environmental effects compared to Site C, both in total and on a per unit energy basis. T8TA added that Site 7B may offer something that Site C cannot offer, that is, the real possibility for reconciliation of the rights of the Crown with the rights of the First Nations and other potentially affected First Nations and Aboriginal groups. T8TA felt that the Panel should recommend additional study of Site 7B and possibly even other site alternatives.

Several participants criticized BC Hydro’s analytic methods.

- Randall Hadland observed that if a system had a multiplicity of geographically dispersed intermittent clean or renewable resources such as run-of-river, wind, small dam hydro, or solar, there would be a potential to dispatch that power more beneficially than one can with

fewer and less diverse intermittent power sources. A broad portfolio with numerous dispersed sites across B.C.'s vast geography would be much more reliable than a few concentrated sites. He said that BC Hydro oversimplified and thus unduly discounted resources, referring to "just wind" or "just run of river," rather than looking at the way they could as a portfolio support the Heritage Hydro system.

- Some participants said that the failure to include BC Hydro's sunk costs on Site C prejudiced the results in its favour.
- T8TA discussed the block and portfolio analysis work used by BC Hydro. The block analysis was seen as being fundamentally flawed as it created blocks of the same size as Site C when there was no indication that such a large block could be economically accommodated. The optimized portfolio analysis was better, but neglected to detail DSM 3. Likewise, the low-load scenario needed more consideration. Other analytical exclusions or flaws were DSM capacity initiatives, high deliverability DSM, time-of-use rates, the imposition of a 17.5 percent capacity factor on single-cycle gas turbines, the risks associated with surplus capacity, and Site 7B.
- T8TA conducted its own analysis of the alternatives to the Project and concluded that "the superiority of Site C in relation to the alternatives has not been demonstrated," and that "for every one of the scenarios reviewed, both alternate scenarios displayed present value costs significantly lower than the Site C portfolios proposed by BC Hydro."
- Some private power producers objected to the difference in the weighted average costs of capital (WACCs) BC Hydro ascribed to independent power producers (IPPs) and to itself. They said that actual WACCs experienced by their members were closer to 6 percent than 8, and noted that these figures do not account for the risk transfer to private investors. They, not the taxpayer or ratepayer, would bear the risks of performance, cost overruns, and the like. They also objected to BC Hydro using 70 years as an amortization period for Site C while arbitrarily limiting IPPs to 30 years. The period should track the useful life of the asset, or at least the contract period, which for some recent contracts has ranged from 40 to 60 years. Such a difference could make a dramatic difference in UECs. In sum, BC Hydro's analytic techniques unfairly penalized independent power producers, to the detriment of ratepayers.

The Canadian Geothermal Energy Association (CanGEA) objected to BC Hydro's labelling of geothermal power in B.C. as technically unviable. It claimed that "BC Hydro has not properly informed themselves about the geothermal option and continues to perpetuate the just-ain't-so information to the public, especially around using Meager Creek as their example of why the industry is not viable." This was a different view than in many other areas of the world where geothermal power is used. It provided cases where geothermal energy has been installed in similar geology. CanGEA addressed the economics of geothermal power, noting that, in many countries, it is often the low-cost provider with power prices well below what BC Hydro has indicated in the IRP.

According to CanGEA, compared to Site C, geothermal offers:

- Lower cost overrun exposure to ratepayers;
- More jobs spread throughout B.C. and First Nations;
- Less system-wide transmission upgrade (cost savings);
- Fewer environmental impacts;
- Lower GHGs;
- High capacity factor;
- Planning flexibility to follow the actual demand growth in the provincial system; and

- The possibility using by-product heat for other industrial purposes

The Kleana Power Corporation presented the Kleana Power Project and compared it to Site C. It disputed BC Hydro's low rating of its dependable energy and capacity potential and believed it should be considered as a partial alternative or a complement to Site C.

The Clean Energy Association of British Columbia said its 225 member companies could produce firm power that is cost-effective and environmentally friendly. Smaller independent power projects have the potential to provide more jobs, benefits, and income to the First Nations than would Site C.

Two participants presented cost-effective alternatives to Site C that were overlooked by BC Hydro. They assembled two new portfolios of alternatives based on data from the IRP that are more cost-effective options to meet future electricity needs of B.C. with a reduced environmental impact. These portfolios are composed of wind, run-of-river, solid waste, wood waste, and peaking gas projects.

15.4 SUPPLY: CAPACITY

15.4.1 Proponent's Assessment

BC Hydro requires sufficient generating capacity to meet peak demands that may arise for only brief periods each year. Thus its forecast of requirements included peak capacity as well as annual energy. As a rule of thumb, 1 GWh of energy needed to be matched by 0.18 MW of capacity.

BC Hydro's 2012 load forecast as amended to March 2014 showed a deficiency of peaking power beginning in 2019 and growing to a range of 1,832-2,532 MW by the end of the forecast period, depending on assumptions about the development of the LNG industry. This early onset of capacity requirements as compared to energy demand was principally due to the low capacity contribution of the IPP contracts that were expected to be renewed over the planning period.

BC Hydro's Executive Vice-President for Generation and Planning, Chris O'Riley, explained that the problem was not with the "needle peaks," as they were covered by specialized smaller hydro plants and not reflected in the reported requirement, but with the shoulders of the load-duration curve. That part of the curve came under particular pressure in the winter, when demand was highest but water flows low.

BC Hydro did not feel that any load curtailment, demand management or industrial load-shedding tools could be reliably factored in to reduce requirements for new capacity.

15.4.2 Views of Participants

Philip Raphals, on behalf of the Treaty 8 First Nations, made the case for including some degree of capacity-reducing measures, especially for industrial customers but not neglecting time-of-use pricing for residential and commercial customers. The fact that no industrial customers have availed themselves of Rate Schedule 1825 was attributed by Mr. Raphals, quoting the IEPR report, to the complexity of the rate rather than the fundamental attractiveness of trading off investment in more flexible production capacity for lower rates.

15.4.3 Panel's Analysis

There are a number of projects available that can add relatively large capacity at economical costs, such as Revelstoke 6 (488 MW) and turbine upgrades at Gordon M. Shrum (220 MW). Pumped storage at Mica (465 MW) can be created, though at a cost (155 GWh) in energy.

15.4.3.1 Methodological issues

The ranking of supply (and demand-moderating) alternatives is properly done through cost-benefit analysis, which has a societal, not corporate, point of view. Distortions caused by taxes and whether costs are internal or external to the organization are removed. This involves pricing all inputs and outputs and bringing them back to present value through the use of a social discount rate (SDR), which expresses society's time preference. Proper analysis would use a (range of) SDR(s) specified by a responsible public body, followed by more detailed analyses of the better alternatives. SDRs are often in the 2 to 4 percent range.

The detailed analyses should then adjust for environmental and social costs, technology risk, ability to follow load, system integration pluses and minuses, deliverability risk, proponent's actual cost of capital and other factors. These would be put forward as a "stack" or "portfolio" of projects that can be drawn on, in optimal order, to meet changes in demand. Only coincidentally would the proponent's own cost of capital equal the social discount rate, as these are different concepts.

BC Hydro, abetted by BCUC, skipped the cost-benefit phase and went directly to present-valuing alternatives. It ascribed a weighted average cost of capital (WACC) of 5 percent to itself and 7 percent (down from 6 and 8 in the EIS) to independent power producers, with the difference put down to the higher cost of capital the latter must face. Yet a principal reason private power producers face higher costs of capital is that they bear most performance risks. In BC Hydro's case, those risks are no less real but are borne by the customer or taxpayer, not BC Hydro. This is no reason to artificially reduce BC Hydro's WACC, especially if it is to be used as a surrogate for the SDR.

Further, BC Hydro defined its WACC as based on a supposed average of 80 percent debt and 20 percent equity. The former is cheap—it is, after all, guaranteed by a triple-A entity with taxing powers—and the latter is shadow-priced by the return on equity BCUC allows to Fortis, a private competitor. But BC Hydro's equity is largely fictional. It is only "deemed" to have equity; in fact it has deferral accounts. Between the EIS and the IRP, the definition went from 80:20 to 70:30—and the WACC declined. Such an accounting marvel should not be allowed to drive choices that would affect the B.C. economy and landscape for many decades.

BC Hydro has run these two stages together, with the result that the Panel cannot be confident that IPP alternatives vs. BC Hydro alternatives, or supply vs. demand management alternatives, are accurately valued.

Whether from a pure benefit-cost approach or a financial analysis, it is appropriate not to include sunk costs. Put another way, if the geothermal opportunity had benefitted from an extensive program of exploratory drilling that had led to the choice of a promising site, no one would have complained. BC Hydro's sunk costs on Site C are $5/MWh, well within the error of estimates for Site C and its alternatives.

Because Site C would be built by an entity that may only be allowed to work down its deferral accounts starting in 2018, and that would need BCUC approval to earn surpluses with which to build its desired 60:40 debt:equity ratio, it is prudent not to ascribe any return to equity in BC

Hydro planning. At a first approximation, all its capital projects to be completed before 2024, the planned in-service date of Site C, would be built with B.C.-guaranteed debt. Prudence would also require that assumptions about the cost of long-term debt not extend farther into the future than the market allows. B.C. carries some 43-year debt. BC Hydro recently floated a 30-year bond at a nominal 3.25 percent, or slightly less than 2 percent real. The Panel is uncomfortable with projecting such a highly advantageous rate into the far future, such as the average 70 years after the in-service date over which BC Hydro plans to amortize the Site C investment. A safer assumption would be 2 percent real and an amortization of the longest-lived components of the Project over a period not exceeding the period over which firm debt pricing is available in the market—say 40 years.

BC Hydro's presentation of the externalities related to alternatives to the preferred option was solidly done, within necessary limits of generality.

The Panel concludes that methodological problems in the weighing and comparison of alternatives render unitized energy costs only generally reliable as a guide to investment. The Panel is more confident about the ranking of BC Hydro's projects, or independent power producers' projects, or demand side management projects considered as separate lists. Uncosted attributes such as the ability to follow load, geographical diversity, or the ability to assist with the integration of intermittent sources need more analytical attention.

The Panel concludes that a number of supply alternatives are competitive with Site C on a standard financial analysis, although in the long term, Site C would produce less expensive power than any alternative.

15.4.3.2 Exports

A further consideration with respect to supply cost is the ability of selected alternatives to follow demand. In the past, it has been relatively easy for BC Hydro to sell its surpluses at prices that fully covered its costs. Even so, there were regulatory risks, such as the decision by the U.S. Federal Energy Regulatory Commission in 2013 to fine BC Hydro (i.e. B.C. ratepayers) three-quarters of a billion dollars for alleged infractions of U.S. rules during the Enron crisis of 2001.

Despite some short-term difficulties currently plaguing supply in California, BC Hydro's outlook is that the market prices it would achieve through the forecast period would average only $35/MWh, radically less than the marginal cost of production and delivery (about $94/MWh). Site C would be a large, sudden addition to supply. BC Hydro projects losing $800 million in the first 4 years of operation. These losses would come home to B.C. ratepayers in one way or another. (BC Hydro's view is that they will be more than made up in lower future rates.) They could be minimized through smaller supply additions that more closely follow the load, or avoided altogether by a minor modification of the self-sufficiency objective. It would make financial sense to import cheap power until its cost rises to the cheapest of domestic alternatives, or until the domestic market can absorb most of the new supply.

The Panel concludes that relying on exports to absorb surplus production would likely be very expensive.

15.4.3.3 Research

Geothermal electricity is well-known and exploited around the world. B.C. has some long-known hot spots in the southern Coast Range, where an exploration license was recently sold for $100,000, as well as moderately hot areas in the northeast B.C. sedimentary basins. BC Hydro, in its IRP, said that "geothermal appears to be a low-cost resource option," and "BC's geothermal resource is estimated to total more than 700 MW of potentially cost-effective clean or renewable power." BC Hydro characterized geothermal energy as "firm."

The 1983 BCUC decision on Site C advised BC Hydro to explore the possibilities of unconventional energy sources, including geothermal energy, but little was done. At that time, BC Hydro's budget for such exploration was about $20 million, mostly concentrated on the geothermal resources near Meager Creek. In testimony, BC Hydro characterized its present level of effort as "under $100,000 [per year]." Moreover, BC Hydro said "we don't really have funding to do R&D… In fact we're expected not to do that." However, section 2(d) of the *Clean Energy Act* states that it is a Provincial objective "to use and foster the development in British Columbia of innovative technologies that support energy conservation and efficiency and the use of clean or renewable resources."

This raises several issues. First, if BC Hydro is to continually scan the resource and technology horizon for future supply and conservation possibilities, it must have a budget and a mandate to do so. Without these, long-term planning is seriously uninformed. Second, that mandate appears to have been encouraged by the regulator more than 30 years ago and confirmed by the shareholder in legislation just 4 years ago. The low level of effort is surprising, especially if it results in a plan that involves large and possibly avoidable environmental and social costs. Third, even the low level of effort invested in characterizing the geothermal opportunity leads to the conclusion that large amounts of firm power may be available at prices in the $100/MWh range. Fourth, the well logs from the oil and gas plays in northeast B.C. are an important source of information. There appears to be an unexploited opportunity for partnerships between two branches of the energy industry.

BC Hydro is not solely to blame for this lack of performance. Governments used to fund geological exploration. In the recent past, B.C. has enjoyed plentiful low-cost electricity, making the exploration of alternative renewable sources seem less than urgent. But times have changed. Failure to ramp up this work a decade ago means that BC Hydro is without a well-understood opportunity in the present.

The Panel concludes that a failure to pursue research over the last 30 years into B.C.'s geothermal resources has left BC Hydro without information about a resource that BC Hydro thinks may offer up to 700 megawatts of firm, economic power with low environmental costs.

With respect to firm energy, there is likely to be a slow long-term increase in the capability of the Heritage Hydro system due to changing climate, but this effect cannot be predicted with accuracy and is properly not (yet) included in calculations of firm supply.

The Panel agrees with BC Hydro on the importance of predictable delivery and hence storage, over periods from hourly to annual. Weather-dependent renewables alone are not the answer. The sun does not always shine or the wind blow, tidal currents come and go, and the rivers run more fiercely in the freshet than at the time of year when B.C. needs energy the most. However, B.C. has two great advantages when it comes to integrating renewables. First, a storage-dominated hydraulic system is excellent for integration, functioning as it does like a huge battery that can follow the load on any basis from hourly to annually. Second, geography: B.C.'s vast distances may make transmission expensive, but they reduce the probability that dispersed wind or solar resources will all go quiet at once. Geographic diversity raises reliability.

The Panel concludes that analytic efforts to quantify the potential benefits of geographic diversity and climate-induced changes to hydrology could allow a better characterization of important resources.

Fortunately, substantial new power resources are not needed for some years yet. There is time to firm up the resource, select technologies, and commission new works either directly or through an energy purchase agreement with an IPP.

RECOMMENDATION 48
The Panel recommends, regardless of the decision taken on Site C, that BC Hydro establish a research and development budget for the resource and engineering characterization of geographically diverse renewable resources, conservation techniques, the optimal integration of intermittent and firm sources, and climate-induced changes to hydrology, and that an appropriate allowance in its revenue requirements be approved by the BC Utilities Commission.

It might be objected that because BC Hydro is required as a matter of policy to leave geothermal energy to the private sector it should not be saddled with the costs of resource characterization. Indeed, if the senior governments were doing their job, there would be no need for this recommendation. Perhaps they should pay for the work. In any case, useful information can be made available to IPPs on a cost-recovery basis in manner analogous to the trading of geophysical information in the oil and gas trade.

15.5 POLICY CONSTRAINTS ON SUPPLY

The Panel is required to consider only those alternatives that are allowed by current formal expressions of public policy. Many participants in the hearings did not feel so limited, however, and frequently urged courses of action that were barred by law or public policy. Since these constraints are important for all readers of this report, it is useful to list those having an important effect on both supply and demand management alternatives. The principal ones are drawn from the objectives stated in Section 2 of the *Clean Energy Act* (CEA) of 2010.

15.5.1 Views of Participants

A number of participants decried the constraints of the *Clean Energy Act:*

- Why, for example, was it permissible to produce, compress, send by pipeline, liquefy, and ship B.C. natural gas as LNG to Asia, where it would be burned, thus adding to the global GHG burden, while burning it here would at least save the enormous costs of liquefaction and transportation? What was so holy about the 7 percent limit on its domestic use—why not 8, or 10? This artificial limit was seen as especially galling in face of the Order-in-Council allowing the LNG developers to use as much gas as they wanted.
- Self-sufficiency was questioned as an objective by several participants. If a large block of power was available under the Columbia River Treaty, why could it not be counted as a Canadian source, since it was already "paid for" by the Columbia investment? If moderate amounts of capacity or energy could be purchased at rates a third of generating it, why not?
- Three discussed the implications of removing Burrard from the energy mix, especially for peaking.

15.5.2 Panel's Analysis

Section 2 of the *Clean Energy Act* (CEA) of 2010 reads in part:

> "(a) to achieve electricity self-sufficiency;
>
> "(b) to take demand-side measures and to conserve energy, including the objective of the authority reducing its expected increase in demand for electricity by the year 2020 by at least 66%;
>
> "(c) to generate at least 93% of the electricity in British Columbia from clean or renewable resources and to build the infrastructure necessary to transmit that electricity;
>
> "(d) to use and foster the development in British Columbia of innovative technologies that support energy conservation and efficiency and the use of clean or renewable resources; …
>
> "(f) to ensure the authority's rates remain among the most competitive of rates charged by public utilities in North America;
>
> "(g) to reduce BC greenhouse gas emissions
>
>> (i) by 2012 and for each subsequent calendar year to at least 6% less than the level of those emissions in 2007,
>>
>> (ii) by 2016 and for each subsequent calendar year to at least 18% less than the level of those emissions in 2007,
>>
>> (iii) by 2020 and for each subsequent calendar year to at least 33% less than the level of those emissions in 2007,

(iv) by 2050 and for each subsequent calendar year to at least 80% less than the level of those emissions in 2007, and

(v) by such other amounts as determined under the *Greenhouse Gas Reduction Targets Act*;

"(h) to encourage the switching from one kind of energy source or use to another that decreases greenhouse gas emissions in British Columbia;

"(j) to reduce waste by encouraging the use of waste heat, biogas and biomass; …

"(l) to foster the development of first nation and rural communities through the use and development of clean or renewable resources;

"(m) to maximize the value, including the incremental value of the resources being clean or renewable resources, of British Columbia's generation and transmission assets for the benefit of British Columbia;

"(n) to be a net exporter of electricity from clean or renewable resources with the intention of benefiting all British Columbians and reducing greenhouse gas emissions in regions in which British Columbia trades electricity while protecting the interests of persons who receive or may receive service in British Columbia;

"(o) to achieve British Columbia's energy objectives without the use of nuclear power…"

In addition, Burrard Thermal is not to be operated (section 11), and after 2020, self-sufficiency was to be interpreted to mean BC Hydro's actual obligations as determined in its accepted load forecast plus 3,000 GWh (section 6.2(b)). Essentially all generation options outside the Heritage Hydro system, which includes Site C, are reserved for independent power producers (IPPs), ostensibly on efficiency grounds. The financial structure of BC Hydro—its "equity," regulatory accounts, dividend requirements, water rentals, no tax obligations but externally defined grants-in-lieu—as well as the regulatory process that governs it, also operate to constrain BC Hydro's choices or to create incentives having unforeseen consequences.

Many of these are noble objectives, perhaps especially those dealing with the reduction of greenhouse gases. Each comes with a price. In the four years since the passage of the *CEA*, the government has amended, clarified, or modified several of these objectives when circumstances required. For instance:

- There is an informal ban on time-of-use pricing, a well-understood method for smoothing out demand and thus avoiding very high-cost supply requirements. The Minister recently made it clear, however, that the ban does not apply to industrial loads.
- There was a danger that lengthy and duplicative proceedings by the BC Utilities Commission might delay the Project, so the Project was exempted from its normal processes by Order-in-Council.
- Likewise, the Project is apparently to be exempted from consideration by the Agricultural Land Commission.

- On the advice of a committee of deputy ministers, the government changed the definition of self-sufficiency to specify that B.C. had to be self-sufficient in an average-water year rather than a critical-water year.
- The statutory objective of building a reserve of 3,000 GWh/yr was set aside following the deputy ministers' review of 2011. It was a very expensive objective.
- And most arrestingly of all, given the government's commitment to GHG control, Order-in-Council 572 of July 24, 2012, allows LNG companies to use their own product for liquefaction. If the government's hopes for this industry are realized, then section 2(g) of the *CEA* above is at risk, as it would undermine the efficacy of the Order-in-Council under section 35(d), which says changes to the objectives can be made by Order-in-Council so long as there is no effect on section 2(g).

Burrard Thermal is a special case. The Panel repeatedly heard from residents in the Peace region that the only reason Site C was to be built was to save the residents of the Lower Mainland from the gas-generated smog that would accompany winter inversions. BC Hydro denied this, saying that Burrard energy had already been replaced by the Clean Power Call and other IPP contracts since 2009, and that Burrard's capacity would be replaced by Mica Units 5 and 6, all of which was factored in prior to determining Project need, and that Site C was needed to meet future demand. This ignores the fact that if Burrard were allowed to operate, perhaps only in peaking or emergency mode, some of those clean power options would have been available for the day when Site C would be called on.

Burrard is roughly the same size as Site C: 6.1 TWh/yr if operated at base load and 875 MW of capacity as against 5.1 and 1,100. Were this old plant to be used more than occasionally, it would require refurbishments estimated at $400-600 million in 2008, possibly more than a billion today. In the view of some participants at the Hearing, British Columbians are being called on to pay the $7.9 billion cost of Site C in order to displace environmental externalities from a paid-for plant in the Lower Mainland to a region that has already "suffered enough." This view, of course, does not account for the price of gas, or the environmental costs of fracking.

15.5.2.1 Portfolio options within policy constraints

Table 19 shows a number of options for both energy and capacity.

Table 19. Energy Supply Options Within Policy Constraints

Option	Energy, GWh/yr	Capacity, MW	UEC at POI, $2013/MWh
Wood-based biomass	9,772	1,226	122-276
Biogas from biomass	134	16	59-154
Municipal solid waste	425	50	85-184
Wind, onshore	46,165	4,271	90-309
Combined-cycle gas turbine and co-generation	6,103	774	58-92
Run-of-river	24,543	1,149	97-493
Geothermal	5,992	780	91-573

Note: UEC at POI means Unitized Energy Cost at Point of Interconnection
Source: Tables 2-2, Integrated Resource Plan, November 2013

Only a fraction of these options have costs close to Site C, but BC Hydro estimates in Chapter 3 of its current Integrated Resources Plan that 4 TWh of geothermal power and about 700 MW of capacity could be available within a range of $91 to $105 per MWh. This is a very large resource. It may not need to be called on until the 2030s, giving plenty of time for further

characterization of the resource, engineering, and possibly the formation of partnerships among potential independent power producers. BC Hydro also calculated that going to DSM 3 would reduce demand by 1.4 TWh by 2021 over DSM 2. Choosing the lowest cost options from the possibilities in Table 19 could produce a portfolio comparable in cost to Site C. Each would bring with it some degree of dependable capacity as well. Of course, each individual project would have to survive environmental review and permitting.

Table 20. Capacity Options

Option	Dependable Capacity	UCC at POI, $2013/KW-yr
5 new turbines at G.M. Shrum	220	35
Revelstoke Unit 6	488	50
Single-cycle gas turbines at various locations	989 or 101	84 or 180
Pumped storage at Mica	465	100
Pumped storage at other locations	1,000	118-124

Note: UCC at POI means Unitized Capacity Cost at point of interconnection
Source: BC Hydro, Integrated Resource Plan, November 2013, Table 2-3.

Several of these are already among BC Hydro's non-Site C alternatives. Revelstoke 6 would involve putting another turbine in the Revelstoke Dam. It would operate infrequently, as a peaking power facility making little (26 MWh) power on an annual basis, but would provide a large increment of capacity. The Mica Dam could provide peaking power through the use of pumped storage at off-peak times. This procedure would use power when it is of little value to provide peaking when needed. Optimally designed new turbines at the G.M. Shrum power plant, could provide an additional 220 MW of inexpensive peaking power.

Adding the Shrum turbines and Revelstoke 6 to the deficits projected in Table 18 would move the requirement for new capacity to 2028. The capacity increments from geothermal sources could add to this total, or substitute for the relatively expensive pumped storage at Mica.

The Panel concludes that, under the Low Liquefied Natural Gas case, available resources could provide adequate energy and capacity until at least 2028.

15.5.3 Portfolio options if selected policy constraints relaxed

Self-sufficiency is defined by B.C. Reg 245/2007: BC Hydro is "to achieve energy and capacity self-sufficiency by becoming capable of…meeting, by 2016 and each year thereafter, [its] electricity supply obligations…solely from electricity generating facilities within the Province, assuming no more in each year than the firm energy capability from the assets that are hydroelectric facilities."

Taken literally, this means a B.C. disconnected to the outside world, a vision of autarchy truly strange for a province that relies on trade, and a long way from its recent history. (It could also explain the neglect of geothermal opportunities.)

Minor relaxations could mean being connected for reliability or for diversity exchange, which are current practices apparently not condoned by the regulation, or for multi-year balance, all of which seem consistent with the intent if not the drafting of the regulation. A definition consistent

with the legislative intent could be that self-sufficiency means enough energy and capacity to serve BC Hydro's B.C. markets on a rolling five-year average, and to support and be supported by its Western Energy Coordinating Council partners for reliability. This would have the effect of modestly lowering the firm supply requirement, better integrating the otherwise allowable natural gas headroom and energy purchase agreements, and might allow taking better advantage of expected low market rates.

B.C.'s Columbia River Treaty entitlement was bought and paid for many years ago, and there is no serious question about the reliability of its partner. The entitlement is firm for a rolling ten-year period. Subject to the negotiations now underway, this large block of power could be regarded as part of the Heritage Hydro base. As it stands, the government of B.C. does not call on this entitlement but usually takes a cash payment. It would probably be financially attractive to BC Hydro, and therefore the Province, to take power rather than cash and retail it to its domestic customers rather than wholesaling it to U.S. utilities. This would also put off the need to borrow more money for new supply for a period of time, reducing the pressure on rates.

Finally, if it is acceptable to burn natural gas to provide power to compress, cool, and transport B.C. natural gas for Asian markets, where its fate is combustion anyway, why not save transport and environmental costs and take care of domestic needs? BC Hydro projects that net demand by 2033 would be on the order of 69 TWh, meaning that 4.8 TWh could be generated within the 93 percent "clean" limit. A modest exceedance could mean highly efficient modern gas turbines scalable to meet demand, located anywhere there is a pipeline and a transmission line. Such a plan could be positioned as a 20- to 40-year bridge to a lower-demand, lower-GHG future.

The Panel does not explore these alternatives in depth as they are beyond its mandate.

15.6 PANEL'S OVERALL ANALYSIS ON NEED FOR THE PROJECT

The timing of the need is necessarily uncertain. BC Hydro has done a responsible job in its forecasting but would be the first to acknowledge that the error band increases the farther out the forecast is projected. It is also a truism that the cheapest watts are megawatts, the ones not manufactured because conservation, efficiency, and new technologies allow society to prosper with decreasing power requirements per unit of GDP. BC Hydro as a matter of policy and law does not base its plans on unproven or speculative resources, prices, or behaviours and therefore will tend to have a forecasting bias toward over-estimating demand. Still, the avoidance or even delay of unnecessary economic, environmental, or social costs is a valid objective, and BC Hydro ought to have an active capacity for scanning the globe and testing promising new techniques both for supply and for demand moderation. It is not unreasonable to hope that every succeeding IRP will increase the contribution of innovations seen today as not well enough understood to be counted upon.

The Panel concludes that B.C. will need new energy and new capacity at some point. Site C would be the least expensive of the alternatives, and its cost advantages would increase with the passing decades as inflation makes alternatives more costly.

The discussions following Tables 19 and 20 indicate that there is time to review the load forecast, taking into account both recent pricing decisions and developments in the LNG industry, and to subject it to public and expert scrutiny.

The Panel concludes that the Proponent has not fully demonstrated the need for the Project on the timetable set forth.

After considering environmental and social costs, the judgment hinges on time preferences, and on the degree to which present consumers should pre-pay the benefits to future generations. The important debate about intergenerational equity was not raised in the EIS process, although it was raised in BC Hydro's closing submission to the Panel, but is fundamental to a government decision about Site C.

RECOMMENDATION 49
The Panel recommends that, if Ministers are inclined to proceed, they may wish to consider referring the load forecast and demand side management plan details to the BC Utilities Commission.

RECOMMENDATION 50
The Panel recommends that, regardless of its decision on Site C, the Province should update its guidance on the social discount rate or rates to be used for the analysis of societal costs and benefits for projects built or procured by public sector entities.

16 PANEL'S REFLECTIONS

Site C is not an ordinary project. At $7.9 billion, it might be the largest provincial public expenditure of the next twenty years. In the long run, it would provide a large increment of inexpensive firm power at a low cost in greenhouse gases, an attribute whose value will only grow with time. Moreover, there is little doubt about the competence of BC Hydro to build and operate the Project efficiently, and to live up to the conditions that would be imposed in its approvals. Today's BC Hydro is not the same company that rode roughshod over the interests of nature and the First Nations in the 1960s. The Panel has been generally impressed by the quality of the EIS, the Proponent's participation at the hearing, and the passionate engagement of so many others.

How one regards the economics of a large capital-intensive project depends on how one values the present versus the future. If today's society values current over future consumption, such a project is daunting. A few decades hence, when inflation has worked its eroding way on cost, Site C could appear as a wonderful gift from the ancestors of that future society, just as B.C. consumers today thank the dam-builders of the 1960s. Today's distant beneficiaries do not remember the Finlay, Parsnip, and pristine Peace Rivers, or the wildlife that once filled the Rocky Mountain Trench.

Site C would seem cheap, one day. But the Project would be accompanied by significant environmental and social costs, and the costs would not be borne by those who benefit. The larger effects are:

- Significant unmitigated losses to wildlife and rare plants, including losses to species under the *Species at Risk Act* and to game and plant resources preferred by Aboriginal peoples;
- Significant unmitigated losses to fish and fish habitat, including three distinct sub-groups of fish preferred by Aboriginal peoples, one of which is federally listed as a species of special concern;
- Losses of certain archaeological, historical and paleontological resources
- Social costs to farmers, ranchers, hunters, and other users of the Peace River valley; and
- Forced changes to the current use of lands and waters by signatories to Treaty 8, other First Nations and Métis, whose rights are protected under article 35 of the *Constitution Act, 1982*.

These losses will be borne by the people of the Valley, some of whom say that there is no possible compensation. Those who benefit, once amortization is well underway, will be future electricity consumers all across the province.

The Panel met with Aboriginal groups. It heard that many of them are not opposed to industrial development in their traditional territories as such, and were looking for economic benefits from the Project. A few have either signed benefit agreements with BC Hydro or are in discussions. But the Panel also heard them assert that Treaty 8 guarantees them the right to hunt, trap, and fish as they did before the Treaty was signed. They told the Panel that exercising that right means there is an obligation on all parties to the Treaty to ensure that there are sustainable populations of fish and animals. They said they are living up to the Treaty: they live in peace, they share the land, and they have stopped hunting caribou to try to preserve the remaining population. They fear that, if the Project goes ahead, they will again pay social and

environmental costs but gain little, even though they will seek job training, guaranteed jobs, and financial benefits. They fear loss of access to graves and cultural sites, loss of hunting opportunities, loss of parts of their trap lines, loss of preferred species to fish, and poisoning from mercury in fish. All Aboriginal groups without exception asserted they will be directly and adversely affected by the Project. All but two Aboriginal groups opposed the Project. Of the remaining two, one favoured the Project and one was ambivalent.

A case has recently been made that large amounts of power may be necessary for new liquefied natural gas (LNG) and mining projects. However, large LNG plants and pipelines are likely to be powered by natural gas directly. Moreover, if projects proceed as rapidly as the government expects, power will be required before Site C would be operational.

Burning a small fraction of that methane for power in B.C. would have several advantages. Capacity could be added relatively quickly, in smaller increments as demand develops, near load center so as to minimize losses, and with a lower overall contribution to the global greenhouse gas burden than if LNG were exported. The LNG developers have been promised a free hand to burn their gas here for their own purposes, but BC Hydro has been denied the same privilege.

Someday, a growing B.C. economy will need another 5 TWh of energy. The question is when. For a number of reasons set out in the text, the Panel cannot conclude that the power of Site C is needed on the schedule presented.

A second question is what alternatives may be available when that day comes. One major alternative should have been fully characterized many years ago. In 1983, the BC Utilities Commission advised BC Hydro to explore the promising geothermal resources in the Coast Range, near the load center. Little has been done. Since then, new geothermal resources have been discovered in the sedimentary rocks of northeast BC. BC Hydro now says 700 MW of firm power via geothermal resources may be available at competitive prices. They are, however, forbidden by policy to develop it. Development is reserved for independent power producers, none of whom have bid geothermal projects into the recent calls for proposals.

There are a number of other renewable alternatives available at costs comparable to Site C, but these have been only roughly costed in the Environmental Impact Statement. As a matter of public policy, BC Hydro is not allowed to develop them and so has not invested much in exploration, research, and engineering. The consequence is that there is less confidence in the costs of the alternatives than with Site C; likewise, the understanding of the environmental costs of alternatives is necessarily generic.

The Panel was asked to present evidence that could lead to the justification of the environmental, social, economic, health, and heritage costs of the Project. Those costs are large, and governments in the past have been cautious about licensing projects with significant adverse residual effects. Justification must rest on an unambiguous need for the power, and analyses showing its financial costs being sufficiently attractive as to make tolerable the bearing of substantial environmental, social, and other costs.

Site C, after an initial burst of expenditure, would lock in low rates for many decades, and would produce fewer greenhouse gas emissions per unit of energy than any source save nuclear. These advantages must be set against permanent damages to nature, the interests of First Nations, and to the specific local interests described in this report.

Report of the Joint Review Panel

Site C Clean Energy Project

Dated: May 1, 2014

Harry Swain
Panel Chair

Jocelyne Beaudet
Panel Member

James Mattison
Panel Member

APPENDIX 1 LIST OF PANEL'S CONCLUSIONS AND RECOMMENDATIONS

The Panel was required to conduct an assessment of the Project in a manner consistent with the requirements of the Terms of Reference. The Panel has identified those conclusions and recommendations that relate to the environmental effects to be taken into account under section 5 of CEAA 2012. See endnote.

The following provides the Panel's conclusions on the significance of the effects of the Project and potential impacts on asserted or established Aboriginal rights or treaty rights in the area of the Project and its recommendations.

A number of the Panel's recommendations are addressed to governments rather than BC Hydro and are not to be interpreted as conditions to be attached to Project approvals. Rather, they are put forward to assist governments and proponents with assessments of this and future projects.

The Panel has reached conclusions and makes recommendations as follows.

Alternative Means of Carrying out the Project

The Panel concludes that the Proponent's assessment of alternative means of carrying out the Project is appropriate.

Aquatic Environment

The Panel concludes that the Project would make small changes to the hydrology of the Peace River, and such changes would be attenuated by the time the flows reach Peace River, Alberta.[4]

> **RECOMMENDATION 1**
> With respect to minimum flow, the Panel recommends that, if the Project proceeds, a minimum release of 390 cubic metres per second from the Site C dam be a condition of approval.

The Panel concludes that there may be some risk to existing infrastructure in Alberta from low flows and that this risk has not been assessed.[2]

> **RECOMMENDATION 2**
> With respect to potential transboundary effects on hydrology, the Panel recommends that, if the Project proceeds, the Proponent must consult with the Province of Alberta and jointly develop an adaptive management plan to manage risks to infrastructure downstream caused by low flows during reservoir filling and operation. The plan should include:
> - Assessment of risks to infrastructure;
> - Monitoring of flows;
> - Identification of problems; and
> - Necessary mitigation through flow regulation or adjustment to Alberta infrastructure to minimize impacts.

The Panel agrees with BC Hydro's assessment that there would not be a change in ice thickness, break-up time, or freeze-up water levels with the Project, downstream at Shaftsbury near Peace River Alberta.[2]

The Panel agrees with BC Hydro's study results that indicate the downstream extent of Site C's influence on the ice regime would be approximately 550 kilometres downstream of the dam site at Carcajou.[2]

The Panel concludes that the Project would result in negligible changes to fluvial geomorphology and sediment transport.[4]

The Panel concludes the Project would result in localized adverse effects on groundwater that would not be significant.[4]

The Panel concludes that there would be a risk of acid generation and metal leaching from construction activities and reservoir creation. However, if the Panel's recommendation is implemented, the effects would not be significant.[4]

> **RECOMMENDATION 3**
> To address the potential risk of acid rock drainage and metal leaching from the Project activities, the Panel recommends that, if the Project proceeds, BC Hydro must consult with Environment Canada, Natural Resources Canada, and Ministries of Environment and Forests, Lands and Natural Resource Operations to design a program to monitor water quality and procedures to mitigate related issues that may arise and to implement the program if necessary.

The Panel concludes there would be no effects from the Project on any aspect of the environment in the Peace Athabasca Delta, and a cumulative effects assessment on the PAD is not required.[2]

Fish and Fish Habitat

The Panel agrees with BC Hydro that the Project would cause significant adverse effects on fish and fish habitat.[1]

The Panel concludes that the construction of the Project would result in significant adverse cumulative effects on fish.[1]

Vegetation and Ecological Communities

The Panel agrees with BC Hydro that the effects of the Project on at-risk and sensitive ecological communities would be significant.[4]

> **RECOMMENDATION 4**
> In order to improve the accuracy and reliability of the baseline mapping and habitat interpretations and to inform mitigation measures and compensation, the Panel recommends that, three month before any activity affecting these habitats, BC Hydro must review its modeling and complete the field work needed to improve identification of rare and sensitive communities and aid in delineation of habitats that may require extra care in the development and operation of the Project.

The Panel disagrees with BC Hydro and concludes that the Project would have a significant adverse effect on wetlands, in particular valley bottom wetlands.[1]

RECOMMENDATION 5
The Panel recommends that, if the Project proceeds, BC Hydro must conduct an assessment of wetland functions lost to the Project that are important to migratory bird and species at risk (wildlife and plants). The Panel also recommends BC Hydro monitor construction and operation activities that could cause changes in wetland functions. The results must inform the development of the mitigation measures to ensure wetland functions at least meet federal and provincial regulatory and policy requirements. BC Hydro must consult with Environment Canada and the Ministry of Forests, Lands and Natural Resource Operations on the duration and frequency of monitoring in relation to migratory birds, species at risk and other wildlife using wetlands.

RECOMMENDATION 6
The Panel recommends that, if the Project proceeds, BC Hydro must complete a Wetland Compensation Plan that includes the results of the functions assessment, surveys, and monitoring program identified above. In developing the Wetland Compensation Plan, BC Hydro must:

a) Discuss migratory birds and species at risk with Environment Canada, the Ministry of Forests, Lands and Natural Resource Operations and Aboriginal groups;
b) Ensure that the Wetland Compensation Plan achieves a full replacement of the wetlands lost in terms of functions and compensates in terms of area;
c) Consult with interested and implicated agencies on the draft Wetland Compensation Plan to ensure effects on Crown land are considered; and
d) Submit the final Wetland Compensation Plan to Environment Canada and other relevant authorities no later than three months prior to any activity affecting the wetlands.

The Panel agrees with BC Hydro that the Project would cause significant adverse effects on rare plants.[4]

RECOMMENDATION 7
The Panel recommends that, if the Project proceeds, BC Hydro must undertake surveys no later than three months prior to any activity affecting rare plants to determine whether the rare plant species potentially facing extirpation are found elsewhere in the region. If the plants cannot be found elsewhere, appropriate conservation methods to ensure the viability of the rare plant species must be put in place, such as ensuring that seeds are kept or relocation of plant communities is attempted.

Given the lack of assessment by BC Hydro, **the Panel cannot conclude** on effects of the Project on plants of interest to Aboriginal groups.[3]

RECOMMENDATION 8
The Panel recommends that, if the Project proceeds, BC Hydro must conduct a comprehensive assessment of effects on traditional plants in collaboration with Aboriginal groups, three months before any activity affecting the plants, to identify areas where plants of interest may be. The results should be used to improve the measures needed to fully mitigate any adverse effects of the Project on plants traditionally used by Aboriginal groups.

RECOMMENDATION 9
The Panel recommends that, if the Project proceeds, BC Hydro be prohibited from using herbicides and pesticides near locations of plants of importance to Aboriginal groups.

The Panel agrees with BC Hydro that cumulative effects on vegetation and ecological communities would be significant.[1,3,4]

Wildlife Resources

The Panel concludes that the Project would likely cause significant adverse effects to the following species that may see their status of protection elevated. These species are: Nelson's sparrow; yellow rail; eastern phoebe; Le Conte's sparrow; old world swallowtail, *pikei* subspecies; Alberta arctic; striped hairstreak; great spangled fritillary, *pseudocarpenteri* subspecies; coral hairstreak, *titus* subspecies; common wood-nymph, *nephele* subspecies; Uhler's arctic; tawny crescent; arctic blue, *lacustris* subspecies; Aphrodite fritillary, *manitoba* subspecies; sharp-tailed grouse, *jamesi* subspecies and Baltimore oriole.[1,3,4]

The Panel disagrees with BC Hydro and concludes that the Project would likely cause significant adverse effects to the western toad.[4]

The Panel disagrees with BC Hydro and concludes that the Project would likely cause significant adverse effects to broad-winged hawk, short-eared owl, eastern red bat, little brown *myotis* and northern *myotis*.[4]

The Panel agrees with BC Hydro that the Project would not likely cause significant adverse effects on fisher and grizzly bear.[3]

The Panel concludes that the effects on caribou as a result of the Project would not be significant.[3]

> **RECOMMENDATION 10**
> The Panel recommends that if the Project proceeds, the Proponent must conduct field work to verify the modeled results for surveyed species at risk and determine, with specificity and by ecosystem, the habitat lost or fragmented for those species. The Proponent shall use these data to inform final project design and to develop additional mitigation measures, as needed, in consultation with appropriate authorities.
>
> **RECOMMENDATION 11**
> The Panel recommends that if the Project proceeds, the Proponent must track updates to the status of listed species identified by the Province, the Committee on the Status of Endangered Wildlife in Canada, and the *Species at Risk Act*. Should the status of a listed species change during the course of the Project, the Proponent must work with Environment Canada and the Ministry of Forests, Lands and Natural Resource Operations to mitigate effects of the Project on the affected species.
>
> **RECOMMENDATION 12**
> The Panel recommends that Environment Canada complete a recovery strategy, in a timely manner, for the species listed under schedule 1 of the *Species at Risk Act* for which recovery strategies have not yet been developed (Canada warbler, olive-sided flycatcher and common nighthawk, rusty blackbird and short-eared owl and western toad).

The Panel concludes that the Project would likely cause significant adverse effects to migratory birds relying on valley bottom habitat during their life cycle and these losses would be permanent and cannot be mitigated.[1]

RECOMMENDATION 13
The Panel recommends that, should the Project proceed, BC Hydro must develop a monitoring and mitigation program in consultation with Environment Canada to avoid the loss of active migratory bird nests in the reservoir area and downstream of the dam.

RECOMMENDATION 14
The Panel recommends that, should the Project proceed, BC Hydro must develop mitigation measures specific to migratory bird species in the Project area that address the changes in aquatic and riparian-related food resources and other habitat features associated with the change from a fluvial to a reservoir system, in consultation with Environment Canada.

RECOMMENDATION 15
The Panel recommends that, should the Project proceed, BC Hydro must conduct a risk assessment for bird collisions under the current transmission line design. BC Hydro must determine if additional mitigation measures (e.g. line marking and diversions) could be implemented to reduce the risk, in consultation with Environment Canada.

RECOMMENDATION 16
The Panel recommends that, should the Project proceed, BC Hydro be required to develop a Compensation Plan for non-wetland migratory birds in consultation with Environment Canada, and implement the plan to address significant adverse effects on Canada warbler, Cape May warbler, and bay-breasted warbler. The plan must be submitted to Environment Canada three months prior to any activity affecting the habitat.

The Panel agrees with BC Hydro that the Project would not likely cause significant adverse effects on moose, elk, white-tailed deer and mule deer.[1]

RECOMMENDATION 17
The Panel recommends that, if the Project proceeds, the Proponent must, in collaboration with the Province, determine whether additional lands owned by BC Hydro or Crown Lands could be maintained as winter range for ungulates.

RECOMMENDATION 18
The Panel recommends that, if the Project proceeds, the Ministry of Forests, Lands and Natural Resource Operations must conduct bi-annual ungulate surveys in Wildlife Management Units overlapping with the LAA during Project construction and for a period of 5 years after. This information must be provided to the Proponent to confirm the effects of the Project and used by the Ministry to determine if mitigation is required (for direct or indirect effects).

The Panel concludes that the wildlife species that would experience significant effects as a result of the Project would also experience significant cumulative effects.[1,3,4]

The Panel concludes that given that fisher are blue-listed and likely already impacted by human pressures, the Project effects in combination with past, existing and future projects may cause significant cumulative effects.[3]

The Panel concludes that the Project would not likely cause significant cumulative effects on ungulates.[3]

Current Use of Lands and Resources for Traditional Purposes

The Panel disagrees with BC Hydro and concludes that the Project would likely cause a significant adverse effect on fishing opportunities and practices for the First Nations represented

by Treaty 8 Tribal Association, Saulteau First Nations, and Blueberry River First Nations, and that these effects cannot be mitigated.[3]

The Panel disagrees with BC Hydro and concludes that the Project would likely cause a significant adverse effect on hunting and non-tenured trapping for the First Nations represented by Treaty 8 Tribal Association and Saulteau First Nations, and that these effects cannot be mitigated.[3]

The Panel concludes that the Project would likely cause a significant adverse effect on other traditional uses of the land for the First Nations represented by Treaty 8 Tribal Association, Saulteau First Nations, and Blueberry River First Nations, and that some of these effects cannot be mitigated.[3]

The Panel concludes that the Project would likely cause significant adverse cumulative effects on current use of lands and resources for traditional purposes.[3]

> **RECOMMENDATION 19**
> The Panel recommends that, if the Project does not proceed, the Province, after consultation with affected local parties, remove the flood reserve in a manner that preserves the agricultural, wildlife and heritage values of the Peace River valley.
>
> **RECOMMENDATION 20**
> The Panel recommends that the Province set aside the hunting, fishing and trapping rights in the Peace Moberly Tract for people holding Section 35 rights under the *Constitution Act*, *1982*. The Panel also recommends that the Province and affected First Nations enter discussions on the Area of Critical Community Interest with a view to the harmonious accommodation of all interests in this land.

Other Harvest of Fish and Wildlife Resources

The Panel agrees with BC Hydro that the effects of the Project on harvest of fish would not be significant.[5]

The Panel agrees with BC Hydro that the effects of the Project on harvest of wildlife would not be significant.[5]

The Panel concludes that, if the Project proceeds, some tenured trappers and outfitters would be adversely affected by the construction and operation activities of the Project. If the Panel's recommendation is implemented, this effect would not be significant.[3,5]

> **RECOMMENDATION 21**
> The Panel recommends that, if the Project proceeds, fair compensation should be offered to affected tenured trappers and outfitters for long term losses.

The Panel concludes that more information is needed to assess the effects of the Project on harvest of wildlife resulting from an influx of workers from outside the Peace region and the opening of the territory by the construction of new access roads and the improvement of the road system.[3,5]

> **RECOMMENDATION 22**
> The Panel recommends that, if the Project proceeds, BC Hydro must determine, in collaboration with applicable agencies, stakeholders and Aboriginal groups, what enforceable restrictions can be put in place with respect to the Project access road, and

which existing roads in the vicinity and new roads built during construction should be decommissioned.

The Panel agrees with BC Hydro that the cumulative effects on harvest of fish and wildlife would not be significant.[3,5]

Agriculture

The Panel concludes that the permanent loss of the agricultural production of the Peace River valley bottomlands included in the local assessment area of the Project is not, by itself and in the context of B.C. or western Canadian agricultural production, significant. **The Panel further concludes** that this loss would be highly significant to the farmers who would bear the loss, and that financial compensation would not make up for the loss of a highly valued place and way of life.[5]

The Panel agrees with BC Hydro that the Project would not cause cumulative effects on agriculture.[5]

Effects on Other Resources Industries

The Panel concludes that the Project would have negligible effects on the regional oil and gas, forest, and mineral and aggregate industries.[5]

Transportation

The Panel concludes that the traffic at some places on Highway 97 is already dangerous, and during the period of construction, the Project would add to that, but there would be no residual effects after the construction period. If the Panel's recommendations are implemented, this effect would not be significant during construction.

RECOMMENDATION 23
As proposed by BC Hydro, the Panel recommends that, if the Project proceeds, it must establish a current baseline of fog occurrences at Taylor Bridge and its approaches in Taylor, as well as follow-up monitoring during the first years of operation to evaluate the magnitude of any changes as a result of the Project.

RECOMMENDATION 24
The Panel recommends that, if the Project proceeds, BC Hydro must conduct monitoring of the Level of Service and road safety. Monitoring and a follow-up program shall focus on the following locations:

- Highway 97 at Old Fort Road in Fort St. John,
- Highway 97 at 100th Street in Fort St. John,
- Highway 97 at 85th Avenue in Fort St. John,
- Canyon Drive in Hudson's Hope,
- Beattie Drive in Hudson's Hope,
- Clarke Avenue in Hudson's Hope.

RECOMMENDATION 25
The Panel recommends that, if the Project proceeds, BC Hydro's Traffic Monitoring and Management Plan and associated work schedules must be prepared, subject to safety considerations, to minimize delays and nuisance caused by the realignment of Highway 29, particularly during peak visitor periods.

Air Navigation

The Panel concludes that the Project would not result in significant adverse effects on air navigation.[4]

Water Navigation

The Panel concludes that the Project would have adverse effects on navigation use of the Peace River but that they would not be significant because the river would still be navigable above and below the dam site. **The Panel further concludes** that the loss would be significant for the small number of people who traverse the dam site.[4]

The Panel concludes that there would be no cumulative effects on navigation of the Peace River if the Project proceeds.[4]

Outdoor Recreation and Tourism

The Panel concludes that the construction period would have an adverse effect on outdoor recreation activities associated with the Peace River, but this effect would not be significant.[5]

The Panel concludes that the cumulative effects on outdoor recreation and tourism would not be significant.[5]

Population and Demographics

The Panel concludes that population effects would be primarily limited to the construction phase of the Project, when modest increments to the local and City population would occur. Because most of these effects would be limited to the construction phase, the Panel concludes these effects would not be significant.

Housing

Considering the mitigation commitments presented by BC Hydro to address housing issues related to the Project, **the Panel is satisfied** that there would not be significant adverse effects on housing solely as a result of the Project.

> **RECOMMENDATION 26**
> The Panel recommends, regardless of whether or not the Project proceeds, that the Province give sympathetic attention to an extension of Fort St. John's municipal boundaries so that contiguous urbanizing areas, plus a reserve, are brought within the planning, service, and taxation ambit of the City's government.

Community Infrastructure and Services

The Panel concludes that the general stress on community infrastructure and services caused by the Project could be managed with sufficient resources. The Panel is confident that mitigation in the form of additional resources would be provided by BC Hydro and appropriately managed by the communities (including municipalities) such that effects would not be significant.

> **RECOMMENDATION 27**
> The Panel recommends that, should the Project proceed, BC Hydro must include in its agreement with the City of Fort St. John expenses for Project-related costs of child and family welfare services.

Employment, Labour Markets and Local Residents

The Panel concludes that the Project would further tighten a labour market where the unemployment rate is only 3.6 percent, and that it is in everyone's interest to ensure that local Aboriginal workers are as well-equipped as possible to compete in that market.

The Panel further concludes that, with the implementation of the proposed mitigation measures, there should be no significant adverse effects on the labour market.

RECOMMENDATION 28
The Panel recommends that, if the Project proceeds, BC Hydro must work with training institutions to focus on employment in indirect and induced sectors for Aboriginal workers, as these jobs are likely to be longer lived than those related strictly to construction.

Local Government Revenue

The Panel concludes that revenues to be received from existing sources, together with payments contemplated in negotiations between the Proponent and local governments, would generally be sufficient to maintain current service quality levels. Several such agreements are already in place. No significant adverse effects are foreseen, nor are cumulative effects.

The Panel further concludes that the negotiations of Impact and Benefit Agreements with local affected Aboriginal groups would generally be sufficient to maintain current service quality levels both on- and off-reserve.

Regional Economic Development

The Panel concludes that there would be excellent opportunities for new and existing jobs and businesses during the construction phase.

Human Health

The Panel concludes that, if the Project proceeds, there is a potential for health effects from a degradation of air quality in the region of Fort St. John, Taylor, Hudson's Hope and for Aboriginal groups using areas close to the construction activities of clearing and burning, the construction of access roads and the realignment of Highway 29. The predicted results would have to be confirmed through monitoring and the mitigation measures adjusted if needed. These effects could be overcome with proper mitigation. If the Panel's recommendation is implemented, there would be no residual effects.[3,5]

RECOMMENDATION 29
The Panel recommends that, if the Project proceeds, BC Hydro must:

- Add monitoring at sensitive receptor group locations to the monitoring plan for dust and smoke;
- Prolong the monitoring proposed for the construction period into the first two years of operation for particulate matter and dustfall. In case of exceedances, appropriate mitigation measures must be implemented;
- Identify places of high Aboriginal group use and develop mitigation measures should adverse effects be predicted at those locations; and
- Ensure procedures are developed to warn and protect sensitive populations in cases of exceedance.

The Panel disagrees with BC Hydro that there would be no effects on individual wells. There would be a risk of exceedances of drinking water quality guidelines for a number of wells. If the Panel's recommendation is implemented, there would no residual effects.[5]

RECOMMENDATION 30
The Panel recommends that, if the Project proceeds, BC Hydro be required to monitor potentially affected wells, starting as soon as Project approval is received. Monitoring must be done twice a year for 10 years. If any changes are observed the owners must be informed. If any functionality problems such as poor water quality or low yield result from the Project, BC Hydro must work with the well owner(s) to provide an alternate source of potable water.

For the City of Fort St. John's and the District of Taylor's water supply wells, **the Panel agrees** with BC Hydro that exceedances of drinking water quality guidelines are not anticipated.[5]

The Panel concludes that there are predicted exceedances of the BC Oil and Gas Commission guidelines and changes in sound levels at some receptors - above 5 dBA at one residence and above 10 dBA at worker camps. If the Panel's recommendation is implemented, there would be no residual effects.[5]

RECOMMENDATION 31
The Panel recommends that, if the Project proceeds, BC Hydro must:

- Design a work and noise management schedule that allows an uninterrupted eight hour sleep schedule for workers; and
- Manage Project noise to provide quiet enjoyment to residents, even if it means temporary relocation.

The Panel agrees with BC Hydro's conclusion that no adverse health effects associated with exposure to electric and magnetic fields are expected.[3]

RECOMMENDATION 32
The Panel recommends that, if the Project proceeds, BC Hydro must measure post-construction electric and magnetic field levels at the right-of-way edge where habitation sites exist and communicate the results to occupants. If monitoring determines an exceedance of the International Commission on Non-Ionizing Raditation Protection guidelines (4.2 kV/m) at a habitation site, BC Hydro must provide the necessary resources for relocation.

Regarding fish consumption data used by BC Hydro in the Mercury Human Health Risk Assessment, **the Panel concludes** there are no reliable data available at this point.[3,5]

RECOMMENDATION 33
The Panel recommends that, if the Project proceeds, BC Hydro must work cooperatively to obtain site-specific data from Aboriginal groups. The dietary information to be collected from potentially impacted groups should include:

- Species and size of fish caught for consumption;
- Location where fish are caught for consumption;
- Consumption of fish by age group;
- Parts of fish consumed;
- Fish preparation methods;

- Fish meal sizes by age group;
- Fish meal frequency; and
- Other relevant consumption information (e.g. events where consumption is higher over a short period of time such as a camping event).

The Panel concludes that only monitoring of the fish in the reservoir and the consumption habits of the people would provide an adequate base for the development of effective mitigation measures for methylmercury.[3,5]

RECOMMENDATION 34
The Panel recommends that, if the Project proceeds, the monitoring program must require the collaboration of Health Canada and include:

- Involving local Aboriginal communities and the First Nations Health Authority in the design, implementation, management and interpretation and communication of results from the methylmercury monitoring program for fish;
- Collecting representative data through collaboration with Aboriginal communities to enable meaningful sampling of the appropriate fish species and fish size in areas where groups harvest fish. The spatial extent of the sampling program should include tributaries used by Aboriginal groups; and
- Working with all levels of government to communicate information to Aboriginal groups and others regarding potential fish consumption advisories and other health-related bulletins or information as may be necessary.

RECOMMENDATION 35
The Panel recommends that, in the event that Health Canada determines a consumption advisory is needed, the Chief Medical Officer of Northern Health must be notified by Health Canada. The advisory should be designed and implemented in accordance with federal and provincial procedures for issuing fish consumption advisories. It should be issued using good practice including:

- Culturally appropriate communications to Aboriginal groups;
- Mechanisms to receive and respond to inquiries from local communities in regards to the advisories; and
- A collaborative monitoring process with Aboriginal and other communities.

RECOMMENDATION 36
The Panel recommends that, if the Project proceeds, effective communication with Aboriginal communities and other stakeholders is required by Health Canada whether an advisory is needed or not. This should include:

- Communication of the results of the Mercury Human Health Risk Assessment, including guidance for people consuming more than one species of fish and how they can continue to eat multiple species without exceeding the provisional tolerable daily intake for methylmercury; and
- Communication of consumption limits in grams per week rather than servings per week. Further guidance should be provided as to what a gram of fish is equivalent to in order to make the communications more user-friendly.

The Panel concludes that some homes close to the construction of the dam and in Hudson's Hope shoreline protection activity area would experience an increase in noise combined with a degradation of the ambient air quality.[3,5]

> **RECOMMENDATION 37**
> The Panel recommends that, if the Project proceeds, where monitoring indicates that homeowners are experiencing serious nuisance as a result of the Project, BC Hydro be required to mitigate those effects, up to and including relocation if necessary.

The Panel agrees with the Proponent that there would be no significant adverse effects on human health taking into account the mitigation measures proposed by the Proponent and the Panel recommendations.[3,5]

Because of the uncertainty in the assessment, **the Panel concludes** that there is no need at present to do a cumulative effects assessment on health indicators but that one may be required once effects are confirmed through monitoring.[3,5]

Heritage Resources

The Panel concludes that residual adverse effects on physical heritage resources caused by the Project would be adverse and significant.[3,5]

> **RECOMMENDATION 38**
> The Panel recommends that, if the Project proceeds, BC Hydro must monitor reservoir erosion during occurrences of low reservoir levels and investigate, according to the requirements of the Archaeology Branch of the Ministry of Forests, Lands and Natural Resource Operations, any potentially new-found sites and carry out emergency salvage.

> **RECOMMENDATION 39**
> The Panel recommends that, if the Project proceeds, BC Hydro must conduct monitoring of shoreline erosion downstream (for approximately 2 km) as part of its chance find procedures to determine if physical heritage resources are affected. The Panel recommends that BC Hydro undertake this monitoring for any spills from the Project reservoir, for a period of 2 years.

> **RECOMMENDATION 40**
> The Panel recommends, if the Project proceeds, that BC Hydro must continue its collaboration with First Nations and the Métis Nation British Columbia, for the days committed on ground truthing for the identification of any burial sites that the Project may disturb.

> **RECOMMENDATION 41**
> The Panel recommends that, if the Project proceeds, BC Hydro must provide sufficient funds to local accredited facilities in close proximity to the Project to curate and display the recovered resources. The Panel further recommends that these funds be provided only to facilities that agree to work with Aboriginal groups on the display and curation of those artifacts.

The Panel concludes that the cumulative adverse effects on heritage resources would be significant.[3,5]

The Panel concludes that there would be significant adverse effects of the Project on cultural heritage resources for both Aboriginal and non-Aboriginal people.[3,5]

The Panel concludes that the effect of the Project on visual resources would be a significant adverse effect.[3,5]

GHG Emissions

The Panel concludes that the Project would produce more power per gram of CO_2e than any alternative (non-nuclear) over its lifetime.[2]

The Panel agrees with BC Hydro that the Project's effects on greenhouse gases would not be significant.[2]

The Panel agrees with BC Hydro that the contribution of the Project to the provincial, national and global problem would not be significant.[2]

Effects of the Environment on the Project

The Panel concludes that the design of the Project adequately accounts for possible adverse effects of the environment on the Project.

Accidents and Malfunctions

The Panel concludes that the effects of the Project from minor accidents and malfunctions are not likely to be significant and that BC Hydro has demonstrated appropriate diligence in its analysis and proposed mitigation.

The Panel concludes that a Site C dam breach would result in significant adverse effects, but that the probability of failure occurring is remote. **The Panel further concludes** that any effects of a cascading dam failure would result in significant cumulative effects, but that the probability of cascading failure is extremely remote.

> **RECOMMENDATION 42**
> The Panel recommends that, if the Project proceeds, BC Hydro be required to conduct an assessment of the impacts of a multiple cascading dam breach and share the results of that study with the Government of Alberta and the authorities of the towns that would be affected. The Panel recommends that BC Hydro consult with Alberta and emergency management officials in both provinces on communication and contingency plans to address the potential occurrence of a multiple cascading dam breach.

Cumulative Effects Assessment

The Panel concludes that, whether the Project proceeds or not, there is a need for a government-led regional environmental assessment including a baseline study and the establishment of environmental thresholds for use in evaluating the effects of multiple, projects in a rapidly developing region.

> **RECOMMENDATION 43**
> Given the rapid developments foreseen for northeast B.C., Ministers may wish to consider commissioning a regional baseline study and environmental assessment as a public good and a basis for planning and regulating all activities requiring review. Such a study would greatly assist future proponents in all sectors, notably oil and gas, forestry, mining and energy production.

Because of the importance of cumulative effects assessment, **the Panel concludes** that there is a need to improve and standardize cumulative effects assessment methods.

> **RECOMMENDATION 44**
> Whether the Project proceeds or not, the Panel recommends that the Canadian Environmental Assessment Agency undertake, on an urgent basis, an update of its guidance on cumulative effects assessment, taking into account the views of the provinces.

Capacity of Renewable Resources

The Panel concludes that because of the significant adverse effects identified on some renewable resource valued components in the long-term, if the Project is to proceed, there would be diminished biodiversity and reduced capacity of renewable resources.

Environmental Management Plans, Follow-up and Monitoring

Subject to the recommendation below, **the Panel is satisfied** with the Proponent's environmental management, including its mitigation measures, monitoring programs, and follow-up programs.

> **RECOMMENDATION 45**
> The Panel recommends that, if the Project is to proceed, all recommendations of the Panel directed to BC Hydro and mitigation measures proposed by BC Hydro become conditions of Project approval.

Purpose of the Proposal

The Panel rejects, as a governing purpose, the maximization of the hydraulic potential of the Peace River.

Project Benefits

The Panel concludes that the Project must rest on its main claims - that it would supply electricity that B.C. customers need and would pay for, at a lower combination of cash and external costs than any alternative - and not on regional economic benefits.

Project Costs

The Panel cannot conclude on the likely accuracy of Project cost estimates because it does not have the information, time, or resources. This affects all further calculations of unit costs, revenue requirements, and rates.

> **RECOMMENDATION 46**
> If it is decided that the Project should proceed, a first step should be the referral of Project costs and hence unit energy costs and revenue requirements to the BC Utilities Commission for detailed examination.

Demand

The Panel concludes that BC Hydro's forecasting techniques are sound, but uncertainties necessarily proliferate in long-term forecasts.

The Panel concludes that it is unlikely that the transmission and liquefaction energy requirements of the new liquefied natural gas industry will be satisfied by any source except natural gas itself, and thus that BC Hydro's *Integrated Resource Plan* sensitivity scenario of "Low Liquefied Natural Gas" forecast is most likely correct.

The Panel concludes that, basing a $7.9 billion Project on a 20-year demand forecast without an explicit 20-year scenario of prices is not good practice. Electricity prices will strongly affect demand, including Liquefied Natural Gas facility demand.

> **RECOMMENDATION 47**
> The Panel recommends that BC Hydro construct a reasonable long-term pricing scenario for electricity and its substitutes and update the associated load forecast, including Liquefied Natural Gas demand, and that this be exposed for public and Commission comment in a BC Utilities Commission hearing, before construction begins.

Demand Moderation

The Panel concludes that the demand-side management yield ought to at least keep up with the growth in gross demand, and therefore the potential savings from 2026 to 2033 may be understated.

Using BC Hydro's price elasticity of demand of -0.57, accepting BC Hydro's forecast of gross demand, and positing a real price increase of 50 percent from 2014 to 2033, **the Panel concludes** that net demand in 2033 is likely to be about 65 terawatt hours.

The Panel concludes that demand management does not appear to command the same degree of analytic effort as does new supply.

Supply: Energy and Capacity

The Panel concludes that methodological problems in the weighing and comparison of alternatives render unitized energy costs only generally reliable as a guide to investment. The Panel is more confident about the ranking of BC Hydro's projects, or independent power producers' projects, or demand side management projects considered as separate lists. Uncosted attributes such as the ability to follow load, geographical diversity, or the ability to assist with the integration of intermittent sources need more analytical attention.

The Panel concludes that a number of supply alternatives are competitive with Site C on a standard financial analysis, although in the long term, Site C would produce less expensive power than any alternative.

The Panel concludes that relying on exports to absorb surplus production would likely be very expensive.

Research

The Panel concludes that a failure to pursue research over the last 30 years into B.C.'s geothermal resources has left BC Hydro without information about a resource that BC Hydro thinks may offer up to 700 megawatts of firm, economic power with low environmental costs.

The Panel concludes that analytic efforts to quantify the potential benefits of geographic diversity and climate-induced changes to hydrology could allow a better characterization of important resources.

RECOMMENDATION 48
The Panel recommends, regardless of the decision taken on Site C, that BC Hydro establish a research and development budget for the resource and engineering characterization of geographically diverse renewable resources, conservation techniques, the optimal integration of intermittent and firm sources, and climate-induced changes to hydrology, and that an appropriate allowance in its revenue requirements be approved by the BC Utilities Commission.

Policy Constraints on Supply

The Panel concludes that, under the Low Liquefied Natural Gas case, available resources could provide adequate energy and capacity until at least 2028.

Panel's Overall Analysis on Need for the Project

The Panel concludes that B.C. will need new energy and new capacity at some point. Site C would be the least expensive of the alternatives, and its cost advantages would increase with the passing decades as inflation makes alternatives more costly.

The Panel concludes that the Proponent has not fully demonstrated the need for the Project on the timetable set forth.

RECOMMENDATION 49
The Panel recommends that, if Ministers are inclined to proceed, they may wish to consider referring the load forecast and demand side management plan details to the BC Utilities Commission.

RECOMMENDATION 50
Regardless of its decision on Site C, the Province should update its guidance on the social discount rate or rates to be used for the analysis of societal costs and benefits for projects built or procured by public sector entities.

[1] CEAA 2012, s. 5(1)(a)
[2] CEAA 2012, s. 5(1)(b)
[3] CEAA 2012, s. 5(1)(c)
[4] CEAA 2012, s. 5(2)(a)
[5] CEAA 2012, s. 5(2)(b)

APPENDIX 2 AGREEMENT AND PANEL TERMS OF REFERENCE

Amended Agreement To Conduct a Cooperative Environmental Assessment, Including the Establishment of a Joint Review Panel, of the Site C Clean Energy Project

Between

The Minister of the Environment, Canada

and

The Minister of the Environment, British Columbia

[As amended by the Amendment to the Agreement to Conduct a Cooperative Environmental Assessment, Including the Establishment of a Joint Review Panel, of the Site C Clean Energy Project between the Minister of the Environment, Canada and the Minister of the Environment, British Columbia (August 3, 2012)]

PREAMBLE

WHEREAS this is a project-specific agreement consistent with the Canada-British Columbia Agreement for Environmental Assessment Cooperation signed on March 11th, 2004; and

WHEREAS the Minister of the Environment, Canada (the federal Minister of the Environment) has statutory responsibilities pursuant to the *Canadian Environmental Assessment Act, 2012 (CEAA 2012)*; and

WHEREAS the Minister of Environment, British Columbia (the provincial Minister of Environment) has statutory responsibilities pursuant to the British Columbia *Environmental Assessment Act (*the *"BCEAA")*; and

WHEREAS British Columbia Hydro and Power Authority is proposing to construct and operate a dam and hydroelectric generating station on the Peace River near Fort St. John, British Columbia, referred to as the Site C Clean Energy Project, which is subject to environmental assessment requirements under both the *CEAA 2012* and the *BCEAA*; and

WHEREAS the federal Minister of the Environment has referred the Site C Clean Energy Project to a review panel in accordance with section 29 of the *CEAA*; and has determined that a joint review panel should be established pursuant to subsection 40(2) of the *CEAA* to consider the Site C Clean Energy Project; and

WHEREAS under section 27 of the *BCEAA*, the provincial Minister of Environment has the authority to enter into an agreement with Canada regarding any aspect of an environmental assessment and may establish procedures with Canada to cooperatively complete an environmental assessment of a project; and has determined that a cooperative environmental assessment including a hearing panel should be established*;* and

WHEREAS the federal Minister of the Environment and the provincial Minister of Environment have determined that a cooperative environmental assessment including a joint review panel for the Site C Clean Energy Project will avoid unnecessary duplication and delays that could arise

from individual reviews by each government; and agree to establish a joint review panel for the Site C Clean Energy Project; and

WHEREAS a draft version of this Agreement, including the Joint Review Panel's Terms of Reference, was subject to consultation with the Responsible Authorities for the Project and with Aboriginal groups as well as a public comment period of 30 days.

WHEREAS the *Canadian Environmental Assessment Act* has been repealed and the *Canadian Environmental Assessment Act, 2012* has come into force; and

WHEREAS pursuant to section 126 of the *Canadian Environmental Assessment Act*, *2012*, the assessment by the joint review panel is continued under the process established under the *Canadian Environmental Assessment Act, 2012* as if it had been referred to a review panel under section 38 of the *Canadian Environmental Assessment Act, 2012*;

THEREFORE, the federal Minister of the Environment and provincial Minister of Environment hereby establish a cooperative environmental assessment including a joint review panel for the Site C Clean Energy Project; in accordance with the provisions of this Agreement and the Joint Review Panel's Terms of Reference attached as Appendix 1 to this Agreement.

1. Definitions

For the purpose of this Agreement and of the Terms of Reference for the Joint Review Panel,

"Aboriginal Groups" means those aboriginal groups that have been identified by the Agency or EAO as having the potential to be adversely affected by the Project.

"Agency" means the Canadian Environmental Assessment Agency.

"Agreement" means this agreement between the Minister of the Environment, Canada and the Minister of Environment, British Columbia.

"British Columbia *Environmental Assessment Act*" or "*BCEAA*" means the *Environmental Assessment Act*, S.B.C. 2002, c. 43.

***"Canadian Environmental Assessment Act, 2012"* or "CEAA 2012"** refers to the *Canadian Environmental Assessment Act*, 2012

"EAO" means the British Columbia Environmental Assessment Office.

"Environmental Impact Statement" or "EIS" means the environmental impact statement report and supplemental information that is prepared by the proponent for submission to the Agency and EAO for review, and to the Joint Review Panel.

"EIS Guidelines" means the document provided to the proponent by the federal Minister of the Environment and the Executive Director of EAO that identifies the issues to be addressed and the information to be provided in the EIS.

"Federal Authority" has the same meaning as set out in subsection 2(1) of the *CEAA 2012*.

"Joint Review Panel" means an independent body established pursuant to this Agreement and considered to be a review panel established under an agreement entered into under the *CEAA 2012,* pursuant to section 126(1) of *CEAA 2012.*

"Joint Review Panel Report" means the report produced by the Joint Review Panel in accordance with the Terms of Reference.

"Joint Review Panel Stage" means those portions of the environmental assessment process that occur from the time the Proponent submits the amended EIS to the Panel, in accordance with section 3.14 of this Agreement, to the time the Joint Review Panel Report is submitted.

"Participant Funding Program" means the program administered by the Agency that provides financial assistance to individuals, non-profit organizations and Aboriginal groups interested in participating in federal environmental assessments.

"Party" means either signatory to this Agreement, and "Parties" means both of them.

"Post-Panel Stage" means those portions of the environmental assessment process that take place following the submission of the Joint Review Panel Report.

"Pre-Panel Stage" means those portions of the environmental assessment process that take place before the Joint Review Panel is appointed.

"Project" refers to the Project proposed by the proponent, a description of which is outlined in Part I of the Terms of Reference.

"Proponent" means British Columbia Hydro and Power Authority.

"Public Registry" means both the Canadian Environmental Assessment Registry established under section 78 of the *Canadian Environmental Assessment Act 2012* which will be maintained by the Agency; and the British Columbia Project Information Centre (e-PIC) established under section 25 of the *BCEAA* which will be maintained by the Executive Director of EAO.

"Referral Package" means the referral package set out in section 8.1 of this Agreement.

"Responsible Authority" has the same meaning as set out in subsection 2(1) of the *CEAA*.

"Steering Committee" means the steering committee established under section 9.1 of this Agreement.

"Terms of Reference" means the Terms of Reference for the Joint Review Panel attached as Appendix 1.

"Working Group" means the Working Group established under section 3.1 of this Agreement.

2. Overview of the Environmental Assessment

2.1 The environmental assessment for the Project will follow the schematic attached in Appendix 2. The environmental assessment will consist of the following components:

- Pre-Panel Stage: As set out in section 3 of this Agreement, the Agency and EAO will oversee the production of the EIS Guidelines and will determine when the EIS is ready for review by the Joint Review Panel;

- Joint Review Panel Stage: As set out in section 4 of this Agreement, the Joint Review Panel will determine the sufficiency of the EIS, hold public hearings, and produce the Joint Review Panel Report, with the support of a secretariat; and,

- Post-Panel Stage: As set out in sections 8 through 10 of this Agreement, the Agency and EAO will coordinate public release of the Joint Review Panel Report and will coordinate referral documentation to federal and provincial decision makers.

CONDUCT OF THE ENVIRONMENTAL ASSESSMENT

3. Pre-Panel Stage

3.1 The Parties agree to establish a Working Group composed of representatives of Aboriginal Groups and of federal, provincial and territorial government agencies, including those of British Columbia, Alberta and the Northwest Territories, and local governments that have been identified as having an interest in the Project, which will be invited by EAO and the Agency to be members of the Working Group.

3.2 The Working Group will provide advice to the Agency and EAO on issues related to the assessment of the Project. The Working Group will not make any decisions in relation to the environmental assessment of the Project.

3.3 All records of Working Group meetings will be made available for the Joint Review Panel's consideration.

3.4 The Proponent will prepare a first draft of the EIS Guidelines following communication with the Agency and EAO.

3.5 The Working Group will review the draft EIS Guidelines and provide comments to the Agency and EAO, which will provide comments to the Proponent. The Proponent will provide a detailed response to these comments. The Proponent's response will be considered by the Agency, EAO and Responsible Authorities, and the Agency and EAO will direct the Proponent to amend the draft EIS Guidelines as required.

3.6 The Agency and EAO will make the draft EIS Guidelines available for a public comment period of 45 days.

3.7 Following the close of the public comment period, the Proponent will provide a detailed response to public comments. The Working Group will consider the public comments and the Proponent's response and will provide its advice on the draft EIS Guidelines to the Agency and EAO. The Agency and EAO will amend the draft EIS Guidelines where appropriate.

3.8 The federal Minister of the Environment and Executive Director of EAO will determine whether the EIS Guidelines are adequate and will finalize the EIS Guidelines. The Federal Minister of the Environment and the Executive Director of EAO will issue the final EIS Guidelines to the Proponent.

3.9 The Parties agree that the part of the final EIS Guidelines respecting the scope of factors to be considered in the environmental assessment is deemed to be incorporated into the Terms of Reference.

3.10 The Proponent will prepare the EIS in accordance with the final EIS Guidelines and will submit the EIS to the Agency and EAO.

3.11 The Working Group will review the EIS and submit comments and information requests to the Agency and EAO, which will provide comments to the Proponent. The Proponent will provide a detailed response to these comments. The Proponent's response will be considered by the Agency and EAO, and the Agency and EAO will direct the Proponent to supplement the EIS as required.

3.12 The Agency and EAO will make the EIS available for a public comment period of 60 days.

3.13 Following the close of the public comment period, the Proponent will provide a detailed response to public comments. The Working Group will consider the public comments and the Proponent's response and will provide its advice on the EIS to the Agency and EAO. The Agency and EAO will direct the Proponent to amend the EIS where appropriate.

3.14 The Agency and EAO will determine when the EIS is satisfactory to them and then direct the proponent to submit the amended EIS to the Panel. When the proponent submits the amended EIS to the Panel, the Pre-Panel Stage is complete and the Joint Review Panel Stage will commence.

3.15 The Pre-Panel Stage is not expected to exceed 24 calendar months from the date that the Notice of Consideration under the *CEAA* was posted on the Agency's website (August 2, 2011).

3.16 EAO will prepare a report summarizing the activities that took place during the Pre-Panel Stage.

4. Joint Review Panel Stage

Establishment of and Administrative Support for the Joint Review Panel

4.1 A Joint Review Panel will be established pursuant to sections 40 and 42 of the *CEAA* 2012 and pursuant to the *BCEAA* for the purposes of conducting an environmental assessment of the Project

4.2 The Parties must establish the Joint Review Panel within 260 days of the coming-into-force of *CEAA 2012.* Any time taken by the proponent to prepare or make revisions to its EIS, or to prepare its responses to public or Working Group comments, is not included in this time period.

4.3 Once the Joint Review Panel is established, the Agency and EAO will make arrangements to coordinate the announcement of the establishment of the Joint Review Panel of the Project by both Parties.

4.4 The Proponent will submit the amended EIS to the Joint Review Panel

4.5 The Joint Review Panel shall satisfy its Terms of Reference and submit its final report to the federal Minister of the Environment and the Executive Director of the EAO within 225 days from the submission of the EIS by the Proponent to the Joint Review Panel. This time period does not include any time required by the proponent to prepare any additional information required by the Panel.

4.6 The Joint Review Panel Stage of the assessment, including preparation and submission of the Joint Review Panel Report, is not expected to exceed eight calendar months from the time the EIS is submitted to the Joint Review Panel.

4.7 A secretariat for the Joint Review Panel will be established by the Agency and EAO. The secretariat will provide administrative, technical and procedural support requested by the Joint Review Panel. The secretariat will consist of employees of the Agency and EAO, and will be free of conflict of interest relative to the Project.

4.8 The secretariat will support the Joint Review Panel and will be structured so as to allow the Joint Review Panel to conduct its review in an efficient and cost-effective manner.

Constitution and Mandate of the Joint Review Panel

4.9 The Joint Review Panel will consist of three members, one of whom will be the chairperson.

4.10 The Agency and EAO will jointly evaluate potential candidates and will each recommend a candidate to be appointed as a panel member, with a joint recommendation of one candidate for chairperson. In developing these recommendations, the Agency and EAO may consider candidate names put forward by Aboriginal Groups or members of the public.

4.11 The federal Minister of the Environment will appoint one panel member, the provincial Minister of Environment will appoint one panel member, and the chair of the panel will be jointly appointed by the federal and provincial Ministers of Environment.

4.12 Joint Review Panel members will be unbiased and free of any conflict of interest relative to the Project.

4.13 Joint Review Panel members will not be employed by the Public Service or Crown Corporations of British Columbia or of Canada.

4.14 The members will have knowledge and experience relevant to the anticipated effects of the Project.

4.15 In the event that a Joint Review Panel member resigns or is unable to continue to work, the remaining members will continue to work and will constitute the Joint Review Panel. However, the Parties may choose to replace the Joint Review Panel member. If they do so, the replacement Panel member will be appointed by the provincial Minister of Environment, the federal Minister of the Environment, or jointly, depending on who had appointed the Panel member being replaced.

4.16 The Joint Review Panel will conduct its review in accordance with the requirements of the CEAA 2012 and associated Regulations, and the requirements in the Terms of Reference.

4.17 The Joint Review Panel will conduct its review in a manner that will facilitate the meaningful participation of Aboriginal Groups.

4.18 The Joint Review Panel may request clarification of the Terms of Reference by sending a letter signed by the chairperson to the President of the Agency and the Executive Director of EAO setting out the request. Upon receiving a request for clarification from the Joint Review Panel, the President of the Agency, on behalf of the federal Minister of the Environment, and the Executive Director of EAO, on behalf of the provincial Minister of Environment, are authorized jointly to provide the Joint Review Panel such clarification. Should clarification be requested, the President and the Executive Director will use best efforts to ensure a joint response is provided to the Joint Review Panel's letter within 14 calendar days. The Joint Review Panel will continue with the joint review to the extent possible while waiting for the response in order to adhere to the time periods of the Terms of Reference. The Joint Review Panel will notify the public of any clarifications to the Terms of Reference.

4.19 The Joint Review Panel may seek an amendment to the Terms of Reference by sending a letter signed by the chairperson to the President of the Agency and the Executive Director of EAO setting out the request. In seeking an amendment, the Joint Review Panel may recommend to the Parties whether a public comment period on the proposed amendment is warranted. The President of the Agency, on behalf of the federal Minister of the Environment, and the Executive Director of EAO, on behalf of the provincial Minister of Environment, are authorized to jointly consider and, if appropriate, amend the Terms of Reference. Should an amendment be requested, the President and the Executive Director will use best efforts to ensure a joint response is provided to the Joint Review Panel's letter within 14 calendar days. The Joint Review Panel will continue with the joint review to the extent possible while waiting for the response in order to adhere to the time lines of the original Terms of Reference. The Joint Review Panel will notify the public of any amendments to the Terms of Reference.

Conduct of the Environmental Assessment by the Joint Review Panel

4.20 The Joint Review Panel will make a determination on the sufficiency of the EIS in accordance with the Terms of Reference, in order to provide public notice of, and hold, public hearings. In making the sufficiency determination, the Joint Review Panel will consider the EIS and information received during the Pre-Panel Stage.

4.21 The Joint Review Panel will undertake a public hearing. The review will provide opportunities for timely and meaningful participation by Aboriginal Groups, the public, governments, the Proponent and other interested groups.

4.22 The Joint Review Panel will have all the powers and duties of a panel described in section 45 of the CEAA 2012 and those set out in the Terms of Reference, as well as powers described in subsection 14(4) of the BCEAA.

4.23 The Joint Review Panel will produce a Joint Review Panel Report which will be submitted to the federal Minister of the Environment and the Executive Director of EAO within 90 days from the date that the chairperson of the Joint Review Panel formally closes the hearing process. The Report will contain an executive summary in both official languages. The Agency and EAO, on behalf of the Parties, will publish and make available this report to the public in a manner consistent with section 8.5 of this Agreement. The Agency and

EAO will also provide a hard copy of the Joint Review Panel Report to each Aboriginal Group that has participated in the environmental assessment.

5. Record of Joint Review

5.1 A public registry will be maintained by the Agency during the course of the joint review in a manner that provides for convenient public access, and that complies with sections 78 to 81 of the CEAA 2012.

5.2 A public registry will be maintained by EAO on the electronic Project Information Centre for purposes of compliance with section 25 of the *BCEAA*.

5.3 Subject to sections 45(4) 45(5), and 81 of the CEAA 2012, the public registry will include all records produced, collected or submitted relating to the environmental assessment of the Project.

6. Participant Funding

6.1 Participant funding for the joint review will be provided by the Agency pursuant to the federal Participant Funding Program, and will be administered by the Agency.

7. Cost Sharing and Invoicing

7.1 Costs associated with this cooperative environmental assessment will be apportioned between the Parties in accordance with a cost-sharing agreement. EAO in consultation with the Agency will develop a budget estimate for the anticipated expenses of the Pre-Panel Stage of the cooperative environmental assessment. Prior to the initiation of the Joint Review Panel Stage, the Agency, in consultation with EAO, will develop a budget estimate for the anticipated expenses of the Joint Review Panel.

Post-Panel Stage

8. Draft Referral Package

8.1 Once the Joint Review Panel submits its Report to the federal Minister of the Environment and the Executive Director of EAO, the Executive Director will prepare a Referral Package for the provincial Minister of Environment and other responsible provincial Minister's consideration, which may include the following documents:

- Draft report summarizing the activities that took place during the Pre-Panel Stage as stated in section 3.16
- Draft provincial report regarding consultation and accommodation
- The Joint Review Panel Report
- Draft response of the Executive Director to the Joint Panel Review Report
- Draft Environmental Assessment Certificate.

Preparation of the draft Referral Package is not expected to exceed 45 days from the time that the Joint Review Panel Report is submitted to the Executive Director of EAO.

8.2 If the Joint Review Panel recommends that the executive summary be translated into Aboriginal languages, the Agency will use this estimated 45 day period to identify and obtain translators or interpreters who would be available to provide this service with the goal to release the oral or written translation of the executive summary in these Aboriginal

languages as soon as possible after the Joint Review Panel Report is made public. Taking into consideration the availability of translators, the Agency will use all reasonable efforts to expedite and make available translated information.

8.3 The Agency and EAO agree to coordinate the timing of the release of the Joint Review Panel Report.

8.4 During this 45 day period, the Agency will initiate translation of the entire Joint Review Panel Report into both official languages. The Agency will also prepare a federal report regarding consultation and accommodation.

8.5 Following the 45 day period during which the draft Referral Package is prepared, the Agency and EAO will make public the Joint Review Panel Report by posting it on the Agency's public registry and EAO's electronic Project Information Centre. The Agency and EAO will provide copies of the Joint Review Panel Report to Aboriginal Groups who have participated in the environmental assessment process in order to initiate consultation on the Joint Review Panel Report.

9. Referral Package

9.1 Once the Joint Review Panel Report has been made public, a Steering Committee will be established consisting of senior representatives of EAO and the Agency in its role as Responsible Authority and federal Crown consultation coordinator.

9.2 The Steering Committee will discuss elements of the proposed provincial response to and the federal Minister's potential decision on the Joint Review Panel Report, the recommendations and conclusions contained in the Joint Review Panel Report, and key issues and responsibilities respecting these recommendations and conclusions in order for EAO and federal government to prepare and finalize their respective key documents.

9.3 Finalization of key documents is not expected to exceed 84 days from the day the Joint Review Panel Report is made public. During this approximately 84 day period, Aboriginal Groups will be consulted on the Joint Review Panel Report and the draft provincial and federal consultation and accommodation reports. Comments will be considered by the federal government and EAO and revisions will be made to the draft reports on consultation and accommodation where appropriate.

9.4 If Aboriginal Groups do not agree with the conclusions of the Joint Review Panel Report or the sections of the provincial report on consultation and accommodation that relate to their interests, they may provide a separate submission to be included in the Referral Package for the provincial Minister of Environment and the other responsible provincial Minister.

9.5 The Executive Director of EAO will finalize the Referral Package.

10. Provincial and Federal Decision Making Authorities

10.1 The Parties agree to make best efforts to coordinate the timing of the issuance of the federal Minister of the Environment's environmental assessment decision statement under section 54 of the *CEAA 2012* and the announcement of the decision of the provincial Minister of the Environment and other responsible provincial Minister under

section 17 of the *BCEAA*. If timing of the release cannot be coordinated, each Party will give advance notice to the other Party regarding timing of decisions.

10.2 The federal and/or the provincial Minister of Environment may require the Joint Review Panel to clarify any of the conclusions or recommendations set out in the Joint Review Panel Report.

10.3 The provincial Minister of Environment and other responsible provincial Minister will make a decision within 45 days of receipt of the Referral Package from EAO, unless the provincial Minister of Environment determines that a timeline extension is required for his or her decision.

10.4 The federal Minister of the Environment will issue an environmental assessment decision statement for the Project within 174 calendar days of the receipt of the Joint Review Panel report. If the federal Minister of the Environment requires the proponent to undertake additional studies or collect additional information in accordance with section 47(2) of the CEAA 2012, the time required by the proponent to prepare and submit this information is not included in the 174 calendar day period.

11. Administration of this Agreement

Amending this Agreement

11.1 This Agreement, and any amendment to it, comes into force upon its execution by both Parties. Subject to section 4.19, this Agreement can be amended at any time with mutual consent of both Parties.

Appendix 1. Joint Review Panel Terms of Reference

PART I: Description of the Project

British Columbia Hydro and Power Authority (the Proponent) proposes to develop and operate a dam and hydroelectric generating station on the Peace River (the Project) approximately 7 kilometres (km) southwest of the city of Fort St. John. The scope of the Project will include all components of the Project as proposed by the Proponent. The specific dimensions and/or characteristics of the proposal are subject to change as project design evolves. The Project would include the following major components:

- **Dam, Generating Station and Associated Structures**
  - Earthfill dam
  - Up to 1,100 megawatt (MW) six-unit generating station with vertical axis turbines
  - Approach channel with concrete training walls to convey water from reservoir to power intakes and spillway
  - Penstocks, power intakes and spillways
- **Reservoir**
  - Access roads, clearing, filling and shoreline protection at Hudson's Hope
- **Transmission Line Connecting Site C to Peace Canyon**
  - Three 500-kilovolt (kV) circuits connecting the generating station to the switchyard
  - A 500 kV switchyard
  - Two 500 kV Alternating Current lines, approximately 77 km in length connecting the switchyard to Peace Canyon Substation. Lines would be located along an existing right-of-way currently occupied by two 138 kV transmission lines and would require a widening of the right-of-way by approximately 35 metres
  - Access roads
- **Highway 29 Realignment**
  - Realignment of segments of the existing highway, including new bridges
  - Erosion protection of highway sections along the shore of the reservoir
- **Temporary Project Components and Activities**
  - Access roads from the north and south sides of the Peace River, temporary construction access bridge across the Peace River, and access roads at site between the various construction facilities and areas
  - Worker housing and offices at site
  - Staging areas, storage facilities, workshops, aggregate processing, concrete batch plants, maintenance shops and other facilities required by contractors to support construction activities and assemble parts
  - Construction of temporary cofferdams and concrete-lined diversion tunnels
  - Excavations and relocation of excess soil and rock near dam site, and excavations for construction materials from quarries and borrow areas north of the dam site and in the Pine Pass vicinity
  - Temporary access and transportation of construction materials from on-site areas and off-site areas by road and/or rail
  - Access roads and laydown areas along the transmission line route as required for right-of-way clearing, construction of the towers, and stringing the lines

PART II: Factors to be considered in the Cooperative Environmental Assessment

2.1 The Joint Review Panel must conduct an assessment of the environmental, economic, social, health and heritage effects of the Project referred to in the Description of the Project (Part I) in a manner consistent with the requirements of the CEAA 2012 and the BCEAA.

2.2 The Joint Review Panel must include in its assessment of the Project, consideration of the following factors:

- the purpose of the Project;
- the need for the Project;
- alternatives to the Project;
- alternative means of carrying out the Project that are technically and economically feasible and the environmental effects of any such alternative means;
- the environmental, economic, social, health and heritage effects of the Project, including 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;
- the environmental effects of malfunctions and accidents that may occur in connection with the Project;
- any change that the Project may cause in the environment on the current use of lands and resources for traditional purposes by aboriginal persons;
- the significance of the environmental, economic, social, health and heritage effects;
- measures that are technically and economically feasible and that would mitigate any significant adverse environmental, economic, social, health or heritage effects of the Project;
- the capacity of renewable resources that are likely to be significantly affected by the Project to meet the needs of the present and those of the future;
- the need for, and the requirements of, any follow-up program in respect of the Project;
- comments from the public and Aboriginal persons and groups that are received during the assessment; and
- community knowledge and Aboriginal traditional knowledge.

2.3 The Joint Review Panel will receive:

- information regarding the manner in which the Project may adversely affect asserted or established Aboriginal rights and treaty rights;
- information provided by Aboriginal persons or groups regarding the location, extent and exercise of asserted or established Aboriginal rights and treaty rights that may be affected by the Project; and
- Information regarding any measures to avoid or mitigate potential adverse effects of the Project on asserted or established Aboriginal rights and treaty rights.

2.4 The Joint Review Panel will use the information collected pursuant to section 2.3 of this Terms of Reference and its assessment made in accordance with 2.2 to:

(a) make recommendations which, if implemented, would avoid or minimize potential adverse effects of the Project on asserted or established Aboriginal rights and treaty rights; and

(b) inform its assessment of the potential environmental, economic, social, health or heritage effects of the Project.

2.5 The Joint Review Panel will not make any conclusions or recommendations as to:
   a) the nature and scope of asserted Aboriginal rights or the strength of those asserted rights;
   b) the scope of the Crown's duty to consult Aboriginal Groups;
   c) whether the Crown has met its duty to consult Aboriginal Groups and, where appropriate, accommodate their interests in respect of the potential adverse effects of the Project on asserted or established Aboriginal rights or treaty rights;
   d) whether the Project is an infringement of Treaty No. 8; and
   e) any matter of treaty interpretation.

2.6 The Joint Review Panel will describe any asserted or established Aboriginal rights and Treaty rights that are raised during the Joint Review Panel Stage and any impacts on those rights as articulated by those Aboriginal Groups in the Joint Review Panel Report.

2.7 All information obtained by the Joint Review Panel for the environmental assessment of the Project shall be made publicly available, unless the Joint Review Panel determines that subsections 45(4) or 45(5) of the *CEAA 2012* applies to the information provided by a participant.

2.8 The scope of factors to be considered in the environmental assessment are those outlined in the EIS Guidelines as finalized by the federal Minister of the Environment and the Executive Director of EAO. The scope of the factors, once finalized as part of the EIS Guidelines, will be appended to this Terms of Reference.

PART III: Environmental Assessment Process

The Joint Review Panel roles and responsibilities are set out in the Agreement. Further directions on the process to be followed by the Joint Review Panel are as follows:

EIS Sufficiency

3.1 The Joint Review Panel must make a determination on the sufficiency of the EIS in accordance with the Terms of Reference, in order to provide public notice of, and hold, public hearings. In making the sufficiency determination, the Joint Review Panel must consider the EIS and information received during the Pre-Panel Stage.

3.2 If the Joint Review Panel determines that the EIS is not sufficient to proceed to public hearings, it must issue a statement requesting additional information from the Proponent. At the same time, the Joint Review Panel must place the statement on the public registry and make it available to the public.

3.3 The Joint Review Panel must place the additional information provided by the Proponent, if any, on the public registry and make it available to the public. The Joint Review Panel must determine whether there is a need for a public comment period on any supplemental information provided by the Proponent in response to deficiencies identified by the Joint Review Panel, and if it so determines, it must allow for a public comment period.

3.4 Upon completion of the public comment period in article 3.3 of these Terms of Reference, if required, the Joint Review Panel, taking into consideration any comments received, must determine within 10 days if the EIS, supplemented by the additional information, is sufficient to proceed to public hearing. The procedures described above in articles 3.1 to 3.3 of the Terms of Reference will apply until such time as the Joint Review Panel determines it has sufficient information to proceed to public hearings.

Announcement of Public Hearing

3.5 Once the Joint Review Panel determines that the EIS contains sufficient information to proceed to public hearings, it must announce the public hearings. The public hearings must not begin earlier than 30 days after the Joint Review Panel has announced that public hearings will take place. In scheduling the public hearings, the Joint Review Panel must take into consideration the timing of traditional activities in Aboriginal communities.

3.6 The Joint Review Panel must issue procedures for the conduct of the public hearings (the "hearing procedures"). The Joint Review Panel may issue the hearing procedures along with or following the notice of the public hearings. The hearing procedures must:

- allow for the public hearings to be conducted in a manner that provides for a full examination of the matters determined by the Joint Review Panel to be relevant; and
- provide the Proponent, federal, provincial, territorial and local governments, Aboriginal Groups and members of the public with an opportunity to present their views on the Project and to question information that has been provided by other participants.

3.7 Before finalizing the hearing procedures, the Joint Review Panel must receive comments from the public about them.

3.8 The Joint Review Panel, where practicable, must hold public hearings in the communities in closest proximity to the proposed Project in order to provide convenient public access for potentially affected Aboriginal persons and groups and the public. The Joint Review Panel must endeavour to complete the public hearing within 30 days.

3.9 The public hearing shall be open to the public, unless the Joint Review Panel determines that subsection 45(3) of the CEAA 2012 applies to the information provided by a participant.

Specialist Advisors to the Joint Review Panel

3.10 The Joint Review Panel may retain experts, or otherwise obtain specialist information with respect to the Project, in order to satisfy these Terms of Reference.

3.11 Should the Joint Review Panel retain the services of non-governmental experts, the names of the experts retained and any documents obtained or created by the experts and that are submitted to the Joint Review Panel must be placed on the public registry, subject to the provisions in section 45 of the CEAA 2012. For greater certainty, this shall exclude any information subject to solicitor-client privilege.

3.12 The Joint Review Panel may require an expert to appear before the Joint Review Panel at the public hearing sessions and present information with regard to the documents they have created or obtained and that were submitted to the Joint Review Panel. The Joint Review Panel has the same power to enforce the attendance of witnesses and to compel them to give evidence and produce documents and other things as is vested in a court of record.

Joint Review Panel Report

3.13 Following the completion of the public hearing, the Joint Review Panel must prepare and submit to the federal Minister of the Environment and the Executive Director of EAO, a report in accordance with the Terms of Reference, which must include:

- a description of the Joint Review Panel process;
- the rationale, conclusions and recommendations of the Joint Review Panel relating to the environmental assessment of the Project, including any recommended mitigation measures and follow-up programs;
- an identification of those conclusions that relate to the environmental effects to be taken into account under Section 5 of the CEAA 2012*;*
- an identification of recommended mitigation measures that relate to the environmental effects to be taken into account under Section 5 of the CEAA 2012;
- a summary of any comments received, including those from the public and Aboriginal Groups;
- recommendations with respect to conditions to be attached to the Environmental Assessment Certificate; and
- an executive summary in both official languages.

3.14 The Joint Review Panel must ensure that where it has concluded that the Project is likely to cause significant adverse environmental, economic, health, heritage or social effects, taking into account the implementation of any mitigation measures, information with respect to the justifiability of any significant adverse effects is included in its Joint Review Panel Report, where the information has been received by the Panel.

3.15 The Joint Review Panel Report must include the views of each member of the Joint Review Panel.

3.16 The Joint Review Panel must consider any requests made by Aboriginal Groups to have the executive summary of the report translated into their Aboriginal languages. If the Joint Review Panel agrees with such a request, it must recommend to the Agency that such translations be provided by the Agency in a timely manner.

3.17 The Joint Review Panel must submit the Joint Review Panel Report to the federal Minister of the Environment and the Executive Director of EAO at the earliest possible date, and no later than 90 calendar days from the date that the chairperson of the Joint Review Panel closes the hearing to the receipt of further information. The Panel must not release the Report publicly. The federal and provincial governments will publish and make available the Joint Review Panel Report as submitted. Further to section 4.6 of this Agreement and section 4.1 of these Terms of Reference, the Joint Review Panel Stage of the assessment is not expected to exceed eight calendar months from the submission of the EIS by the Proponent to the Joint Review Panel.

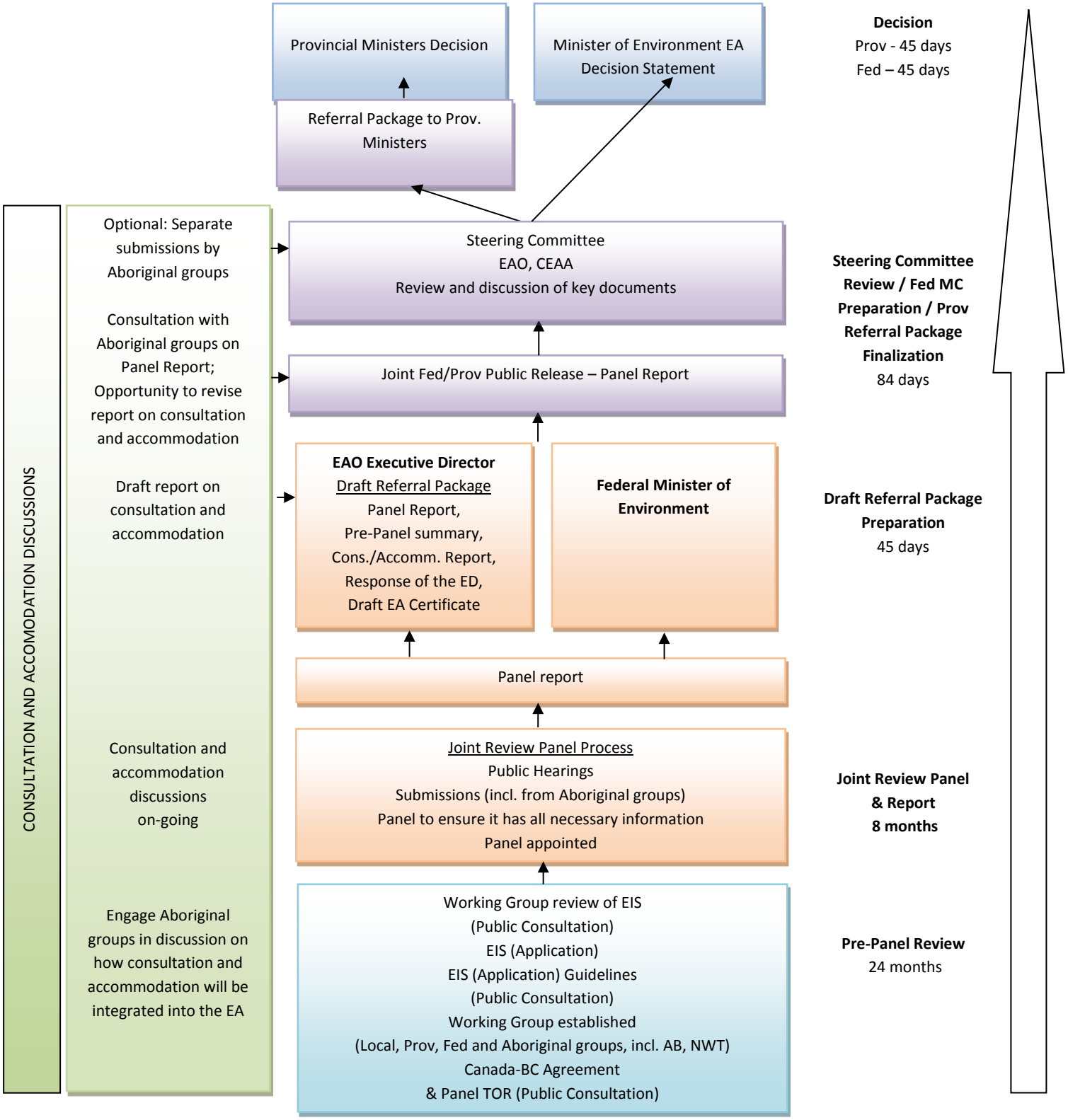
PART IV: TIMELINES

4.1 Subject to section 4.2 of these Terms of Reference, the Panel shall satisfy its Terms of Reference and submit its final report to the federal Minster of the Environment and the Executive Director of EAO within 225 days from the submission of the EIS by the proponent to the Joint Review Panel.

4.2 The time period between the issuance by the Joint Review Panel of any request for information as per section 3.2 of these Terms of Reference and the submission of the requested information by the proponent is not included in the timeline referred to in section 4.1 of these Terms of Reference.

Appendix 2
SITE C ENVIRONMENTAL ASSESSMENT

If inconsistencies are identified between this schematic and the text of the agreement, the text supersedes this schematic



APPENDIX 3 STAGES IN THE ASSESSMENT PROCESS

Completion Dates	Description of Milestones
April 19, 2010	B.C. Government announced Environmental and Regulatory Review of the Site C project
May 18, 2011	BC Hydro submitted project description to both governments
August 2, 2011	Project description accepted; EAO referred the proposed Project to the BC Minister of Environment under Section 10(1)(a) of the *Environmental Assessment Act* for Ministerial determination of the scope, procedures and methods for conducting the EA.
September 30, 2011	British Columbia and Canada announced that the proposed Project would undergo a cooperative EA, including a review by a joint panel. A draft Joint Review Panel Agreement and Terms of Reference (Agreement) was made available to First Nations and the public for comment. Revisions were made as a result of comments received.
October 5, 2011	Introductory meeting of representatives of the federal, provincial territorial and local governments and Aboriginal groups to discuss the process for the EA and the Project
February 13, 2012	The provincial and federal Ministers of the Environment announced the signing of an Agreement establishing the scope, procedures and methods for conducting the EA process including the Pre-Panel Stage, Joint Review Panel Stage and Post Panel Stage, the establishment of a Working Group consisting of federal, provincial, local government and Aboriginal groups, and the Terms of Reference for the Joint Review Panel.
March 1, 2012	Working Group meeting on the draft EIS Guidelines prepared by the Proponent. The draft Guidelines were reviewed and amended by BCEAO and CEAA, reviewed by the Working Group, the public (through six open houses in central and northern British Columbia and Alberta in early May 2012), and again by some members of the Working Group. The Guidelines were reviewed and amended by the Agency and BCEAO following advice from the Working Group on the Proponent's responses to the comments. Amendments were made to the draft EIS to reflect *CEAA 2012* EIS Guidelines guidance document.
August 2, 2012	Following changes made to the *Canadian Environmental Assessment Act* in July 2012, amendments were made to the Agreement to reflect federal timelines and requirements for the federal Minister's decision statement.
September 5, 2012	EAO Executive Director and the federal Minister of Environment approve the EIS Guidelines including determining the scope of the factors that must be in the EA and the information requirements that must be contained in the Proponent's EIS (Application) for an EA certificate. The document was issued to the Proponent on September 7, 2012

January 25, 2013	Proponent submitted its EIS to EAO and CEAA. The EIS was reviewed by Aboriginal groups, government agencies, First Nations, and the public in February, March and April 2013. Six public open houses were held in the last two weeks of February in central and northern British Columbia and Alberta. Proponent responses to public and government agency comments were received on April 29, 2013 and the Working Group had until May 21, 2013 to provide advice to EAO and CEAA. Proponent responded to Aboriginal comments on May 8, 2013, and the Working Group provided advice by May 29, 2013. Three technical sub-working group meetings on the EIS took place on June 4, 5, and 6, 2013 in Dawson Creek, Fort St. John and Peace River Alberta.
July 2013	EAO/CEAA directed the Proponent to make amendments to the EIS and Canada and BC appointed the Panel.
August 1-2, 2013	CEAA and EAO determined that the Proponent's amended EIS was satisfactory and directed the Proponent to submit the amended EIS to the Joint Review Panel. The Proponent submitted the amended EIS to the newly-appointed Panel on August 2, 2013, ending the Pre-Panel Stage of the environmental assessment.
August 6-7, 2013	Panel toured the Project area by car, boat and helicopter.
August 26, 2013	Draft Hearing Procedures published on websites for comment
September 13, 2013	BC Hydro Evidentiary Update sent to Panel
November 6, 2013	Final Hearing Procedures and draft Schedule of Hearings published on websites
November 13, 2013	BC Hydro publishes its Integrated Resource Plan, modifying certain parameters applicable to Site C
November 26, 2014	BC Minister of Energy makes announcements about rates and about financial relation between BC and BC Hydro
December 9-19, 2013	Public hearings
January 6-23, 2014	Public hearings
February 3, 2014	Close of public record
May 1, 2014	Final report delivered to Executive Director of BCEAO and federal Minister of Environment

APPENDIX 4 PANEL MEMBER BIOGRAPHIES

Harry Swain (Panel Chair)

Harry Swain is an acknowledged expert in public policy with extensive experience in both the public and private sectors. He is currently a member of the Indian Affairs and Northern Development audit committee, president of the Victoria Symphony board, and a research associate of the Centre for Global Studies at the University of Victoria. Harry Swain holds a PhD in economic geography from Minnesota and an honorary doctorate from Victoria, where he currently lives. His book *Oka* was a runner-up for the Donner Prize in 2011.

Harry Swain served for 22 years in the federal government, working in nine federal departments between 1971 and 1995. He was the federal government's first senior advisor on renewable energy and subsequently Director General for Electricity, Coal, Uranium and Nuclear Energy with the Department of Energy, Mines and Resources. Later, he was Deputy Minister of Indian Affairs and Northern Development and then Deputy Minister of Industry Canada. On leaving government he became a director of Hambros Bank (London) and CEO of its Canadian subsidiary, as well as a director of a number of related companies. When Hambros was sold he became a partner in Sussex Circle, a policy consulting firm. He chaired the research advisory panel and related public meetings for the Walkerton Inquiry and chaired the subsequent Ontario Expert Panel on Water and Wastewater. He also chaired the federal Expert Panel on Safe Drinking Water for First Nations that conducted hearings across Canada in 2006. Its report resulted in an Act of Parliament given Royal Assent in June 2013.

James S. Mattison (Panel Member)

James Mattison is a professional engineer and senior natural resources expert with thirty years of experience, including twenty-five years with British Columbia's water program within the Ministry of Environment. He holds a Bachelor's degree in Applied Science from the University of British Columbia and a Masters of Natural Resources Management from Simon Fraser University. He currently resides in Victoria, British Columbia.

James Mattison has extensive experience and knowledge of hydroelectric projects in British Columbia and public review processes. During his tenure with the Government of British Columbia he served as Assistant Deputy Minister and Comptroller of Water Rights with the Ministry of the Environment. In this latter position he was responsible for reviewing licensed rights and managing a $50 million per year compensation fund. He has also chaired a panel to conduct public consultation and recommend options for a $100 million trust fund to enhance the environment of the Nechako River.

He has served on the Boards of Control for the International Joint Commission and has made significant contributions to both policy and legislative initiatives in B.C. He was a finalist for the Premier's Award for contribution to the public service in 2010.

Jocelyne Beaudet (Panel Member)

Jocelyne Beaudet is a communications consultant with thirty-two years of experience in various fields related to the environment and public participation. She holds a Bachelor's degree in physical anthropology from the University of Montréal and a Master's degree in cultural anthropology from McGill University. She resides in Lunenburg, Nova Scotia.

Jocelyne Beaudet has developed communications plans and public consultation strategies for numerous environmental initiatives. As a consultant, she has advised the Office of the Auditor General of Canada on issues related to the Canadian North, organized strategies on climate change and air pollution, and advised the Task Force on Sustainable Transportation for the National Round Table on the Environment and the Economy. While working for Tecsult Inc., she developed communications and public consultation plans for transportation and mining projects in Quebec and Africa.

Jocelyne Beaudet has extensive experience undertaking public consultation as a panel member for federal, provincial and municipal environmental agencies. She served as a member of the Joint Review Panel for the Darlington New Nuclear Power Plant Project (2009 – 2012), the Joint Federal-Provincial Review Panel for the Eastmain 1-A/Rupert Hydroelectric Project (2004 – 2006) in Quebec, and as the Provincial Executive Co-Secretary of the Joint Review Panel for the Lachine Canal Decontamination Project (1995). She has served both as a member and as a chair for panels for the Bureau d'audiences publiques sur l'environnement du Québec and for the Office de consultation publique de Montréal. Several of her mandates addressed Aboriginal issues.

APPENDIX 5 NOTICE OF PUBLIC HEARING; HEARING AND CONFIDENTIALITY PROCEDURES

Joint Review Panel for Proposed Site C Project -

Notice of Hearing

November 7, 2013 – The Joint Review Panel reviewing the proposed Site C Clean Energy Project in British Columbia announced today that the Environmental Impact Statement (EIS) along with the additional information submitted by the proponent BC Hydro contain sufficient information to proceed to the public hearing. The public hearing will begin with an opening session in Fort St. John, B.C. on **December 9, 2013** and will be completed in January 2014.

The Public Hearing

All hearing sessions are open to members of the public wishing to observe the proceedings. The primary purpose of the hearing is for the Panel to receive the information it requires to complete its environmental assessment of the project. The hearing will also give the proponent, the public, Aboriginal groups, and governments, an opportunity to present their views in person to the Panel on the project and its potential environmental, economic, social, heritage and health effects.

The Panel will hold public hearing sessions in Fort St. John, Hudson's Hope, Prince George, Chetwynd, Dawson Creek and Peace River as indicated in the **preliminary schedule** and as follows:

General hearing sessions will provide an opportunity for registered participants to present their overall views on the project and its potential effects. The first general session will be held in December 2013.

Topic-Specific hearing sessions will allow interested parties and experts who possess specialized knowledge to present technical information relevant to the environmental assessment of the project. The first topic-specific session will be held in December 2013 and subsequent sessions in January 2014.

Community hearing sessions will be held in selected Aboriginal communities to allow community members to express their views and present their information and issues to the Panel in an informal setting. The first community session will be held in December 2013.

How to Participate

The Panel will conduct the hearing in accordance with its Public Hearing Procedures. For all hearing sessions, the Panel invites persons who wish to participate in the hearing, to **register as soon as possible** using the registration form.

For the General and Community sessions, participants may make an oral presentation or file a written submission or both. At the Topic-Specific sessions, oral presentations by Interested Parties must be accompanied by a written submission.

For all hearing sessions, any written submissions must be submitted to the Panel **by November 25, 2013.** The Panel will soon provide a more detailed hearing schedule, including specific locations for the hearing sessions.

To register, file a submission for the hearing sessions and schedule a presentation, contact either Panel Co-Manager:

Courtney Trevis, Panel Co-Manager Site C Review Panel Secretariat 160 Elgin Street, 22nd Floor Ottawa ON K1A 0H3 Tel.: 613-960-0286 Toll free: 1-866-582-1884 Fax: 613-957-0935 Email: SiteCReview@ceaa-acee.gc.ca	Brian Murphy, Panel Co-Manager Site C Review Panel Secretariat 2nd Floor, 836 Yates St. PO Box 9426 Stn Prov Govt Victoria BC V8W 9V1 Tel.: 250- 387-2402 Email: brian.murphy@gov.bc.ca

Following the close of the public hearing, the Panel will submit its report to the federal Minister of the Environment and the Executive Director of the British Columbia Environmental Assessment Office.

To view the preliminary Public Hearing Schedule, the registration form, the Hearing Procedures or the sufficiency determination letter, consult the Canadian Environmental Assessment Registry at www.ceaa-acee.gc.ca , reference number 63919, or the Electronic Project Information Centre at www.eao.gov.bc.ca . All submissions received will be considered public and posted on the online public registries.

To be added to the distribution list and be kept informed of activities relating to the panel review process, provide contact information to: SiteCReview@ceaa-acee.gc.ca .

PUBLIC HEARING PROCEDURES

1.0 Introduction

1.1. This document outlines the procedures for the public hearing to be conducted by the Joint Review Panel (the Panel) established to review the proposed Site C Clean Energy project proposed by the Proponent, BC Hydro and Power Authority. The Panel has been mandated by its Terms of Reference, appended to the *Agreement To Conduct a Cooperative Environmental Assessment, Including the Establishment of a Joint Review Panel, of the Site C Clean Energy Project* issued on February 13, 2012 by the federal Minister of the Environment and the provincial Minister of Environment and amended on August 3, 2012 (the Agreement), to conduct an assessment of the environmental, economic, social, health and heritage effects of the Project in a manner consistent with the *Canadian Environmental Assessment Act, 2012* (*CEAA, 2012*) and the British Columbia *Environmental Assessment Act* (*BCEAA*).

1.2. The purpose of these procedures is to ensure that the Panel may conduct the public hearing so that it is thorough, timely and fair. The Panel may vary these procedures or dispense with their compliance to achieve that end.

1.3. In these procedures, “person” includes any individual, Aboriginal group, government, agency, institution or other entity. “Participant” means any person, including the Proponent and an Interested Party who participates in this public hearing process. “Interested Party” means a person who participated in the Pre-Panel Stage of the review. Other persons who wish to be considered for Interested Party Status are required to provide the information requested in Attachment A to the Panel Secretariat.

1.4. The Panel may deal with any non-compliance with these procedures as it deems appropriate, including imposing restrictions on a participant, or excluding any person from participating in or attending the public hearing.

2.0 Background Information

2.1 The Project is a proposal by the Proponent to develop and operate a dam and hydroelectric generating station on the Peace River approximately 7 kilometres southwest of the city of Fort St. John. The scope of the Project would include the following major components: a dam, a generating station and associated structures, a reservoir, transmission lines connecting the Project to the Peace Canyon Dam, highway realignments, access roads and other project components and activities.

2.2 Information provided by the Proponent in the form of its Environmental Impact Statement and supplementary material, and information provided by persons during the review, can be found on the Canadian Environmental Assessment Registry (http://www.ceaa.gc.ca/050/details-eng.cfm?evaluation=63919) and at the Electronic Project Information Centre (http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_project_home_371.html).

3.0 Role of the Panel

3.1 The Panel was appointed by the federal Minister of the Environment and the provincial Minister of Environment to conduct an environmental assessment of the Project in accordance with *CEAA, 2012* and the Agreement.

3.2 The Panel will conduct the public hearing portion of the environmental assessment in a manner that ensures a thorough, timely and fair examination of matters within its mandate and that provides for meaningful public participation. The Panel considers the public hearing to be an essential part of the review process, and will give careful consideration to all submissions and presentations.

3.3 Within 90 days of the close of the public hearing record, the Panel will submit an environmental assessment report to the federal Minister of the Environment and the EAO Executive Director outlining the information that the Panel received through the process, its conclusions, and its recommendations as they relate to the Project and supporting rationale.

4.0 Objective of the Public Hearing

4.1 The objective of the public hearing is to provide the Panel with relevant information from participants in a fair manner, to enable it to conduct a thorough and timely review of the Project.

4.2 The public hearing will provide opportunities for timely and meaningful participation by Aboriginal Groups, the public, governments, the Proponent and other interested groups, and in particular for

- the Proponent to explain the Project and respond to concerns and questions raised by other participants during the hearing;
- the Proponent and other participants to share with the Panel information and perspectives on the Project as outlined in Section 4.3; and
- the Panel to receive information consistent with the Agreement and its Terms of Reference that will help it complete its assessment of the Project.

4.3 Factors to be considered in the environmental assessment include:

- the purpose of the Project;
- the need for the Project;
- alternatives to the Project;
- alternative means of carrying out the Project that are technically and economically feasible and the environmental effects of any such alternative means;
- the environmental, economic, social, health and heritage effects of the Project, including 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;
- the environmental effects of malfunctions and accidents that may occur in connection with the Project;
- any change that the Project may cause in the environment on the current use of lands and resources for traditional purposes by Aboriginal persons;
- the significance of the environmental, economic, social, health and heritage effects;
- measures that are technically and economically feasible that would mitigate any significant adverse environmental, economic, social, health or heritage effects of the Project;
- the capacity of renewable resources that are likely to be significantly affected by the Project to meet the needs of the present and those of the future;

- the need for, and the requirements of, any follow-up program in respect of the Project;
- comments from the public and Aboriginal persons and groups that are received during the assessment;
- community knowledge and Aboriginal traditional knowledge.

5.0 Participation in the Public Hearing

5.1 The Panel will announce the start of the public hearing once it is satisfied that it has received sufficient information to hold the hearing, from the Proponent in its EIS as supplemented by any additional information it has provided as a result of the review by the Canadian Environmental Assessment Agency, British Columbia Environmental Assessment Office and the Panel.

5.2 The Panel will provide at least 30 days of notice before the start of the public hearing. The notice will include a preliminary schedule of the dates, locations and topics.

5.3 The public hearing will provide for three types of sessions: General, Community and Topic-Specific. A description of each type of hearing session is provided in Attachment B:

- General sessions will provide the Proponent, Interested Parties and, time permitting, other persons with the opportunity to present information to the Panel on the potential effects of the Project;
- Community sessions are designed to provide the Proponent, Interested Parties and other persons living in potentially-affected communities with the opportunity to present information to the Panel on the potential effects of the Project to their community; and
- Topic-Specific sessions will provide the Proponent and Interested Parties with the opportunity to present information to the Panel including information from experts on the topics of the session.

5.4 Hearing sessions are open to all members of the public wishing to observe the proceedings, except in cases where a confidential session has been requested and agreed by the Panel.

5.5 To ensure the Panel can complete the public hearing in accordance with the time limits in the Agreement, persons who wish to participate in writing, orally, or both are requested to register as soon as possible, and to provide a synopsis of the information they intend to present. Instructions to register can be found in Attachment C.

5.6 The public hearing will conform to the principles of procedural fairness, but the Panel is not required to follow the rules of procedure and evidence of a Court. Participants may appear without counsel.

5.7 If a Participant relies on an expert report, the report must include the expert's relevant qualifications and experience, and the expert must be available to answer questions at the appropriate hearing session, unless excused from appearing by the Panel.

5.8 As part of the review, the Panel invites Aboriginal groups to describe their asserted or established Aboriginal rights and treaty rights. The Panel will receive information on the location, extent and exercise of asserted or established Aboriginal rights and treaty rights that may be affected by the Project, and on measures to avoid or mitigate potential

adverse effects of the Project. The Panel will have due regard to community and Aboriginal traditional knowledge in all of its proceedings.

5.9 Where the Panel considers it necessary, it may require persons to provide information orally or in writing, and may require the production of documents.

5.10 The Panel may allow a Participant to provide information in rebuttal to information provided by others, in writing to the Panel. Prior to the conclusion of the public hearing, the Panel will advise Participants whether and by what date they must provide written rebuttal information.

5.11 Interested Parties and the Proponent will have the opportunity to provide written closing comments based on the information the Panel has received, but not to include any new information. Prior to the conclusion of the public hearing, the Panel will advise the Proponent and Interested Parties by what date they must provide written closing comments.

Written submissions

5.12 Appearance before the Panel during the public hearing is not required for participation in the process. Any person may participate in the review by providing information in writing to the Panel.

5.13 Participants must provide any written submission to the Panel, including all relevant references and data, no later than 2 weeks before the start of the first session of the public hearing. Participants are requested to limit all written submissions to a reasonable number of pages, including appendices.

5.14 The Panel will give careful consideration to all submissions, whether written or oral.

Oral presentations at the public hearing

5.15 Interested Parties may present information orally to the Panel in the public hearing and may ask questions of the Proponent and others presenting information orally. Any other Person may present information orally to the Panel in the public hearing if time permits.

5.16 Participants must register in advance to make an oral presentation at the public hearing. The Panel may consider requests on the day-of for Community and General hearing sessions, time permitting.

5.17 Participants may present information to the Panel individually or collectively. Participants with similar views should consider how to make a joint presentation and should identify a spokesperson to receive questions for the group when registering. The Panel may require Participants to do so in the interests of making efficient use of hearing time and resources.

5.18 The Panel will determine the time limits for the oral presentations. Participants should plan to make them as brief as possible and advise the Panel secretariat of their time estimate when they register. For guidance, Participants, including the Proponent, should consider 20 minutes to be the maximum time for an oral presentation. However, time constraints may require shorter allocations. Further, the Panel may limit or extend the time of any oral presentation.

5.19 In exceptional circumstances the Panel may allow participation via teleconference or videoconference. To request participation via teleconference, the participant should contact the Panel Secretariat as early as possible.

Questioning

5.20 The Panel members may ask questions at any time.

5.21 The Panel Chair will require participants at the hearing to direct all questions and responses through him. At his discretion, presenters may be asked questions by the Panel, the Proponent and Interested Parties, either directly or by counsel.

5.22 The Panel Chair will determine the order and may limit the time for questions.

5.23 Participants must be courteous and respectful when asking and answering questions. The Panel Chair may refuse to permit further questioning from an individual who is being discourteous or disrespectful. Clarity and brevity in questions and responses is encouraged.

5.24 No demonstrations of approval or disapproval either of the Project or of the opinions expressed during the public hearing will be permitted inside the public hearing room or hall.

5.25 If a presenter is unable to answer a question, the Panel Chair may ask the presenter to undertake to answer the question later orally or in writing.

5.26 The Panel Chair will limit or exclude questions or comments that fall outside the mandate of the Panel, or are repetitive or irrelevant. The Panel Chair may also limit questions if, in the opinion of the Panel, sufficient information on a specific topic has been received.

5.27 Questions should seek to clarify, expand or inform the discussion and should not be used as an opportunity to state or restate the questioner's position.

Record of the Public Hearing

5.28 All hearing sessions will be transcribed in English, and will be made available as soon as possible following the completion of a daily session at the Canadian Environmental Assessment Registry (http://www.ceaa.gc.ca/050/details-eng.cfm?evaluation=63919) and at the Electronic Project Information Centre (http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_project_home_371.html).

5.29 All documents related to the public hearing, including submissions and other documents to which a presenter refers (transcripts, schedules, exhibits and undertakings), will be placed on the public registry in a timely manner.

Interpretation

5.30 The public hearing will be conducted in English. Participants wishing to speak in a language other than English must advise the Panel Secretariat at the time of registering for a public hearing session. The Panel Secretariat will try to accommodate requests for interpretation or translation.

Audio-Visual Equipment

5.31 A laptop computer and a projector will be available at all hearing sessions. If a participant requires additional audio-visual equipment for a presentation, a request should be made at the time of registering.

5.32 Presenters should bring four hard copies of any additional documentation they refer to in their presentation.

Posted Schedule

5.33 A schedule for the public hearing will be available before the start of the public hearing. It will list the dates, locations and the order of all General, Community, and Topic-Specific hearing sessions. This schedule will be subject to change as required but the Panel will make every effort to adhere to the schedule as originally planned.

5.34 A schedule for each hearing session, listing the order of presenters will be available as early as possible in advance of each hearing session. A copy of the list of presenters will be updated as required and a final list will be available at the start of each day of the hearing session. This schedule will be subject to change as required but the Panel will make every effort to adhere to the original schedule.

6.0 Media

6.1 Media inquiries regarding the Panel’s activities should be directed to the Panel's communications advisor at the contact information provided below. The Panel will not be available for media interviews.

6.2 Members of the media are welcome to attend the public hearing or set up in the designated media area, if available. The conduct of media interviews will not be allowed in the room while the public hearing is underway.

6.3 Filming or photography may be allowed in the room while the public hearing is underway with prior approval of the Panel. Requests should be forwarded to the Panel’s communication advisor in advance of the hearing session.

All questions relating to the conduct of the public hearing may be addressed to the Panel Secretariat at the following coordinates:

Courtney Trevis
Panel co-Manager
Site C Review Panel Secretariat
Canadian Environmental Assessment Agency
160 Elgin Street, 22nd Floor
Ottawa ON K1A 0H3
Telephone: 613-960-0286
Telephone (Toll-free): 1-866-582-1884
Email: SiteCReview@ceaa-acee.gc.ca

Brian Murphy
Panel co-Manager
Site C Review Panel Secretariat
British Columbia Environmental Assessment Office
2nd Floor 836 Yates St.
PO Box 9426 Stn Prov Govt
Victoria BC V8W 9V1
Telephone: 250-387-2402
Email: Brian.Murphy@gov.bc.ca

Media may contact:

Lucille Jamault
Communications Advisor
Site C Review Panel Secretariat
Telephone: 613-957-0434
Email: Lucille.Jamault@ceaa-acee.gc.ca

Attachment A – Application to become an Interested Party

This attachment outlines the application process to become an Interested Party in accordance with subsection 2(2) of *CEAA, 2012*. Interested Parties may present information orally to the Panel in the public hearing, may ask questions of the Proponent and others presenting information orally, and submit closing remarks.

The Panel considers an Interested Party to be any individual, organization or Aboriginal group that participated in the Pre-Panel Stage of the review. Individuals, organizations, or Aboriginal groups that participated in the Pre-Panel Stages of the review do not need to apply. Other persons who wish to be considered for Interested Party Status are required to provide the information below to the Panel Secretariat. The Panel will then determine if you qualify to be an Interested Party.

(a) Your name or organization name, address, phone number, and email address.

(b) If you are applying on behalf of an organization, briefly describe its objectives and membership.

(c) A brief explanation of:

- The relevance of the Project to you;
- Your specific connection with the Project area or activities; and
- How the Project may affect your interests.

(d) A summary of the relevant information or expertise that you or your organization can provide to assist the Panel.

(e) A brief statement describing:

- how you or your group or a representative intend to participate in the environmental assessment process; and
- the issues that you or your group intend to address and why those issues are relevant to your interests.

(f) An explanation of how you or your group may collaborate with other persons or groups whose interests or perspectives may overlap with yours.

Attachment B – General, Community and Topic-Specific Hearing Sessions

This attachment outlines the specific procedures for the different hearing sessions to be conducted by the Panel. All of the procedures outlined in the *Public Hearing Procedures* will apply during the General, Community, and Topic-Specific hearing sessions.

More information on the locations, dates, and schedule for the hearing sessions will be available in advance of the public hearing.

1.0 General and Community Hearing Sessions

1.1 The Proponent, Interested Parties and, time permitting, other persons may make oral presentations at General sessions

1.2 The Panel will open the hearing with a General hearing session in Fort St. John, British Columbia to provide an opportunity in this central location for public input into the review. The first topic will be any preliminary motions, procedural or otherwise, that Interested Parties wish to register. Any such motions must be received by the Panel Secretariat no less than a week before the hearing. The number of days required to complete this hearing session will be confirmed at the time the hearing schedule is released by the Panel.

1.3 The Proponent, Interested Parties and other persons living in potentially-affected communities may make oral presentations at Community sessions.

1.4 The Community hearing sessions are intended to be informal so participants have the opportunity to communicate community views about the Project. Such sessions will be one day or longer as needed. The number of days in each community visited will be confirmed at the time the schedule is released by the Panel. The Panel Chair will apply the Public Hearing Procedures to maintain order and procedural fairness.

1.5 The Panel will respect the customs of individual communities to the extent it can reasonably do so and will accommodate a flexible approach to Community hearing sessions as appropriate for the circumstances of each community.

1.6 Presentations at General and Community hearing sessions may be on any aspect within the scope of the review as established by the Agreement.

1.7 Participants wishing to make an oral presentation at the General or Community hearing sessions are asked to register with the Panel Secretariat as soon as possible. Advance registration will allow the hearing sessions to be planned to accommodate participants wishing to express their views.

1.8 A schedule of presenters will be made available at the start of each hearing session and at the beginning of each day. Within the limits of the time available for each hearing, the Panel will try to accommodate all participants wishing to make an oral presentation. However, priority will be given to Interested Parties who have registered in advance.

General Hearing Sessions Outline

1.9 These sessions will generally progress as follows:

- Call to order by the Panel Chair
- Welcoming statements or cultural ceremony by local or Aboriginal leadership on the opening day and short opening ceremonies, as appropriate, on other days.
- Opening remarks by the Panel Chair.
- Presentation by the Proponent. The presentation by the Proponent should provide a general overview of the Project and main findings of the environmental impact statement (EIS).
- Presentations by Interested Parties who have registered in advance of the hearing session.
- Presentations by Participants who have registered in advance of the hearing session.
- Presentations by persons who registered on the day of the hearing session, time permitting.
- Proponent response to information presented.
- Closing remarks by the Panel Chair.
- Short closing ceremony, as appropriate for the circumstances.

Each presentation will be followed by a question period. Questioning will be conducted according to the provisions described in Sections 5.20 to 5.28 of the *Public Hearing Procedures*.

Community Hearing Sessions Outline

1.10 A Community hearing session will generally progress as follows:

- Call to order by the Panel Chair
- Welcoming statement given by Aboriginal leadership.
- Opening cultural ceremony by an Aboriginal Elder(s)/representative, as appropriate.
- Opening remarks by the Panel Chair.
- Presentation by the Proponent. The presentation by the Proponent should be no longer than 20 minutes and should provide a description of the Project in plain language and focus on the Project's potential effects on the community.
- Presentations by Participants from the community who registered before the day of the community hearing session.
- Presentations by Participants from the community who registered on the day of the community hearing session, time permitting.
- Proponent response to information presented.
- Closing remarks by the Panel Chair.
- Closing cultural ceremony by an Aboriginal Elder(s) / representative, as appropriate.

Each presentation will be followed by a question period. Questioning will be conducted according to the provisions described in Sections 5.21 to 5.29 of the *Public Hearing Procedures*.

2.0 Topic-Specific Hearing Sessions

2.1 The Proponent and Interested Parties may make oral presentations at Topic-Specific sessions.

2.2 Topic-Specific hearing sessions will be held in locations determined by the Panel to allow thorough evaluation of the particular topics of the session.

2.3 The purpose of the Topic-Specific hearing sessions is to provide an opportunity for experts with specialized knowledge or expertise to inform the Panel of the results of their technical review of the potential effects of the Project, to assist the Panel in its assessment of the technical aspects of the project.

2.4 Interested Parties who wish to present information at a Topic-Specific session must register with the Panel Secretariat as soon as possible in advance of the start of the public hearing. A list of topics to be discussed at these sessions will be confirmed at the time the schedule is released by the Panel.

2.5 The Panel expects that participation at the Topic-Specific sessions will include the following parties:

- The Proponent.
- Federal departments who have specialized knowledge or legislated responsibilities under the CEAA, 2012.
- Provincial ministries with specialized knowledge.
- Technical experts who are providing specialized information to the Panel on behalf of the Proponent, Interested Parties, or at the request of the Panel.
- Other Interested Parties with specific expertise related to the topic in question.

Questions

2.6 Each presentation will be followed by a question period. Questioning of other presenters will proceed in an order determined by the Panel Chair, dependent on the session. The Panel may ask questions at any time. Questioning will be conducted according to the provisions described in Section 5.20 to 5.28 of the *Public Hearing Procedures*.

2.7 Questions must be specifically related to the topics being reviewed in the hearing sessions.

2.8 The Panel will identify the topics to be discussed at the Topic-Specific sessions based on the issues that are raised during the course of its review of the EIS. Issues that do not relate to one of the identified topics will normally not be discussed during the Topic-Specific sessions. However, if the Panel receives written comments or questions on a topic not included in the sessions, and determines that the comments or questions are relevant, the Panel may allow the questions to be asked of the party to whom they are addressed.

Topic-Specific Hearing Sessions Outline

2.9 A Topic-Specific hearing sessions will generally progress as follows:

- Opening remarks by the Panel Chair.
- Presentation by the Proponent. The presentation by the Proponent should be no longer than 20 minutes and should provide the main findings of, and references to, the EIS in relation to the topic.
- Questions to the Proponent related to the hearing session topic.
- Presentations by Interested Parties who have registered for the specific topic (maximum 20 minutes).
- Time permitting, questions and comments from others.
- Proponent response. (maximum 10 minutes)
- Short closing remarks by the Panel Chair.

Attachment C – Public Hearing Registration Form

This attachment outlines the process for registering to participate in the public hearing. This form is posted on the public registry. When registering, please include the following information:

Full name	
Organization	
Email address	
Mailing address	
Telephone	
I intend to participate	☐ In a general session – Location: ☐ In a community session – Location: ☐ In a topic-specific session – Location and Topic: ☐ In writing ☐ Orally (I request ___ minutes to present)
If you require translation, specify language	
Please submit a synopsis of the information to be presented *(attach a separate sheet if necessary)*	

PANEL PROCEDURES FOR CONFIDENTIAL INFORMATION

1.0 Introduction

1.1 Sections 43(1)(b) and 45(4) & (5) of the *Canadian Environmental Assessment Act, 2012* (CEAA 2012) and section 2.7 of the Terms of Reference appended to the Amended Agreement to Conduct a Cooperative Environmental Assessment including the Establishment of a Joint Review Panel of the Site C Clean Energy Project require, except as provided in section 1.2 hereof, that all information used by the Panel for the assessment is made available to the public.

1.2 If the Panel is satisfied that the disclosure of evidence, records or other things would cause specific, direct and substantial harm to a witness, or harm to the environment, the evidence, records or things are privileged and must not, knowingly be or be permitted to be communicated, disclosed or made available to any person.

1.3 The Panel therefore wishes to establish a process consistent with its Terms of Reference for considering and deciding on any request by a participant that any information it receives be kept confidential.

2.0 Procedure for Requesting Confidentiality

2.1 Any participant who submits a document to the Panel, all or part of which the participant wishes to be kept confidential must include that request in writing with the document.

2.2 Any participant who intends to present information orally, all or part of which the participant wishes to be kept confidential must make that request prior to presenting the information.

2.3 The request must clearly identify which information the participant wishes to be kept confidential and the grounds for the request.

2.4 A request for confidentiality will be placed on the public registries.

2.5 The information or documents will be reviewed in confidence by Counsel for the Panel, who will make a recommendation to the Panel.

2.6 The Panel will consider and decide on the request. In its decision, the Panel may approve or deny the request in whole or in part, and either unconditionally or subject to conditions that it deems appropriate for the fair conduct of the hearing. The Panel will post its decision on an application that it consider confidential information on the public registries for the Project or by reading it into the record during the public hearing, unless doing so would itself compromise the confidentiality of the information.

2.7 Without limiting the Panel's discretion, an approval may be made conditional on one or more participants, including the Proponent, signing a confidentiality agreement setting forth the terms under which that party may see or use the confidential information.

2.8 In the event the Panel denies a request for confidentiality, in whole or in part or subject to conditions, the information which the requesting participant had sought to keep confidential will be returned to that participant and considered to have been withdrawn, unless the participant expressly and in writing advises the Panel that it wishes to file the information and waive confidentiality.

2.9 In its final report, the Panel will describe how any confidential information has been considered and used in its conclusions and recommendations.

3.0 Handling of Confidential Information

3.1 Participants are cautioned that, although reasonable precautions will be taken, there can be no absolute guarantee that information will remain confidential.

3.2 Information accepted as confidential will be held by Counsel or the Secretariat during the hearings and will be available to the Panel and its staff, and to other participants who have signed confidentiality agreements as contemplated in section 2.7, until the Panel's report is delivered.

3.3 On or before the date on which the Panel delivers its report, participants who have signed confidentiality agreements must return all copies of the confidential information they received or made to the participant who provided the information.

3.4 For a year from that date, the documents will be kept at Canadian Environmental Assessment Agency headquarters in Ottawa and B.C. Environmental Assessment Office headquarters in Victoria under the security procedures in operation from time to time by the two government agencies.

3.5 The confidential information held by the Canadian Environmental Assessment Agency and the B.C. Environmental Assessment Office will be destroyed one year following the deposit of the Panel's report, unless such action is stayed by due process of law. The participant providing the confidential information will be informed of actions taken with respect to the confidential information.

APPENDIX 6 HEARING SCHEDULE

Date	Hearing Topic	Location	Session time
December 2013			
9	Opening	Pomeroy Hotel – Ralph Pomeroy Ballroom 11308 Alaska Rd., Fort St. John, BC	9am-12pm
9	Topic-Specific Session: Need, Purpose and Alternatives	Pomeroy Hotel – Ralph Pomeroy Ballroom 11308 Alaska Rd., Fort St. John, BC	1:30pm-5:30pm
10	Topic-Specific Session: Need, Purpose and Alternatives	Pomeroy Hotel – Ralph Pomeroy Ballroom 11308 Alaska Rd., Fort St. John, BC	9am-12pm 1:30pm-5:30pm
11	General Session	Pomeroy Hotel – Ralph Pomeroy Ballroom 11308 Alaska Rd., Fort St. John, BC	1pm-5pm 7pm-9pm
12	General Session	Pomeroy Hotel – Ralph Pomeroy Ballroom 11308 Alaska Rd., Fort St. John, BC	9am-12pm
12	Topic-Specific Session: Atmospheric	Pomeroy Hotel – Ralph Pomeroy Ballroom 11308 Alaska Rd., Fort St. John, BC	1:30pm-5:30pm
13	General Session	The Pearkes Centre Gymnasium 10801 Dudley Drive, Hudson's Hope, BC	9am-12pm 1:30pm-5:30pm
14	General Session	The Pearkes Centre Gymnasium 10801 Dudley Drive, Hudson's Hope, BC	9am-12pm 1:30pm-5:30pm
15			
16	Community Session	West Moberly Community Hall	10am-5pm
17	Community Session	Saulteau Community Gymnasium	12pm-7pm
18	Community Session	McLeod Lake Community Gymnasium	10am-5pm
19	General Session	Ramada Hotel – Cranbrook Room 444 George Street, Prince George, BC	9am-1pm
20			
January 2014			
6	Community Session	Doig River Community Gymnasium	1pm-5pm
7	Community Session	Halfway River Community Hall	1pm-5pm
8	General Session	George Dawson Inn 11705 8th Street, Dawson Creek, BC	10am-11:30am 1pm-5pm 7pm-9pm
9	General Session	George Dawson Inn 11705 8th Street, Dawson Creek, BC	9:30am-11:30am
9	Community Session (Métis)	George Dawson Inn 11705 8th Street, Dawson Creek, BC	12:30pm-4:30pm
10	General Session	Sawridge Inn – Ballroom 9510 100 St, Peace River, BC	9am-12:30pm
10	Topic-Specific Session: Aquatic and Downstream Environment	Sawridge Inn – Ballroom 9510 100 St, Peace River, BC	1:30pm-6pm
11	Topic-Specific Session: Aquatic and Downstream Environment	Sawridge Inn – Ballroom 9510 100 St, Peace River, BC	9am-12pm 1:30pm-5:30pm
12			
13	Topic-Specific Session: Aquatic Environment	Pomeroy Hotel – Scott Pomeroy Ballroom 11308 Alaska Rd., Fort St. John, BC	9am-12pm 1:30pm-5:30pm
14	Topic-Specific Session: Vegetation	Pomeroy Hotel – Scott Pomeroy Ballroom 11308 Alaska Rd., Fort St. John, BC	9am-12pm 1:30pm-5:30pm
15-16	Topic-Specific Session: Wildlife	Pomeroy Hotel – Scott Pomeroy Ballroom 11308 Alaska Rd., Fort St. John, BC	9am-12pm 1:30pm-5:30pm
17	Topic-Specific Session: Asserted or Established Aboriginal Rights and Treaty Rights	Pomeroy Hotel – Scott Pomeroy Ballroom 11308 Alaska Rd., Fort St. John, BC	9am-12pm 1:30pm-5:30pm
18	Topic-Specific Session: Regional Development	Pomeroy Hotel – Scott Pomeroy Ballroom 11308 Alaska Rd., Fort St. John, BC	9am-12pm 1:30pm-5:30pm
19			
20-21	Topic-Specific Session: Local and Socio-Economic Environment	Pomeroy Hotel – Scott Pomeroy Ballroom 11308 Alaska Rd., Fort St. John, BC	9am-12pm 1:30pm-5:30pm
22	Community Session	Blueberry River First Nations Community Centre	10am-5pm
23	Responses to undertakings	Pomeroy Hotel – Scott Pomeroy Ballroom 11308 Alaska Rd., Fort St. John, BC	9am-12pm 1:30pm-5:30pm

APPENDIX 7 LIST OF APPEARANCES AT THE PUBLIC HEARING

A

Abel, Diane
West Moberly First Nations
Achla, Norman
Halfway River First Nation
Achla, Tyron
Halfway River First Nation
Ackerman, Lori
City of Fort St. John
Acko, Alveena
Doig River First Nation
Acko, Sammi
Saulteau First Nations
Acko, Shirley
Doig River First Nation
Ackroyd, Stephie
Addison, Chris
Ministry of Forests, Lands and Natural Resources Operation
Alleyne, Dr. Carl
Health Canada
Andreeff, Walter
Peace River Environmental Society
Andres, Dave
BC Hydro
Apps, Dr. Clayton
Yellowstone to Yukon Conservation Initiative
Apsassin, Clarence
Blueberry River First Nations
Apsassin, Doug
Blueberry River First Nations
Apsassin, May
Blueberry River First Nations
Apsassin, Rick
Blueberry River First Nations
Apsassin, Sylvester
Blueberry River First Nations
Apsassin, Winston
Blueberry River First Nations
Ardill, Renee
Ardill, Richard
Ash, Gary
BC Hydro
Ashley, Willow Davis
Saulteau First Nations
Askoty, Jack
Doig River First Nation
Atkins, Tony
Attachie, Gerry
Doig River First Nation
Attachie, Jessie
Doig River First Nation
Attachie, Tommy
Doig River First Nation

B

Baccante, Nick
Ministry of Forests, Lands and Natural Resources Operation
Badenhorst, Dr. Charl
Baker, Randy
BC Hydro
Barton, Phillip
Boughton Law Corporation
Beam, Derrek
Beam, Caroline
Bear, Destiny
McLeod Lake Indian Band
Beck, Stanley
Deninu K'ue First Nation
Beltaos, Dr. Spyros
Environment Canada
Berg, Penny
Saulteau First Nations
Biem, Jenny
Duncan's First Nation
Bishop, Debbie,
Yellowstone to Yukon Conservation Initiative
Blandin, Patricia
Saulteau First Nations
Bobrowsky, Peter
Natural Resources Canada
Bolin, Trevor
City of Fort St. John
Bonamis, Alston
Fisheries and Oceans
Boon, Arlene
Boon, Ken
Peace Valley Landowners Association
Borodula, Colleen
Heritage Waterkeepers Society
Boyd, Doug
School District #60 Peace River North

Bradford, Dr. Mike
Fisheries and Oceans
Breault, Andre
Environment Canada
Brisbin, Pat
BC Hydro
Brown, Darcy
West Moberly First Nations
Brown, Kyle
West Moberly First Nations
Bruno, Rene
Athabasca Chipewyan First Nation
Burges, Dr. Steve
BC Hydro
Burgess, Neil
Health Canada
Burseth, Katherine

C

Calliou, Clifford
Kelly Lake Cree Nation
Calvert, Jane
Doig River First Nation
Cameron, Donovan
Saulteau First Nations
Cameron, Judy
Saulteau First Nations
Cameron, Robert
Peace River Environmental Society
Cameron, Stewart
Saulteau First Nations
Campbell, Ida
School District #60 Peace River North
Campbell, Margaret
West Moberly First Nations
Campbell-Letendre, Lyle
Kelly Lake Métis Settlement Society
Candler, Dr. Craig
Athabasca Chipewyan First Nation
Mikisew Cree First Nation
Treaty 8 Tribal Association
Caron, Denise
Saulteau First Nations
Carver, Dr. Martin
Athabasca Chipewyan First Nation
Mikisew Cree First Nation
Cassidy, John
Natural Resources Canada
Chadder, Dr. David
BC Hydro
Chamberlin, Robert
Union of British Columbia Indian Chiefs
Chapman, Lynn
Chingee, Alec
McLeod Lake Indian Band
Chingee, Georgina
McLeod Lake Indian Band
Chipesia, Kim
Blueberry River First Nations
Christensen, Bruce
City of Fort St. John
Churchill, Brian
Peace Conservation and Endowment Trust
Ciruna, Dr. Kristy
Ministry of Forests, Lands and Natural Resources Operation
Clayton, Anne Heather
Copes, Jill
British Columbia's Women's Institute
Cornthwaite, Shawn
Métis Nation British Columbia Natural Resources
Coulson, Jessica
Natural Resources Canada
Courtoreille, Paul
Halfway River First Nation
Courtoreille, Steve
Mikisew Cree First Nation
Courtoreille, Yvonne
Saulteau First Nations
Coxon, Peter
City of Fort St. John
Culling, Diane
Curtis, John Gordon

D

Dahlen, Wayne
Darnall, Ruth Ann
Peace Valley Environment Association
Darvill, Rachel
Davidson, Glen
Ministry of Forests, Lands and Natural Resources Operation
Davies, Angela
Ministry of Forests, Lands and Natural Resources Operation
Davis Watson, Mari
Saulteau First Nations
Davis, Chantel
Blueberry River First Nations
Davis, Harley
Saulteau First Nations

Davis, Jack
Saulteau First Nations
Davis, Jennifer
Ministry of Forests, Lands and Natural Resources Operation
Davis, Kelvin
Doig River First Nation
Davis, Lucille
Doig River First Nation
Davis, Madeline
Doig River First Nation
Davis, Margaret
Doig River First Nation
Davis, Melvin
Saulteau First Nations
Davis, Norman
Doig River First Nation
Davis, Shawn
Blueberry River First Nations
Davis, Steve
Boughton Law Corporation
Davis, Victoria
Saulteau First Nations
De Shield, Coral
Environment Canada
Demeulemeester, Teena
Saulteau First Nations
Desjarlais, George
West Moberly First Nations
Desjarlais, Lorisha
Saulteau First Nations
DeVink, Jean-Michel
BC Hydro
Dibike, Dr. Yonas
Environment Canada
Dokkie, Dean
West Moberly First Nations
Dominic, Sherry
Blueberry River First Nations
Donnelly, James
City of Fort St. John
Doucette, Paula
Transport Canada
Doyle, Mary
Saulteau First Nations
Drew, Teresa
BC Hydro
Duff, Judy

E

Easton, Wendy
Environment Canada
Erdreich, Dr. Linda
BC Hydro
Erwin, Corey
Ministry of Forests, Lands and Natural Resources Operation
Eunall, Dr. Alexander
Kleana Power Corporation
Evans, Earl
Northwest Territories Métis Nation
Evans, Larry
City of Fort St. John
Evans, Peter
BC Hydro

F

Fanos, Brad
Fisheries and Oceans
Feldberg, Peter
BC Hydro
Field, Darlene
Halfway River First Nation
Field, Randy
Halfway River First Nation
Flett, Scott
Athabasca Chipewyan First Nation
Forest, Kenneth
Forrester, Ed
Forrester, Nedra
Francis, Wendy
Yellowstone to Yukon Conservation Initiative
Freer, Michael
Saulteau First Nations
Fuchs, Sandra
Saulteau First Nations

G

Gagnon, Penny
Fort St. John Child Development Centre
Gail, Sharleen
Fort Nelson First Nation
Gailus, John
Treaty 8 Tribal Association
Gall, Christopher
Métis Nation British Columbia
Garbitt, Fernie
Saulteau First Nations
Garbitt, Lana
Saulteau First Nations
Gardiner, Angela
Blueberry River First Nations
Gardiner, Denise

Garson, John
BC Chamber of Commerce
Gauthier, Amy
Saulteau First Nations
Gauthier, Amy-Ann
Saulteau First Nations
Gauthier, Geraldine
Saulteau First Nations
Gauthier, Myron
Saulteau First Nations
Gauthier, Randy
Saulteau First Nations
General, Matthew
Duncan's First Nation
Gevatkoff, Paul
Gilbride, Bridget
BC Hydro
Giltrow, Maegen
City of Fort St. John
Gislason, Gord
BC Hydro
Gladue, Martha
Duncan's First Nation
Glover, Adrianna
Saulteau First Nations
Godsoe, Craig
BC Hydro
Goodings, Karen
Peace River Regional District Electoral Area B
Green, D'Arcy
BC Hydro
Grey Eyes, Jayden
Blueberry River First Nations
Grey Eyes, Patsy
Blueberry River First Nations
Gutsell, Dr. Sheri
Saulteau First Nations

H

Hadland, Laurel-Ann
Hadland, Arthur
Area C, Peace River Regional District
Hadland, Doreen
Hadland, Randal
Hallin, Lillian
BC Hydro
Hannaford, Heather
School District #60 Peace River North
Harrison, Daryl
BC Hydro
Harrison, Peter
Ministry of Forests, Lands and Natural Resources Operation
Hatziantoniou, Yota
Health Canada
Hendriks, Rick
Treaty 8 Tribal Association
Henry, Keith
Kelly Lake Métis Settlement Society
Heron, Cec
West Moberly First Nations
Hilton, Shawn
BC Hydro
Hobbs, Brian
City of Fort St. John
Hobby, Beverly
Health Canada
Hochstein, Philip
Independent Contractors and Business Association
Hoffmann, Donald
Hoffmann, Dr. Sandra
Hofmann, Verena
Treaty 8 Tribal Association
Holland, Melissa
BC Hydro
Holm, Wendy
Peace Valley Environment Association
B.C. Women's Institute
Horvath, Celesa
BC Hydro
Hotte, Lisa
Blueberry River First Nations
Howard, Tim
Peace Valley Environment Association
B.C. Women's Institute
Hunter, Darlene
Halfway River First Nation
Hunter, Dianne
City of Fort St. John
Hunter, Gerry
Halfway River First Nation

I

Ince, David
BC Hydro
Inglis, Richard
BC Hydro
Inkster, Jim
Isadore, Eugene
McLeod Lake Indian Band

Isadore, Zepheria
McLeod Lake Indian Band
Izett, Alex
BC Hydro

J

Jackson, Janell
Saulteau First Nations
Jackson, Ray
Jackson, Siobhan
BC Hydro
Jasek, Martin
BC Hydro
Jobin, Blaine
Saulteau First Nations
Johansson, Gwen
District of Hudson's Hope

K

Kariya, Paul
Clean Energy Association of British Columbia
Kelly, Roy
Keutzer, Rosemary
High Prairie Outfitters and Tracks BC
King, Renata
Northern Development Initiative Trust
Kirkland, Dale
Environment Canada
Knoblauch, Kevin
Koechl, Richard
Kolay, Josh
Dene Tha' First Nation
Komers, Dr. Petr
Saulteau First Nations
Kopach, Brian
Saulteau First Nations
Krichbaum, Randy
BC Hydro
Kroecher, Mike
Kurschner, Renata
BC Hydro
Kyle, Rosanne
Athabasca Chipewyan First Nation
Mikisew Cree First Nation

L

La Rocque, George
Deninu K'ue First Nation
Lafferty, Frank
Deninu K'ue First Nation
Lahaye, Guy
North Peace Road and Gun Club
Lalonde, Richard
Saulteau First Nations
Langlois, Jeff
Athabasca Chipewyan First Nation
Mikisew Cree First Nation
Dene Tha' First Nation
Lavallee, Rev. Fay
St. Peter's Church
Lawson, John
Kwadacha Nation
Layman, Danielle
Leahy, Jean
Save Our Northern Seniors
Lee, Jason
Treaty 8 Tribal Association
Lekstrom, Blair
Lepine, Mathew
Mikisew Cree First Nation
Lepine, Melody
Mikisew Cree First Nation
Letendre, Lan
Kelly Lake Métis Settlement Society
Lewis, Adam
BC Hydro
Lidstone, Don
City of Fort St. John
Lilly, Russell
Halfway River First Nation
Lindsay, William
Hudson's Hope Historical Society
Little, James
North Peace Rod and Gun Club
Little, Tim
BC Hydro
Locher, John
Ethix Consulting Inc.
Logan, Liz
Treaty 8 Tribal Association
London, Clara
Lonergan, Robert
BC Hydro
Lundgren, Jeff
BC Hydro
Lundquist, Gerry
Luttermann, Dr. Annette
Treaty 8 Tribal Association

M

MacLean, Laura
Environment Canada
MacMillan, Stuart

Parks Canada
Marcel, Freddie
Athabasca Chipewyan First Nation
Marcel, Greg
Athabasca Chipewyan First Nation
Marcel, Joe
Athabasca Chipewyan First Nation
Marmorek, David
BC Hydro
Marshall, Carmen
Saulteau First Nations
Marten, Jocelyn
Mikisew Cree First Nation
Marten, Larry
Mikisew Cree First Nation
Marten, Terry
Mikisew Cree First Nation
Martin, George
Mikisew Cree First Nation
Matus, Tom
District of Hudson's Hope
Maurice, Cheryl
Saulteau First Nations
McConnell, Marggie
West Moberly First Nations
McConnell, Megan
Athabasca Chipewyan First Nation
McCormick, Jesse
Saulteau First Nations
McKaanacha, Mary
Doig River First Nation
McKinnon, Greg
Treaty 8 Tribal Association
McNay, Dr. Scott
Treaty 8 Tribal Association
McPhee, Teresa
Blueberry River First Nations
Meek, Blaine
Meek, Maryann
Mera, Pascale
BC Hydro
Metecheah, Amanda
Halfway River First Nation
Metecheah, Aron
Halfway River First Nation
Metecheah, Jeff
Halfway River First Nation
Metecheah, Katie
Halfway River First Nation
Metecheah, Maisie
Halfway River First Nation
Metzger, Steven
Moola, Dr. Faisal
David Suzuki Foundation
Moore, Jennifer
North Peace Economic Development Commission
Mooswah, Darcy
Duncan's First Nation
Morin, Joyce
Halfway River First Nation
Mossop, Brent
BC Hydro
Muir, Bruce
West Moberly First Nations
Munson, Matt
Dene Tha' First Nation
Munzar, Steve
BC Hydro
Murdoch, Alyssa
Saulteau First Nations
Murphy, Michael
BC Hydro
Myers, Jeffrey
West Coast Energy

N

Nagel, Patsy
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Nagy, Dr. John
North Peace Rod and Gun Club
Naito, Brian
Fisheries and Oceans
Napoleon, Bud
Saulteau First Nations
Napoleon, Stan
Saulteau First Nations
Naylor, Ben
Ministry of Forests, Lands and Natural Resources Operation
Neary, Kevin
BC Hydro
Nelson, Eli
West Moberly First Nations
Nelson, Shona
Treaty 8 Tribal Association
Neufeld, Richard
Nicol, Steve
BC Hydro
Nielsen, Linda
School District #60 Peace River North
Nister, Craig
BC Hydro

Nunn, John
BC Hydro

O

Oates, Steve
Parks Canada
Okada, Grace Setsuko
Oker, Garry
Doig River First Nation
O'Riley, Chris
BC Hydro
Orr, Derek
McLeod Lake Indian Band
Owens, Della
Saulteau First Nations
Owens, Naomi
Saulteau First Nations

P

Palmer, Rick
Saulteau First Nations
Parent, Dr. Michel
Natural Resources Canada
Parkinson, Colin
Transport Canada
Peck, Victor Ross
Hudson's Hope Historical Society
Pederson, Esther
Pederson, Poul
Peeling, Albert
McLeod Lake Indian Band
Peters, Dr. Daniel
Environment Canada
Phillip, Stewart
Union of British Columbia Indian Chiefs
Pierrot, Dave
Deninu K'ue First Nation
Porter, Mike
BC Hydro
Power, Christine
Kleana Power Corporation
Prince, Patrick
McLeod Lake Indian Band
Proverbs, Trevor
BC Hydro
Pryse-Phillips, Amy
BC Hydro
Pyle, Norma
Blueberry River First Nations

Q

Qualey, Blair

R

Raphals, Philip
Treaty 8 Tribal Association
Read, Dave
District of Hudson's Hope
Reimann, Randy
BC Hydro
Reynier, Judith
BC Hydro
Ridington, Amber
McLeod Lake Indian Band
Robertson, Krista
Deninu K'ue First Nation
Robinson, Gary
BC Hydro
Rogers, Ken
City of Fort St. John
Rohel, Bev
Saulteau First Nations
Ronnenberg, Doris
Saulteau First Nations
Rudakewich, Mike

S

Sandberg, William Frederick
Sander, Bettina
BC Hydro
Sashaw, Keith
Association of Consulting Engineering Companies of BC
Savidant, Michael
BC Hydro
Sawchuk, Wayne
Sawicki, Joan
Scheck, Joelle
Ministry of Forests, Lands and Natural Resources Operation
Scott, Roxanne
BC Hydro
Selbie, Dr. Dan
Fisheries and Oceans
Sewepagaham, Conroy
Duncan's First Nation
Shaffer, Dr. Marvin
Peace Valley Environment Association
Simpson, Keith
BC Hydro
Smith, Barry
Environment Canada

Smith, Dallas
Nanwakolas Society
Smith, Dr. Derald
BC Hydro
Smol, Dr. John
BC Hydro
Sneep, Dan
Fisheries and Oceans
Solonas, Geraldine
McLeod Lake Indian Band
Solonas, Jenine
McLeod Lake Indian Band
Solonas, Jolene
McLeod Lake Indian Band
Somers, Doreen
Athabasca Chipewyan First Nation
Stano, Maya
Kwadacha Nation
Staples, Lindsay
Peace Valley Landowners Association
Steiner, Charles Erick
Steiner, Esther May
Stewart, Byron
City of Fort St. John
Strang, Al
BC Hydro
Summer, Douglas
Sykes, Edward
Sykes, June

T

Talis, Gary
Blueberry River First Nations
Tennant, Jennifer
Environment Canada
Testawich, Stan
Duncan's First Nation
Thompson, Alison
Canadian Geothermal Energy Association
Thompson, Neil
Thorlakson, Steve
Timoney, Dr. Kevin
BC Hydro
Tonn, Gerhard
City of Fort St. John
Toth, Brian
McLeod Lake Indian Band
Totusek, Colleen
Saulteau First Nations
Tsakoza, Lynette
Prophet River First Nation
Tupper, Yvonne
Saulteau First Nations
Tylee, Josie
McLeod Lake Indian Band
Tyson, Russ
BC Hydro

U

Upstone, Deejay
Halfway River First Nation

V

Vandenberg, Jerry
BC Hydro
Veiner, Ruth
British Columbia's Women's Institute
Voyageur, Charlie
Athabasca Chipewyan First Nation

W

Walker, Art
Saulteau First Nations
Walker, Bev
Saulteau First Nations
Walker, Pauline
Saulteau First Nations
Watson, Alana
Saulteau First Nations
Watson, Dr. Emma
Environment Canada
Watson, Tammy
Saulteau First Nations
Watterson, Daniel
City of Fort St. John
Webb, Jim
Little Red River Cree Nation
West Moberly First Nations
Webb, Laura
West Moberly First Nations
Webster, Terry
Weder, Dr. Christoph
Weisgerber, Jack
BC Hydro
Wenger, Maya
British Columbia's Women's Institute
Whitehead, Joe Sr.
Woodland Cree First Nation
Whitehead, Matthew
Woodland Cree First Nation

Whiten, Reginald
InterraPlan Inc.
Willson, Clarence
West Moberly First Nations
Willson, Roland
West Moberly First Nations
Wolf, Liza
Prophet River First Nation
Wolterson, Eveline
Peace Valley Environment Association
B.C. Women's Institute
Wright, Steven
Environment Canada

Y

Yahey, Georgina
Blueberry River First Nations
Yahey, Marvin
Blueberry River First Nations
Yahey, Randy
Blueberry River First Nations
Yahey, Wayne
Blueberry River First Nations
Yaworsky, Dr. Ron
Northwest Territories Métis Nation
Yurkovich, Susan
BC Hydro

Z

Zbeetnoff, Darrell
BC Hydro

APPENDIX 8 SPECIES AT RISK TABLES

Table 1. Occurrences of rare plants found in the LAA and potentially affected by the Project (Construction and Operation Phases)

Scientific name	Common Name	Status	Occurrences found in the LAA	Occurrences Potentially Lost during Construction and Operation
Vascular Plants				
Anemone virginiana var. cylindroidea	Riverbank anemone	Blue	27	16
Arnica chamissonis ssp. incana	Meadow arnica	Blue	4	4
Artemisia herriotii	Herriot's sage /Western mugwort	Red	40	23
Atriplex gardneri var. gardneri	Gardner's sagebrush	Red	2	1
Calamagrostis montanensis	Plains reedgrass	Blue	10	4
Carex heleonastes	Hudson Bay sedge	Blue	1	1
Carex sychnocephala	Many-headed sedge	Blue	1	1
Carex tenera	Tender sedge	Blue	6	5
Carex torreyi	Torrey's sedge	Blue	3	1
Carex vulpinoidea	Fox sedge	Blue	1	0
Carex xerantica	Dry-land sedge	Red	4	1
Chrysosplenium iowense	Iowa golden-saxifrage	Blue	2	2
Cicuta virosa	European water-hemlock	Blue	10	6
Cirsium drummondii	Drummond's thistle	Red	11	7
Eleocharis elliptica	Elliptic spike-rush	Blue	1	1
Epilobium halleanum	Hall's willowherb	Blue	2	1
Epilobium saximontanum	Rocky Mountain willowherb	Red	2	2
Galium labradoricum	Northern bog bedstraw	Blue	6	4
Glyceria pulchella	Slender mannagrass	Blue	1	1
Helictotrichon hookeri	Spike-oat	Blue	23	3
Juncus arcticus ssp. alaskanus	Arctic rush	Blue	4	4
Juncus confusus	Colorado rush	Red	2	2
Lomatium foeniculaceum var. foeniculaceum	Fennel-leaved desert parsley	Red	2	0
Malaxis brachypoda	White adder's-mouth orchid	Blue	1	1
Muhlenbergia glomerata	Marsh muhly	Blue	1	1
Oxytropis campestris var. davisii	Davis' locoweed / Davis' oxytrope	Blue	10	9
Pedicularis parviflora ssp. parviflora	Small-flowered lousewort	Blue	1	1
Penstemon gracilis	Slender penstemon	Red	9	1
Polypodium sibiricum	Siberian polypody	Red	2	2
Rosa arkansana var. arkansana	Arkansas rose	Blue	1	0
Salix petiolaris	Meadow willow	Blue	1	0
Salix serissima	Autumn willow	Blue	1	1
Schizachyrium scoparium	Little bluestem	Red	5	1
Selaginella rupestris	Rock selaginella	Red	1	0
Silene drummondii var. drummondii	Drummond's campion	Blue	8	3
Sphenopholis intermedia	Slender wedgegrass	Blue	3	3
Symphyotrichum puniceum var.	Purple-stemmed aster	Blue	31	26

puniceum				
Trichophorum pumilum	Dwarf clubrush	Blue	1	1
Utricularia ochroleuca	Ochroleucous bladderwort	Blue	1	1
Mosses				
Aloina bifrons	No common name	Blue	1	1
Amblyodon dealbatus	No common name	Blue	1	1
Pohlia sphagnicola	No common name	Blue	3	3
Lichens				
Collema multipartitum	Protracted tarpaper	Red	2	2
Lempholemma polyanthes	Mourning phlegm	Blue	1	1
Leptogium intermedium	Fourty-five vinyl	Blue	2	1
Leptogium tenuissimum	Birdnest vinyl	Red	1	1
Peltigera evansiana	Peppered pelt	Red	5	5
Phaeophyscia hirsuta	Smiling shadow	Red	2	2
Phaeophyscia kairamoi	Five o'clock shadow	Blue	3	3
Physcia stellaris	Immaculate rosette	Blue	10	9
Ramalina sinensis	Threadbare ribbon	Blue	1	1
Squamarina lentigera	Snow-white dimple	Red	2	2

RED LIST - Includes any ecological community, and indigenous species and subspecies that is extirpated, endangered, or threatened in British Columbia. Extirpated elements no longer exist in the wild in British Columbia, but do occur elsewhere. Endangered elements are facing imminent extirpation or extinction. Threatened elements are likely to become endangered if limiting factors are not reversed. Red-listed species and sub-species may be legally designated as, or may be considered candidates for legal designation as Extirpated, Endangered or Threatened under the *Wildlife Act* (see http://www.env.gov.bc.ca/wld/faq.htm#2). Not all Red-listed taxa will necessarily become formally designated. Placing taxa on these lists flags them as being at risk and requiring investigation.

BLUE LIST - Includes any ecological community, and indigenous species and subspecies considered to be of special concern (formerly vulnerable) in British Columbia. Elements are of special concern because of characteristics that make them particularly sensitive to human activities or natural events. Blue-listed elements are at risk, but are not Extirpated, Endangered or Threatened.

Source: Modified from EIS, Volume 2, Section 13, Table 13.12, 13.13.

Table 2. Potential Habitat Loss for Species at Risk in the LAA

Species	Provincial Status	Federal Status	% of habitat lost in the LAA
Birds			
Bay-breasted Warbler	Blue		20.1%
Black-throated Green Warbler	Blue		13.3%
Canada Warbler	Blue	SARA - Threatened	21.9%
Cape May Warbler	Red		20.9%
Connecticut Warbler	Red		10.4%
Olive-sided Flycatcher	Blue	SARA - Threatened	NA
Rusty Blackbird	Blue	SARA – Special Concern	7.8%
Barn Swallow	Blue		NA
Bank Swallow	Yellow	COSEWIC – Threatened	NA
American Avocet	Red		>20% river/backchannel habitats
American Golden-Plover	Blue		>20% river/backchannel habitats
American White Pelican	Red		>20% river/backchannel habitats
Brant	Blue		>20% river/backchannel habitats
Cackling Goose	Blue		>20% river/backchannel habitats
California Gull	Blue		>20% river/backchannel habitats
Double-crested Cormorant	Blue		>20% river/backchannel habitats
Forster's Tern	Red		>20% river/backchannel habitats
Great Blue Heron	Blue		>20% river/backchannel habitats
Horned Grebe	Yellow	COSEWIC – Special Concern	>20% river/backchannel habitats
Hudsonian Godwit	Red		>20% river/backchannel habitats
Red-necked Phalarope	Blue		>20% river/backchannel habitats
Short-billed Dowitcher	Blue		>20% river/backchannel habitats
Surf Scoter	Blue		>20% river/backchannel habitats
Upland Sandpiper	Red		>20% river/backchannel habitats
Wandering Tattler	Blue		>20% river/backchannel habitats
Western Grebe	Red		>20% river/backchannel habitats
American Bittern	Blue		NA
Le Conte's Sparrow	Blue		23.3%
Nelson's Sparrow	Red		23.3%
Yellow Rail	Red	SARA – Special concern	23.8%
Common Nighthawk	Yellow	SARA – Threatened	17.8%
Broad-winged Hawk	Blue		11%
Short-eared Owl	Blue	SARA – Special concern	14.5%
Mammals			
Fisher	Blue		14%
Grizzly bear	Blue	COSEWIC – Special concern	NA
Little Brown Myotis	Yellow	COSEWIC – Endangered	Foraging habitat: 24.5% Reproducing habitat: 13.5%
Northern Myotis	Blue	COSEWIC – Endangered	Foraging habitat: 24.5% Reproducing habitat: 13.5%
Eastern Red bat	Red		Foraging habitat: 24.5% Reproducing habitat: 13.5%
Woodland Caribou – Northern Mountain Caribou	Blue	SARA – Special Concern	NA
Invertebrates			
Prairie bluet	Blue		19%
Hagen's bluet	Blue		19%
Beaverpond baskettail	Blue		19%
Albert's fritillary	Blue		NA
Alberta arctic	Red		NA

Aphrodite fritillary, *manitoba* ssp.	Blue		14.1%
Arctic blue, *lacustris* ssp.	Blue		9.8%
Arctic skipper, *mandan* ssp.	Blue		19.7%
Assiniboine skipper	Red		16.5%
Checkered skipper	Blue		NA
Common ringlet, *benjamini* ssp.	Blue		10.5%
Common woodnymph, *nephele* ssp.	Blue		16.9%
Coral hairstreak, *titus* ssp.	Red		NA
Great spangled fritillary, *pseudocarpenteri* ssp.	Red		17.7%
Mead's sulphur	Blue		NA
Mormon fritillary, *eurynome* ssp.	Red		NA
Old world swallowtail, *hudsonianus* ssp.	Red		12.1%
Old world swallowtail, *pikei* ssp.	Blue		12.1%
Pelidne sulphur	Blue		NA
Striped hairstreak	Red		NA
Tawny crescent	Blue		13.7%
Uhler's arctic	Blue		9.7%
White-veined arctic, *edwardsi* ssp.	Blue		NA
Amphibians			
Western Toad	Blue	SARA – Special Concern	29%[a]

[a] Note that the EIS indicates a percentage loss of 38% for the Western Toad, but that this number was revised to 29% by BC Hydro during the course of the Hearing.

SARA - Extirpated species - a wildlife species that no longer exists in the wild in Canada, but exists elsewhere in the wild.

SARA - Endangered species - a wildlife species that is facing imminent extirpation or extinction.

SARA - Threatened species - a wildlife species that is likely to become an endangered species if nothing is done to reverse the factors leading to its extirpation or extinction.

SARA - Species of special concern - a wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.

RED LIST - Includes any ecological community, and indigenous species and subspecies that is extirpated, endangered, or threatened in British Columbia. Extirpated elements no longer exist in the wild in British Columbia, but do occur elsewhere. Endangered elements are facing imminent extirpation or extinction. Threatened elements are likely to become endangered if limiting factors are not reversed. Red-listed species and sub-species may be legally designated as, or may be considered candidates for legal designation as Extirpated, Endangered or Threatened under the *Wildlife Act* (see http://www.env.gov.bc.ca/wld/faq.htm#2). Not all Red-listed taxa will necessarily become formally designated. Placing taxa on these lists flags them as being at risk and requiring investigation.

BLUE LIST - Includes any ecological community, and indigenous species and subspecies considered to be of special concern (formerly vulnerable) in British Columbia. Elements are of special concern because of characteristics that make them particularly sensitive to human activities or natural events. Blue-listed elements are at risk, but are not Extirpated, Endangered or Threatened.

Source: Modified from BC Hydro EIS, Volume 2, Section 14.

Table 3. Fish Species At Risk in the LAA

Scientific name	Common Name	Provincial Status		Federal Status
		B.C.	AB	
Sport Fish				
Thymallus arcticus	Arctic grayling	Yellow	Sensitive	
Salvelinus confluentus	Bull trout	Blue	Sensitive	COSEWIC – Special Concern
Hiodon alosoides	Goldeye	Blue	Secure	
Salvelinus namaycush	Lake trout	Yellow	Sensitive	
Prosopium coulteri	Pygmy whitefish	Yellow	May be at risk	
Oncorhynchus mykiss	Rainbow trout	Yellow	At risk	
Suckers				
Catostomus macrocheilus	Largescale sucker	Yellow	Sensitive	
Minnows				
Ptychocheilus oregonensis	Northern pikeminnow	Yellow	Sensitive	
Phoxinus eos	Northern redbelly dace	Unknown	Sensitive	
Margariscus margarita	Pearl dace	Blue	Undetermined	
Notropis hudsonius	Spottail shiner	Red	Secure	
Suckers				
Cottus ricei	Spoonhead sculpin	Yellow	May be at risk	

RED LIST - Includes any ecological community, and indigenous species and subspecies that is extirpated, endangered, or threatened in British Columbia. Extirpated elements no longer exist in the wild in British Columbia, but do occur elsewhere. Endangered elements are facing imminent extirpation or extinction. Threatened elements are likely to become endangered if limiting factors are not reversed. Red-listed species and sub-species may be legally designated as, or may be considered candidates for legal designation as Extirpated, Endangered or Threatened under the *Wildlife Act* (see http://www.env.gov.bc.ca/wld/faq.htm#2). Not all Red-listed taxa will necessarily become formally designated. Placing taxa on these lists flags them as being at risk and requiring investigation.

BLUE LIST - Includes any ecological community, and indigenous species and subspecies considered to be of special concern (formerly vulnerable) in British Columbia. Elements are of special concern because of characteristics that make them particularly sensitive to human activities or natural events. Blue-listed elements are at risk, but are not Extirpated, Endangered or Threatened.

YELLOW LIST – Includes species and ecological communities that are secure

COSEWIC – Special Concern - Those wildlife species that are particularly sensitive to human activities or natural events but are not endangered or threatened wildlife species.

Source: Modified from BC Hydro EIS, Volume 2, Section 12, Table 12.5.

APPENDIX 9 LIST OF BC HYDRO'S MITIGATION MEASURES AND FOLLOW-UP PROGRAMS

Project Interaction/Potential Effect	Proposed Mitigation	CEAA s. 5
Fish and Fish Habitat		
Dam, Generating Station and Spillways Hazardous Materials Storage and Refuelling Sites (includes explosives and petroleum fuels)	Facilities will be distanced from watercourses and discharges will comply with provincial and municipal permitting requirement.	Section 5(1)(*a*)
Dam, Generating Station, Spillways and Reservoir Existing infrastructure inventory, protection and/or relocation	Best management practices are available for instream works.	Section 5(1)(*a*)
Reservoir Preparation and Filling Access: upgrades to existing licencee roads, winter road construction	Best management practices are available for temporary road works, temporary bridges and instream works.	Section 5(1)(*a*)
Reservoir Preparation and Filling Clearing of vegetation and timber by manual or mechanical means	Activities can be managed and mitigated with best management practices, and buffer areas will be maintained.	Section 5(1)(*a*)
Reservoir Preparation and Filling Post-harvest terrestrial debris management	Standard measures will be implemented when activities are conducted adjacent to a watercourse.	Section 5(1)(*a*)
Reservoir Preparation and Filling Access road deactivation and reclamation of exposed cuts and fills, where required	Standard measures will be implemented when activities are conducted adjacent to a watercourse.	Section 5(1)(*a*)
Reservoir Preparation and Filling Aquatic debris management during inundation	Activities can be managed and mitigated with best management practices.	Section 5(1)(*a*)
Substation and Transmission Line to Peace Canyon Site/corridor clearing and preparation	Activities can be managed and mitigated with best management practices.	Section 5(1)(*a*)
Substation and Transmission Line to Peace Canyon: Access construction and right-of-way improvement	Activities can be managed and mitigated with best management practices.	Section 5(1)(*a*)
Quarried and Excavated Construction Materials: West Pine Siding extension, 85th Avenue Industrial Lands, West Pine Quarry, Del Rio granular borrow, other Sources | Granular borrow (within inundation zone, along Hwy. 29), other sources (Area E and on-site)	Standard measures will be implemented when activities are conducted adjacent to a watercourse.	Section 5(1)(*a*)
Quarried and Excavated Construction Materials: Wuthrich Quarry, Portage Mountain Quarry	Standard measures will be implemented when activities are conducted adjacent to a watercourse.	Section 5(1)(*a*)
Road and Rail Access Development Transmission line access roads	Activities can be managed and mitigated with best management practices.	Section 5(1)(*a*)
Road and Rail Access Development: Jackfish Lake Rd works (incl. improvement of existing Jackfish Lake Rd., extension of existing Jackfish Lake Rd., improvement of existing Jackfish Plateau PDRs leading towards dam site and Project Access Road), Old Fort Road realignment and widening, paving of 240 Road, widening of 271 Road and paving and extension of 269 Road., West Pine Quarry access, West Pine Siding	Activities can be managed and mitigated with best management practices available for instream drainage works.	Section 5(1)(*a*)

Project Interaction/Potential Effect	Proposed Mitigation	CEAA s. 5
construction, Septimus Rail Siding construction		
Worker Accommodation: Temporary Accommodation Northern Regional Site (Halfway-Farrell), Temporary Accommodation -Southern Regional Site (Jackfish Lake Rd)	Facilities will be distanced from watercourses and discharges will comply with provincial and municipal permitting requirements.	Section 5(1)(*a*)
Dam, Generating Station, and Spillways: Maintenance of the powerhouse, and substation	Best management practices are available for maintenance works.	Section 5(1)(*a*)
Reservoir Debris management Hudson's Hope Shoreline Protection maintenance	Best management practices are available for instream works and maintenance activities.	Section 5(1)(*a*)
Substation and Transmission Line to Peace Canyon: Right-of-way vegetation maintenance Maintenance of access roads	Standard measures will be implemented when activities are conducted adjacent to a watercourse.	Section 5(1)(*a*)
Loss of habitat due to construction of the dam and generating station, Highway 29, and Hudson's Hope shoreline protection during construction	Implement the Fish and Aquatic Habitat Management Plan. A 15 m riparian buffer will remain adjacent to watercourses during reservoir clearing Place material relocation sites (R5a, R5b, and R6) 15 m back from the high water level to avoid affecting Peace River fish habitat. Incorporate fish habitat features into the final capping of material relocation sites upstream of the dam. Contour and cap with gravels and cobble substrate the spoil area between elevations 455 m and 461 m to provide a productive fish habitat that will be available to fish during the operation phase. Include fish habitat features (e.g., shears, large riprap point bars, etc.) in the final design of the north bank haul road bed material that would be placed in the Peace River. Compensate for fish habitats affected by Highway 29 realignment ‘like for like‘ in the vicinity of the habitat loss. Fish habitat features will be incorporated into the final designs of the watercourse crossings. Replant disturbed riparian areas with local vegetation. Incorporate fish habitat features into the final design of the Highway 29 roadway that would border the reservoir, east of Lynx Creek. Construct the Hudson‘s Hope shoreline protection with large material that will provide replacement fish habitat. Incorporate additional fish habitat features (e.g., shear zones and point bars) into the final design of the Hudson‘s Hope shoreline protection Merchantable trees, and vegetation that could interfere with navigation, will be removed using clearing practices to maintain a 15 m machine-free zone Manage construction footprints to reduce the impact on fish and fish habitat. Remove temporary structures as soon as they are no longer required.	Section 5(1)(*a*)
Loss of habitat due to construction headpond and reservoir filling during construction	Contour Highway 29 borrow sites prior to decommissioning to provide littoral fish habitat in the reservoir. Cap material repositioning areas with gravel and cobble, and contour to enhance fish habitat conditions. Where appropriate, plant a 15 m wide riparian area along the reservoir shoreline adjacent to BC Hydro-owned farmland to provide riparian habitat and bank stabilization.	Section 5(1)(*a*)

Project Interaction/Potential Effect	Proposed Mitigation	CEAA s. 5
Altered fish habitat due to transformation of reservoir habitat during reservoir operations	Manage reservoir fluctuation within a 1.8 m maximum normal operating range to reduce effects to the shoreline fish habitat. Future mitigation and compensation options will be evaluated after reservoir development and follow-up monitoring. Compensation options that are technically and economically feasible will be implemented.	Section 5(1)(*a*)
Altered fish habitat downstream of Site C Dam during operations	Enhance side channel complexes between the dam site and the confluence of the Peace and Pine rivers to increase wetted habitat during low flows. Create new wetted channels and restore back channels on the south bank island downstream of the dam to create off channel and back channel habitat.	Section 5(1)(*a*)
Reduced fish health and survival due to sediment inputs by dam and generating station construction	Implement the following Environment Management Plans: • • Air Quality Management Plan • • Erosion Prevention and Sediment Control Plan • • Surface Water Quality Management Plan Adjust the timing of construction activities to coincide with periods of high background sediment levels where feasible. Use clean rock materials for riprap construction to reduce the amount of sediment that is introduced into the aquatic environment. Reduce equipment production rates to reduce the amount of sediments generated by equipment when needed.	Section 5(1)(*a*
Reduced fish health and survival due to sediment inputs from construction headpond and reservoir filling during construction	Berm or cap areas with high potential to produce sediments. Leave stumps in the headpond area in place during reservoir clearing to reduce soil disturbance and potential sedimentation issues, where feasible. Clear reservoir in winter, where feasible, to reduce soil disturbance	Section 5(1)(*a*)
Reduced fish health and survival due to sediment inputs by Highway 29 realignment and construction of Hudson‘s Hope shoreline protection during construction	Implement the following Environment Management Plans: • • Air Quality Management Plan • • Erosion Prevention and Sediment Control Plan • • Surface Water Quality Management Plan Use clean rock materials for riprap construction to reduce the amount of sediments that are introduced into the aquatic environment. Conduct in-stream construction in isolated work areas when feasible.	Section 5(1)(*a*)
Reduced fish health and survival due to stranding during construction	Surveillance of fish habitat areas where periodic exposure of channel margins occurs as a result of headpond fluctuation As feasible, salvage and relocation of fish trapped in potholes, side channels, or other habitat area at risk of dewatering as a result of headpond fluctuation	Section 5(1)(*a*)
Reduced fish health and survival due to fish entrainment during construction	Utilize large diameter diversion tunnels and associated hydraulics that provide low risk of fish mortality. Incorporate smooth and gradual transitions from the round tunnels to the square exits. Complete tunnel linings with a smooth concrete surface finish. Reduce any obstructions (e.g., boulders) in the tunnel tailrace area. Operate the modified diversion tunnel for a short duration, as described in Volume 1 Appendix B Reservoir Filling Plan. Approaches to mitigate the potential effects of fish entrainment on health and survival	Section 5(1)(*a*)

Project Interaction/Potential Effect	Proposed Mitigation	CEAA s. 5
	of fish during construction are considered in more detail in Volume 2 Appendix Q Fish Passage Management Plan.	
Reduced fish health and survival due to increased total dissolved gas during construction	Modify spillway design to reduce the magnitude of total dissolved gas generated. Develop and implement an operational procedure to reduce the number of hold points and duration of the reservoir filling and turbine commissioning to reduce total dissolved gas concentration in tailwater.	Section 5(1)(*a*)
Reduced fish health and survival due to stranding during operations	Monitor fish habitat areas where periodic exposure of side channel and mainstem margins occurs as a result of water fluctuations. Enhance side channel complexes in the reach between the dam site and the confluence of the Peace and Pine Rivers to increase wetted habitat and to reduce stranding potential during low flows. Where practical, contour mainstem bars to reduce potential for fish stranding.	Section 5(1)(*a*)
Reduced fish health and survival due to fish entrainment during operations	Use large, slow rotating Francis turbines to increase entrainment survival. Design smooth and gradual transitions at the approach channel and penstock entrances and tailrace exit structures into the final design. Design the orientation and size of openings and exits to reduce hydraulic turbulence to reduce fish injury. Ensure smooth surface finishing on linings of spillways. Reduce obstructions (e.g., boulders) from the turbulent zone in the spillway and tailrace areas. Approaches to mitigate the potential effects of fish entrainment on health and survival of fish during operation are considered in more detail in Volume 2 Appendix Q Fish Passage Management Plan.	Section 5(1)(*a*)
Reduced fish health and survival due to increased total dissolved gas supersaturation during operations	The spillway design has been modified to reduce total dissolved gas generation. Develop and implement an operational procedure to manage the rate of discharge at each gate to reduce dissolved gas generation – initiate spillway discharge operations through multiple gates to reduce the rate of discharge at each gate. Develop and implement an operational procedure to reduce operation of turbines in water discharge ranges that produce rough load operation‘ to reduce total dissolved gas concentration in tailwater.	Section 5(1)(*a*)
Hindered fish movement due to obstruction to fish passage during construction	Provide upstream fish passage during construction by a trap and haul facility. Implement a periodic capture and translocation program for small-fish species, contingent on the results of investigative studies into the genetic exchange requirements of upstream and downstream populations. Approaches to mitigate the potential effects of obstructed fish movement during the construction of the Project are considered in more detail in Volume 2 Appendix Q Fish Passage Management Plan.	Section 5(1)(*a*
Hindered fish movement due to obstruction to fish passage during operations	Provide upstream fish passage during operations by a trap and haul facility Implement a periodic capture and translocation program for small-fish species, contingent on the results of investigative studies into the genetic exchange requirements of upstream and downstream populations. Approaches to mitigate the potential effects of obstructed fish movement during the operations of the Project are considered in more detail in Volume 2 Appendix Q Fish Passage Management Plan.	Section 5(1)(*a*)

Project Interaction/Potential Effect	Proposed Mitigation	CEAA s. 5
Potential effects on fish and fish habitat during construction and operations	Implementation of Environmental Monitoring Program for the protection of fish and fish habitat: • evaluate the effectiveness of standard mitigation measures for reducing sedimentation and fish stranding in the construction headpond and proximal reach of the river downstream of the dam, • to validate predictions about physical changes to habitat in the reservoir area during the development and operation of the construction headpond during the diversion stage of the project • A systematic monitoring program design would be conducted over the approximate eight-year construction period. • Physical and biological monitoring would be conducted to an appropriate scale to document spatial and temporal changes occurring in physical environmental conditions resulting from headpond hydrology, and in localized areas in relation to the effects of construction activities and mitigation procedures. • The environmental construction monitoring program will also confirm the effectiveness of mitigation measures for management of predicted effects of sediment and fish stranding, and provide information required to adjust the mitigation program to reduce unforeseen adverse effects, as required. Environmental monitoring will be developed as described in Volume 5 Section 35 Summary of Environmental Management Plans Habitat Compensation Plan will be developed and implemented in accordance with a *Fisheries Act* Section 35(2) Authorization	Section 5(1)(*a*)
Potential effects on fish and fish health due to changes in water quality	Implement an Acid Rock Drainage and Metal Leachate Management Plan. Develop and implement a Water Quality Monitoring Plan in consultation with responsible provincial regulators.	Section 5(1)(*a*)
	Follow-up Program Objective(s): To monitor the effectiveness of environmental protection measures undertaken during construction to mitigate effects on fish and fish habitat **Description:** Environmental Management Plans **Frequency:** Annual **Duration:** 15 years following reservoir filling	Section 5(1)(*a*)
	Follow-up Program Objective(s): Reservoir filling and commencement of operation to test the hypotheses used to predict the temporal development of the new reservoir and changes in the downstream river physical environment and productivity **Description:** Fish and fish habitat productivity monitoring program for reservoir and reservoir tributaries. Fish and fish habitat productivity monitoring program for downstream Peace River. Fish passage management program. Total dissolved gas monitoring program. **Frequency:** Annual **Duration:** 15 years following reservoir filling	Section 5(1)(*a*)
	Follow-up Program Objective(s): Habitat: Construction: Loss of habitat due to construction of the dam and generating station, Highway 29 and Hudson's Hope	Section 5(1)(*a*)

Project Interaction/Potential Effect	Proposed Mitigation	CEAA s. 5
	shoreline protection **Description:** Construction Environmental Monitoring Program Habitat Compensation Program **Frequency / Duration:** BC Hydro will work with appropriate regulatory authorities in the development of specific mitigation measures, including compensation, as and when required.	
	Follow-up Program Objective(s): Habitat: Construction: Altered fish habitat due to construction headpond and reservoir filling **Description:** Habitat Compensation Program **Frequency / Duration:** BC Hydro will work with appropriate regulatory authorities in the development of specific mitigation measures, including compensation, as and when required.	Section 5(1)(*a*)
	Follow-up Program Objective(s): Habitat: Operation, Altered fish habitat due to transformation of reservoir habitat during reservoir operations **Description:** Fish and Fish Habitat Productivity Monitoring Program (Reservoir) Habitat Compensation Program **Frequency / Duration:** BC Hydro will work with appropriate regulatory authorities in the development of specific mitigation measures, including compensation, as and when required.	Section 5(1)(*a*)
	Follow-up Program Objective(s): Habitat: Operation Altered fish habitat downstream of Site C Dam **Description:** Fish and Fish Habitat Productivity Monitoring Program (River) Habitat Compensation Program **Frequency / Duration:** BC Hydro will work with appropriate regulatory authorities in the development of specific mitigation measures, including compensation, as and when required.	Section 5(1)(*a*)
	Follow-up Program Objective(s): Health and Survival: Construction Reduced fish health and survival due to stranding in construction headpond **Description:** Construction Headpond Fish Salvage and Monitoring Program **Frequency / Duration:** BC Hydro will work with appropriate regulatory authorities in the development of specific mitigation measures, including compensation, as and when required.	Section 5(1)(*a*)
	Follow-up Program Objective(s): Health and Survival: Construction Reduced fish health and survival due to fish entrainment **Description:** Fish Passage Management Program **Frequency / Duration:** BC Hydro will work with appropriate regulatory authorities in the development of specific mitigation measures, including compensation, as and when required.	Section 5(1)(*a*)
	Follow-up Program Objective(s): Health and Survival: Construction Reduced fish health and survival due to increased total dissolved gas **Description:** Total Dissolved Gas Monitoring Program **Frequency / Duration:** BC Hydro will work with appropriate regulatory authorities in the development of specific mitigation measures, including compensation, as and	Section 5(1)(*a*)

Project Interaction/Potential Effect	Proposed Mitigation	CEAA s. 5
	when required.	
	Follow-up Program Objective(s): Health and Survival: Operations Reduced fish health and survival due to fish entrainment **Description:** Fish Passage Management Program **Frequency / Duration:** BC Hydro will work with appropriate regulatory authorities in the development of specific mitigation measures, including compensation, as and when required.	Section 5(1)(*a*)
	Follow-up Program Objective(s): Health and Survival: Operations Reduced fish health and survival due to increased total dissolved gas **Description:** Total Dissolved Gas Monitoring Program **Frequency / Duration:** BC Hydro will work with appropriate regulatory authorities in the development of specific mitigation measures, including compensation, as and when required.	Section 5(1)(*a*)
	Follow-up Program Objective(s): Fish Movement: Construction Hindered fish movement due to obstruction to fish passage **Description:** Fish Passage Management Program **Frequency / Duration:** BC Hydro will work with appropriate regulatory authorities in the development of specific mitigation measures, including compensation, as and when required.	Section 5(1)(*a*)
	Follow-up Program Objective(s): Fish Movement: Operations Hindered fish movement due to obstruction to fish passage **Description:** Fish Passage Management Program **Frequency / Duration:** BC Hydro will work with appropriate regulatory authorities in the development of specific mitigation measures, including compensation, as and when required.	Section 5(1)(*a*)
	Follow-up Program Objective(s): Additional adaptive programs to verify assessment predictions, if required **Description:** • • Confirm specific adaptive management plans based on follow-up monitoring results • • Implement directed studies to address specific uncertainties (e.g., what is the kokanee population in the reservoir?) • • As part of the habitat compensation program, funding will be available to verify uncertainty in the effects and will be used on technically feasible, cost-effective, and environmentally sound projects to compensate for unforeseen adverse effects **Frequency / Duration:** BC Hydro will work with appropriate regulatory authorities in the development of specific mitigation measures, including compensation, as and when required.	Section 5(1)(*a*)
Vegetation and Ecological Communities		
Habitat alteration and fragmentation: Construction: Old growth, grasslands and wetlands	Project design to date has located new proposed roads and other linear disturbances along existing disturbed areas as much as possible to minimize the effects of habitat	Section 5(1)(a) Section 5(1)(c)

Project Interaction/Potential Effect	Proposed Mitigation	CEAA s. 5
	loss. Place transmission towers and temporary roads away from wetlands and known rare plant occurrences where feasible. All known occurrences will be provided as inputs during the final design phase for consideration. If there is limited or no existing data to help facilitate avoidance measures, then supplemental pre-construction surveys will be conducted. These pre-construction surveys will target rare plants as defined in Section 13.2.2 and plants of interest to Aboriginal groups where these are made known to BC Hydro—including vascular plants, mosses, and lichens. If avoidance is not feasible, other mitigation measures will be considered, including effect reduction and compensation.	Section 5(2)(a)
Habitat alteration and fragmentation: Construction: Tufa seeps, wetlands and rare plants	An Environmental Protection zone will be established to protect occurrences located adjacent to construction areas. Signage will be added where necessary to indicate the boundaries of the exclusion area. Construction personnel will be required to attend a field-based orientation session where the exclusion areas will be explained, and the importance of avoiding disturbance within them will be stressed. This will form part of the Environmental Training Management Plan (Section 35.2.2.8 in Volume 5 Section 35 Summary of Environmental Management Plans). A Wetland Mitigation and Compensation Plan will be developed, incorporating information on location, size and type of wetlands affected by the Project. The plan will include applying a mitigation hierarchy that prioritizes mitigation actions to be undertaken: 1. Avoid direct effects where feasible; 2. Minimize direct effects where avoidance is not feasible; 3. Maintain or improve hydrology where avoidance is not feasible; 4. Replace like for like where feasible; 5. Improve the function of existing wetland habitats; and 6. Create new wetland habitat The wetland mitigation plan will be developed using the mitigation hierarchy outlined above and will incorporate expert advice provided by Ducks Unlimited. A staged approach for the plan is proposed which includes the development of conceptual plans for wetland mitigation projects, development of detailed designs, and production of completed construction plans. The plan will be developed with appropriate federal and provincial regulatory authorities and advice and input gained through consultation with First Nation and Aboriginal groups will be included in the plan.	Section 5(1)(a) Section 5(1)(c) Section 5(2)(a)
Habitat alteration and fragmentation: Construction Grasslands, wetlands, and rare plants	The Soil Management, Site Restoration and Revegetation Plan will take into account the location of known occurrences, and suggest the seed mixes and methods to avoid indirect loss or alteration to nearby occurrences	Section 5(1)(a) Section 5(2)(a)
Habitat alteration and fragmentation: Construction Old growth, wetlands and rare plants	Temporary construction access roads will be closed and reclaimed following construction. During construction, access roads will be controlled to limit use.	Section 5(1)(a) Section 5(2)(a)
Habitat alteration and fragmentation: Operation Wetlands and rare plants	A spatial database of known rare plant occurrences in the vicinity of Project components will be maintained and searched to avoid effects during operations and maintenance activities. The database will be actively updated as new information	Section 5(1)(a) Section 5(2)(a)

Project Interaction/Potential Effect	Proposed Mitigation	CEAA s. 5
	becomes available.	
Habitat alteration and fragmentation: Construction Old growth, grasslands, wetlands, and rare plants	Efforts have been made during Project design to use existing access corridors, plan for deactivation of temporary access roads, and minimize disturbance to help limit additional fragmentation. Project components where this has occurred are listed below. • **Substation and Transmission Lines to Peace Canyon Dam:** Constructing the new transmission lines adjacent to the existing line, and using the existing corridor and maintenance access roads. • **Highway 29 Realignment:** Using portions of existing roads and selecting borrow sites that already exist or that would be eventually covered by the reservoir. • **Quarried and Excavated Construction Materials:** Further developing existing quarry sites (e.g., Wuthrich, Del Rio, and West Pine) and using a site that has already been affected by development (85th Avenue Industrial Lands). • **Construction Access Roads:** Use of existing infrastructure for moving material, upgrading existing access roads, and deactivation of temporary roads used for reservoir clearing, and placing the south bank access to the Dam Site along the existing transmission line corridor.	Section 5(1)(a) Section 5(2)(a)
Habitat alteration and fragmentation: Construction Wetlands and rare plants	The construction methods used will take into account the location of known occurrences and high-suitability habitat. Where complete avoidance is not feasible, effect reduction will be considered. This can include timing construction activities to winter months, and surface protection measures such as placing ramps to reduce vehicle compaction within occurrences, or using rubber-tired versus tracked equipment to minimize ground disturbance.	Section 5(1)(a) Section 5(2)(a)
Habitat alteration and fragmentation: Construction Grasslands, wetlands, and rare plants	The indirect effects associated with increased dust deposition are expected to be diffuse, and are not considered to threaten the continued viability of any known rare plant occurrences. Fugitive dust from construction activities will be minimized through the application of an Air Quality Monitoring and Dust Control Plan (Section 35.2.2.7 in Volume 5 Section 35 Summary of Environmental Management Plans).	Section 5(1)(a) Section 5(2)(a)
Habitat alteration and fragmentation: Construction and operations: Wetlands	Construction and maintenance activities in and around watercourses and wetlands will conform to BC Hydro's regulator-accepted practices including Approved Work Practices for Managing Riparian Vegetation (BC Hydro et al. 2003). An Agreement between BC Hydro, the B.C. Ministry of Environment, and Fisheries and Oceans Canada (BC Hydro et al. 2009) identifies other accepted work practices that are to be developed and available for use in the near future. Additional guidance will be used from Standards and Best Practices for Instream Works (B.C. Ministry of Water, Land and Air Protection 2004) and the Land Development Guidelines for the Protection of Aquatic Habitat (Chilibeck et al. 1992), which are designed to reduce sedimentation and avoid introduction of deleterious substances to aquatic environments. Maintaining surface flow patterns is important in the retention of functioning wetlands. Construction activities will be designed and carried out in a manner that seeks to maintain the hydrology of adjacent wetlands, particularly where known rare plant	Section 5(1)(a)

Project Interaction/Potential Effect	Proposed Mitigation	CEAA s. 5
	occurrences are present. Measures will be implemented to maintain existing hydrological patterns as much as possible, if roads cannot avoid wetlands. Culverts will be installed under access roads to maintain hydrological balance, and sedimentation barriers will be installed as needed. A hydrologist will be employed to assist with developing site-specific measures to reduce changes to existing hydrologic balance and wetland function during construction of the Jackfish Lake Road and Project access roads and the transmission line.	
Habitat alteration and fragmentation: Construction Wetlands	Stormwater management will be designed to control runoff and direct it away from work areas where excavation, spoil placement, and staging activities occur. Consideration for maintaining recharge levels to wetlands will be given when diverting water around work sites, providing there is not expected to be a measurable increase in sediment transport to these sensitive areas. Surface water quality management will be addressed in the Erosion Prevention and Sediment Control Management Plan (Section 35.2.2.9), Fisheries and Aquatic Habitat Management Plan (Section 35.2.2.10) and Emergency Response Plan (Section 35.2.1.1), all in Volume 5 Section 35 Summary of Environmental Management Plans.	Section 5(1)(a)
Habitat alteration and fragmentation: Construction Old growth, rare plants	A hierarchal decision matrix has been developed for reservoir clearing to reduce erosion potential along steep, unstable slopes and along riparian zones for all defined watercourses. Specifically the decision matrix includes: • Retention of all trees in on steep, unstable slopes that would be highly susceptible to landslides if the vegetation was removed • Retention of non-merchantable trees and vegetation in riparian areas within a 15 m buffer from the high water mark. Merchantable trees may still be removed using clearing practices to maintain a 15 m machine-free zone. These same standards will be employed in other work areas, and will follow BC Hydro‘s approved work practices.	Section 5(2)(a)
Habitat alteration and fragmentation: Construction rare plants	An experimental rare plant translocation program will be considered for suitable rare plant species found within the reservoir and other areas where Project components are certain to remove the populations. The translocation program will follow the B.C. Ministry of Environment's Guidelines for Translocation of Plant Species at Risk in British Columbia (Maslovat 2009). Translocation of endangered plants is generally thought to have a low likelihood of success and should be considered a follow-up monitoring opportunity, rather than a means to relocate occurrences to prevent their loss.	Section 5(2)(a)
Habitat alteration and fragmentation: Construction and operations Old growth, grasslands, wetlands, and rare plants	All activities that involve potentially harmful or toxic substances such as oil, fuel, antifreeze, and concrete will follow approved work practices and consider the provincial BMP guidebook Develop with Care (BCMOE 2012b). All construction machinery and vehicles will be properly maintained to ensure that harmful fluids do not leak into aquatic environments or other sensitive areas. Prior to initiating construction activities in proximity to any water body, the hydraulic, fuel, and lubrication systems of all equipment will be checked to ensure that systems are in good condition and free of leaks. Biodegradable hydraulic fluids will be considered for	Section 5(1)(a) Section 5(2)(a)

Project Interaction/Potential Effect	Proposed Mitigation	CEAA s. 5
	machines used for in-stream works. All machines will have a spill kit, and operators will be educated its use. Maintenance and refuelling will be conducted at a designated area at an approved distance from watercourses. BC Hydro's fuel handling and storage management plan (Section 35.2.2.11 in Volume 5 Section 35 Summary of Proposed Environmental Management Plans) will include appropriate planning for fuel handling and storage, spill prevention, and emergency response.	
Habitat alteration and fragmentation: Construction and operations Tufa seeps, grasslands, wetlands, and rare plants	A Vegetation and Invasive Plant Management Plan (Section 35.2.2.22 in Volume 5 Section 35 Summary of Proposed Environmental Management Plans) will be developed and implemented during the entire construction phase (including restoration) and integrated during operations. The plan will be designed using the locations of known rare plant or sensitive site occurrences and locations of high-suitability habitats as inputs. Weed control efforts will be coordinated with the rare plant botanists to ensure that effects to occurrences are avoided or reduced.	Section 5(1)(a) Section 5(2)(a)
Habitat alteration and fragmentation: Construction and operations Grasslands, wetlands, and rare plants	Disturbed sites will be replanted quickly with ground cover, shrubs, or trees that are regionally appropriate once erosion concerns have been addressed. This will be part of BC Hydro's Soil Management, Site Restoration and Revegetation Plan (Section 35.2.2.19 in Volume 5 Section 35 Summary of Environmental Management Plans). Additional mitigation measures to reduce the spread of invasive species are described below. Prior to work commencing, surveys will be conducted to identify invasive species populations. Treatment will be initiated as required. All vehicles entering and leaving work sites will be washed thoroughly, with special attention to wheel wells, tire treads, and tracks where mud and seeds of noxious weeds may be lodged. Wash areas will be located away from any water body and riparian areas. Used wash water will be treated to prevent seed dispersal.	Section 5(1)(a) Section 5(2)(a)
Habitat alteration and fragmentation: Operations Old growth, wetlands and rare plants	BC Hydro has considerable experience managing and maintaining an extensive transmission line network within the province, including the existing transmission corridor along which the new lines will be constructed. The Integrated Vegetation Pest Management Plan for Transmission Line Rights-of-Way (BC Hydro 2010) will be followed in order to reduce or avoid the spread of invasive species during the operations phase of the transmission line and the Pest Management Plan For Management of Vegetation at BC Hydro Facilities (BC Hydro 2012b) will be used to manage invasive species at other Project facilities.	Section 5(1)(a) Section 5(2)(a)
Habitat alteration and fragmentation: Construction Wetlands and rare plants	With the creation of the Project, BC Hydro will fund a compensation program. This program would include: • A survey of habitat enhancement projects in the RAA will be conducted to identify projects that might provide compensation for rare and sensitive habitats and protect occurrences of rare plants (e.g., wetlands). If suitable habitat enhancement projects can be found, BC Hydro will provide assistance (financial or in-kind) to the managing organization. The inventories will also identify areas that are under threat from development or in need of habitat enhancement. Where opportunities exist, BC Hydro will	Section 5(1)(a) Section 5(2)(a)

Project Interaction/Potential Effect	Proposed Mitigation	CEAA s. 5
	consider direct purchase – if offered for sale – and management of these lands to enhance or retain rare plant values. BC Hydro will also consider contributing to other protection options where direct purchase is not feasible. BC Hydro will fund or undertake targeted surveys in the RAA to locate additional occurrences of the 18 directly affected rare plant species that the Conservation Framework identifies as requiring additional inventories (Table 13.14). Full element occurrence data will be collected and transmitted to the B.C. Conservation Data Centre for each additional occurrence found.	
Habitat alteration and fragmentation: Construction Rare plants	BC Hydro will fund or undertake a study in an attempt to clarify the taxonomy of Ochroleucus bladderwort. This is the only species of the 34 directly affected taxa for which the Conservation Framework identifies further taxonomic research as being required for its conservation. The study plan will be developed in consultation with the B.C. Conservation Data Centre and may include field, herbaria, and genetic work.	Section 5(2)(a)
	Follow-up Program Objective(s): To evaluate success of rare plant translocation and understand responses to disturbance: these will be monitored and reported to provide an understanding of success **Description:** The selection of candidate species, identification of suitable sites, and further establishment of the study design will be discussed with specialists. **Frequency:** Annual **Duration:** During construction and first 10 years of operations	Section 5(2)(a)
	Follow-up Program Objective(s): To document the adequacy of habitat enhancement and possible compensation programs to document their progress in meeting expectations **Description:** Measurement criteria will include vegetation growth, persistence of rare plants and success of invasive plant species. **Frequency:** Annual **Duration:** During construction and first 10 years of operations	Section 5(2)(a)
Wildlife Resources		
Effects on wildlife resources during construction and operations	Refine Project boundaries and select the most appropriate construction methods, equipment, material, and timing of activities. Additional mitigation measures to consider include environmental protection measures such as establishment of no-or restricted-activity buffer zones around wildlife features, Best Management Practices (BMPs) and protocols, and engineering standards. Where feasible, mitigation measures can be refined based on consultation with federal and provincial regulatory agencies and Aboriginal group. Table 4.1 in Section 4.1 Project Evolution summarizes changes that have been incorporated into the project design to avoid project effects (Table 4.1 has been duplicated above in section 39.1)	Section 5(1)(a) Section 5(1)(c) Section 5(2)(a)
Habitat Alteration and Fragmentation	Efforts on this Project have been made to use existing corridors, deactivate temporary access roads, and minimize disturbance where possible, to help minimize fragmentation. Project components where this has occurred include: • **Substation and Transmission Lines to Peace Canyon Dam:** building the transmission lines adjacent to the existing line, therefore using the existing	Section 5(1)(a) Section 5(1)(c) Section 5(2)(a)

Project Interaction/Potential Effect	Proposed Mitigation	CEAA s. 5
	corridor and maintenance access roads • **Highway 29 Realignment:** use portions of existing roads and select borrow sites that already exist or would be covered by the reservoir • **Quarried and Excavated Construction Materials:** further develop existing quarry sites such as Wuthrich, Del Rio, and West Pine, and use a site that has already seen development – the 85th Avenue Industrial Lands. • **Road and Rail Access:** use existing infrastructure for moving material, upgrade existing access roads, and deactivate temporary roads used for reservoir clearing, and place the Project access road to the dam site area along the existing transmission line corridor	
Habitat alteration and fragmentation: construction and operations Wetlands and wetland-associated key indicators: amphibians and reptiles, butterflies and dragonflies, migratory birds, raptors, bat	All known wetland locations (e.g., breeding habitat for butterflies and dragonflies, amphibians, migratory birds), snake hibernacula, bat hibernacula, Sharp-tailed Grouse lek sites, beaver lodges, and large raptor stick-nest locations would be provided as inputs during the final design phase so further reductions and avoidances can be considered. If work is required immediately adjacent to any wetlands, then appropriate barriers and no-or restricted-activity buffer zones would be established to avoid direct disturbance to these sites. Habitat would be cleared in the approved areas only and construction would be monitored to prevent any unnecessary clearing. Construction and maintenance activities in and around watercourses and wetlands would conform to BC Hydro‘s regulator-accepted practices including Approved Work Practices for Managing Riparian Vegetation (BC Hydro et al. 2009). New wetland habitat areas would be created as partial compensation for wetland loss due to the reservoir. Consideration for creating areas that are fish-free would be included to minimize the effects of fish predation on invertebrate and amphibian eggs and larvae and young birds.	Section 5(1)(a) Section 5(1)(c) Section 5(2)(a)
Habitat alteration and fragmentation: Construction and operations Wetlands and wetland-associated key indicators: amphibians and reptiles, butterflies and dragonflies, migratory birds, raptors, bats	Measures would be implemented to maintain existing hydraulic patterns as much as possible if roads cannot avoid wetlands. Ditches, culverts, and other structures would be placed to maintain the natural drainage patterns and allow the movement of flows.	Section 5(1)(a) Section 5(1)(c) Section 5(2)(a)
Habitat alteration and fragmentation: Construction and operations All key indicators: • Introduction of deleterious substances • Erosion and sedimentation • Hydrocarbon and hazardous materials management • Invasive species management	Construction and maintenance activities in and around watercourses and aquatic habitats would conform to BC Hydro‘s accepted work practices with additional input from Standards and Best Practices for Instream Works (B.C. Ministry of Water, Land and Air Protection 2004b) and the Land Development Guidelines for the Protection of Aquatic Habitat (Chilibeck et al. 1992), which are designed to reduce sedimentation and avoid introduction of deleterious substances to aquatic environments. BC Hydro would have an Erosion Prevention and Sediment Control Plan (Section 35.2.2.9 in Volume 5 Section 35 Summary of Proposed Environmental Management Plans) as part of their Construction Management Framework. Stripping vegetation and soils would be minimized as much as possible, taking into consideration proximity to sensitive habitats, e.g., wetlands, and slope stability.	Section 5(1)(a) Section 5(1)(c) Section 5(2)(a)

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	Within the reservoir, a hierarchal decision matrix has been developed for clearing to reduce erosion potential along steep, unstable slopes and along riparian zones for all defined watercourses. Specifically, the decision matrix includes: • Retention of all trees in areas with steep, unstable slopes that would be highly susceptible to landslides if the vegetation was removed • Retention of non-merchantable trees and vegetation within riparian areas around existing water bodies within a 15 m buffer from the high water mark. Merchantable trees may still be removed using clearing practices, in order to maintain a 15 m machine-free zone. These same standards would be employed in other work areas and would follow BC Hydro's approved work practices. Stormwater management would aim to control runoff and direct it away from work areas where excavation, spoil placement, and staging activities occur. Consideration for maintaining recharge levels to wetlands would be considered when diverting water around work sites, providing there is not expected to be a measurable increase in sediment transport to these sensitive areas. A Surface Water Quality Management Plan (Section 35.2.2.21 in Volume 5 Section 35 Summary of Proposed Environmental Management Plans) would be developed as part of BC Hydro's Construction Environmental Management Framework. Cleared areas that will not have permanent features would be replanted with appropriate vegetation in order to promote soil stability. Regionally appropriate vegetation would be included in the reclamation activities. BC Hydro would develop a Soil Management, Site Restoration and Revegetation Plan (Section 35.2.2.19 in Volume 5 Section 35 Summary of Proposed Environmental Management Plans). All activities that involve potentially harmful or toxic substances, such as oil, fuel, antifreeze, and concrete, would follow approved work practices and consider the provincial BMP guidebook Develop with Care (B.C. Ministry of Environment 2012). BC Hydro would have a Fuel Handling and Storage Management Plan (Section 35.2.2.11 in Volume 5 Section 35 Summary of Proposed Environmental Management Plans). This plan would include the need for all construction machinery and vehicles to be properly maintained to ensure that harmful fluids do not leak into aquatic environments or other sensitive areas. Prior to initiating construction activities in proximity to any water body, the hydraulic, fuel, and lubrication systems of all equipment would be checked to ensure that systems are in good condition and free of leaks. All machines would have a spill kit and operators would be educated on how to use the kit. Minimum distances between maintenance and refuelling sites and water bodies would be specific in the plan. BC Hydro's Construction Environmental Management Framework would include an Emergency Response Plan (Section 35.2.1.1 in Volume 5 Section 35 Summary of Proposed Environmental Management Plans) as well as a Hazardous Waste Management Plan (Section 35.2.2.13 in Volume 5 Section 35 Summary of Proposed Environmental Management Plans). Herbicide application would be used to control invasive plants and for the maintenance of some vegetation along the transmission line and at project facilities.	

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	The use of herbicides is described in BC Hydro's Pest Management Plan for Management of Vegetation at BC Hydro Facilities (BC Hydro 2012) and Integrated Vegetation Management Plan for Transmission Rights-of-way (BC Hydro 2010). Disturbed sites would be replanted quickly with ground cover, shrubs, or trees that are regionally appropriate, once erosion concerns have been addressed per BC Hydro's Soil Management Site Restoration and Revegetation Plan. A Wildlife Management Plan (Section 35.2.2.24 in Volume 5 Section 35 Summary of Proposed Environmental Management Plans) and Vegetation and Invasive Plant Management plan (Section 35.2.2.22 in Volume 5 Section 35 Summary of Proposed Environmental Management Plans) would also be included, defining objectives for limiting invasive species by monitoring the presence and possible spread of invasive plants in temporarily disturbed areas, as well as the success of revegetation programs. Mitigation measures to reduce the spread of invasive species include: • Prior to work commencing, surveys would be conducted to identify invasive species populations. Treatment would be initiated as required • All vehicles entering and leaving work sites would be washed thoroughly, with special attention to wheel wells, tire treads, and tracks where mud and seeds of noxious weeds may be lodged • Locating wash areas away from any water body and riparian areas • Treating used wash water to prevent seed dispersal The Pest Management Plan for Management of Vegetation at BC Hydro Facilities (BC Hydro 2012) and the Integrated Vegetation Management Plan for Transmission Rights-of-Way (BC Hydro 2010) would be followed in order to reduce or avoid the spread of invasive species during the operations phase of the Project.	
Habitat alteration and fragmentation: Construction Loss of snake hibernacula	As mitigation for the loss of snake hibernacula, artificial dens would be considered during habitat compensation. These artificial dens would be located on warm aspect slopes in open areas away from major roads.	Section 5(2)(a)
Habitat alteration and fragmentation: Construction Loss of nesting habitat: migratory birds	Nest boxes for cavity-nesting waterfowl would be incorporated into wetland mitigation plans. Additional boxes would be established within riparian vegetation zones established along the reservoir on BC Hydro-owned properties, where feasible. The feasibility of placing small floating islands along some areas within the reservoir would be examined. Based on present land ownership, it is estimated there would be over 300 ha of BC Hydro-owned Cultivated Field remaining after the reservoir is filled. A portion of these fields would be managed to provide some breeding habitat for Northern Harrier and Short-eared Owl. Wetland compensation would also address some habitat losses for these two species.	Section 5(1)(a)
Habitat alteration and fragmentation: Construction Bats	Bat roosting habitat features would be considered for incorporation into new bridge designs. This can be achieved following published guidelines (Keely and Tuttle 1999; Johnston et al. 2004; Gore and Studenroth 2005) without compromising bridge safety or structural integrity. Bridge night roosts are currently the only public sites within the Peace River valley where relatively large numbers of bats can be captured in a night. Bat boxes may be installed on free-standing poles or on facility walls where their	Section 5(2)(a)

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	presence would not interfere with facility operations and maintenance. The feasibility of incorporating bat boxes onto mounting poles being used for artificial eagle nest sites would be examined. Bat boxes should be situated where they will get at least 10 hours of sun to provide warm conditions for maternity roosts. Additional information on design, construction, and installation of bat boxes is available from Bat Conservation International (2012). Balsam poplar and aspen would be considered in plantings when reclaiming disturbed habitats and when enhancing habitat for wildlife compensation. Deciduous trees would provide future roosting habitat for bats. Once rock extraction is complete at Portage Mountain, opportunities for creating hibernating and roosting sites would be explored. This can include leaving deep drill holes at least 3 m deep in remaining rock faces, and creating roost microsites on warm aspects that are inaccessible to predators.	
Habitat alteration and fragmentation: Construction and Operations Fisher	The fisher population, particularly south of the Peace River, is lower than initial estimates, based on habitat availability and provincial density. Throughout its range, fur harvest, timber harvest, predator control, and urbanization have been the greatest contributors to fisher population declines (Lofroth et al. 2010). Mitigation measures that limit these factors may increase the population. Create natural or artificial piles of coarse woody debris dispersed throughout the disturbed landscape to maintain foraging areas and cold-weather rest sites. Focus on younger plateau forest where coarse woody debris is limited. Create arboreal resting sites. Spruce rust broom was found to be rare in the Peace River valley, primarily due to the lack of coniferous forests. Creating rust broom-like structure in deciduous stands may provide additional resting opportunities for fisher. Provide artificial den boxes within forested stands that have limited den trees.	Section 5(1)(c)
Habitat alteration and fragmentation: Construction and Operations Ungulates	BC Hydro would continue to manage lands it owns to the east of the Halfway River and west of Wilder Creek to maintain values of these areas as winter range and their accessibility.	Section 5(1)(c)
Disturbance and displacement: • Migratory birds, non-migratory birds, raptors • Timing of works • Lighting • Roads	The clearing of vegetation for all work would consider both the Migratory Bird Convention Act and the B.C. Wildlife Act, where active nests are protected from disturbance and removal. The provincial government has developed least-risk windows for terrestrial wildlife that are of management concern within the Peace Region of the B.C. Ministry of Forests, Lands and Natural Resource Operations. Suggested critical time periods when construction should be avoided are: • Songbirds: May 1 through July 31, when nesting could occur (B.C. Ministry of Forests, Lands and Natural Resource Operations 2011) • Trumpeter Swan, raptors and owls: April 1 through July 31 Goddard (2010) observed lek attendance by Sharp-tailed Grouse between mid-April and mid-May in the Peace River region, and a nesting initiation to hatching date range from early May to mid-July. There is no specific mention for grouse within the least-risk windows, but nesting overlaps the critical time frame suggested for raptors. Clearing activities for much of the area are presently scheduled to occur during the	Section 5(1)(a) Section 5(1)(c) Section 5(2)(a)

Project Interaction/Potential Effect	Proposed Mitigation	CEAA s. 5
	winter months, thereby avoiding conflicts with nesting birds (see Volume 1 Appendix A Vegetation, Clearing, and Debris Management Plan). Scheduling constraints may require clearing activities to occur outside the winter months. If clearing work during the critical bird breeding season outlined above cannot be avoided, a nest and lek search protocol would be developed and implemented prior to clearing, to avoid disturbance to active nests. The protocol would be developed in consultation with Environment Canada, Canadian Wildlife Service, and the Ministry of Environment. The protocol would outline buffers required around active nest sites. As feasible, lighting would be focused on work sites, minimizing light pollution in surrounding areas. During construction, access would be restricted on roads used by work crews. Temporary roads would be closed and reclaimed when no longer needed.	
Disturbance and displacement: construction and operations Butterflies and dragonflies, amphibians and reptiles, migratory birds, non-migratory birds, raptors, bats, fur-bearers, ungulates, and large carnivores	BC Hydro uses a GIS-based mapping system for recording, storing, and analyzing information for managing resources along all of its rights-of-way. The information is reviewed when developing vegetation management prescriptions during operations. If occurrences for rare species (e.g., Yellow Rail) are known along the transmission line right-of-way or are adjacent to generation facilities, the location of these sites would be incorporated into the database for future planning and consideration, so as to minimize or avoid unnecessary disturbance.	Section 5(1)(a) Section 5(1)(c) Section 5(2)(a)
Disturbance and displacement: construction and operations Caribou	Stop operation in the West Pine Quarry during January and March to avoid interaction with caribou during critical winter months.	Section 5(1)(c)
Displacement and disturbance: Construction Sharp-tailed Grouse	All known lek locations would be provided as inputs during the final design phase so further reductions and avoidances are considered. If new construction sites are added or the area where disturbance is to occur is poorly understood, the new areas would be checked to confirm if leks are present and possible ways to minimize disturbance. If work is required immediately adjacent to any leks, then appropriate barriers would be added so as to instruct construction personnel to avoid these sites. Habitat would be cleared in the approved Project activity zone only, and construction would be monitored to prevent any unnecessary clearing.	Section 5(1)(c)
Disturbance and displacement: Construction Bald Eagle nests	The baseline data on Bald Eagle nest sites from 2011 would be updated prior to commencement of construction to ensure an accurate understanding of the number of nests that would be affected by the Project. To mitigate the loss of Bald Eagle nests within the proposed reservoir, new nesting platforms would be erected along the expected reservoir shoreline. Platforms would be designed to be attractive to nesting Bald Eagles – i.e., platform suitable for supporting a large stick-nest, with structures extending above the platform to provide perch sites for adults and juveniles prior to fledging – and would be placed in areas removed from potential human disturbance. The Best Management Practices for Raptor Conservation during Urban and Rural Land Development in British Columbia (Demarchi et al. 2005) provides further guidance. For each active nest lost due to the Project, two nesting structures would be provided; the two-to-one ratio is proposed by BC Hydro.	Section 5(1)(c)

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	Bald Eagle nests are typically located adjacent to water. With construction lasting up to eight years, it is possible Bald Eagles would not use the newly erected platforms until the reservoir is filled. Bald Eagle nests confirmed active the year clearing is started within the reservoir, and outside the dam construction area would be retained through the entire construction phase until reservoir filling is initiated. Nests that could be lost during seasonal flooding associated with Stage 2 dam construction would be removed to limit displacement or possible mortality. Appropriate government approvals and permits would be obtained prior to removing any nest. For active nests retained through construction, a no-clearing buffer centred on each active nest would be employed.	
Disturbance and displacement: Construction and Operations • Large carnivores	Preventative measures would be used to avoid creating human-bear conflicts. Before commencement of work, all crews should participate in a Bear Aware™ or similar training program. Feeding of wildlife (including birds) would be prohibited at work sites. Construction areas and worker housing sites would be fenced and kept clean and free of waste, with garbage securely stored in bear-proof containers or removed from site. Trucks and work vehicles are not secure storage areas for garbage, because bears have been known to break into vehicles for food (Davis et al. 2002). Work crews would be prohibited from hunting and cleaning game around construction sites. If precautions to remove bear attractants such as food and garbage are not effective in deterring aggressive bears from construction areas, the Environmental Monitor would notify a Conservation Service Officer that a potential ―problem bear‖ is in the area. A bear would only be classified as a ―problem bear‖ if: • It shows repeated interest in people and their facilities • It is heavily habituated to people and has repeatedly obtained unnatural foods • It displays aggressive behaviour (unprovoked charges or predatory behaviour) and is an imminent threat to human safety The Conservation Service Officer would determine whether further actions, such as more aggressive aversive conditioning (e.g., use of rubber bullets, hard capture and release, etc.), translocation, or destruction of the bear are necessary, and would advise about how to ensure worker safety. A detailed Human-Bear Conflict Management Plan would be developed for the Project.	Section 5(1)(c)
Mortality: Construction and Operations • Migratory birds, non-migratory birds, raptors • Timing of works • Collision and electrocution mortality	The clearing of vegetation for all work would consider both the *Migratory Bird Convention Act* and the B.C. *Wildlife Act,* where active nests are protected. The provincial government has developed least-risk windows for terrestrial wildlife that are of management concern within the Peace Region of the B.C. Ministry of Forests, Lands and Natural Resource Operations (see above in Disturbance and Displacement mitigation). Clearing activities for much of the area are presently scheduled to occur during the winter months, thereby avoiding conflicts with nesting birds (see Volume 1 Appendix A Vegetation, Clearing, and Debris Management Plan). Scheduling constraints may	Section 5(1)(a) Section 5(2)(a)

Project Interaction/Potential Effect	Proposed Mitigation	CEAA s. 5
	require clearing activities to occur outside winter months. If clearing work during the critical bird breeding season outlined above cannot be avoided, a nest and lek search protocol would be developed and implemented prior to clearing to avoid disturbance and possible mortality to nesting birds. The protocol would be developed in consultation with Environment Canada, Canadian Wildlife Service, and the Ministry of Environment. The protocol would outline buffers required around active nest sites. The design of the transmission towers reduces the risk of collision and electrocution by: 1. BC Hydro's standard design has all of the conductors in the same horizontal plane. This configuration will be used unless there is a requirement to reduce the right-of-way. 2. The standard phase-to-phase spacing (distance between the lines) for 500 kV transmission lines is approximately 10 meters and phase-toground (conductors to the tower body) is over 3 meters so the risk of electrocution by contacting two phases or one phase and the tower is virtually non-existent.	
Mortality: Construction • Butterflies and dragonflies, amphibians and reptiles, migratory birds, non-migratory birds, raptors, bats, fur-bearers, ungulates and large carnivores • Introduction of deleterious substances • Erosion and sedimentation • Hydrocarbon and hazardous materials management • Invasive species management	The project would avoid the release of deleterious hydrocarbons and other hazardous materials by conforming to BC Hydro's accepted work practices with additional input from Standards and Best Practices for Instream Works (B.C. Ministry of Water, Land and Air Protection 2004b) and the Land Development Guidelines for the Protection of Aquatic Habitat (Chilibeck et al. 1992), which are designed to reduce sedimentation and avoid introduction of deleterious substances to aquatic environments. Mortality due to sedimentation would be reduced or avoided following similar plans, e.g., BC Hydro would have an Erosion Prevention and Sediment Control Plan (Section 35.2.2.9 in Volume 5 Section 35 Summary of Proposed Environmental Management Plans) as part of their Construction Management Framework. Surface water quality would be monitored to ensure it does not exceed established guidelines for aquatic life (see Volume 2 Appendix E Water Quality Baseline Conditions in the Peace River). BC Hydro would follow their Pest Management Plan for Management of Vegetation at BC Hydro Facilities (BC Hydro 2012) and Integrated Vegetation Management Plan for Transmission Rights-of-Way (BC Hydro 2010) for the use of herbicides. This includes consideration for use around wetlands and species at risk.	Section 5(1)(a) Section 5(1)(c) Section 5(2)(a)
Mortality: Construction and Operations • Butterfly and dragonfly, amphibians and reptiles • Predation	A portion of the wetlands created to compensate for habitat loss would be designed to remain fish-free to eliminate predation to invertebrates (dragonfly larva) and amphibians and reptiles.	Section 5(2)(a)
Mortality: Construction and Operations • Amphibians and reptiles, mammals • Roads	Road mortality for both amphibians and snakes was documented during baseline studies and is expected to occur during Project construction, as many roads have multiple users. During detailed road design, efforts would be made to minimize or avoid additional losses. Where roads are adjacent to wetlands or amphibian migrations across roads are anticipated, fencing would be placed along the length of the road to guide amphibians through structures designed for wildlife passage under the road. The size and number of the structures needed and the length of fencing	Section 5(1)(c) Section 5(2)(a)

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	would be determined in consultation with regulators. Road mortality of mammals is expected to occur during Project construction. Measures to minimize road mortality include: • Reducing vehicle traffic by using buses and car-pooling for workers • Requiring workers to adhere to strict speed limits • Instructing workers that wildlife has right-of-way unless there are safety concerns • Maintaining a logbook of wildlife sightings, including roadkills, and posting warning signs at locations with frequent wildlife crossings • Promptly moving roadkill well off the road to avoid secondary mortality of scavengers • Including wildlife-vehicle collisions as safety issues for discussion on worker tailboard meetings Temporary workers involved in on-site Project construction would be encouraged not to hunt in the LAA. Prohibit that possession or storage of firearms or weaponry within the facilities or project activity zone.	
Mortality: Construction and Operations • Mammals • Roads	Mammal mortality associated with filling the reservoir can be reduced by clearing forested habitat – potential roosting and cover sites for bats and fisher – before flooding begins. Clearing should take place during late fall and winter before the birthing season and when bats are not present or are in hibernacula. Scheduling of construction activities should follow guidance in Peace Region Selected Terrestrial and Aquatic Wildlife Least Risk Windows (B.C. Ministry of Forests, Lands and Natural Resource Operations 2011).	Section 5(1)(c) Section 5(2)(a)
Mortality: Construction and Operations • Large carnivores	Preventative measures would be used to avoid creating human-bear conflicts. Before commencement of work, all crews should participate in a Bear Aware™ or similar training program. Feeding of wildlife (including birds) would be prohibited at work sites. Construction areas and worker housing sites would be fenced and kept clean and free of waste, with garbage securely stored in bear-proof containers or removed from site. Trucks and work vehicles are not secure storage areas for garbage, because bears have been known to break into vehicles for food (Davis et al. 2002). Work crews would be prohibited from hunting and cleaning game around construction sites. If precautions to remove bear attractants such as food and garbage are not effective in deterring aggressive bears from construction areas, the Environmental Monitor would notify a Conservation Service Officer that a potential ―problem bear‖ is in the area. A bear would only be classified as a ―problem bear‖ if: • It shows repeated interest in people and their facilities • It is heavily habituated to people and has repeatedly obtained unnatural foods • It displays aggressive behaviour (unprovoked charges or predatory behaviour) and is an imminent threat to human safety The Conservation Service Officer would determine whether further actions, such as more aggressive aversive conditioning (e.g., use of rubber bullets, hard capture and release, etc.), translocation, or destruction of the bear are necessary, and would	Section 5(1)(c)

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	advise about how to ensure worker safety. A detailed Human-Bear Conflict Management Plan would be developed for the Project. Mitigation for wolves will include previously-described measures for minimizing road traffic, deactivation and reclamation of temporary construction roads, maintaining clean worksites and camps, and encouraging temporary workers to not hunt in the LAA. Filling the reservoir during the fall will prevent potential drowning of young pups. It should be noted that mitigation is not designed to promote increases in the wolf population as that would conflict with the current regional goal of reducing wolf predation on livestock and ungulates.	
	Follow-up Program Objective(s): To verify the accuracy of the effects assessment and to determine the effectiveness of the measures implemented to mitigate the adverse effects of the Project on wildlife resources during construction and operations **Description:** Targeted mitigation monitoring studies will include monitoring of: • Bald Eagle nesting populations adjacent to the reservoir, including use of artificial nest structures • Waterfowl and shorebird use in natural wetlands, created wetlands, and artificial wetland features • The effectiveness of artificial den creation for fishers • The effectiveness of toad migration crossing structures installed along Project roads Directed studies will include surveys of: • Songbird populations and ground-nesting raptors during construction and operations • Western toad and garter snake distribution downstream of the dam • Monitoring of mercury level in Kingfisher **Frequency:** Annual **Duration:** During construction and first 10 years of operations	Section 5(1)(a) Section 5(1)(c) Section 5(2)(a)
Greenhouse Gases		
Substation and Transmission Line to Peace Canyon Right-of-way vegetation maintenance Maintenance of access roads	Emissions are expected to be nominal and are very unlikely to be considered important on the regional or provincial scale due to standard mitigation regarding fuel conservation, fleet management and trip reduction	Section 5(1)(b)
Emission of GHGs from construction activities	Implement fleet management measures to reduce fuel consumption and increase fuel efficiency. (see Volume 2 Section 35 Summary of Environmental Management Plans) Initiatives to mitigate the GHG emissions have been incorporated into the design of the Project.	Section 5(1)(b)
Release of GHGs during operation	Reduce the long-term conversion of land while still achieving the purpose of the Project. This was taken into consideration in the design of the Project.	Section 5(1)(b)
	Follow-up Program Objective(s): To verify the accuracy of the GHG estimates and predictions presented in this EIS **Description:** Monitor changes in GHG emissions from Site C reservoir. **Frequency:** Annual **Duration:** First 10 years of operations	Section 5(1)(b)
	Follow-up Program Objective(s): To verify the accuracy of the GHG estimates and predictions presented in this EIS	Section 5(1)(b)

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	Description: Monitor and report GHG emissions during operation and maintenance activities. in accordance with BC Hydro corporate requirements, and report results to the province or other organizations per corporate reporting requirements **Frequency:** In accordance with BC Hydro reporting requirements **Duration:** In accordance with BC Hydro reporting requirements	
Local Government Revenue		
Dam, Generating Station, and Spillways and Reservoir Operations -Component Level Interactions	Grants-in-lieu as determined by the provincial government is a well-understood and previously used mitigation for similar BC Hydro projects. Once operational, BC Hydro will provide annual grants-in-lieu payments to local governments as directed by provincial funding obligations order-in-council.	N/A
Change in local government revenue – increased costs to serve residents, damage to infrastructure	Local governments may experience increased costs related to meeting the demands of new local residents and Project workforce camp populations, or may have infrastructure that, if affected and not mitigated, would increase local government expenditures. To mitigate this change, Volume 4 Section 30 Community Infrastructure and Services further identifies adverse effects and mitigation and monitoring measures as appropriate. Permanent inundation of land no longer available for development will be addressed by providing a one-time contribution of $160,000 to the District of Hudson's Hope within one year of reservoir filling.	N/A
Labour Market		
Dam, Generating Station, and Spillways and Reservoir Operations -Component Level Interactions	Interactions are nominal relative to current and projected regional employment/ economic/ population/ housing/ infrastructure activities.	N/A
Change in demand for direct and indirect construction phase labour A comparison of the Project labour requirements against the baseline and forecast local labour supply and demand by skill category, where the data are available	Augment labour supply through recruitment and enhancing local labour market participation rate. Recruitment: • Access labour pools outside of the region, and attract new entrants to the local labour force (including mobile workers). • Encourage contractors to hire locally available workers with the requisite skills. • Facilitate regional job fairs to provide a venue for local workers to meet with contractors. Enhancing local labour market participation rate: Enhance local labour market participation via training and skill development, focused on increasing the local labour market participation rate and skill level of LAA population: • Provide $1 million to the Northern Lights College Foundation to fund student bursaries, focusing on trades and skills training to support the development of skilled workers in the LAA • Enter into a three-year (2011-2014) funding agreement with Northern Opportunities, a partnership of the school districts of Fort Nelson, Peace River North, and Peace River South, Northern Lights College, local First Nations, industry and local communities, with the objective of providing young people with a seamless learning pathway from secondary school to post-secondary training, which is open to Aboriginal and non-Aboriginal	N/A

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	students • Participate in regional workforce training initiatives, such as the Northeast Regional Workforce Table Task Force, to support alignment of training programs with the need for skilled workers to meet the needs of northeast B.C. • May work with contractors and labour organizations to identify apprenticeship opportunities during construction • Provide additional daycare spaces in the Fort St. John area to increase spousal participation in the labour market Support Aboriginal training initiatives and students: • Consider commitments respecting capacity building, education, and training associated with Aboriginal participation in the labour market • Support training, industry, and Aboriginal partnership opportunities in the region • Support the North East Native Advancing Society (NENAS) with $100,000 in funding over two years (2013-2014) to support trades training under its North East Aboriginal Trades Training Program • Dedicate $500,000 of the $1 million provided to Northern Lights College to Aboriginal student bursaries with a priority given to Treaty 8 First Nations in British Columbia. • Develop a plan for inclusion of Aboriginal persons in its Project contracted workforce, including communication of employment opportunities, and evaluation criteria for hiring and training Aboriginal persons in contractor procurement packages	
Regional Economic Development		
Dam, Generating Station, and Spillways and Reservoir Operations Component Level Interactions	Interactions are nominal relative to current and projected regional employment/ economic/ population/ housing/ infrastructure activities.	N/A
Change in business opportunities during construction Change in business and contracting profile, capabilities and capacity during construction	General Population: • Implement Business Participation Strategy to increase awareness in the business community about Project procurement opportunities (refer to Volume 1 Appendix F Project Benefits Supporting Documentation) • Partner with local business organizations and with economic development offices and programs to deliver business information sessions and to communicate contracting opportunities • Mitigation in the Labour Market assessment will also contribute to expansion and diversification of the contractor profile, capabilities, and capacity. Aboriginal Peoples: • Continue outreach initiatives to make Aboriginal businesses aware of Project contracting opportunities • Where identified by Aboriginal groups as an interest, BC Hydro will consider commitments respecting capacity building, education, and training associated with Aboriginal participation in labour market opportunities • Implement a Business Participation Strategy: continue to notify Aboriginal	N/A

Project Interaction/Potential Effect	Proposed Mitigation	CEAA s. 5
	groups of business information sessions, and about opportunities to register with BC Hydro's Aboriginal Business Director (refer to Volume 1 Appendix F Project Benefits Supporting Documentation) • Continue to engage directly with the Aboriginal business community in the LAA and elsewhere in the province, including providing opportunities to sponsor and participate in Aboriginal business events and conferences • BC Hydro's Aboriginal Contract and Procurement Policy includes a commitment to increasing Aboriginal participation in providing its goods and services. Activities to achieve this objective include set-asides, direct awards, select tenders, and the inclusion of Aboriginal content in bidding documents • BC Hydro will seek information from Aboriginal suppliers in the LAA, and from other Aboriginal groups with whom BC Hydro is engaged, about their business capacity and capabilities to provide goods and services for the Project	
Current Use of Land and Resources for Traditional Purposes		
Changes in fishing opportunities and practices during construction and operations	Consider developing fish habitat compensation projects that align with BC Hydro compensation programs. Develop a communications program to inform harvesters of planned or unplanned events related to construction activities that may affect fishing opportunities or access. Develop a communications program to inform harvesters of longer-term changes in fish community composition. Provide information to the Province of Alberta to assist in communicating with anglers in Alberta. Implement mitigation measures set out in Volume 2 Section 12 Fish and Fish Habitat. Implement measures supporting the development of 3 boat launches along the Site C reservoir accessible via Highway 29 to support navigability and navigable use, and the re-establishment of recreational sites on the Site C reservoir and downstream, and to re-establish and create new use patterns and access, as set out in Volume 3 Section 26 Navigation	Section 5(1)(c)
Changes in hunting and trapping opportunities and practices during construction and operations	Consider developing wildlife habitat compensation projects that align with BC Hydro compensation programs. Develop mitigation measures intended to decrease impacts on First Nation trap lines in the Project activity zone. Financial compensation for Aboriginal and non-Aboriginal trap line holders Monitor effects to trap lines Develop a communications program to inform harvesters of planned or unplanned events related to construction activities that may affect hunting and trapping opportunities or access. Implement mitigation measures set out in Volume 2 Section 14 Wildlife Resources. Implement all mitigation measures set out in Volume 3 Section 24 Harvest of Fish and Wildlife Resources pertaining to trapping.	Section 5(1)(c)
Changes to other cultural and traditional uses of land	Work with Aboriginal groups to ground truth traditional land use information for	Section 5(1)(c)

Project Interaction/Potential Effect	Proposed Mitigation	CEAA s. 5
during construction and operations	specific areas within the Project activity zone prior to commencing construction, e.g., when determining the exact location of an access road. Develop a communications program to inform harvesters of planned or unplanned events that may affect opportunities to harvest plants, berries, and other resources. Consider developing habitat compensation projects that align with BC Hydro compensation programs. Work with Aboriginal groups to identify permanent habitation structures used in the current use of lands and resources for traditional purposes that may be lost to inundation. Effects on cabins associated with tenured trap lines will be addressed as set out in Volume 3 Section 24 Harvest of Fish and Wildlife Resources. Where untenured cabins may be impacted by the Project, BC Hydro will work with Aboriginal individuals to determine appropriate measures that could be implemented. Work with Aboriginal groups to identify potential sites for relocation of medicinal and food plants to compensate for areas that will be inundated. Use only indigenous and/or non-invasive plants and grasses in re-vegetation programs associated with the Project. Engage with Aboriginal groups around any reclamation phase that may present opportunities to restore ecological communities that support species of high traditional use value. Be prepared to provide support for the indigenous plant nursery owned by West Moberly and Saulteau First Nations located at Moberly Lake. The First Nations have a business plan to support propagation of a wide range of indigenous plant species for use in reclamation work. Establish a Culture and Heritage Resources Committee to provide advice and guidance on the mitigation of specific effects of the Project on culture and heritage resources. The Committee would consist of BC Hydro officials and Aboriginal members whose communities are in the immediate vicinity of the Project. Consider implementing, in consultation with Aboriginal groups and British Columbia where appropriate, the following potential initiatives: • identification and naming of key cultural sites and the potential to integrate Aboriginal names into Project operations and sites; • recording of stories and history associated with key cultural sites that may be affected by the Project; • protecting and documenting, including mapping, of important Aboriginal trails and sites; • contribute funding to sponsor a youth culture camp that includes transfer of knowledge around medicinal and food plants; • engage with Aboriginal groups to commemorate lost and/or inundated places; • engage with Aboriginal groups around potential plans to undertake ceremonies prior to the commencement of construction on key elements of the Project; and • develop and implement an education program respecting Aboriginal culture,	

Project Interaction/Potential Effect	Proposed Mitigation	CEAA s. 5
	history and use of lands and resources in the Project Area to be offered to all workers on the Project Implement mitigation measures set out in Volume 2 Section 13 Vegetation and Ecological Communities, Volume 4 Section 32 Heritage Resources, and those measures supporting the development of new shoreline recreation sites in Volume 3 Section 25 Outdoor Recreation and Tourism. Implement measures supporting the development of 3 boat launches along the Site C reservoir accessible via Highway 29 to support navigability and navigable use, and the re-establishment of recreational sites on the Site C reservoir and downstream, and to re-establish and create new use patterns and access, as set out in Volume 3 Section 26 Navigation	
	Follow-up Program Objective(s): To verify the accuracy of the predictions of potential effects and the effectiveness of mitigation measures on fishing hunting and trapping opportunities **Description:** Consider community-based monitoring programs, which may involve incorporation of local, community or traditional knowledge, where potential effects and the effectiveness of mitigation measures on fishing and hunting opportunities are uncertain, provided a sound methodology with clear indicators and outcomes is delineated. BC Hydro is prepared to engage with Aboriginal groups to discuss potential community-based monitoring programs, such as programs intended to monitor the productivity and abundance of fish and wildlife species. Monitoring and follow-up programs for fish and fish habitat are described in Volume 2 Section 12 Fish and Fish Habitat. Monitoring and follow-up programs for vegetation and ecological communities are described in Volume 2 Section 13 Vegetation and Ecological Communities. Monitoring and follow-up dealing specifically for wildlife resources are described in Volume 2 Section 14 Wildlife Resources. **Frequency:** Annual **Duration:** During construction and for the first five years of operations	Section 5(1)(c)
Agriculture		
Dam, Generating Station, and Spillways and Substation and Transmission Line to Peace Canyon Transportation of construction materials and supplies (includes quarried materials and other materials needed for all project components Reservoir Preparation and Filling Transport of merchantable timber away from the reservoir area by truck Quarried and Excavated Construction Materials West Pine Quarry Worker Accommodation Supply and transportation of goods and services for camp	Traffic Management Plan (including access restrictions where required) will mitigate effects on Land and Resource Use Valued Components. (see Volume 5 Section 35 Summary of Environmental Management Plans)	N/A
Temporary loss of agricultural land during construction and operations	Implement the following Environmental Management Plans: • Soil Management, Site Restoration and Revegetation Plan, Borrow and Quarry Site Reclamation Plan, Vegetation and Invasive Plant Management Plan	Section 5(2)(a)

Project Interaction/Potential Effect	Proposed Mitigation	CEAA s. 5
Permanent loss of agricultural land during construction and operations	Implement mitigation measures including: • Agricultural compensation fund to support projects, such as irrigation and drainage improvements • Relocation of suitable quality soil in selected locations • Inclusion of land in the Agricultural Land Reserve, based on discussions with the ALC, Crown and private landowners	Section 5(2)(a)
Effects on individual farm operations during construction • Temporary loss of land • Disruption of farming operations • Disruption of livestock movement patterns • Loss of farm infrastructure (buildings, corals, septic fields, etc) • Loss of water supplies • Changes to farm yard and field access • Changes to equipment and livestock crossings of Highway 29 • Loss of water supplies • Farm yard and field access • Equipment and livestock crossings • Changes to current and potential highway utility (water, electricity) crossings • Loss or disruption of livestock watering or drainage works • Highway traffic and congestion • Increased public access during construction • Loss of fencing • Severance or fragmentation of farm properties • Introduction and proliferation of invasive plant species • Changes to farm worker safety	• Acquire land required for the Project as outlined in Section 11.3 Land Status, Tenure and Project Requirements • Reimburse associated financial losses, mitigate or compensate for increased operational costs due to disruptions • Implement Farm Mitigation Plans • Implement the following Environmental Management Plans: Soil Management, Site Restoration and Revegetation, Vegetation and Invasive Plant Management, including biosecurity protocols if required; Traffic Management; Public Safety Management • Provide alternative livestock movement options and compensation for associated increased costs • Relocate or replace infrastructure, or provide appropriate compensation • Provide alternative water supplies or appropriate • Provide alternative farm and field access • Provide alternative highway crossings • Provide alternative utility crossings • Provide alternative livestock watering and drainage works during construction; restore original works after construction is completed • Minimize access to farm properties by construction workers and implement measures to minimize unauthorized public access • Replace fencing or provide compensation for replacement fencing • Consolidate fragmented parcels with other parcels, where practical and when owner(s) agree(s)	Section 5(2)(a) Section 5(2)(b)
Effects on individual farm operations during operations	Evaluate effects at a property level and enter into agreements with affected landowners to mitigate in the event of: • Crop and stored feed damage due to changes in wildlife habitat utilization • Crop drying due to changes in climatic factors • Crop production due to changes in groundwater elevation • Potential for unauthorized access to farm properties due to change in land or water-based access • Livestock damage due to new access to the reservoir	Section 5(2)(a) Section 5(2)(b)
Change to agricultural economic activity during construction and operations	Implement an agricultural compensation fund.	Section 5(2)(b)
Change to regional food production and consumption	No change anticipated to regional food self-reliance. No mitigation required.	Section 5(2)(b)
	Follow-up Program Objective(s)	Section 5(2)(a)

Project Interaction/Potential Effect	Proposed Mitigation	CEAA s. 5
	For reservoir-adjacent agricultural operations where there is not already an agreement with BC Hydro, monitor specific environmental factors, and evaluate associated potential effects on: • Crop and stored feed damage due to changes in wildlife habitat utilization • Crop drying due to changes in climatic factors • Crop production due to changes in groundwater elevation Monitoring objectives would be to 1. Confirm if a Project change has occurred, and 2. Specify the adverse effect on agricultural operations 3. Determine appropriate mitigation measures **Description:** Monitor Project-induced changes in wildlife habitat utilization in, and evaluate associated crop or feed storage damage for, agricultural operations within 5 km of the reservoir, to assess if there is an increase in wildlife depredation due to Project-related habitat losses. Monitoring will include pre-and post-reservoir filling field surveys, wildlife monitoring, farm operator interviews, and analysis of relevant records related to wildlife depredation. Monitor Project-induced changes to humidity within 3 km of the reservoir, and evaluate associated effects on crop drying within this area. Monitoring will include collection and analysis of climate data, calculation of crop drying indices, and farm operator interviews. Monitor Project-induced changes to groundwater elevations within 2 km of the reservoir (the area potentially influenced by groundwater elevation changes), and evaluate associated effects on crop productivity. Monitoring will include field surveys and farm operator interviews. **Frequency:** Annual **Duration:** Five years prior to reservoir filling and first five years of operations	Section 5(2)(b)
	Follow-up Program Objective(s): Monitor climatic factors relevant to future irrigation improvement decisions that may be proposed under the agricultural compensation fund. **Description:** Monitor climatic factors to estimate moisture deficits and to estimate irrigation water requirements in the vicinity of the reservoir to provide information for potential future irrigation projects. Data collection will be undertaken before reservoir filling, and in the early years after reservoir filling, and data will be reviewed as required for proposed irrigation projects. **Frequency:** Annual **Duration:** Five years prior to reservoir filling and first five years of operations	Section 5(2)(a) Section 5(2)(b)
Forestry		
Dam, Generating Station, and Spillways and Substation and Transmission Line to Peace Canyon Transportation of construction materials and supplies (includes quarried materials and other materials needed for all project components) Reservoir Preparation and Filling | Transport of merchantable timber away from the reservoir area by truck	Standard mitigations include Traffic Management Plan and road use agreements (where appropriate).	N/A
Quarried and Excavated Construction Materials West Pine Quarry	Traffic Management Plan (including access restrictions where required) will mitigate effects on Land and Resource Use valued Components	N/A

Project Interaction/Potential Effect	Proposed Mitigation	CEAA s. 5
Worker Accommodation Temporary Accommodation Northern Regional Site (Halfway-Farrell) Temporary Accommodation Southern Regional Site (Jackfish Lake Rd)	Tenures required to construct and operate regional accommodation will be part of Project's overall tenuring process and related mitigation.	N/A
Change in land use, resource use, access, and activities related to industrial forestry use	No change anticipated to industrial forest use. No mitigation required.	5(2)(b)
Change in land use that affects Crown Forest Management	The province would use existing policies to manage changes to Old Growth Management Areas and one wood lot license area.	5(2)(b)
Oil, Gas and Energy		
Worker Accommodation Temporary Accommodation Northern Regional Site (Halfway-Farrell) Temporary Accommodation Southern Regional Site (Jackfish Lake Rd)	Tenures required to construct and operate regional accommodation will be part of Project's overall tenuring process and related mitigation.	5(2)(b)
Change in land and resource use, and oil and gas infrastructure during construction and operations	Conclude agreements and implement any agreed to provisions, where appropriate, with third-party tenure holders Implement monitoring measures for infrastructure that could be affected by the Project; if adverse effects are identified, work with affected party to identify and implement appropriate mitigation. Spectra Energy monitoring: if adverse effects identified, mitigation would be implemented.	5(2)(b)
Access to oil and gas resources and industry activity during construction	Access to resources would not be restricted. No mitigation required.	5(2)(b)
	Follow-up Program Objective(s): To determine the effects of changes in water temperature and sedimentation during operations, on Spectra Energy operations. **Description:** At Spectra Energy intakes, monitor baseline conditions and effects of increased sedimentation during construction, and effects of increased water temperature and sedimentation during operations, on Spectra cooling operations **Frequency:** To be determined in discussion with Spectra **Duration:** During construction and first 10 years of operations	5(2)(b)
Minerals and Aggregates		
Worker Accommodation Temporary Accommodation Northern Regional Site (Halfway-Farrell) Temporary Accommodation Southern Regional Site (Jackfish Lake Rd)	Tenures required to construct and operate regional accommodation will be part of Project's overall tenuring process and related mitigation. As referenced in Volume 2 Section 11.3 Land Status, Tenure, and Project Requirements, BC Hydro will discuss any overlap with the Project activity Zone and preliminary reservoir impact lines with affected third-party tenure holders and, where appropriate, enter into agreements regarding potential conflicts with mineral and aggregate tenure holders. This mitigation measure is considered standard mitigation, per Section 23.1.3 Standard Mitigation Measures and Effects Addressed.	N/A
Change to land use, resource use, access and activities related to industrial mineral and aggregate utilization during construction	Negotiate a memorandum of understanding with the BC Ministry of Transportation and Infrastructure to compensate for material used by the Project and to maintain material availability for ministry operational needs. Memorandum of understanding to include: • aggregate source strategy to compensate for inundated Ministry aggregate	5(2)(b)

Project Interaction/Potential Effect	Proposed Mitigation	CEAA s. 5
	sources • BC Hydro commitment to stockpile surplus rock material at the West Pine, Wuthrich, and Portage Mountain quarries	
Harvest of Fish and Wildlife Resources		
Road and Rail Access Development Old Fort Road realignment and widening, paving of 240 Road, widening of 271 Road and paving and extension of 269 Road. West Pine Quarry access West Pine Siding construction Septimus Rail Siding construction	Traffic Management Plan (including access restrictions where required) will mitigate effects on Land and Resource Use Valued Components. Conclude agreements and implement any agreed to provisions, where appropriate, with third-party tenured trapline holders and guide outfitters.	N/A
Changes in fishing opportunities during construction	Implement Outdoor Recreation and Tourism mitigation measures that support recreational shoreline use, boating access, and water-based navigation (Volume 3 Section 25 Outdoor Recreation and Tourism; Volume 3 Section 26 Navigation) to mitigate construction effects on fishing opportunities. Implement Fish and Fish Habitat mitigation measures that support fish populations (Volume 2 Section 12 Fish and Fish Habitat) to mitigate construction effects on fishing opportunities.	Section 5(2)(b)
Changes in fishing opportunities during operations	A residual positive effect on fishing opportunities is expected during the operations phase. No mitigation required.	Section 5(2)(b)
Changes in hunting opportunities during construction	Implement Outdoor Recreation and Tourism mitigation measures that support recreational shoreline use, boating access, and water-based navigation (Volume 3 Section 25 Outdoor Recreation and Tourism; Volume 3 Section 26 Navigation) to mitigate construction effects on hunting opportunities. Implement Wildlife Resources mitigation measures that support harvestable game populations (Volume 2 Section 14 Wildlife Resources) to mitigate construction effects Section 5(2)(b)on hunting opportunities.	Section 5(2)(b)
Changes in hunting opportunities during operations	No residual effects are expected on hunting opportunities during operations. No mitigation required.	Section 5(2)(b)
Changes in use of harvesting areas during construction	A residual positive effect on the use of harvesting areas is expected during construction. No mitigation required.	Section 5(2)(b)
Changes in use of harvesting areas during operations	No change anticipated in use of harvesting areas during operations. No mitigation required.	Section 5(2)(b)
Changes in trapping opportunities during construction	Implement Wildlife Resources mitigation measures that support fur-bearing populations (Volume 2 Section 14 Wildlife Resources) to support the availability of harvestable species for trapping. Financial compensation for Aboriginal and non-Aboriginal trap line holders	Section 5(1)(c) Section 5(2)(b)
Changes in guide outfitter opportunities during construction	Provide communications regarding area or road closures, to help outfitters plan their guided activities to avoid conflict with the Project.(see Volume 2 Section 35 Summary of Environmental Management Plans, Public Safety Management Plan) Implement Outdoor Recreation and Tourism mitigation measures that support recreational shoreline use, boating access, and water-based navigation (Volume 3 Section 25 Outdoor Recreation and Tourism; Volume 3 Section 26 Navigation) to mitigate construction effects on guide-outfitting opportunities. Implement Wildlife Resources mitigation measures that support game populations	Section 5(2)(b)

Project Interaction/Potential Effect	Proposed Mitigation	CEAA s. 5
	(Volume 2 Section 14 Wildlife Resources) to support the availability of harvestable species for guide outfitting activities. Financial compensation for guide outfitters	
Changes in guide outfitter opportunities during operations	Implement Wildlife Resources mitigation measures that support large game populations (Volume 2 Section 14 Wildlife Resources) to also support the availability of harvestable species for guide outfitting activities.	Section 5(2)(b)
Outdoor Recreation and Tourism		
Dam, Generating Station, and Spillways and Substation and Transmission Line to Peace Canyon Transportation of construction materials and supplies (includes quarried materials and other materials needed for all project components) Road and Rail Access Development Old Fort Road realignment and widening, paving of 240 Road, widening of 271 Road and paving and extension of 269 Road. West Pine Quarry access West Pine Siding construction Septimus Rail Siding construction	Traffic Management Plan (including access restrictions where required) will mitigate effects on Land and Resource Use Valued Components. Any overlap or conflict between existing third-party recreation tenure holders and BC Hydro‘s proposed activities, or BC Hydro‘s required tenure over Crown land, will be addressed through discussions, permitting and, where appropriate, agreements with the tenure holders. Further information is available in Volume 2 Section 11.3 Land Status, Tenure, and Project Requirements	N/A
Changes in outdoor recreation and tourism infrastructure during construction and operations	• Develop an Outdoor Recreation Mitigation Plan (Volume 3 Appendix E). The plan specifies opportunities for recreation infrastructure on the Site C reservoir, and provides technical support to recreation providers in the region to assist with their development along, or adaptation to, new shoreline conditions. • Develop a Public Safety Management Plan that will identify public communications procedures for public safety hazards, and access restrictions and closures during construction and operation of the Site C reservoir (Volume 5 Section 35 Summary of Environmental Management Plans). • Establish and operate three new permanent Site C reservoir launches and day use sites (Cache Creek and Lynx Creek trailer launches and Hudson‘s Hope Shoreline Protection small craft launch) to replace flooded boat launch areas. • Provide funds to the District of Hudson‘s Hope for the enhancement of Alwin Holland Park or other community shoreline recreation areas ($150,000) • Provide a Community Recreation Site Fund to support development of new shoreline recreation sites within the Peace River and tributaries through to the Alberta border, as well as the Site C reservoir. • Provide technical support to outdoor recreation providers that require access to the Site C reservoir to assist with their development along, or adaptation to, new shoreline conditions. • Fund the development of a B.C. Peace River / Site C Reservoir Navigation and Recreation Opportunities Plan • Enter into agreements with the owners of the campground at Cache Creek	Section 5(2)(b)

Project Interaction/Potential Effect	Proposed Mitigation	CEAA s. 5
	and the hunting camp near the Site C dam site. Where it is both physically and economically feasible, the costs to relocate facilities will be included in the agreements. • Establish a permanent north bank Site C dam site public viewpoint. • Establish a south bank Site C dam site public viewpoint.	
Change in outdoor recreation and tourism use levels during construction and operations	Project effects on outdoor recreation levels are expected to be beneficial and not require mitigation. However, mitigation proposed for changes in recreation and tourism infrastructure will enhance outdoor recreation benefits by replacing and improving outdoor recreation infrastructure that is lost due to the Project. BC Hydro will also work with the private sector and local governments to develop at least 20 new long-stay serviced RV sites at Peace Island Park (per mitigation described in Volume 4 Section 29 Housing). Mitigation proposed in Volume 4 Section 29 Housing (e.g., implementing on-site workforce housing) will enhance tourism benefits by avoiding shortages in hotel, motel, and campground availability that might inconvenience leisure travellers.	Section 5(2)(b)
Navigation		
Reservoir Preparation and Filling Hudson's Hope Shoreline Protection	Public Safety Management Plan will mitigate potential effects on the VC.	Section 5(1)(c) Section 5(2)(a)
Substation and Transmission Line to Peace Canyon Tower installation Conductor stringing	Standard navigation mitigations for signals, markings and notifications re: overhead structures such as towers and conductors crossing navigable waters.	Section 5(1)(c) Section 5(2)(a)
Quarried and Excavated Construction Materials Highway 29 Realignments	Navigation interactions and effects mitigated through standard practices defined by Transport Canada exercising its authority under the Navigable Waters Protection Act.	Section 5(1)(c) Section 5(2)(a)
Changes to navigability, navigational use and access during construction and operations	Implement Public Safety Management Plans and supporting boater communication tools to communicate with the boating public about changes to navigability and navigation use, and about hazards and navigation restrictions, such as restricted navigation zones at the dam site, interferences, public safety issues, and any temporary navigation or boat launch access closures associated with active work areas for reservoir clearing, Highway 29 relocation, and Hudson‘s Hope shoreline protection construction. • The Public Safety Management Plans and supporting boating protocols will be based on established marine communication plans developed for other major infrastructure projects throughout BC, which included input from the Navigable Waters Protection Program, Transport Canada, local user groups and Aboriginal groups. Communications will help boaters plan their trips and provide information about alternative boating areas or launches, when restrictions are in place. • Develop signage for public safety around dams in accordance with the Guidelines for Public Safety Around Dams adopted by BC Hydro. Develop three boat launches along the Site C reservoir to replace Halfway River and Lynx Creek boat launches and the Hudson‘s Hope ferry landing boat launch. The new boat launches, complete with upgraded amenities, will be located at Hudson‘s Hope, Lynx Creek and Bear Flat, and will be accessible via Highway 29. Provide a Community Recreation Site Fund to support development of new shoreline	Section 5(1)(c) Section 5(2)(a)

Project Interaction/Potential Effect	Proposed Mitigation	CEAA s. 5
	recreation within the Peace River and tributaries through to the Alberta border as well as the Site C reservoir. This will support re-establishment of recreational sites on the Site C reservoir and downstream, and re-establish and create new use patterns and access. Provide technical support to outdoor recreation providers that require access to the Site C reservoir (such as RV parks, campgrounds, and marinas operated by the private sector, as well as local, regional, or provincial governments) to assist with their development along, or adaptation to, new shoreline conditions. Provide technical support to outdoor recreational providers to facilitate further public and private sector investment opportunities associated with the use of the Site C reservoir and downstream. Fund the development of a Navigation and Recreation Opportunities Plan, intended to enable user groups, First Nations, local and regional government, as well as provincial and federal (Transport Canada) government agencies to understand, plan for, and optimize new recreation opportunities created as a result of the Project.	
Potential navigational hazards in waterways during construction	No mitigation required.	Section 5(1)(c) Section 5(2)(a)
Potential navigational hazards in waterways during operations	Communicate navigational hazards to boaters and supporting boater communication protocols during the operations phase through the Public Safety Management Plans. Provide signage, as required, in accordance with the Guidelines for Public Safety Around Dams.	Section 5(1)(c) Section 5(2)(a)
Navigation use restrictions during construction	Implement BC Hydro's Public Safety Management Plan and supporting boater communication protocols, inclusive of adhering to the Canadian Dam Association Guidelines for Public Safety Around Dams, to address navigability and navigation use, and the identification of potential hazards and interferences in waterways during construction. Areas that remain open to navigation and are accessible during construction (inclusive of boat launches and other public access) will be communicated to users and the public at large.	Section 5(1)(c) Section 5(2)(a)
Navigation use restrictions during operations	Implement BC Hydro's Public Safety Management Plan and supporting boater communication protocols, inclusive of adhering to the Canadian Dam Association Guidelines for Public Safety Around Dams, throughout the early years of the Site C reservoir operations. This will address navigability and navigational use, and the identification of potential hazards and interferences in waterways, and will enable trip planning and safety for boaters' recreational boating activities.	Section 5(1)(c) Section 5(2)(a)
Microclimate changes on aviation use at North Peace Regional airport during operations	No change anticipated. No mitigation required.	Section 5(2)(a)
Changes to visibility of structures and overhead wiring during construction	No change anticipated. No mitigation required.	Section 5(1)(c) Section 5(2)(a)
Changes to Shaftesbury and Tompkins Landing ferry and ice bridge operations during operations	No change anticipated. No mitigation required.	Section 5(1)(b)
	Follow-up Program Objective(s): To identify the requirements for regular monitoring of shoreline conditions, including groundwater levels, shoreline erosion rates and landslide activity.	Section 5(1)(c) Section 5(2)(a)

Project Interaction/Potential Effect	Proposed Mitigation	CEAA s. 5
	Description: As described in Volume 5 Section 35 Summary of Environmental Management Plans, BC Hydro will commit to regular monitoring of shoreline conditions during the early years of Site C reservoir operations. Monitoring program results would support implementation of prescribed Public Safety Management Plan boater communication protocols related to managing for navigation hazards and public safety within the Site C Reservoir. BC Hydro will be responsible for the implementation of proposed mitigation measures, including mitigation identified in the Volume 3 Appendix E Outdoor Recreation Mitigation Plan **Frequency:** Annual **Duration:** During first five years of operation	
Visual Resources		
Changes to visual resources during construction	Restore and re-vegetate disturbed surfaces in construction areas after disturbance activities cease in accordance with the Project Soil Management, Site Restoration, and Re-vegetation Plan. Naturally landscape the shoreline protection in Hudson's Hope Paint permanent Site C dam site buildings and other aboveground structures to blend in with the character of the surrounding environment where possible. Select previously disturbed areas or areas generally hidden from view for the potential off-site workforce accommodation camps, where feasible.	Section 5(1)(c) Section 5(2)(b)
Changes to visual resources (shoreline erosion) during operations	No mitigation proposed.	Section 5(1)(c) Section 5(2)(b)
Population and Demographics		
Dam, Generating Station, and Spillways and Reservoir Operations – Component Level Interactions	Interactions are nominal relative to current and projected regional employment/ economic/ population/ housing/ infrastructure activities.	N/A
Changes to PRRD population, with specific reference to City of Fort St. John during construction	Implement mitigation measures proposed for the Labour Market and Housing VCs (Volume 3 Section 17 and Volume 4 Section 29), including measures to increase the local labour supply (thus reducing the need to hire persons living outside the LAA) and the provision of camp accommodation, to moderate growth of the local population Implement mitigation measures proposed for the Community Infrastructure and Services VC (Volume 4 Section 30) to mitigate the effects of an increased local population	N/A
Changes to Aboriginal community populations during construction	Implement mitigation measures as proposed for the Labour Market, Housing and Community Infrastructure and Services VCs (Volume 3 Section 17, Volume 4 Section 29, and Volume 4 Section 30). If implemented with Aboriginal organizations and First Nations communities, these measures will eliminate the adverse effect of certain population and demographic changes from the Project. Support Aboriginal persons in maintaining permanent residence in home communities by providing camp housing and commuter support where demand warrants. Implement workforce management policies to require contractors to offer cross-cultural awareness training to their workers and to adopt and monitor codes of conduct. BC Hydro will work with local area First Nations to develop and deliver the	N/A

Project Interaction/Potential Effect	Proposed Mitigation	CEAA s. 5
	cross-cultural awareness training. Procurement of local Aboriginal businesses for Project construction contracts where feasible.	
Housing		
Substation and Transmission Line to Peace Canyon Substation and Transmission Line to Peace Canyon Construction -Component Level Interactions Quarried and Excavated Construction Materials Quarried and Excavated Construction Materials Development - Component Level Interactions Road and Rail Access Development Road and Rail Access Development - Component Level Interactions	Non-dam site worker housing interactions are nominal relative to current and projected regional population/housing activities, are well understood, and are managed under the provincial regulatory framework.	N/A
Dam, Generating Station, and Spillways and Reservoir Operations -Component Level Interactions	Interactions are nominal relative to current and projected regional Employment /economic /population /housing /infrastructure activities.	N/A
Change in the demand for housing, with specific reference to the City of Fort St. John during construction	Scale camp capacity up or down as required to accommodate direct workers. Two smaller camps may be used in off-site locations depending on short-term housing market conditions in the local area at the time of construction, while the south bank camp would be designed to be easily expanded to accommodate potentially higher annual direct workforce during construction. Provide logistical assistance to the Project workforce seeking local accommodation, through a community camp co-ordinator. Expand the supply of rental housing by building at least 40 energy efficient rental units in partnership with BC Housing for use by Project workforce during construction. Transition the units to permanent affordable housing use after construction (in partnership with BC Housing). Fill housing units giving a priority to workers with families and use the units as a way to transition the families into the community and find their own permanent residence in the area. Build up to 10 new affordable housing units to be used by the community in the Fort St. John area, in partnership with BC Housing, to expand the supply of affordable housing. Expand the supply of temporary accommodation by expanding the supply of long-stay RV sites in partnership with the private sector or local governments. Pre-book hotel and motel space when substantial temporary hotel accommodations are required when feasible. Provide financial support to emergency or transitional housing providers in the City of Fort St. John (e.g., Salvation Army), to support for people who require transitional or emergency housing, or who need help to become job-ready and able to participate in market housing Mitigation measures listed above will address adverse effects on Aboriginal renters in the City of Fort St. John as well as on its non-Aboriginal renters. It is proposed that BC Hydro work with First Nation communities in the LAA to track net migration to on-reserve housing and, using the results of the monitoring of rental market conditions in the City of Fort St. John, identify if additional housing related mitigation may be needed.	N/A

Project Interaction/Potential Effect	Proposed Mitigation	CEAA s. 5
	Follow-up Program Objective(s): To verify the anticipated changes to housing demand, and to evaluate the effectiveness of proposed mitigation measures to reduce effects on the apartment rental market **Description:** Monitor apartment vacancy rate and price for Fort St. John area, as published by CMHC. Work with the City of Fort St. John to review rental market vacancy and affordability, and to identify if additional mitigation is needed. Work with Aboriginal communities in the LAA to track net migration to on-reserve housing that is attributable to Project effects on rental market conditions in the City of Fort St. John, and to identify if additional mitigation is needed **Frequency:** Semi-annual **Duration:** During construction	N/A
Community Infrastructure and Services		
Dam, Generating Station, and Spillways and Reservoir Operations -Component Level Interactions	Interactions are nominal relative to current and projected regional employment/ economic/ population/ housing/ infrastructure activities.	N/A
On-site provisions	On-site accommodation and services will be provided for the direct construction workforce. Services required for dam-site accommodations and for the overall construction areas will be provided through a combination of on-site development and private procurement. For example, for worker camp accommodation, on-site water and sewer services will be developed, site electricity will be provided by BC Hydro, and site telecommunications services will be procured by or provided by BC Hydro. Firefighting and emergency services will be provided as on-site activities and augmented as necessary by private services. On-site recreation, safety and medical transport, and health services will be provided at the Project site, including at the worker camp accommodations, and would be augmented by provincial health services (e.g., hospital care and, for BC residents, the use of Medical Services Plan) or by local government providers, where agreements are reached.	N/A
Change in demand for, or provision of, services – health and social services during construction	Work with Northern Health to plan for appropriate health care services for Project workforce, including camp residents; on-site health care for all workers residing in camps would include a combination of: • Physician care • On-site nurse or nurse practitioner care • Coordination on program delivery (i.e., Employee Assistance Program, men's health programs) Provide Northern Health with actual workforce and camp population statistics to help plan for service levels Support Northern Health and partner agencies in planning for anticipated changes in resident population by communicating workforce schedules, in-community population forecasts, housing plans, and on-site medical and social services Support Northern Health initiatives as they develop approaches for delivery of health services for camp workers Provide new families with local information package about health, education, and social services. Provide an annual contribution of $100,000 during construction to support North and	N/A

Project Interaction/Potential Effect	Proposed Mitigation	CEAA s. 5
	South Peace non-profit organizations.	
Change in demand for, or provision of, services – emergency services during construction	Provide on-site emergency services to minimize the need for community-based services: • Security services that support compliance and enforcement of all camp and construction policies relating to the terms of employment • Firefighting services for all project construction activities and work sites • First aid and medical transport for medical emergencies at the on-site accommodations and work sites Implement policies on safe living and work environment Implement Traffic Management Plan Work with local fire departments to identify incremental demands on emergency rescue services, and provide funding to local governments for accident coverage during Project construction. Work with RCMP to identify incremental demands on policing services, and provide direct funding to detachments in the LAA to cover identified increases during Project construction. Entered into an agreement for additional policing resources between the Ministry of Justice and BC Hydro with input from the RCMP based on their review of BC Hydro management plans and discussions with local communities. Involve RCPM in the early stage of the Project planning to inform policies and requirements that would go into the procurement processes. Develop emergency service provide site access protocols to enable safe site access during construction and operations. Work with emergency service providers to plan for and adjust to anticipated changes in resident population and new service demands by communicating workforce schedules, in-community population forecasts, housing plans, and on-site emergency services. Develop and update Project emergency plans, including integration with existing BC Hydro Peace River generating facilities during Project construction. Communicate project management plans and activities to emergency service providers.	N/A
Change in demand for, or provision of, services – education services during construction	Work with School Districts 59 and 60 to plan for and adjust to anticipated changes in resident population and potential new enrolments by communicating in-community population forecasts. Work with School Districts and Northern Lights College to identify the number of foreign worker hires and the potential need for in-community education services to match their skills to Project requirements. Communicate with School Districts and post-secondary institutions about expected deficits in the local labour pool and how education providers can tailor high school and post-secondary apprenticeship programs to help meet those needs. Continue to participate in and support northern training initiatives, including participation in Northern Opportunities and financial support to Northern Lights College Foundation, for funding student bursaries.	N/A
Change in demand for, or provision of, services –	Provide recreation facilities and programming at the camps for workforce.	N/A

Project Interaction/Potential Effect	Proposed Mitigation	CEAA s. 5
recreation and leisure services during construction	Work with City of Fort St. John to resolve local concerns about potential use of community recreation or leisure facilities by Project workforce	
Change in demand for, or provision of, services – solid waste during construction	Develop and implement construction Waste Management Plan that integrates waste reduction, recycling and reuse standard practice, and management of industrial waste, in coordination with the PRRD municipal waste management plan.	N/A
Change in demand for, or provision of, services – sewer and water	Evaluate options to integrate sewer and water systems required for the workforce camps to provide lasting benefits to the City of Fort St. John system. Otherwise camps will operate on self-sufficient systems that will not affect municipal systems. Work with local governments to plan for and adjust to anticipated changes in resident population by communicating workforce schedules, in-community population forecasts, and housing plans.	N/A
Displacement of infrastructure during construction	Provide funds for the relocation or replacement of Hudson‘s Hope water intake, pumping station, and treatment plant to meet the reasonable water supply needs of the residents and District of Hudson‘s Hope Work with each local government to develop an approach to determine or monitor the effects of the Project on the Hudson‘s Hope sewage lagoon, Fort St. John water supply (production and access) and outfall system, Taylor water supply, and Peace River Regional District‘s Charlie Lake outfall. BC Hydro would fund appropriate mitigation measures to maintain functionality of these municipal systems if adverse effects from the Project are identified.	Section 5(2)(b)
Potential ice jam related flooding in the town of Peace River	Work with the Province of Alberta to monitor ice condition and provide data to the town of Peace River and others during critical times. Implement flow control during ice break-up at the town of Peace River when required.	Section 5(1)(b)
Changes affecting Aboriginal Peoples and Communities	Mitigation measures identified for Community Infrastructure and Services have general applicability in the LAA, and will therefore also avoid adverse effects on Aboriginal people living in Fort St. John and other urban centres that will see a rise in population related to the Project.	N/A
Transportation		
Substation and Transmission Line to Peace Canyon Access construction and right-of-way improvement	Traffic Management Plan (including access restrictions where required) will mitigate effects on Land and Resource Use Valued Components.	N/A
Dam, Generating Station, and Spillways and Reservoir Operations -Component Level Interactions	Use of access roads during operations will be limited in duration and intensity and the resultant effect on Transportation will be nominal.	N/A
Substation and Transmission Line to Peace Canyon Maintenance of access roads	Use of access roads during operations will be limited in duration and intensity and the resultant effect on Transportation will be nominal. Effects will be mitigated by the Traffic Management Plan (including access restrictions where required).	N/A
During construction: • Minor traffic delays • Decline in level of Service on some roads and at some intersections • Potential for impeded access to and egress from properties on some roads • Small increase in collision frequency due to increased traffic on some routes	**Highway 29 North** Implement Traffic Management Plan to include Traffic Control Plans, Public Information Plans, Incident Plans, and Implementation Plans. Realign sections of Highway 29 that would be inundated by the reservoir between Hudson‘s Hope and Bear Flat, incorporating geometric and cross-section improvements. On Canyon Drive west of Hudson‘s Hope, construct a paved brake check before the start of the 10% grade, and make it a mandatory requirement for Project-related	N/A

Project Interaction/Potential Effect	Proposed Mitigation	CEAA s. 5
• Lower collision frequency due to permanent road upgrades on some routes	trucks to stop and check vehicle brakes. Explore opportunities for constructing, and install if feasible, either arrestor beds or runaway lanes, or both, on Canyon Drive above Hudson's Hope. **Highway 29 South** Provide shuttle service between Chetwynd and dam site, based on demand. Work with District of Chetwynd to identify suitable parking locations for workers using shuttles. **Jackfish Lake Road** Provide a shuttle service between Chetwynd and the Project site, based on demand Equip Project vehicles travelling on Project access road with radios. Control access to Project access road at north end of Jackfish Lake Road. Strengthen road base and hard-surface 31 km of Jackfish Lake Road, widening where required. Examine the feasibility of widening the shoulders along the first 30 km of Jackfish Lake Road to meet current BC Ministry of Transportation and Infrastructure rural collector standards, potentially including two 1.5 m wide paved shoulders. **North Bank Minor Roads** Provide carpool programs, such as preferred parking, for regional workforce commuters, to reduce the number of private vehicles commuting to site Use conveyor belt for transport of materials from 85th Avenue Industrial Lands to dam site. Hard-surface 240 Road and the portion of 269 Road south of the intersection with 240 Road. Realign a portion of Old Fort Road south of 240 Road. Potentially widen shoulders or add a path on Old Fort Road between Highway 97 and the realigned segment, and between the end of the realigned segment and the gravel pit entrance at km 5.5. Widen shoulders or add a path on 271 Road between the Wuthrich Quarry and Highway 97. Conduct intersection lighting calculations to determine if illumination is warranted and then, in collaboration with BC Ministry of Transportation and Infrastructure, consider installing intersection lighting. Provide funding to the Ministry of Transportation and Infrastructure to increase their pavement condition monitoring and provide fund for any required improvements to regional transportation routes used by the Project.	
Road safety during operations – Potentially higher accident rate due to poor visibility caused by fog during operations Improved road safety on some routes due to permanent road upgrades	**Taylor Bridge and Approaches** Monitor Taylor Bridge and low-lying approaches for changes in fog hours and density during the early years of Project operations. If required, implement mitigation measures to reduce driver speed, minimize fog-related collisions and maintain overall road safety by considering the following: • Illumination on, and on the approaches to, the Taylor Bridge • Changeable message signs that are visible in dense fog • Radio broadcasts and other forms of public communication	Section 5(2)(b)

Project Interaction/Potential Effect	Proposed Mitigation	CEAA s. 5
	Follow-up Program Objective(s): To determine if Project related traffic volumes are adversely affecting traffic operations **Description:** Record traffic counts and monitor traffic operations at the following intersections: • Highway 29 and Canyon Drive in Hudson's Hope • Highway 97/Highway 29 in Chetwynd • Highway 97 intersections in Fort St. John Monitor traffic operations on local roads to determine if road restrictions for Project-related traffic should be implemented **Frequency:** Annual **Duration:** During construction	N/A
	Follow-up Program Objective(s): To determine if fog mitigation measures are required on, and on the approaches to, Taylor Bridge to maintain overall road safety **Description:** Monitor the change in fog hours on, and on the approaches to, the Taylor Bridge. **Frequency:** Seasonal **Duration:** Initiate during construction to develop a baseline, and continue through Years 0 to 4 of operation or until the changes in fog can be confirmed	Section 5(2)(b)
Heritage Resources		
Substation and Transmission Line to Peace Canyon Right-of-way vegetation maintenance	Site prep and clearing interaction has already occurred been accounted for. In the event that heritage resources are identified during vegetation maintenance, the resources would be managed in accordance with applicable legislation (e.g., the B.C. Heritage Conservation Act) and policy.	Section 5(1)(c) Section 5(2)(b)
During construction: Changes to resource integrity: • Surface disturbance • Disturbance of structures • Subsurface disturbance • Compaction • Erosion Changes to resource accessibility: • Increased access • Unauthorized collection • Lack of access Other relevant considerations raised by Aboriginal groups	Implement the following: • Heritage Resources Management Plan • Chance find management procedure • Construction monitoring • Erosion monitoring Depending on the nature and importance of identified heritage resources, various mitigation measures will be used: • Avoid sites and reduce resource damage where possible • Clear under winter conditions • Manage any found burials following provincial guidelines (disinter or reinter burial) • Conduct additional reconnaissance and field surveys as warranted • Document historical sites and relocate important structures, if found • Class I Staged Scientific Excavation • Class II Stratified Sample Excavation • Systematic surface collection • Resource capping • Commemorate heritage resources as appropriate • Provide funds to local museums to support heritage programming Through implementation of Heritage Resources Management Plan any specific issues raised by Aboriginal groups can be addressed.	Section 5(1)(c) Section 5(2)(b)

Project Interaction/Potential Effect	Proposed Mitigation	CEAA s. 5
During operations: Changes to resource integrity: • Surface disturbance • Disturbance of structures • Subsurface disturbance • Compaction • Erosion Changes to resource accessibility: • Increased access • Unauthorized collection • Lack of access Other relevant considerations raised by Aboriginal groups	Implement the following: • Heritage Resources Management Plan • Chance find management procedure • Reservoir erosion monitoring in conjunction with EPAST • Resource Capping • Resource Monitoring • Conduct reconnaissance and systematic surface collection of exposed resources) or installation of protective measure • Clear under winter conditions	Section 5(1)(c) Section 5(2)(b)
	Follow-up Program Objective / Description: A Heritage Resources Management Plan would be implemented that addresses heritage site stewardship and protection relative to Project construction activities, as described in Volume 5 Section 35 Summary of Environmental Management Plans. The plan would include procedures for monitoring at known heritage site locations within the Project activity zone, as well as chance find procedures to be implemented in the event that heritage resources are encountered during construction.	Section 5(1)(c) Section 5(2)(b)
	Follow-up Program Objective(s): To verify the anticipated effects of erosion on heritage sites due to reservoir operations in the first five years of service, and to evaluate the effectiveness of mitigation measures implemented on heritage sites along the reservoir shoreline **Description:** Effects of shoreline erosion on heritage resources will be monitored. **Frequency:** Annual **Duration:** First five years of operations	Section 5(1)(c) Section 5(2)(b)
	Follow-up Program Objective(s): To evaluate the effectiveness of mitigation measures implemented on heritage sites, and to identify previously unknown heritage sites in the reservoir and mitigate potential effects of erosion on those sites. **Description:** Follow-up work on archaeological sites will be prescribed by the methods put forth in B.C. *Heritage Conservation Act* Permits Heritage work could include opportunity for scientific examination of heritage resources within the operating range of the reservoir during periods of maximum drawdown for maintenance. Activities may include emergency salvage and systematic data collection of exposed resources. **Frequency / Duration:** TBD, in consultation with the B.C. Archaeology Branch	Section 5(1)(c) Section 5(2)(b)
Human Health		
Dam, Generating Station, and Spillways Maintenance of the powerhouse, and substation	No overlap in time and space between the Project activity or component and the Valued Component.	Section 5(1)(c) Section 5(2)(b)
Reservoir Debris management	Assumes that air quality, water quality, noise and vibration will be mitigated and managed within applicable standards.	Section 5(1)(c) Section 5(2)(b)

Project Interaction/Potential Effect	Proposed Mitigation	CEAA s. 5
Hudson's Hope Shoreline Protection maintenance		
Substation and Transmission Line to Peace Canyon Right-of-way vegetation maintenance Maintenance of overhead structures Maintenance of access roads	Assumes that air quality, water quality, noise and vibration will be mitigated and managed within applicable standards.	Section 5(1)(c) Section 5(2)(b)
Change in ambient air quality during construction	**Project activity zone** Implement the following: • Air Quality Management Plan • Dust Control Management Plan • Blasting Management Plan • Vegetation and Clearing Debris Management Plan • Smoke Management Plan **Site C Dam, generating station, and spillways (including worker accommodation sites):** Install baghouses at concrete batch plants and crushers Install silos for fly ash cement and aggregate at concrete batch plants Retain vegetation barriers where practical Reduce burning of wood waste and follow BC Ministry of Environment Open Burning Smoke Control Regulation Conduct detailed modelling once the exact locations of emission sources are better defined. Use modelling results to determine where to place PM2.5 and PM10 monitors on the north and south bank. Locate work camps outside the area of potential air quality exceedance. **Site C reservoir preparation and filling (including clearing):** Reduce burning of vegetative debris ad follow BC Ministry of Environment Open Burning Smoke Control Regulation Relocate temporarily affected residents as necessary **Transmission line to Peace Canyon (corridor and clearing preparation; vehicle operations)** Reduce burning of vegetative debris ad follow BC Ministry of Environment Open Burning Smoke Control Regulation Monitor air quality associated with construction of Hudson‘s Hope shoreline protection; implement mitigation measures as required **Construction access road development and Highway 29 Realignment** Reduce burning of vegetative debris and follow BC Ministry of Environment Open Burning Smoke Control Regulation Utilize filters at crushers **Quarried and excavated material development** Reduce burning of vegetative debris ad follow BC Ministry of Environment Open Burning Smoke Control Regulation	Section 5(1)(c) Section 5(2)(b)

Project Interaction/Potential Effect	Proposed Mitigation	CEAA s. 5
	Conduct further screening modelling at residences located 1.5 km from West Pine Quarry to identify potential exceedances at this site and implement an air quality management plan at this site as required Monitor air quality at 85th Avenue Industrial Lands Use a covered conveyor belt from 85th Avenue Industrial Lands to dam site. **Site C Reservoir (Hudson's Hope Shoreline Protection)** Erect temporary barriers Erect portable enclosures/barriers Implement notification program for residents	
Change in noise and vibration during construction	**Hudson's Hope Shoreline Protection** Monitor noise levels associated with construction of Hudson's Hope Shoreline Protection **Highway 29 Realignment:** Implement notification program for residents Implement noise monitoring program **Quarried and excavated material development (85th Ave Industrial Lands)** Develop Noise and Vibration Management Plans for work site (Schedule traffic to avoid "bunch up" activity, "no engine compression brake" policy, "no free-swinging tailgate" policy, equipment in good repair and fitted with standard silencers/mufflers, ambient adjustable and low-frequency tone backup alarms) Develop and implement noise monitoring and adaptive management as required Implement notification of work program / Communication Plan for residents Mitigate nighttime noise (perimeter berms and acoustic barriers, and portable enclosures/barriers to the conveyor hopper, silent backup alarms) Monitor noise at 85th Avenue Industrial Lands Construct perimeter fencing Retain or plant tree screens Relocate temporarily affected residents as necessary	Section 5(1)(c) Section 5(2)(b)
Change in potable and recreational water quality during construction	Implement the following Environmental Management Plans: • Spill Prevention and Emergency Response Plan • Erosion Prevention and Sediment Control Plan Implement Groundwater Protection Plan to identify potential for groundwater contamination and appropriate groundwater quality protection measures.	Section 5(1)(c) Section 5(2)(b)
Change in potable and recreational water quality during operations	Implement the following Environmental Management Plans: • Spill Prevention and Emergency Response Plan • Erosion Prevention and Sediment Control Plan Implement Groundwater Protection Plan to identify potential for groundwater contamination and appropriate groundwater quality protection measures.	Section 5(1)(c) Section 5(2)(b)
Change in Electric and Magnetic Fields during construction and operations	Mitigation not required	Section 5(1)(c) Section 5(2)(b)
Change in country foods during construction and operations	Monitoring of mercury concentrations in fish in year 1, year 3, year 6, year 10, and every 5 years thereafter during operations, as described in the Methylmercury Technical Memo. Provide the public with information about safe fish consumption levels, if required. Any consumption advisories would be designed and implemented in accordance with	Section 5(1)(c) Section 5(2)(b)

Project Interaction/Potential Effect	Proposed Mitigation	CEAA s. 5
	federal and provincial procedures for issuing fish consumption advisories (Environment Canada, B.C. Ministry of Forests, Lands and Natural Resource Operations, B.C. Ministry of Health, Health Canada) and in accordance with good practice, including: • Communications that are culturally appropriate to Aboriginal groups (including translation into local Aboriginal languages where required) • Supporting a collaborative methylmercury monitoring process with Aboriginal and other communities (e.g., communities providing tissue samples, participation in data collection and analysis) • Mechanisms to solicit and respond to comments and questions from local communities on fish consumption advisory information	

APPENDIX 10 ASSERTED OR ESTABLISHED ABORIGINAL RIGHTS AND TREATY RIGHTS

This appendix sets out the asserted or established Aboriginal rights and treaty rights raised during the Joint Review Panel Stage and the impacts on those rights as articulated by each Aboriginal group referred to in Chapter 7. The information for 24 of the groups has been compiled from the written submissions and oral evidence received in community sessions of the public hearing and at the topic-specific session on asserted or established Aboriginal rights and treaty rights, held on January 17, 2014, in Fort St. John. Six Aboriginal groups did not participate in the Joint Review Panel Stage or submit to the Panel for consideration any assertion of Aboriginal rights or treaty rights, or the articulation of any impacts on those rights. For those groups, the information is based on BC Hydro's Environmental Impact Statement EIS, Volume 5 and amendments of May 2013.

Treaty 8 First Nations

1. Blueberry River First Nations

Blueberry River First Nations (BRFN) is a Treaty 8 First Nation in British Columbia. BRFN holds rights under Treaty 8, and asserts rights from oral promises made by representatives of the Crown, and incidental to Treaty 8. BRFN also asserts Aboriginal rights under section 35 of the *Constitution Act, 1982*.

BRFN claims a traditional territory of approximately 61,000,000 hectares that includes lands stretching from the Blueberry community located in Buick Creek, north to Sikanni Chief River, west to the height of land in the Rocky Mountains, south to Tumbler Ridge, and east to the Alberta border. The main BRFN community resides on Blueberry Indian Reserve No. 205, located approximately 80 km northwest of Fort St. John.

Manner in which the Project may adversely affect asserted or established Aboriginal Rights and Treaty Rights

The Blueberry community is located approximately 52 km from the proposed reservoir and 54 km from the proposed dam site. Many members of BRFN still maintain a traditional lifestyle, with hunting, trapping, and fishing playing important roles as major sources of sustenance.

Key concerns of the BRFN are potential impacts on wildlife and wildlife habitat due to increased access to non-Aboriginal harvesters, and human health risks from consuming fish containing methylmercury. Other concerns were about potential impacts on wildlife movement across the proposed reservoir, due to frequent changes in water flow rate and water levels, and on the loss of vegetation species. Adverse impacts on the availability or productivity of these resources would impair the BRFN's ability to continue the exercise of their traditional way of life and current use of the lands and resources.

Location, extent, and exercise of asserted or established Aboriginal rights and treaty rights that may be affected by the Project

Some of BRFN's important cultural and harvesting areas include areas around the Peace River and Beatton River, Taylor and Old Fort, Pine River, around Charlie Lake, Cache Creek, Halfway River, Butler Ridge, and lands around Hudson's Hope, Moberly River and Del Rio, dancing grounds and Pink Mountain. BC Hydro also acknowledged the particular importance of Bear

Flats, Attachie, and Farrell Creek because they will be inundated as a result of the proposed reservoir and access to the three areas would be permanently lost.

BRFN members are concerned that the removal of approximately 5,000 hectares of productive land base, including farmland from the Treaty 8 territory for the reservoir, would lead to the effective loss of rights to hunt elk, moose, caribou, and other animals; loss of bear habitat; mercury contamination of fish; downstream effects; and cumulative effects from the Project in combination with extensive existing and future developments, particularly oil and gas development, in their territory. They are also concerned about fish mortality from turbine operation.

Measures to avoid or mitigate potential adverse effects of the Project on asserted or established Aboriginal rights and treaty rights

BRFN did not suggest any measure to avoid or mitigate potential adverse effects, but rather asked that the Panel recommend against Project approval. If the Project is approved, BRFN seeks, as compensation, partial ownership, and that First Nations be exempt from provincial sales tax on electricity consumed on-reserve.

2. Fort Nelson First Nation

Fort Nelson First Nation (FNFN) is a Treaty 8 First Nation in British Columbia. FNFN holds treaty rights under Treaty 8 and also oral promises made by representatives of the Crown, as well as incidental rights, under Treaty 8. FNFN also asserts Aboriginal rights under section 35 of the *Constitution Act, 1982*.

FNFN has its traditional territory in the northeast region of B.C., lying outside the regional assessment area (RAA) for the Current Use of Land and Resources for Traditional Purposes.

Manner in which the Project may adversely affect asserted or established Aboriginal rights and treaty rights

The Project would be located within Treaty 8 territory and in close proximity to the southern boundary of the FNFN traditional territory. FNFN is of the view that the Project would have significant impacts on their members' ability to exercise their Treaty rights.

The identity of the FNFN is inseparable from the land. FNFN told the Panel that the land "is our culture, our history, and our identity. Without our land, we don't have an identity, and we have nothing." Chief Sharleen Gale remarked that the way of life promised to them in Treaty 8 has been greatly diminished, and it continues to be threatened by the current pace of development in their territory.

Location, extent, and exercise of asserted or established Aboriginal rights and treaty rights that may be affected by the Project

Chief Gale observed that the population of woodland caribou, fish, beaver, and other fur-bearing animals is declining, and their health is deteriorating, which she attributed directly to the intensive development of the oil and gas industry in the Treaty 8 territory. Site C would reduce or eliminate hunting, trapping, and harvesting opportunities for T8FN members who have traditionally exercised their rights within the Project footprint, which FNFN anticipates will result in increased harvesting and non-consumptive use pressures in the area north of Site C, including areas primarily used by FNFN members. The increased pressure would cause social

and cultural conflict within the Fort Nelson territory. The increased pressures on their land, water, and resources would further adversely affect the wildlife, fisheries, vegetation, and habitat in their territory, driving Fort Nelson members to practice their treaty rights in the southern reaches of Treaty 8, including within the Site C footprint. If Site C proceeds, the ability to exercise their Treaty rights in the south of Treaty 8 would be greatly reduced.

FNFN said BC Hydro's rationale for Site C, that it is required to power LNG facilities, demonstrated the seriousness of the cumulative effects risk. Chief Gale suggested that the development of Site C would lead to a snowballing effect that would result in incentives to undertake even more gas development in Treaty 8 territory, and the construction of the northeast transmission line, further increasing adverse impacts on treaty rights.

Measures to avoid or mitigate potential adverse effects of the Project on asserted or established Aboriginal rights and treaty rights

FNFN did not suggest any measures to avoid or mitigate identified effects that may impact their asserted or established Aboriginal rights and Treaty rights. Rather, it is unequivocally opposed to the Project.

3. McLeod Lake Indian Band

The McLeod Indian Band (MLIB) is a Treaty 8 First Nation in British Columbia. MLIB holds rights under Treaty 8, and asserts rights from oral promises made by representatives of the Crown, and incidental to Treaty 8. MLIB also asserts Aboriginal rights under section 35 of the *Constitution Act, 1982*.

The MLIB traditional territory covers an area of over 130,000 square kilometres from McLeod Lake east to Alberta, north to the north bank of the Williston reservoir, and south to an area near Highway 97. MLIB was traditionally a semi-nomadic people that lived and flourished by hunting and gathering seasonal resources from multiple landscapes in and around the Rocky Mountain Trench and the upper Peace River region of northeastern B.C.

Manner in which the Project may adversely affect asserted or established Aboriginal rights and treaty rights

MLIB band members have two active traplines that would be affected by the Project. Adverse impacts are expected because of environmental and game movement changes resulting from the development of the reservoir environment to replace the naturally formed Peace River. The traplines also would be affected by the development's supporting infrastructure such as roads, transmission right-of-way, and new construction.

One MLIB member owns an outfitting company that relies on bringing hunters into the Rocky Mountains on the east side of the Parsnip River. The game they expect to hunt would be affected by the environmental changes, including wildlife mortality and dislocation resulting from the construction of the Site C reservoir and infrastructures.

Additional concerns related to the potential for increased toxicity in fish due to methylmercury contamination; increased sloughing, erosion, and landslides in the reservoir; and exacerbated changes in water levels and water flow rate upstream in the Williston reservoir.

Location, extent, and exercise of asserted or established Aboriginal rights and treaty rights that may be affected by the Project

The MLIB traplines are located in the Colbourne Creek area on the east side of the Parsnip River, and in the Mackenzie area on both the east and west sides of the Williston reservoir. These sources of beaver meat, groundhog meat, and cash income from cured furs have been used for generations and have cultural and family significance to MLIB members. .

The outfitting company operates in the Omineca guiding region. Neither the area of the traplines nor the Omineca guiding region is within BC Hydro's defined local assessment area (LAA) for the current use of lands and resources for traditional purposes.

Locations of cultural significance are identified as Carp Lake, important sites on the Peace River including the confluence of the Peace River and Halfway River, Del Rio, Taylor Flats area for harvesting elk and moose, Hudson's Hope and Dinosaur Lake areas for fishing, the outlet of Farrell Creek, Halfmoon Lake, Jackfish Lake, Tembec road area, lower Moberly River for gathering, and Rocky Mountain Fort and Charlie Lake for heritage resources, and current and historical trails including Pine Pass Trail, Rocky Mountain Portage Trail, and a trail on the north bank of Peace River.

Measures to avoid or mitigate potential adverse effects of the Project on asserted or established Aboriginal rights and treaty rights

MLIB asked for avoidance of adverse effects by denial of approval for the Project. MLIB did not suggest any measure to avoid or mitigate effects that may impact their asserted or established Aboriginal rights and Treaty rights

4. Saulteau First Nations

Saulteau First Nations (SFN) is a member of the Treaty 8 First Nations of British Columbia. SFN holds rights under Treaty 8, and asserts rights from oral promises made by representatives of the Crown, and incidental to Treaty 8. SFN also asserts Aboriginal rights under section 35 of the *Constitution Act, 1982*.

SFN has the largest population of the Treaty 8 First Nations. Approximately half of the members live on-reserve at East Moberly Lake, about 25 km from Chetwynd, B.C., and 100 km southwest of Fort St. John. The SFN described its traditional territory as extending "well beyond" the boundaries of the reserve. The SFN identified as its traditional harvesting areas the Peace-Moberly Tract (PMT) and the Area of Critical Community Interest (ACCI). The PMT is located within the ACCI and is part of an area initially identified by SFN and the West Moberly First Nations (WMFN) for special protection. The PMT is a relatively undisturbed area of land near the SFN reserve.

Manner in which the Project may adversely affect asserted or established Aboriginal rights and treaty rights

SFN described the scope and content of its members' treaty rights in the context of court decisions, notably *West Moberly First Nation v. British Columbia*, in which Chief Justice Finch concluded: "The nature and scope of the petitioners' right to hunt must be understood as the petitioners' ancestors, and as the Crown's treaty makers, would have understood that right when the treaty was made or adhered to. That understanding is to be derived from the language used in the treaty, informed by the report of the Commissioners." At the January 17, 2014 hearing, former Chief Stewart Cameron said this of Treaty 8:

> The true spirit and intent was about peace, sharing, and coexistence. It wasn't a one-sided treaty where people could just come in onto our land base, take our

> resources and use them up as they so wish…we know what the true spirit and intent of Treaty No. 8 is to us…for hunting, fishing, trapping…but it goes way more than that also. It's a way of life, mode of life, meaning that's the land. It's related to the land. The land and our language are related to the land. Our teachings come from that. Our way of life, our laws come from that, from all this.

An Elder expressed strongly that their Treaty rights are violated when Aboriginal people are not informed when future projects are to take place within their traditional territory, threatening their lands, their "grocery store," "pharmacy," and "church." The Aboriginal people are the "primary stakeholders" to the land and the resources, and they should not be being pushed aside in the entire process of managing resources. Indigenous people are concerned about environmental pollution and impacts to their traditional culture.

Location, extent, and exercise of asserted or established Aboriginal rights and treaty rights that may be affected by the Project

The Peace-Moberly Tract is a preferred harvesting location for SFN members within the ACCI, one of the primary areas relied upon by SFN members for subsistence harvesting. The proposed Site C Project intersects the PMT. The SFN was concerned that the expansion of the right-of-way to accommodate the transmission line would result in increased industrial development within the PMT and ACCI, attracting other development by providing access to new areas, enhanced availability of electricity for projects, or new routes for oil and gas infrastructure.

SFN also raised concerns for proposed expansion of the Del Rio Pit into areas of the ACCI that are currently forested. As the Del Rio Pit would not be reclaimed, the disturbance would be a permanent adverse environmental effect of the Project. Reliance on the Del Rio Pit would also entail additional traffic and noise, and the creation of new access and use of the ACCI that could lead to increased mortality due to wildlife collisions, increased predators, and disturbance and fragmentation of habitats.

SFN rely on traditional resources for food, medicine, and other purposes. Particular concerns were raised regarding the potential impacts of industrial developments on moose, fish, plants, and other harvestable and culturally significant resources within the PMT. Moose was noted as intrinsic to the SFN identify, a "cherished food stuff, a key cultural resource, and a primary component of the SFN's traditional practices."

SFN members fish in all seasons, year-round. Fish is a very big part of the SFN's diet, particularly the Arctic grayling in the Peace River. The SFN has lost access to their fishing resources due to the decline in fish population and the presence of mercury in the fish, both consequences that SFN attributed to the development of the Bennett Dam, Peace Canyon Dam, and the Williston reservoir. There is significant anxiety that the Project would further contaminate the fish.

SFN also raised concerns for the potential of the Project to negatively impact the shorelines, thus leading to adverse impacts on nesting sites for smaller species that SFN rely on for hunting and trapping purposes, including eagles, swans, beavers, muskrats, porcupines, groundhogs, and small birds. SFN anticipated that the Site C Project would result in negative impacts on their ability to pass on knowledge and culture, and to ensure continuity of their culture and practices of their traditional way of life.

Measures to avoid or mitigate potential adverse effects of the Project on asserted or established

Aboriginal rights and treaty rights

SFN did not support the Project and said BC Hydro should find less intrusive ways to create power.

If the Project is approved, the SFN asked that the Panel reject BC Hydro's proposed mitigation measure of stocking the reservoir with kokanee, a fish species that the SFN predicted would eat their preferred fish species and risk the availability of preferred species for SFN fishing purposes.

SFN also asked that the Panel:

- Recommend that the use of the transmission line right-of-way be limited to Project purposes unless the SFN consented to alternative uses;
- Recommend that BC Hydro undertake additional investigations before a transmission route would be selected for the Project;
- Recommend the use of the Del Rio Pit be limited or avoided in order to minimize effects in the ACCI;
- Recommend regulatory changes to reduce competition for wildlife resources in SFN preferred hunting areas, in order to protect the interests of SFN subsistence hunters by limiting hunting within the ACCI and PMT; and
- Recommend that BC Hydro provide free power to all northeast British Columbians, for all times.

5. Doig River First Nation

Treaty 8 Tribal Association (T8TA) represented Doig River, Prophet River, Halfway River, and West Moberly First Nations at the public hearing. All four hold rights under Treaty 8, and assert rights from oral promises made by representatives of the Crown, and incidental to Treaty 8. T8TA also asserts Aboriginal rights under section 35 of the Constitution Act, *1982*.

In both its oral and written submissions to the Panel, T8TA said the development of the Project would not be justified and not in the public interest, in view of the expected impact of the Site C Project on Treaty 8 rights, existing infringements from present developments, and a lack of clear plans for the protection of resources or lands in the Peace River valley that are integral to the current and future practice of Treaty 8 rights in preferred areas and in accordance to preferred means.

The T8TA appeared for these four First Nations before the Panel on January 17, 2014, and filed a written submission on February 3, 2014.

Manner in which the Project may adversely affect asserted or established Aboriginal rights and treaty rights

T8TA described its understanding of the legal framework for Treaty 8 and what T8TA understands to be their members' treaty rights under Treaty 8. Under Treaty 8, First Nations have the right to hunt, fish, and trap, as well as to trade and sell what they harvest.

In addition, T8TA stated, as guiding principles for the interpretation of treaties, including Treaty 8, that:

> Treaties also must be interpreted liberally, with any uncertainties, ambiguities, or doubtful expressions resolved in favour of the First Nations signatories. The words in a Treaty must not be interpreted in their strict technical sense nor subjected to rigid modern rules of construction…The terms of the Treaty must be interpreted in light of the historical context and the Treaty's underlying purpose.

T8TA submitted that it would be unconscionable for the Crown to ignore oral terms and promises. In *R. v. Badger*, 1996 1S.C.R.771, the Supreme Court of Canada emphasized the significance of oral promises to the interpretation of Treaty 8. The court found it necessary to look not only at the written text of the agreement but also at written accounts of eyewitnesses to the agreement, to know what had been promised at the time of the treaty signing. For example, the court found that oral assurances guaranteeing harvesting rights were at the core of the negotiations. The court also noted that "right" refers not just to the right to hunt and fish and trap for food, but also to the protection of important species and other components of harvesting practices traditionally exercised by a First Nation within its local hunting and fishing grounds, so that the continuity of traditional harvesting patterns and practices could be preserved. Evidence of traditional patterns of travel and seasonal rounds is relevant in the interpretation of their rights.

The traditional seasonal rounds consist of five main periods of land use activities: 1) early fall to hunt and trap for large game, such as buffalo, moose, and deer; 2) late winter to mid-summer to hunt and trap for small game and fur-bearing animals, such as marten, lynx, fisher, and wolverine; 3) late winter to spring to hunt intensively; 4) spring to trap; and 5) summer to hunt, pick berries, fish, and visit.

T8TA asserts that Treaty 8 protects "the important species and other components of harvesting practices traditionally exercised by a given Treaty 8 First Nation." This "meaningful right to hunt" is to be determined with respect to each First Nation and its local hunting grounds, and for particular species forming the seasonal hunting round. The rights include rights incidental to harvesting rights, such as the right to have the habitat managed for the sustainability of the resource, to construct a cabin, and to have access to the resource.

In the *Tsilhqot'in Nation v. British Columbia,* 2007 B.C.S.C. 1700, the B.C. Supreme Court found that a management regime that allows wildlife to continue to exist for the harvesting of wildlife is an incidental right. Similarly, in the *R. v. Nikal*, 1996 1S.C.R. 1013, the court found that the exercise of Aboriginal fishing rights "is dependent on the continued existence of that resource."

T8TA recognizes that the Treaty allows the Crown the right to take land for settlement, mining, lumbering, and other purposes. But, in accordance with the *Claxton v. Saanichton Bay Marina*, 1989 3 C.N.L.R. 46, the Crown's right to do so is not absolute. Treaty rights are not inferior to the Crown's right to take up land. In the *Mikisew Cree First Nation v. Canada (Minister of Canadian Heritage)*, 2005 S.C.C. 69, the Supreme Court of Canada recognized the importance of reconciliation, or balance, between the respective claims, interests, and ambitions of Aboriginal and non-Aboriginal peoples. Reconciliation is also the objective of the Crown's duty to consult. T8TA urged the Panel to contribute to the objective of reconciliation by understanding the perspective of the First Nations with regard to their Treaty rights and how the Peace River valley supports the meaningful exercise of those rights.

Intangible cultural heritage resources are of critical importance to the Treaty 8 First Nations. These resources include values such as the knowledge of fishing areas, skills, cooking, sharing, and social relations. Such values are not substantively, or meaningfully, addressed in BC Hydro's Environmental Impact Statement (EIS).

Location, extent, and exercise of asserted or established Aboriginal rights and treaty rights that may be affected by the Project

T8TA asserted that the Peace River is the heartland of Treaty 8 territory. It retained the Firelight Group to conduct a Traditional Use Study (TUS) on the current use of lands and resources by Aboriginal peoples. The TUS mapped 796 site-specific use values within the local study area (LSA), defined by BC Hydro as within 5 km of the inundation area and Site C Project footprint. Of these values, 368 (almost 46%)—145 subsistence values, 42 cultural spiritual values, 74 environmental features, 77 habitation values, and 30 transportation values—were found to be inside the inundation zone and footprint. The confluence area does not include private lands in the valley.

The TUS led to the identification of key concerns raised by Treaty 8 First Nations, some related to impacts from the density of activity along the river corridor. The TUS identified sites where rare medicinal plants are harvested on the south slopes of the Peace valley; corridors and habitat areas in the valley (one at Farrell Creek and another near the West Moberly reserve) that wildlife, including grizzly bear and elk, use; and areas of intense subsistence use—hunting, fishing, and trapping. The harvesting of preferred fish, particularly Rocky Mountain whitefish, bull trout (Dolly Varden), and rainbow trout, is extremely dense at the confluence of the Halfway and Peace Rivers. At certain times of the year, species including Arctic grayling and kokanee also come up to the area. The LSA includes important rainbow and bull trout spawning areas. The development of Site C would permanently destroy these identified critical cultural areas, and that destruction would have a significant effect on First Nations' exercise of their Treaty rights.

In addition, the dam and the reservoir would mean the irreversible loss of key riverine habitats, which should be considered a significant adverse effect as some species require riverine habitat, fish contaminated by methylmercury and unsuitable for human consumption, and up to 40 percent mortality of large fish from entrainment through the generating station and turbines. T8TA stated all of these would have significant adverse effects on their members' Aboriginal and treaty rights.

T8TA was also concerned that by excluding from the LAA Peace River tributaries downstream of Site C, including the Pine, Beatton, Kiskatinaw, and Alces Rivers, and tributaries downstream to Many Islands, Alberta, BC Hydro understated potential adverse effects on fish. T8TA believed the exclusion is not justified because a number of fish species move between mainstem and tributary habitats, and BC Hydro has not demonstrated that the Project's effects on downstream water levels and flows would not have a measurable effect on fish use of, or access to, tributary habitats.

T8TA also believed that BC Hydro has failed to provide adequate information for a proper assessment of effects on ungulates and carnivores. A detailed study of all important habitat features during the life cycle of each specific species is required. Although historic records and Aboriginal traditional knowledge have shown that caribou used the Project area in the past, and habitat mapping used in current recovery planning has identified areas within this area as important for recovery of caribou populations, BC Hydro has not shown any consideration of effects on the caribou. BC Hydro has failed to recognize that most of the proposed Project, including both source areas for rip-rap, would be located within the recovery planning area for the adjacent Klinse-Za (formerly "Moberly") caribou herd, one that is close to extirpation and is currently undergoing intensive and aggressive management actions in attempts to recover the population and its former distribution. The potential for adverse residual effects on caribou was not assessed. BC Hydro's conclusion that the Project would not have residual effects on large

carnivores cannot be accepted because BC Hydro did not conduct any studies to establish baseline data.

Sixty percent of the Peace River valley has already been inundated by the development of the Bennett Dam and Peace Canyon Dam. The ability of the T8FN to exercise their treaty rights in the inundated portion of the Peace River is effectively precluded by these existing hydroelectric projects. Of the remaining 40 percent of the Peace River valley, Site C would inundate half. The remaining 20 percent is downstream of the Old Fort, and is less accessible and lacks the hunting, fishing, and cultural significance of the portion proposed for inundation by Site C. Currently, there are no conservation lands, parks, or reserve lands within the valley in which wildlife and First Nation land use values might be protected. The road and transmission lines required by Site C would undermine the potential for conservation in the adjacent lands containing wildlife and First Nation land use values (e.g. the Peace-Moberly Tract). Cumulative effects resulting from the intense exploration for conventional gas, unconventional gas, coal bed methane, shale gas, and oil in Treaty 8 territory are significant concerns.

T8TA suggested that a regional cumulative effects study is required. In particular, the geographic extent, duration, reversibility, and context cannot be fully appreciated without a more comprehensive analysis and assessment of the Williston and Dinosaur reservoirs. In the cumulative effects assessment of vegetation and ecological communities, BC Hydro did not appear to have considered past projects in its assessment, only existing and future projects.

Measures to avoid or mitigate potential adverse effects of the Project on asserted or established Aboriginal rights and treaty rights

T8TA is not against hydroelectric development, but it does oppose the government's policy to maximize the hydroelectric potential of the Peace River. This policy cannot be reconciled with T8TA's values and uses of their lands, nor can it be reconciled with the ongoing use of the Peace River valley as a refuge for wildlife, as a place for agriculture, and as a place where Treaty 8 First Nations' cultural and spiritual values can be protected. T8TA cannot support the Project.

Alternatively, T8TA proposed that the Panel require BC Hydro to conduct further work prior to making a decision on the Site C Project, or adopt a precautionary approach. T8TA did not support BC Hydro's proposed mitigation measures that focus on First Nations adapting to exercising their Treaty rights at other available locations or relying on the use of non-preferred resources. Treaty rights, and incidental rights, require that availability of resources be within the First Nations' traditional territory.

T8TA asks the Panel to recommend that BC Hydro:

- Consider Site 7B, rather than Site C, for the production of energy because of reduced adverse environmental effects, and it is said to be more likely to reconcile conflicting interests and rights;
- Consider Peace Canyon Energy Corporation's 2005 proposal to construct a small-scale dam downstream of Peace Canyon and upstream of Hudson's Hope; and
- Revise BC Hydro's definition for fish and fish habitat to consider loss or reduction in the context of "per unit area."

6. Halfway River First Nation

The Halfway River, Doig River, Prophet River, and West Moberly First Nations were jointly

represented in the Joint Review. All derive rights from Treaty 8 and are referred to collectively in this report as the Treaty 8 Tribal Association (T8TA). The T8TA's assertions of rights and articulation of impacts are set out in the Doig River entry above.

7. Prophet River First Nation

The Prophet River, Doig River, Halfway River, and West Moberly First Nations were jointly represented in the Joint Review. All derive rights from Treaty 8 and are referred to collectively in this report as the Treaty 8 Tribal Association (T8TA). The T8TA's assertions of rights and articulation of impacts are set out in the Doig River entry above.

8. West Moberly First Nations

The West Moberly, Doig River, Halfway River, and Prophet River First Nations were jointly represented in the Joint Review. All derive rights from Treaty 8 and are referred to collectively in this report as the Treaty 8 Tribal Association (T8TA). The T8TA's assertions of rights and articulation of impacts are set out in the Doig River entry above.

9. Athabasca Chipewyan First Nation

The Athabasca Chipewyan First Nation (ACFN) and Mikisew Cree First Nation (MCFN) are members of the Treaty 8 First Nations of Alberta. ACFN and MCFN hold treaty rights under Treaty 8 and assert rights from oral promises made by representatives of the Crown, and incidental to Treaty 8. They also assert Aboriginal rights under section 35 of the *Constitution Act, 1982*.

ACFN traditional territory is located in the northeast corner of Alberta and the northwest corner of Saskatchewan, centred at Lake Claire, the western end of Lake Athabasca, and the lower Athabasca River. ACFN has reserves located near the southwestern tip of Lake Athabasca, across the lake from Fort Chipewyan and on the Athabasca River.

Dr. Craig Candler gave an oral presentation to the Panel on behalf of ACFN and MCFN on January 17, 2014. ACFN and MCFN also filed a joint submission to the Panel on February 3, 2014.

Manner in which the Project may adversely affect asserted or established Aboriginal rights and treaty rights

The ACFN and MCFN assert that Treaty 8 guarantees them the right to hunt species they have harvested traditionally, such as moose, bison, caribou, muskrat, beaver, otter, lynx, duck, and geese; to fish; and to gather plants and berries for food and medicine in their preferred areas, and in particular, in the Peace Athabasca Delta (PAD). "The Treaty also guarantees rights incidental to those activities, such as the right to access unoccupied lands, the right to build cabins and trails for harvesting purpose, the right to teach harvesting to younger generations on the land, the right to come together in groups to hold ceremonies and other events, and the right to use various means of travel to assist with hunting, trapping, fishing and gathering."

The ACFN and MCFN spoke of the right to rely on the resources of the land and the right to protect the land and water. They emphasized the cultural and spiritual context of those rights, and that their "oral traditions, personal identities, and spiritual beliefs and practices were implicated in the landscape."

ACFN and MCFN members emphasized, in their oral presentation at the public hearing, the importance of water access to preferred locations within their traditional lands.

Of primary concern to the ACFN and MCFN are incremental effects of the Project contributing to cumulative effects resulting from the extensive industrial development in the area relating to oil and gas, forestry, and mining, as well as to the ongoing operations of the Bennett Dam and Peace Canyon Dam located upstream of the PAD and, in particular, downstream Aboriginal use of the PAD.

ACFN and MCFN also had concerns for downstream effects of the Project related to potential changes to water flow rate, water levels, and ice jams, and how those potential effects would affect ACFN and MCFN's ability to continue to exercise their Treaty 8 rights to hunt, trap, fish, gather resources, and to assure the continuity of their culture and practices.

Location, extent, and exercise of asserted or established Aboriginal rights and treaty rights that may be affected by the Project

The PAD is one of the world's largest freshwater deltas at some 500,000 hectares. With its nutrient-enriched flood plains and long growing season, it is a highly productive ecosystem the ACFN and MCFN have relied on for centuries. The waterways of the PAD were the principal means of access to important harvesting and cultural areas within the PAD. However, the ACFN and MCFN expressed grave concern about the drying trend in the PAD. Previously, "regular spring flooding from hydraulic damming and reverse flows, and through ice jam floods have been replaced with multi-decadal intervals between significant flood events." (para. 167) The timing of high water has changed so that it is now in the winter, making travel by skidoo more dangerous, thereby restricting access to traplines.

The ACFN and MCFN said the impacts of these trends include significant declines in fish and wildlife populations and their habitats in the PAD, and increased difficulty in accessing preferred harvesting areas. The ACFN and MCFN blame BC Hydro's regulation of the Peace River, since the development of the Bennett Dam, as a contributing factor in the drying trend resulting in the present state where a small incremental change could result in significant effects, and in the loss of the PAD's resilience to withstand more impact. ACFN and MCFN alleged that very small changes in water level in the PAD could result in massive changes in the microclimate and ecology of the area. Of particular concern to the ACFN and MCFN are the impact of reservoir filling that, even if the range of active storage were small behind Site C, reservoir filling would have the potential to influence the timing of freshets, and the impact of BC Hydro's failure to consider the potential effects of climate change.

They stated, in effect, that the impact of Site C on the PAD was not understood and it would be an abrogation of their treaty rights to proceed with the Project without that understanding.

Some areas ACFN and MCFN used for the harvesting of traditional resources include: Lake Mamawi, Lake Claire, Hilda Lake, Hay River, Egg Lake, Goose Island, Jackfish Lake (aka Richardson Lake), Embarras River, Prairie River, Baril Lake and Creek, in and around Fort Chipewan, Rocky Point along the Peace River, the Peace River, the Fletcher Channel, Lake Athabasca, Athabasca River, and Flour Bay. The resources they rely on include but are not limited to:

- Aquatic fur-bearing animals, including muskrat, beaver, and otter;
- Terrestrial fur-bearing animals, such as lynx;
- Large game, such as moose, bison, and caribou;
- Migratory birds, particularly duck and geese; and,
- Fish, especially whitefish.

Measures to avoid or mitigate potential adverse effects of the Project on asserted or established Aboriginal rights and treaty rights

ACFN and MCFN recommended that the Panel recommend against Project approval.

ACFN and MCFN felt that the methodology BC Hydro used to determine Project effects was lacking in several respects, such that the Panel cannot properly consider the potential environmental effects of the Project, or the potential effects to the rights of the ACFN and MCFN. In its written submission of September 23, 2913, ACFN and MCFN asked that the Panel recommend further studies for a full understanding of the environmental impacts on Aboriginal and treaty rights, and in particular that BC Hydro:

- expand the spatial boundaries for the effects assessments of valued components, particularly for wildlife resources, fish and fish habitat, vegetation and ecological communities, navigation and current use of land and resources for traditional purposes, to include Wood Buffalo National Park, and the PAD ecosystem;
- include Bennett Dam and Peace Canyon Dam in the scope of the cumulative effects assessment;
- include a study of impacts of reservoir filling on downstream locations;
- conduct a study of the potential for water levels in Lake Athabasca to decrease under future climate and water use scenarios and an assessment of the potential effects of the Project on open-water recharge of the PAD under such future scenarios;
- conduct a study of the potential effects of the Project on surface water that considers the effects of ice and ice-related events on flow;
- conduct a study of the potential impacts of the Project on the ice-jam flood recharge mechanisms for the PAD;
- conduct an assessment of the Project's potential impacts on the open-water recharge mechanisms under future climate scenarios; and
- assess the effects on surface water to address the present gap in information regarding Site C's effects using an approach similar to the approach BC Hydro used for the modeling of the ice regime.

In the absence of such studies, if a Certificate were issued, the ACFN and MCFN asked that the Panel recommend the inclusion of a set of comprehensive conditions to address the concerns identified through monitoring and follow-up programs.

10. Mikisew Cree First Nation

MCFN is a member of Treaty 8 First Nations of Alberta, whose traditional territory centres on the region of the Peace Athabasca Delta (PAD) and northwest of Lake Athabasca. MCFN has nine reserves in northeastern Alberta, including one within Wood Buffalo National Park.

The MCFN was represented jointly in the Joint Review Panel process with the Athabasca Chipewyan First Nation. The MCFN assertions of rights and its articulation of impacts are set out in the ACFN entry above.

11. Beaver First Nation

Beaver First Nation (BFN) is a member of Treaty 8 First Nations of Alberta. BFN did not participate in the Joint Review Panel Stage or submit to the Panel for consideration any

assertion of Aboriginal or treaty rights, or the articulation of any impacts on those rights. The following summary is based on BC Hydro's Environmental Impact Statement (EIS), Volume 5, Appendix A02.

BFN is a Danne-zaa community with two Indian Reserves, Boyer 164 and Child Lake 164A, located northwest of Fort Vermilion in Alberta. BFN is currently in Treaty Land Entitlement negotiations with Canada and Alberta.

Manner in which the Project may adversely affect asserted or established Aboriginal rights and treaty rights

BC Hydro did not enter into a Traditional Land Use Study (TLU) agreement with BFN, and no traditional land use information was made available by the BFN. Based on past TLU studies completed relating to pipeline projects, the region around Zama Lake in northeastern Alberta was reported to have once been used by BFN for hunting, fishing, and trapping.

Location, extent, and exercise of asserted or established Aboriginal rights and treaty rights that may be affected by the Project

The proposed Site C dam is distant from the traditional lands of the BFN. No specific information was identified that described or documented the exercise of Aboriginal or treaty rights by BFN within the LAAs and RAAs for hunting, fishing, trapping, or other traditional activities.

Measures to avoid or mitigate potential adverse effects of the Project on asserted or established Aboriginal rights and treaty rights

BFN did not suggest any measure to avoid or mitigate potential adverse effects of the Project.

12. Dene Tha' First Nation

Dene Tha' First Nation (DTFN) is a member of Treaty 8 First Nations of Alberta. DTFN holds treaty rights under Treaty 8 and asserts rights from oral promises made by representatives of the Crown, and incidental to Treaty 8. They also assert Aboriginal rights under section 35 of the *Constitution Act, 1982*.

Dene Tha' people define their traditional territory as lying primarily in Alberta, but also extending into the southern parts of the Northwest Territories and the northeast parts of B.C., including the Site C Project area. All DTFN Indian Reserves are located in Alberta.

Manner in which the Project may adversely affect asserted or established Aboriginal rights and treaty rights

The proposed Site C dam is located on the Peace River near Fort St. John on the southern boundary of DTFN traditional territory. Of the 2,500 Dene Tha' members, approximately 1,000 are active harvesters. Much of their current harvesting activities take place at or near the Peace River valley.

The DTFN assert that Treaty 8 established a balanced sharing of the land, guaranteeing hunting, fishing, and trapping rights to sustain DTFN members' traditional livelihood, rights that cannot be limited or interfered with to an extent that render them meaningless. Fundamentally altering the environment would be a breach of Treaty 8, because "a hunting and trapping vocation is only possible if there are adequate, accessible hunting and trapping grounds

populated by sufficient wildlife."

DTFN commissioned both a Traditional Land Use Study and a revision that it used to demonstrate the importance of the Peace River to its people and why the valley is a unique place. The maps show a high level of activity and use along the Peace River valley; year-round activities are identified at some areas, and seasonal activities are identified at others. There are camps at Sulphur Lake and Boundary Lake, in and around Pink Mountain, and west of the Blueberry River Indian Reserve that are repeatedly occupied. DTFN was concerned that the proposed dam would negatively impact its members' treaty rights to hunt, trap, fish, and gather not only within but also outside the LAA. In the summer, the base and slope of Clear Hills are preferred locations to gather cranberries, blueberries, and raspberries. DTFN members gather huckleberries and Saskatoon berries along the Peace River downstream of Fort St. John and especially at Flatrock Creek.

The Dene Tha' household economy is dependent, to a large extent, on country foods. The DTFN said that any adverse impact on resources in the Peace River valley, or access to those resources, would directly also result in adverse impacts on the DTFN's ability to exercise their Treaty rights to transfer traditional knowledge and practices to future generations. Such knowledge defines the Dene Tha' language, culture, and values and is what gives the Dene Tha' their identity.

DTFN asserted that it is inappropriate to conclude, as BC Hydro did, that DTFN members would not be not adversely affected by the Project as they can go elsewhere to harvest. This conclusion ignores the cultural and spiritual context, and that with disturbances related to oil and gas, forestry, mining, and agriculture, the "elsewheres" within the DTFN traditional territory are diminishing. The right is to hunt, trap, and fish species that traditionally sustained them, and to pass their traditional knowledge to future generations. For DTFN that right refers to the harvesting of moose, beaver, duck, and geese in their preferred areas; that right also includes incidental rights to build cabins and trails, to come together in groups to hold ceremonies, and to use various means of travel for hunting, fishing, trapping, and gathering.

While DTFN acknowledged that the Project would not impact the entirety of the Dene Tha' traditional territory and that not all of their treaty rights would be extinguished as a result of the Project, DTFN did not agree with BC Hydro's conclusion that impacts on Dene Tha' treaty rights would be close to zero.

Location, extent, and exercise of asserted or established Aboriginal rights and treaty rights that may be affected by the Project

The Dene Tha' referred to themselves as "multi-species" hunters, or opportunistic harvesters, who do not hunt with one target species in mind and ignore all others. While the preferred hunting species are moose, beaver, duck, and geese in the DTFN preferred hunting areas, DTFN hunters also harvest other available resources. Moose is of critical importance to their diet. Moose, and other game, are hunted by the DTFN year-round throughout their traditional territory. Dene Tha' were concerned that the Project would adversely affect the availability of moose, caribou, bison, elk, bear, lynx, and wolves whose home ranges include the LAA, as well as various species of fish that migrate along the Peace River and spawn in tributaries outside the LAA.

Primary areas used for hunting are Sulphur Lake, Boundary Lake, and between the McKenzie Highway and Fort Nelson/Fort Liard. It has been estimated that 25 percent of all the moose consumed by DTFN members comes from these areas. Depending on the time of year, other

areas may be used for hunting: between Notikewin River/Doig River headwaters and the Peace River; the base, slopes, and plateau of Clear Hills; and all areas within the current use RAA and LAA. Moose hunting also occurs along the south side of Peace River, from the Moberly River to the Alberta border.

Bull trout are among the fish species harvested by Dene Tha'. BC Hydro has determined that there would be some adverse effects to bull trout In particular, those that spawn in the Halfway River may be lost, and those that migrate downstream of the dam may experience unpredictable outcomes.

Key concerns of DTFN were the impacts of industrial development in its traditional territory on members' ability to exercise their treaty rights and Aboriginal rights, and the incremental contribution of the Site C Project to the cumulative effects from current and future developments, particularly those relating to oil and gas, and forestry activities.

BC Hydro concluded that the significance of effects on the Dene Tha' people would be low because their traditional practices are adaptive spatially and affected areas are at the periphery of the Project area. However, the Dene Tha' advised the Panel that, given the current level of development, they have nowhere else to go. More and more Dene Tha' are concentrating their traditional use within an activity corridor that stretches from Sulphur Lake (west of Manning, Alberta) to the Beatton River (east of Fort St. John).

Measures to avoid or mitigate potential adverse effects of the Project on asserted or established Aboriginal rights and treaty rights

DTFN asked that the Panel recommend the provincial and federal ministers of environment to deny approval for the Project to proceed.

If the Project is approved, DTFN asked the Panel to reject BC Hydro's proposals to construct more boat launches, which would increase pressure on already scarce fish population, and to add land to the Agricultural Land Reserve, which would reduce the land available for DTFN's current use to exercise their treaty rights.

13. Duncan's First Nation

Duncan's First Nation (DFN) is a member of Treaty 8 First Nations of Alberta. DFN holds treaty rights under Treaty 8 and asserts rights from oral promises made by representatives of the Crown, and incidental to Treaty 8. It also asserts Aboriginal rights under section 35 of the *Constitution Act, 1982*.

The greatest concentration of DFN activities is in Alberta along the Peace River in an area of the Peace River wildlands, within the main DFN Indian Reserve IR #151A situated on the north side of the Peace River near Brownvale, Alberta, and in the area north of the two areas on both sides of the Peace River. DFN has a second reserve located southeast of the town of Peace River.

DFN asserts treaty rights to access sufficient quality and quantity of traditional resources such as water, fish, moose, medicines, and berries to meet the community's needs, and to trade its harvest in B.C. DFN also claims incidental rights to construct shelters, access preferred areas, and transmit traditional ecological knowledge and cultural teachings to future generations.

Manner in which the Project may adversely affect asserted or established Aboriginal rights and treaty rights

DFN is concerned about the downstream effects of the Project because they exercise their rights in traditional land use in the Peace River valley downstream of Site C.

DFN asserts that their Aboriginal and treaty rights, cultural heritage, health and socio-economic conditions, and traditional land use would be significantly adversely impacted by the construction of the Project, and over the long term by its operation as an indivisible component of BC Hydro's Peace River electrical system.

Additional concerns related to alignment changes to Highway 29, including Highway 97, and cumulative effects associated with the Project and current and future industrial activities related to oil and gas, logging, coal mining, and forestry activities in the region.

Location, extent, and exercise of asserted or established Aboriginal rights and treaty rights that may be affected by the Project

DFN informed the Panel that hunting is clearly the most important traditional activity that continues to present day. Fishing is relatively less important but still practiced. Of particular relevance and interest to the DFN are the following resources:

- Large animals: Moose, white-tailed deer, mule deer, elk, grizzly and black bear, ungulates such as caribou, mountain goat, sheep;
- Small animals: Porcupine, rabbit, beaver;
- Birds: Waterfowl such as ducks and geese; upland birds;
- Fish: Various species of trout, northern pike, walleye, whitefish, grayling; and
- Vegetation: Saskatoon berry, wild raspberry, blueberry, wild strawberry, choke cherry, low bush/high bush cranberry, rat root, mint, Labrador tea, wild rhubarb, herbs, diamond willow, dandelion, rosehip, red willow, birch.

DFN Elders expressed concerns based on their experience with changes along the Peace River, which they attributed to the Bennett and Peace Canyon Dams. These changes included lower water, and because of contamination, undrinkable water and limits on the number of fish they can safely eat. Elders observed that the dams have changed the migration patterns of the animals; moose and beaver, as well as toads, garter snakes, and water snakes, are now gone from along the Peace River. DFN is concerned that the development of the Project would worsen DFN members' ability to exercise their treaty rights to safely fish and hunt. An Elder predicted that the development of the Project would dry out the river.

DFN said the spatial limits of the environmental assessment used by BC Hydro unsustainably limit consideration of downstream impacts of the Project.

Measures to avoid or mitigate potential adverse effects of the Project on asserted or established Aboriginal rights and treaty rights

DFN asked the Panel to include the following mitigation measures in its report:

- DFN be provided capacity and meaningful opportunity to be included in planning and authorization processes under each provincial Water Act and federal authorization issued

under the Fisheries Act, for the purpose of developing mitigation measures for Project effects flowing to DFN; and,

- BC Hydro, the Province, and DFO consult with DFN on the operational parameters to be included in any water license issued and associated Water Use Plan, as well as authorization under the federal Fisheries Act in relation to Site C.

14. Horse Lake First Nation

Horse Lake First Nation (HLFN) is a member of Treaty 8 First Nations of Alberta. HLFN holds treaty rights under Treaty 8 and asserts rights from oral promises made by representatives of the Crown, and incidental to Treaty 8. It also asserts Aboriginal rights under section 35 of the *Constitution Act, 1982*.

HLFN was represented early in the environmental assessment but did not participate in the Joint Review Panel process.

15. Little Red River First Nation

Little Red River Cree Nation (LRRCN) is a member of Treaty 8 First Nations of Alberta. LRRCN asserts treaty rights under Treaty 8 and asserts rights from oral promises made by representatives of the Crown, and incidental to Treaty 8. It also asserts Aboriginal rights under section 35 of the *Constitution Act, 1982*.

LRRCN has three communities located downstream of the Peace River. All use a large territory stretching along the Peace River from Wabasca River into Wood Buffalo National Park, to the west side of the PAD:

- John D'Or Prairie—located on the north side of the Peace River and west of Fox Lake;
- Fox Lake—located on the east side of Peace River and west of Wood Buffalo National Park; and
- Garden River—located on the north bank of Peace River just inside the boundary of Wood Buffalo National Park. The site is in the process of being created as an Indian Reserve for 350 LRRCN members.

The territory used is the boreal lowlands ecosystem characterized by approximately 60% wetlands. The wetlands have similar characteristics to the PAD and have experienced the same type of drying.

Due to the loss of seasonal flooding associated with ice-damming, about 50 to 60 percent of the productive wetland ecosystem is now mostly non-productive areas of willow and aspen.

LRRCN claims land-based[1] rights under Treaty 8 within Wood Buffalo National Park, including the PAD.

[1] Letter from LRRCN to CEA Agency and EAO, dated April 2, 2012, defines the term "land-based rights" as, "… Treaty 8 livelihood and vocational interests are grounded in a residual First Nation proprietary interest within Crown lands not taken up by the Crown." "Land-based" rights/interests are also discussed in a LRRCN submission, "*What Would Treaties Mean if Canada Took Indian Understandings Seriously?"*

Manner in which the Project may adversely affect asserted or established Aboriginal rights and treaty rights

The LRRCN community has an unemployment rate of approximately 80 to 95 percent. The citizens depend heavily on the resources they harvest from the wetland ecosystems for subsistence.

LRRCN indicated concerns for potential impacts on the land and resources relating to changes to the surface water flow regime, ice regime, water quality, fish and fish habitat, as well as cumulative effects.

Location, extent and exercise of asserted or established Aboriginal rights and treaty rights that may be affected by the Project

LRRCN identified the areas downstream on the lower Peace River and the PAD, including Wood Buffalo National Park, as having cultural significance, where members use and rely on the extensive boreal wetlands, particularly the Wabasca Lowlands and the Big Slough, and the PAD.

Measures to avoid or mitigate potential adverse effects of the Project on asserted or established Aboriginal rights and treaty rights

Given the critical significance of the wetland ecosystems to the LRRCN's traditional lifestyle and current use, LRRCN asked that the Panel recommend mitigation measures designed to restore and protect the land base. LRRCN suggested that Environment Canada consult with them about using the provisions of the federal *Water Act* and *Parks Act* to establish Crown negotiations about the need for restoration of the "natural flow regime" of the Peace River in order to restore, protect, and safeguard the ecological integrity of Wood Buffalo National Park.

The LRRCN did not make any specific technical measure for the Panel's consideration to avoid or mitigate identified effects that may impact their asserted or established Aboriginal rights and treaty rights.

16. Smith's Landing First Nation

Smith's Landing First Nation (SLFN), a northern Alberta Dene band, is a member of Treaty 8 First Nations of Alberta. SLFN holds treaty rights under Treaty 8 and asserts rights from oral promises made by representatives of the Crown, and incidental to Treaty 8. It also asserts Aboriginal rights under section 35 of the *Constitution Act, 1982*.

SLFN asserts rights to 8,700 hectares of Reserve Lands in northern Alberta and Wood Buffalo National Park, along a 25 km stretch of the Slave River, under the 2000 Treaty Land Settlement Agreement with Canada, and to an additional 80,000 hectares of traditional land in northern Alberta and southern NWT.

Manner in which the Project may adversely affect asserted or established Aboriginal rights and treaty rights

BC Hydro's amended EIS provided the following. "SLNF stated that, by BC Hydro's failure to use a 1950's pre-industrialization baseline for its cumulative effects assessment of the Project, BC Hydro has failed to properly assess, in conjunction with the Bennett and Peace Canyon Dams, the Project's cumulative effects on SLNF treaty rights, SLNF stated, in particular, that BC

Hydro has changed the Peace River flow regime from one of high spring-summer and minimal winter flows to one of lower spring and increased winter flows, which the Project may exacerbate. The Project may also inhibit mitigation of the impacts of the current flow regime on the Peace River, the PAD, the Slave River, and the Mackenzie River system."

Location, extent, and exercise of asserted or established Aboriginal rights and treaty rights that may be affected by the Project

SLFN was concerned that potential downstream effects may have been missed because BC Hydro has inappropriately omitted the lower Slave River from the spatial boundaries for effects assessment and analysis, resulting in BC Hydro's conclusion of "negligible" impact from changes in water levels due to further regulation of the Peace River at Site C. SLFN Elders and land users have observed fewer occurrences of floods since the operation of the Bennett Dam, and, as a result, what were once important shoreline habitats for moose and their calves no longer exist and the moose have moved from the area in search of alternative sanctuaries, jeopardizing the SLNF's meaningful right to hunt.

Measures to avoid or mitigate potential adverse effects of the Project on asserted or established Aboriginal rights and treaty rights

The SLFN urged the Panel to suspend consideration of the Project pending completion of cumulative effects assessment using a pre-industrialization baseline, a revised environmental assessment that includes the lower Slave River within its spatial boundaries, and a comprehensive assessment of current and planned hydroelectric development on the Peace River to seek to mitigate the downstream effects of the current flow regime.

17. Sturgeon Lake Cree Nation

Sturgeon Lake Cree Nation (SLCN) is a member of Treaty 8 First Nations of Alberta. SLCN did not participate in the Joint Review Panel Stage or submit to the Panel for consideration any assertion of Aboriginal or treaty rights, or the articulation of any impacts on those rights. The follows summary is based on BC Hydro's EIS, Volume 5, Appendix A25.

The main population is located 365 km northwest of Edmonton, 97 km east of Grand Prairie, and 12 km west of Valley View.

Manner in which the Project may adversely affect asserted or established Aboriginal rights and treaty rights

BC Hydro did not enter into a Traditional Land Use Study agreement with SLCN, and no traditional land use information was made available by the SLCN. The SLC did not identify any concerns relating to the Project.

Location, extent, and exercise of asserted or established Aboriginal rights and treaty rights that may be affected by the Project

The proposed Site C dam is distant from the traditional lands of SLCN. No specific information was identified that described or documented the exercise of Aboriginal or treaty rights by the SLCN within the LAA and RAA for hunting, fishing, trapping, or other traditional activities.

Measures to avoid or mitigate potential adverse effects of the Project on asserted or established Aboriginal rights and treaty rights

SLCN did not suggest any measure to avoid or mitigate potential adverse effects of the Project.

18. Tallcree First Nation

Tallcree First Nation (TFN) is a member of Treaty 8 First Nations of Alberta. TFN did not participate in the Joint Review Panel Stage or submit to the Panel for consideration any assertion of Aboriginal or treaty rights, or the articulation of any impacts on those rights. The follows summary is based on BC Hydro's EIS, Volume 5, Appendix A26.

TFN has seven reserves near Fort Vermilion, Alberta. TFN identifies the region of the existing TFN Indian Reserves (173C, 163A and 163B) as the most important.

Manner in which the Project may adversely affect asserted or established Aboriginal rights and treaty rights

BC Hydro did not enter into a Traditional Land Use Study agreement with TFN, and no traditional land use information was made available by the TFN.

Location, extent, and exercise of asserted or established Aboriginal rights and treaty rights that may be affected by the Project

The proposed Site C dam is distant from the traditional lands of TFN. No specific information was identified that described or documented the exercise of Aboriginal or treaty rights by the TFN within the LAA and RAA for hunting, fishing, trapping, or other traditional activities.

Measures to avoid or mitigate potential adverse effects of the Project on asserted or established Aboriginal rights and treaty rights

TFN did not suggest any measure to avoid or mitigate potential adverse effects of the Project.

19. Woodland Cree First Nation

The Woodland Cree First Nation (WCFN) is a member of Treaty 8 First Nations of Alberta. WCFN holds treaty rights under Treaty 8 and asserts rights from oral promises made by representatives of the Crown, and incidental to Treaty 8. It also asserts Aboriginal rights under section 35 of the *Constitution Act, 1982*.

WCFN territory is located in the north Peace region of Alberta, along the Peace River.

Manner in which the Project may adversely affect asserted or established Aboriginal rights and treaty rights

WCFN stated concerns regarding potential downstream environmental impacts on their ability to preserve their cultural heritage, exercise their inherent treaty rights and traditional land uses, and preserve their land for future generations. WCFN identified concerns related to the alterations of the surface water flow regime in the Peace River, changes in the ice regime on the Peace River, fish toxicity in the Peace River, dam safety, and cumulative effects on traditional lands and waters.

Location, extent, and exercise of asserted or established Aboriginal rights and treaty rights that may be affected by the Project

WCFN expressed concern that the alterations in the flows of the Peace River downstream of the Project, especially when combined with the changes in the flow regime from the two previous BC Hydro dams, may affect WCFN's use and access to traditional plants and food sources along the shores of the Peace River.

Changes in the ice regime on the Peace River due to the Project could affect WCFN members' ability to practice their treaty rights, and impact traditional activities such as hunting, fishing, gathering, and trapping. Specifically, poor ice conditions on the Peace River may delay or prevent river crossings in early winter by large animals, such as moose, or by WCFN members.

The Project would cause increased levels of methylmercury in fish in the reservoir and downstream. Given that there could be contaminated fish in the Peace River downstream of the dam, WCFN was concerned about the avoidance of fish, or reduced consumption of fish, because of fear and anxiety over mercury toxicity.

WCFN was concerned about the potential for failure of one or more of the three large dams and the impact of the release of large volumes of water from the reservoirs over a very short period of time. While the release of large volumes of water from the dams is allowed under emergency situations, under BC Hydro's license, WCFN was concerned that the impact of such releases was not assessed or considered in the EIS.

The Project has the potential to add to the cumulative effects on WCFN's traditional lands and waters. The area has already experienced significant changes due to the construction and operations of the two previous dams on the Peace River, from forestry operations, and from the recent growth in oil and gas activities in the area.

Measures to avoid or mitigate potential adverse effects of the Project on asserted or established Aboriginal rights and treaty rights

WCFN did not suggest any specific technical measure for the Panel's consideration to avoid or mitigate identified effects that may impact their asserted or established Aboriginal rights and Treaty rights.

20. Deninu K'ue First Nation

Deninu K'ue First Nation (DKFN) is a member of the Akaitcho Treaty 8 Tribal Corporation of the Northwest Territories. DKFN holds treaty rights under Treaty 8 and asserts rights from oral promises made by representatives of the Crown, and incidental to Treaty 8. It also asserts Aboriginal rights under section 35 of the *Constitution Act, 1982*.

The DKFN is located at Fort Resolution on the south shore of the Great Slave Lake and by the mouth of the Slave River in the Northwest Territories. Its traditional territory includes the Treaty 8 area located in the southern part of the Northwest Territories. The DKFN holds treaty rights to hunt, fish, trap, and gather to sustain their livelihood in their traditional territory, in the Slave River watershed that includes the Slave River Delta and around the hamlet of Fort Resolution.

Manner in which the Project may adversely affect asserted or established Aboriginal rights and treaty rights

DKFN members have observed the "drying up" of the Slave River watershed and resulting impacts on DKFN traditional use. DKFN attributed the adverse changes to the commissioning of the Bennett and Peace Canyon Dams, and expects additional disruption of the Peace River by Site C would result in more "drying up" effects on the Slave River watershed, further reducing the ability to travel by boat; loss or increased costs of access; significant decrease in abundance of muskrat, beaver, and other animals they have traditionally trapped, and of birds and fish; and loss of the ability to maintain and transmit traditional knowledge to younger generations.

The DKFN were concerned because the Slave River watershed area lies outside the Project's LAA and RAA, BC Hydro did not explore the question of impacts in the watershed. The DKNF also identified BC Hydro's failure to include the effects of the Bennett and Peace Canyon Dams as a deficiency in its cumulative effects assessment. As a result, it said BC Hydro has failed to provide the Panel with an adequate foundation upon which to assess the environmental, social, health, and heritage effects of the Project on DKFN treaty rights. Without that understanding, BC Hydro cannot properly determine potential Project effects on the DKFN and their Aboriginal rights and treaty rights.

Location, extent, and exercise of asserted or established Aboriginal rights and treaty rights that may be affected by the Project

DKFN is concerned that Site C would reduce their ability to continue to travel by boat throughout the Slave River watershed due to diminishing water channels for hunting, trapping, fishing, and transportation.

DKFN is concerned that the Project would add to existing impact on the Slave River Delta and infringe on their treaty rights to harvest from the delta. It was observed that as a result of low water levels, migratory patterns of duck and geese have changed and they no longer reliably stop at the delta. The delta is noted as being so dry now that it has sandbars on all sides. Similarly, the slower water flow rate has resulted in reduced fish population in the delta, leading to also reduced population of muskrats, thus adversely impacting the DKFN's ability to fish and trap. In addition, the changing water flows have affected ice jams in the delta, resulting in the loss of moose habitat. Good moose hunting spots are now difficult to find and no longer accessible by boat.

Measures to avoid or mitigate potential adverse effects of the Project on asserted or established Aboriginal rights and treaty rights

The DKFN did not make any specific technical measure for the Panel's consideration to avoid or mitigate identified effects that may impact their asserted or established Aboriginal rights and Treaty rights.

21. Salt River First Nation

Salt River First Nation (SRFN) is a member of Treaty 8 First Nations of Alberta. SRFN did not participate in the Joint Review Panel Stage or submit to the Panel for consideration any assertion of Aboriginal or treaty rights, or the articulation of any impacts on those rights. The follows summary is based on BC Hydro's EIS, Volume 5, Appendix A22.

SRFN has three reserves in Alberta, one settlement in Fort Smith, Northwest Territories, and

four land parcels in Wood Buffalo National Park that are to become Indian Reserves. The SRFN territory is located in the region of northeastern Alberta and southern Northwest Territories. This region is interpreted to be the major area where SRFN members exercise their asserted Aboriginal or treaty rights.

Manner in which the Project may adversely affect asserted or established Aboriginal rights and treaty rights

BC Hydro did not enter into a Traditional Land Use Study agreement with SRFN, and no traditional land use information was made available by the SRFN.

Location, extent, and exercise of asserted or established Aboriginal rights and treaty rights that may be affected by the Project

The proposed Site C dam is distant from the traditional lands of SRFN. No specific information was identified that described or documented the exercise of Aboriginal or treaty rights by the SRFN within the LAA and RAA for hunting, fishing, trapping, or other traditional activities.

Measures to avoid or mitigate potential adverse effects of the Project on asserted or established Aboriginal rights and treaty rights

SRFN did not suggest any measure to avoid or mitigate potential adverse effects of the Project.

Non-treaty British Columbia First Nations

22. Kwadacha First Nation

Kwadacha First Nation (KFN) is a non-treaty First Nation in B.C. KFN asserts Aboriginal rights under section 35 of the *Constitution Act, 1982*.

KFN traditional territory is located north of the Williston reservoir and the Bennett and Peace Canyon Dams. Due to the flooding of the Williston reservoir in the 1960s, Kwadacha trap lines, trails, burial grounds, cabins, and transportation routes were lost, and KFN members were forced to leave their traditional homelands permanently and relocate north to Fort Ware, approximately 250 miles north of Prince George.

Manner in which the Project may adversely affect asserted or established Aboriginal rights and treaty rights

KFN said that while the Project would not be immediately adjacent to them, based on KFN's experience with the Williston reservoir and the Bennett and Peace Canyon Dams, it would adversely affect the exercise of their Aboriginal rights.

KFN identified four key concerns:

- Potential change to the Williston reservoir to maximize generation and reduce fluctuations in water levels for the Site C facility;
- Regional and long-term impacts on ungulates and large carnivore populations in the region;
- Cumulative effects arising from Site C combined with other major industrial developments in the near to mid-term; and
- Imposition of higher costs and availability of goods and services to KFN during Project construction.

Location, extent, and exercise of asserted or established Aboriginal rights and treaty rights that may be affected by the Project

Despite Williston reservoir, Kwadacha members have continued to exercise their Aboriginal rights across Kwadacha territory. Members regularly hunt and fish, gather medicinal and edible plants, use traditional trails, and generally use their territory for their culture and spiritual uses of the land. Kwadacha members continue to pass traditional knowledge from one generation to the next.

Kwadacha First Nation identified three significant potential effects of Site C on the exercise of their asserted Aboriginal rights:

- Possible effects of the Project on water levels and water management of the Williston reservoir;
- Regional and long-term impacts on ungulate and large carnivore populations, wildlife movement, and migration; and
- Cumulative effects arising from Site C in combination with past, existing, and future projects across the region.

KFN raised particular concerns about adverse impacts on ungulate and carnivore populations from unmanaged or unrestricted access to their traditional territory for non-Aboriginal recreational use, and from cumulative impacts of Site C combined with past, existing, and future projects.

Measures to avoid or mitigate potential adverse effects of the Project on asserted or established Aboriginal rights and treaty rights

Kwadacha suggested the following mitigation measures:

- Mitigation activities and monitoring, with ongoing and meaningful First Nation's involvement, of upstream impacts of the Project;
- Confirmation that the proposed storage in the Williston reservoir not increase above the projected 0.56 metres during the construction or the operation of the Project without further consultation with Kwadacha and other affected First Nations;
- BC Hydro be required to undertake a review and update of the Peace Water Use Plan, prior to the construction of Site C; and
- Establishment of enhanced wildlife monitoring and compensation programs, implementation of workforce management policies, amendment of the Provincial regulatory limits on hunting, and regional level planning, monitoring, and assessment on an ongoing basis, with meaningful First Nations' involvement, instead of the current reliance on a project-by-project approach to development in the northeast region of BC.

23. Tsay Keh Dene First Nation

Tsay Keh Dene First Nation (TKDFN) is a non-treaty First Nation in B.C. TDKFN did not participate in the Joint Review Panel Stage or submit to the Panel for consideration any assertion of Aboriginal or treaty rights, or the articulation of any impacts on those rights. The follows summary is based on BC Hydro's EIS, Volume 5, Appendix A27.

TDKFN asserts Aboriginal rights under section 35 of the *Constitution Act, 1982.* The TDKFN traditional territory is centred on the Williston reservoir, with its main community at the north

end, approximately 430 km north of Prince George.

Manner in which the Project may adversely affect asserted or established Aboriginal rights and treaty rights

BC Hydro did not enter into a Traditional Land Use Study agreement with TKDFN, and no traditional land use information was made available by the TKDFN. Based on BC Hydro's research, the TKDFN continue to live a lifestyle largely based on the lands and resources within their traditional territory for hunting, fishing, trapping, and other traditional activities.

Location, extent, and exercise of asserted or established Aboriginal rights and treaty rights that may be affected by the Project

No specific information was identified that described or documented the exercise of Aboriginal or treaty rights by TKDFN within the LAA or RAA for hunting, fishing and trapping activities, or other traditional activities.

Measures to avoid or mitigate potential adverse effects of the Project on asserted or established Aboriginal rights and treaty rights

TKDFN opposes the development of the Site C Project while past grievances related to the Peace Canyon and Bennett Dams remain not addressed. TKDFN did not suggest any measure to avoid or mitigate potential adverse effects of the Project.

24. The Kelly Lake Cree Nation

As noted above, Kelly Lake Cree Nation (KLCN) is not recognized as an Aboriginal group by the federal Department of Indian and Northern Affairs or as having Aboriginal rights under section 35 of the *Constitution Act, 1982*. Under the EIS Guidelines, BC Hydro is not required to consult with KLCN on Site C, but the B.C. Archaeology Branch listed the group to be part of the heritage assessment program in its permit. KLCN is included in this report because KLCN presented oral evidence at the public hearing.

BC Hydro says it has undertaken consultation activities with KLCN on Project effects on its asserted Aboriginal rights. However, KLCN stated that BC Hydro has not involved it in the development of critical baseline studies or with respect to the current use of lands and resources for traditional practices or asserted or established Aboriginal and treaty rights.

The Kelly Lake people are of the Dunne-Za and Nehiyaw, also known as the Cree, the descendants of Aboriginal people who lived in the area that straddles the current border of Alberta and B.C. KLCN represents approximately 800 members living within their territory. The community of Kelly Lake is located south of Toms Lake, approximately 10 km east of Highway 52 and 150 km from Fort St. John. KLCN has never ceded its land or resources.

Manner in which the Project may adversely affect asserted or established Aboriginal rights and treaty rights

Due to limited resources and capacity, the Kelly Lake Cree Nation has not been able to fund a project-specific Traditional Land Use Study.

Members have lived, hunted, trapped, fished, and gathered in their traditional territory, and they continue to do so today, preserving their traditional way of life and their identity as a distinct Aboriginal people.

KLCN said the negative impacts on river flow patterns in the Peace River valley would likely impact hunting, gathering, fishing, and trapping both upstream and downstream, reducing land resource values in their territory in adverse ways. KLCN identified a risk of further elevating the levels of chemical pollutants in fish consumed by humans as an important adverse effect from the Project.

Location, extent, and exercise of asserted or established Aboriginal rights and treaty rights that may be affected by the Project

This is unclear from the information provided by the KLCN.

Measures to avoid or mitigate potential adverse effects of the Project on asserted or established Aboriginal rights and treaty rights

KLCN asked that the Panel recommend that BC Hydro enter into a consultation agreement with it and fund a project-specific Traditional Land Use Study to identify any potential adverse impacts from Site C.

Métis

25. Métis Nation of Alberta—Zone 6

The Métis Nation of Alberta, Region VI (MNA6) is the Aboriginal political organization representing the over 7,000 Métis people in northwest Alberta, and a part of the Métis Nation of Alberta. MNA6 asserts Aboriginal rights under section 35 of the *Constitution Act, 1982.*

MNA6 is located in the northwest area of Alberta. It is the largest Métis region in Alberta, and the Peace River travels through much of the region. Métis trappers, hunters, voyageurs' communities, and Aboriginal business have been in this region since the days of the first explorers and fur traders. Local culture and economy continue to centre on the rivers, lakes, and wetlands, both as areas of transportation and sustenance or commerce through harvesting activities such as trapping, fishing, and hunting.

Manner in which the Project may adversely affect asserted or established Aboriginal rights and treaty rights

On May 29, 2012, the Métis people organized an information session in Fairview, Alberta, for an exchange of information about the Project and its potential effects. Métis participants said their communities are located on the upper Peace River sub-basin and central Peace River sub-basin, and rely on these locations for the exercise of their Aboriginal rights to fish, trap, hunt, gather plants, and use for transportation, as well as for ceremonial purposes.

Several members of MNA6 said many of the spatial boundaries for the study of current use of land and resources for traditional purposes, heritage resource, and harvest of fish and wildlife resources stopped at the B.C.–Alberta border.

Location, extent, and exercise of asserted or established Aboriginal rights and treaty rights that may be affected by the Project

MNA6 provided no additional details advising that the community had not been provided with the proper technical resources to assess the potential impact of the Project on the continuation of its Métis traditional way of life.

Measures to avoid or mitigate potential adverse effects of the Project on asserted or established Aboriginal rights and treaty rights

MNA6 said the spatial boundaries should be extended into Alberta and upstream into some of the main tributaries of the Peace River. However, it did not suggest any mitigation measures.

26. Paddle Prairie Metis Settlement Society

Paddle Prairie Métis Settlement Society (PPMSS) is one of eight Métis Settlement corporations established under the *Métis Settlements Act, RSA 2000.* PPMSS did not participate in the Joint Review Panel Stage or submit to the Panel for consideration any assertion of Aboriginal or treaty rights, or the articulation of any impacts on those rights. The following summary is based on BC Hydro's EIS, Volume 5, Appendix A20.

Paddle Prairie Métis Settlement is a rural settlement located south of High Level, Alberta. The traditional lands of the Paddle Prairie Métis encompass most of northern Alberta. The Paddle Prairie Métis asserted its Aboriginal rights to hunt, fish, trap, and gather around the Peace River and the rights to beneficial use and enjoyment of the lands around the Peace River, under section 35 of the *Constitution Act, 1982.*

Manner in which the Project may adversely affect asserted or established Aboriginal rights and treaty rights

BC Hydro did not enter into a Traditional Land Use Study agreement with the Paddle Prairie Métis and no traditional land use information was made available by the PPMSS. The eastern boundary of the settlement is the Peace River, in an area that is within the Current Use of Lands and Resources for fish and fish habitat RAA. The Paddle Prairie Métis asserts that the Peace River and its environment are an important, central, and integral part of their traditional lands. Based on BC Hydro's research, historically, the Paddle Prairie Métis supported themselves by hunting, fishing, trapping, and gathering throughout the area of the Settlement and traditional lands outside the settlement including the Peace River.

Location, extent, and exercise of asserted or established Aboriginal rights and treaty rights that may be affected by the Project:

The proposed Site C dam is distant from the traditional lands of the Paddle Prairie Métis. No specific information was identified that described or documented the exercise of Aboriginal or treaty rights by the Paddle Prairie Métis within the LAA and RAA for hunting, fishing, trapping, or other traditional activities.

The Paddle Prairie Métis are concerned that the Project would impact their Aboriginal rights including the potential changes to ice bridges and ferry operations required for access to traditional hunting grounds including the Shaftsbury and Tompkins Landing ice bridges.

Measures to avoid or mitigate potential adverse effects of the Project on asserted or established Aboriginal rights and treaty rights

PPMSS did not suggest any measure to avoid or mitigate potential adverse effects of the Project.

27. Fort Chipewyan Métis Association

Métis have asserted Aboriginal rights under section 35(1), pursuant to section 35(2) of the

Constitution Act, *1982*, which includes Métis in the definition of "aboriginal peoples of Canada." Fort Chipewyan Métis (FCM) are recognized in Alberta as aboriginal peoples under section 35(2) of the *Constitution Act, 1982*.

In the absence of any traditional land use or occupancy studies provided in this process, FCM's traditional territory boundaries are unclear. The government of Alberta has established an area around Fort Chipewyan with a radius of 160 km as "deemed traditional territory" for the FCM. This deemed territory extends upstream of Garden River, which is upstream of Peace Point. Wood Buffalo National Park was identified as important for FCM's current use; over 22 registered trapping areas are within Wood Buffalo National Park.

Manner in which the Project may adversely affect asserted or established Aboriginal rights and treaty rights

FCM said the Project would have serious, adverse, and permanent impacts on their Aboriginal rights to harvest for subsistence, culturally and commercially in, on, and under the lands and waters; navigate the waters and lands for commercial, recreational, and cultural reasons; exercise of their spiritual and cultural practices; and protect and allow their Métis way of life to survive and thrive. As FCM members hold over 22 registered trapping areas in Wood Buffalo National Park, any potential Project effect on components of the park and the PAD were of concern to the FCM.

Location, extent, and exercise of asserted or established Aboriginal rights and treaty rights that may be affected by the Project

FCM did not provide additional information in the review process. FCM stated its lack of funding, time, and expertise severely limited its capacity to discuss/negotiate with the Crown and BC Hydro, and its capacity to inform the Panel.

Measures to avoid or mitigate potential adverse effects of the Project on asserted or established Aboriginal rights and treaty rights

The FCM did not suggest any measures to avoid or mitigate identified effects to its asserted or established Aboriginal rights and treaty rights.

28. Northwest Territory Métis Nation

The Northwest Territory Métis Nation (NWTMN) comprises the Fort Resolution Métis Council, Fort Smith Métis Council, and Hay River Métis Government Council. NWTMN asserts Aboriginal rights under section 35 of the *Constitution Act, 1982.*

NWTMN comprises the indigenous Métis from the South Slave region in the Northwest Territories and northern Alberta that includes the PAD and the Slave River. Ancestors of the NWTMN lived in areas along the lands of the Slave River and around the Great Slave Lake and elsewhere in the Northwest Territories. They continue to practice their traditions of wildlife harvesting, trapping, fishing, hunting, and harvesting of plants and trees. Main communities now exist in Fort Resolution, just southwest of the Slave River Delta, on the south side of the Great Slave Lake; Fort Smith, located southeast of Salt River along the Slave River; and Hay River, on the south side of the Great Slave Lake at the mouth of Hay River.

Manner in which the Project may adversely affect asserted or established Aboriginal rights and treaty rights

The Slave River is used in the summers and winters as a transportation route and a source of drinking water for all NWTMN communities.

NWTMN was concerned that, during the reservoir filling stage, there would be highly variable water releases through the fall and early winter. Depending on the inflow rate for the year the Site C reservoir is filling, there may be large flow increases in early to mid-November. NWTMN was concerned that BC Hydro has not addressed the potential downstream impacts of the varying flows or the duration of low flows during the critical early winter period. NWTMN communities have depended on the Slave River and the surrounding ecosystems for hundreds of years.

The potential for highly variable water flows may adversely affect the downstream productivity and availability of fish, wildlife, birds, and plants.

Location, extent, and exercise of asserted or established Aboriginal rights and treaty rights that may be affected by the Project

Areas of significance to the NWTMN include Slave River, Slave River Delta, and the Slave River ecosystems.

NWTMN expressed concern for impacts on areas downstream within the PAD, including Wood Buffalo National Park, and along the South Slave River. Their concern was that the Project would affect their Aboriginal rights to harvest wildlife and migratory birds, to fish, to trap, and to undertake other traditional activities, including from cumulative effects of Site C and historical developments. Observations were made that since the construction of the Bennett Dam, the flow regime of the Slave River has been altered so that the Slave River ecosystem now shows loss of channels and islands, changes in ice flow, all resulting in a dramatic reduction in fish population, bird population, and wildlife.

Measures to avoid or mitigate potential adverse effects of the Project on asserted or established Aboriginal rights and treaty rights

NWTMN asked that the Métis be involved in the management of water within the South Slave region. It also requested funding to document the adverse effects of the Bennett Dam and to compensate NWTMN for impacts from past projects and to capture traditional knowledge that is being lost.

29. Métis Nation of British Columbia

Métis have asserted Aboriginal rights under section 35(1), pursuant to section 35(2) of the *Constitution Act, 1982,* which includes Métis in the definition of “aboriginal peoples of Canada.” While Métis in B.C. assert Aboriginal rights, at this time, the government of B.C. does not recognize them. Also, no court has recognized Métis as a rights-bearing community in B.C.

The Métis Nation of BC (MNBC) represents 8,100 Métis in B.C. A large number of Métis reside in the central-interior and northwest parts of the province. The Métis have had an established community in the Project area and continue to use the land and resources for traditional purposes.

While the government of B.C. does not recognize a legal obligation to consult with Métis people in B.C, the federal government has directed BC Hydro, through the EIS Guidelines, to consult with both the Kelly Lake Métis Settlement Society and the Métis Nation of BC.

Manner in which the Project may adversely affect asserted or established Aboriginal rights and treaty rights

Métis currently conduct traditional harvesting (hunting, fishing, and plant harvesting for food and medicine) in the Project area. These activities and related preservation and transmission of Métis traditional knowledge and land use information could be adversely impacted.

MNBC members have raised concerns about the high concentrations of methylmercury in fish in the Williston reservoir and the potential for the Project to further increase toxicity in fish and risks to human health and safety. MNBC also identified the availability and quality of drinking water as a concern.

Location, extent, and exercise of asserted or established Aboriginal rights and treaty rights that may be affected by the Project

MNBC noted that none of the drinking water collection sites have a spiritual significance for the Métis who use them. The drinking water collection sites are used in a practical sense to provide drinking water for home use or for use while out on the land during harvesting activities. Four drinking water collection sites are within, or very nearby, the proposed Site C Reservoir area:

- Near Farrell Creek;
- Along Halfway River;
- West of the Site C dam at the river bend, west of the construction project area; and
- Within the Site C dam construction project area, opposite Moberly River.

Measures to avoid or mitigate potential adverse effects of the Project on asserted or established Aboriginal rights and treaty rights

The MNBC did not propose any specific technical measure for the Panel's consideration to avoid or mitigate identified effects that may impact their asserted or established Aboriginal rights and treaty rights.

30 Kelly Lake Métis Settlement Society

Métis have asserted Aboriginal rights under section 35(1), pursuant to section 35(2) of the *Constitution Act, 1982* which includes Métis in the definition of "aboriginal peoples of Canada." However, the Government of B.C. does not recognize Métis as Aboriginal rights-holders in B.C. Kelly Lake Métis Settlement Society (KLMSS) vehemently disagreed with the government's position.

KLMSS represents the only Métis settlement in B.C. The Kelly Lake Métis settlement is a settlement of privately owned lands owned by its approximately 150 members.

The Kelly Lake Métis assert their Aboriginal rights within territory that straddles the B.C.–Alberta border, extending from the continental divide in B.C. east of the Smoky River, to the northern portion of the territory, and to Lac Ste. Anne in the south, following commonly traveled routes. The north-south stretch of land encompasses lands in the Peace River south to about the

latitude of Hinton, Alberta.

Manner in which the Project may adversely affect asserted or established Aboriginal rights and treaty rights

This is unclear from the information provided.

Location, extent, and exercise of asserted or established Aboriginal rights and treaty rights that may be affected by the Project

Current use of resources is a mix of traditional Métis activities, with some bush economy and culture consisting of harvesting plants and wildlife, gathering medicine from the natural environment, wage labour, and community-based businesses. The community today continues to be deeply dependent on and connected to their traditional territory.

The Kelly Lake Métis assert the right to harvest animals, the right to the water, and the right to their territory. The people continue to practice these rights as integral to who they are. The community disagreed with BC Hydro's assessment that the Project would have no adverse impact on Métis in B.C. Kelly Lake Métis maintained that Site C would infringe on their rights. KLMSS completed a Traditional Knowledge Study (TKS) setting out information regarding the locations, extent, and exercise of rights. The report provided information indicating use of the Peace River valley in a general sense, but no specific information of current use for traditional purposes.

Kelly Lake Métis reported declines in the purity and the absence of surface water due to civic and industrial contamination. Site C is anticipated to add to the significant existing impacts caused by the LNG industry. In addition, Kelly Lake Métis expected extensive and progressive declines of wildlife habitat, loss of sensitive ecological features and moose licks, adverse impacts on food and cultural security from non-Aboriginal harvesters, destruction of high-yield harvesting sites, and cumulative environmental decline.

Measures to avoid or mitigate potential adverse effects of the Project on asserted or established Aboriginal rights and treaty rights

The Kelly Lake Métis Settlement Society suggested the Panel consider recommending that BC Hydro undertake the following mitigation measures:

- maintain pre-Project flow levels throughout the life of the Site C Project;
- employ knowledgeable environmental monitors from local communities to monitor air and water quality during construction;
- identify and document muskeg and mineral licks within the local study area;
- avoid muskeg and mineral licks within 200 metres of the local study area;
- provide clarity on the scope and nature of opportunities for employment and contracting benefits; and
- conduct a Traditional Land Use Study of Kelly Lake Métis territory.

APPENDIX 11 LIST OF ACRONYMS AND ABBREVIATIONS

Acronym	Meaning
AAC	allowable annual cut
ACCI	area of critical community interest
ACFN	Athabasca Chipewyan First Nation
ALC	Agricultural Land Commission
ALCA	Agricultural Land Commission Act
ALR	Agricultural Land Reserve
ARD/ML	Acid Rock Drainage/Metal Leaching
BCEAA	British Columbia Environmental Assessment Act
BCEAO	British Columbia Environmental Assessment Office
BCIOM	British Columbia Input-Output Model
BCMOF	British Columbia Ministry of Forests
BCOGC	BC Oil and Gas Commission
BCUC	British Columbia Utilities Commission
BHM	broader habitat mapping
BRFN	Blueberry River First Nations
CAC	criteria of air contaminants
CanGEA	Canadian Geothermal Energy Association
CCME	Canadian Council of Ministers of the Environment
CDC	Conservation Data Centre
CEA	cumulative effects assessment
CEAA	Canadian Environmental Assessment Agency
CEAA 2012	*Canadian Environmental Assessment Act, 2012*
CEAR	Canadian Environmental Assessment Registry
CMA	collaborative management agreement
CN	Canadian National Railway
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CO_2e	carbon dioxide equivalent
DFO	Department of Fisheries and Oceans Canada
DSM	demand side managment
DTFN	Dene Tha' First Nation
EA	environmental assessment
EAO	British Columbia Environmental Assessment Office

EC	Environment Canada
EIS	Environmental Impact Statement
ELUA	*Environment and Land Use Act*
EMF	electric and magnetic fields
EMP	environmental management plan
ePIC	Electronic Project Information Centre
ES	ecosystem services
FCMA	Fort Chipweyan Métis Association
FERC	Federal Energy Regulatory Commission
FLNRO	Ministry of Forests, Lands and Natural Resource Operation
GDP	gross domestic product
GHGs	greenhouse gases
GIS	Geographical Information System
GWh	gigawatt-hours
HLFN	Horse Lake First Nation
IBA	Impact Benefit Agreement
ICES	International Committee on Electromagnetic Safety
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IPP	independent power producer
IRP	Integrated Resource Plan
JRP	Joint Review Panel
KLMSS	Kelly Lake Métis Settlement Society
LAA	local assessment area
LEH	Limited Entry Hunting
LNG	liquified natural gas
LOS	level of service
LRB	load-resource balance
LRMP	Land and Resource Management Plan
LRRCN	Little Red River Cree Nation
MBCA	*Migratory Birds Convention Act, 1994*
MCFN	Mikisew Cree First Nation
Mg/dm^2-d	milligrams per decimetre squared per day
MLIB	McLeod Lake Indian Band
MNA	Métis Nation of Alberta
MNBC	Métis Nation British Columbia
MOTI	Ministry of Transportation and Infrastructure (B.C.)

MW	megawatt
NGO	non-governmental organization
NRCan	Natural Resources Canada
NWPA	*Navigable Waters Protection Act*
OBSCR	Open Burning Smoke Control Regulation
OGMA	old-growth management area
PAD	Peace Athabasca Delta
PAZ	Project activity zone
PC	Parks Canada
PM	particulate matter
PMT	Peace-Moberly Tract
PPMS	Paddle Prairies Métis Settlement Society
PRRD	Peace River Regional District
PSL	permissible sound level
PSS	primary smoke sensitivity
pTDI	provisional tolerable daily intake
RAA	regional assessment area
RCC	roller compacted concrete
ROW	right-of-way
SARA	*Species at Risk Act*
SCGT	single-cycle gas turbine
SD	school district
SDR	social discount rate
SFN	Saulteau First Nations
T8FN	Treaty 8 First Nations
T8TA	Treaty 8 Tribal Association
TC	Transport Canada
TCFN	TallCree First Nation
TDG	total dissolved gas
TEM	Terrestrial Ecosystem Mapping
THLB	timber harvesting land base
TSS	total suspended solids
TWh	terawatt hours
UEC	unitized energy cost
VC	valued component
VRI	Vegetation Resource Inventory

WACC	weighted average cost of capital
WHO	World Health Organization
WMFN	West Moberly First Nations
WMU	Wildlife Management Units
Y2Y	Yukon to Yellowstone Conservation Initiative

REPORT ERRATA

With respect to the Joint Review Panel Report submitted on May 1, 2014, the Panel acknowledges the following errata:

Page 99; section 7.2.1.5	"…and fishing could continue in other areas important to the Dene Tha' First Nation" should read "…and fishing could continue in other areas important to the Duncan's First Nation"
Page 124; Table 6	Add: Horse Lake First Nation under "Treaty 8 First Nation Signatories – Alberta"
Page 283; Table 16 Page 292; Table 18	Add the Low LNG demand column in Table 16 to the results of Net 2. Replace the Net 2 results of Table 18 by the modified Net 2 results of Table 16. Energy LRB and LRB 2+ in Table 18 would be modified accordingly. Conclusions remain as noted.
Page 305; section 15.6	"It is also a truism that the cheapest watts are megawatts…" should read "It is also a truism that the cheapest watts are negawatts…"
Appendix 7	Add: "Allisun Rana, Legal Counsel, Treaty 8 Tribal Association"

June 10, 2014

SECOND REPORT ERRATA

With respect to the Joint Review Panel Report submitted on May 1, 2014, the Panel acknowledges the following additional errata:

Page 19; section 3.1.1	"…and a volume of approximately 2.1 million cubic metres." should read "…and a volume of approximately 2,310 million cubic metres."

June 25, 2014

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RESEARCH ARTICLE

The inclusion of stakeholders and cultural ecosystem services in land management trade-off decisions using an ecosystem services approach

Rachel Darvill · Zoë Lindo

Received: 25 January 2015 / Accepted: 17 August 2015

Abstract
Context An ecosystem service approach for land-use or conservation decisions normally uses economic or biophysical assessments for valuating nature's services. In contrast, even though ecosystem services are required for human well-being, the actual use of services by differing stakeholder groups are rarely considered in typical ecosystem service assessments, especially the more intangible, cultural ecosystem services.
Objectives The aim of this research was to quantify different uses for 15 cultural and provisioning ecosystem service indicators across seven stakeholder groups in a watershed proposed with large hydroelectric dam development.
Methods We used a large-scale survey to quantify use and frequency of use for ecosystem services.
Results We demonstrate that different stakeholder groups use ecosystem services differently, both in terms of specific ecosystem service indicators, as well as for frequency of ecosystem service use. Across all stakeholder groups, specific cultural ecosystem services were consistently more important to participants when compared to provisioning ecosystem services, especially aesthetic/scenic values.
Conclusions This work is of global importance as it highlights the importance of considering cultural ecosystem services (e.g. aesthetic/scenic, sense-of-place values) along with multiple stakeholder groups to identify the trade-offs and synergies during decision-making processes for land-use or conservation initiatives.

Keywords Conservation · Cultural ecosystem services · Ecosystem services · Hydroelectric · Land-use planning · Provisioning ecosystem services · Stakeholder groups

Electronic supplementary material The online version of this article (doi:10.1007/s10980-015-0260-y) contains supplementary material, which is available to authorized users.

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Introduction

Ecosystem services, the products and services derived from nature that bring benefits to humans (Daily 1997), link the functioning of ecosystems to the well-being of persons living locally, regionally, and globally. Yet it is estimated that up to 60 % of global

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ecosystem services are degraded, overused, or have been lost to unsustainable anthropogenic activities (MEA 2005) under the continued growth of the human population and the associated consumption of natural resources (Rands et al. 2010; Cimon-Morin et al. 2013).

As such, ecosystem services are increasingly being considered in policy development, land-use decisions, and in conservation planning initiatives (Daily 1997; MEA 2005; Menzel and Teng 2010), but managing ecosystem services across different spatial scales within a dynamic landscape context is challenging because the importance of different types of ecosystem services changes with different stakeholder groups, and with spatial scale. For instance, at small spatial scales, provisioning (e.g. food, water, shelter) and cultural (e.g. recreation, aesthetic, sense-of-place) ecosystem services are important for local community members, while regulating (e.g. climate mitigation, pollination) and supporting services (e.g. nutrient cycling, photosynthesis) are important at larger, regional or even global scales.

The concept of ecosystem services inherently links social and ecological systems (Alessa et al. 2008), which can be used to identify congruent locations and land cover types that support both human needs and ecological space (Alessa et al. 2008). As the perceived value of nature varies with different land covers (Brown 2013; Brown et al. 2014) a developed understanding of the perceived and actual use of multiple ecosystem services can inform land management plans. This approach can be particularly valuable in a land-use planning context (Brown et al. 2014) where there is often strong opposition to resource development, and a strong favoring of cultural and lifestyle attributes such as wildlife viewing, and non-motorized recreation activities (Brown and Donovan 2013) associated with natural areas. Public participation in land-use planning can further elucidate attitudes towards land management, and when combined with mapping methods, can reveal areas where potential for a conflict in land-use could arise (Brown and Donovan 2013; Brown et al. 2014; Darvill and Lindo 2015).

While the ecosystem services approach can integrate land management decisions with human well-being and stakeholder values (Chan et al. 2012a), to date, this integrated approach has mainly focused on determining the market value of ecosystem services, primarily for provisioning and regulating services. The economic valuation of ecosystem services using for instance, hedonic pricing, willingness-to-pay, and the travel cost method (Hein et al. 2006; Chan et al. 2012b) has been used to make policy recommendations (Menzel and Teng 2010), and has proved useful during decision-making processes, but has been criticized as limited since economic valuations assume that all people use, and value, the same ecosystem services (Menzel and Teng 2010; Klain and Chan 2012). Public participation methods can help engage multiple interest or stakeholder groups to elucidate a better understanding for what is being used and valued locally (Brown and Fagerholm 2015). By involving multiple stakeholder groups, decision-making for land-use and conservation initiatives can lead to more legitimate and higher quality decisions, identify trade-offs and synergies, and avoid conflict through improved relationships between groups (Jones-Walters and Çil 2011). Here we define 'stakeholder group' as any group sharing common interests, and who may be affected by land-use decisions.

The public participatory approach has been most successful at acknowledging cultural ecosystem services (Brown and Fagerholm 2015) and incorporating non-economic valuation methodologies (e.g. Klain and Chan 2012; Fagerholm, et al. 2012). Cultural benefits such as aesthetic values and sense-of-place can be considered irreplaceable in a landscape (Plieninger et al. 2013), and are often tightly linked to specific geographic features and land cover (e.g. forested areas and water bodies) (Brown 2013). Cultural ecosystem services can be more important to people than ecosystem services from other categories (Raymond et al. 2009; Ruiz-Frau et al. 2011; Brown et al. 2012; Martín-López et al. 2012; Darvill 2014), and be more socially relevant in addressing real-world issues (Milcu et al. 2013), potentially leading to enhanced sustainability of local communities (Plieninger et al. 2015) and their overall well-being.

Several studies have used a multiple stakeholder approach for assessing ecosystem services (see Raymond et al. 2009; Ruiz-Frau et al. 2011; Lamarque et al. 2011; Klain and Chan 2012), but none to our knowledge have ranked the needs (perceived, and actual) of multiple ecosystem services (including cultural ecosystem services) on a regional scale for multiple stakeholder groups. In this study we collected information on the use and frequency of use for fifteen

ecosystem services indicators across seven stakeholder groups using a rural watershed in northeastern British Columbia, Canada, a portion of which was under consideration for a large hydroelectric dam development at the time of the study. We focus on cultural and provisioning ecosystem services as these are the local and regional scale services directly utilized by the communities residing on the land base. Since starting this study, the hydroelectric project (Site C) has been approved for development in the Upper Peace River Watershed, our study area.

Methods

Study site

The Upper Peace River Watershed (UPRW) encompasses 581,994 hectares including an 82 km stretch of riparian valley bottom following the Peace River between the town of Hudson's Hope (population: 1012) and Fort St. John (population: 19,000) in northeastern British Columbia, Canada (56°13′41″0.03 N; 121°24′26″0.05 W) (Fig. 1). The majority of the study area is boreal forest ecosystem. Human land-use activity in the watershed comprises oil and gas development and privately held agricultural land. There are two Provincial Parks and a proposed protected area within the UPRW (natural preserves). The study area is within a large (84,000,000 ha) First Nations (indigenous peoples on the geographic land known as Canada) territory (Treaty 8), and there are two First Nations reserves located within in the study area (populations: 205 and 840). There are multiple recreation sites, a cultural use area, and archeological evidence dating back 5830 ± 80 years (Valentine et al. 1980), with historic human occupation estimated to 10,500 B.P. directly adjacent to the study area boundary (Driver et al. 1996). Expanding resource developments include oil and gas exploration (BC Oil and Gas Commission 2013), wind power turbine farms, and coal mines, in addition to the Site C proposal for a hydroelectric dam (North Peace Economic Development Commission 2011). The Site C project will be the third hydroelectric dam in this region on the Peace River; the W.A.C. Bennett dam is located 19 km west of Hudson's Hope, while the Peace River Canyon Dam is located 6 km southwest of Hudson's Hope (Fig. 1).

Survey data collection

Survey participants were recruited using convenience and purposive sampling in addition to snowball sampling (see Brown et al. 2014). Posters (65) describing this research project were distributed throughout the study communities; advertisements were placed in the local newspaper, and presentations were offered to all identified stakeholder groups residing within the study area in May 2013 (e.g. Rod and Gun Club, municipal town councils). First Nations participation was requested through a meeting held at the Treaty 8 Land Office (www.treaty8.bc.ca) with two Treaty 8 First Nations representatives, and informal consent to involve First Nations was granted. Invitations (259) were sent out using FluidSurveys® software version 4.0, which encouraged people to distribute the online survey link to other interested participants. Some stakeholders (e.g. Boating club, Regional District) sent emails to their membership/employees with a research description and link to the online survey.

Online survey questions were designed to elicit responses regarding ecosystem service indicators that fit within two major ecosystem services categories: provisioning and cultural ecosystem services. As it is not possible to measure all ecosystem services within an area, we use the term 'indicator' to mean a measureable representation of human benefits (material or non-material) that are utilized or valued within a landscape (based on Fagerholm et al. 2012; Müller and Burkhart 2012; Reyers et al. 2013). Indicators are mostly straight forward for provisioning ecosystem services as they are readily measurable, but focus strongly on delivery and economic value, while cultural ecosystem service indicators for well-being are still lacking. Cultural ecosystem services are harder to apply indicator status to (Hernández-Morcillo et al. 2013), but can be quantified as supply (e.g. areas that provide aesthetic views), delivery (e.g. collection rates of plants for cultural use), contributions to well-being (e.g. frequency of cultural activities), or economic value (e.g. revenues derived from tourism). We used a slightly modified MEA (2005) typology where we chose ecosystem service indicators that we assumed would be most relevant to the study region and its social dynamics (Raymond et al. 2009; Fagerholm et al. 2012). For instance, the 'wildlife used for viewing' was added to our working ecosystem

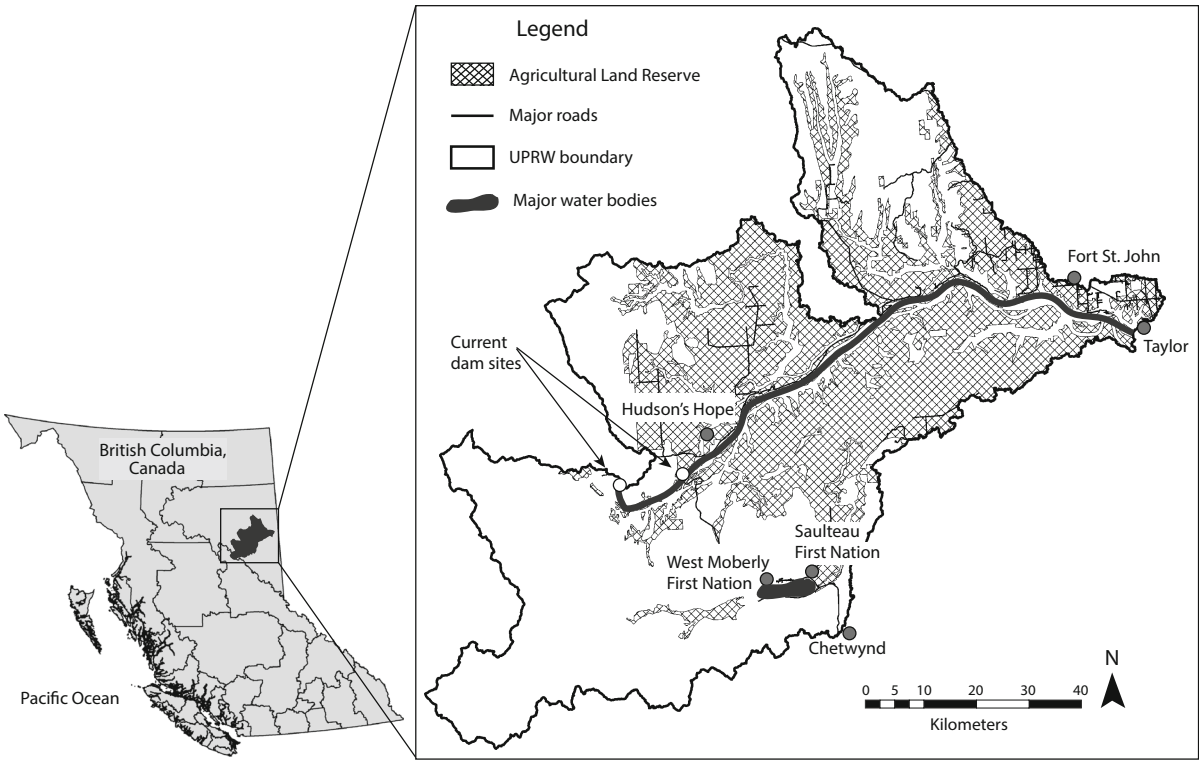

Fig. 1 Location of study area in the Upper Peace River Watershed, British Columbia, Canada. Hatched bar area is the Agricultural Land Reserve, an area recognized as an important land base of the agricultural sector. Agricultural Land Reserves are generally protected from residential, commercial or industrial development

services typology, since wildlife is plentiful in the study area and can be a prominent and highly valued feature of the landscape (Klain and Chan 2012).

To test the suitability and effectiveness of the survey, preliminary sampling was completed with seven individuals who reside outside of the study area. The final online survey comprised five sections: (1) respondent characteristics (i.e. length of residency, community type (e.g. rural, urban), occupation, primary and secondary stakeholder group association, age group, gender, ecosystem services concept familiarity); (2) provisioning ecosystem services indicators including frequency of use (categorical); (3) cultural ecosystem services indicators including frequency of use (categorical); (4) listing ecosystem services indicators in order of highest to lowest use (rank order), and (5) self-perceived changes in the ecosystem services use using two Likert-scale questions. Participants self-identified their stakeholder affiliations (see Table 1 for summary of participants). A map outlining the study area was provided on every page of the online survey for easy reference. Additionally, a widely accepted definition for the term 'ecosystem services' was provided at the beginning of the survey: "Ecosystem Services are the resources that come from nature and bring benefits to humans (Daily 1997), and that contribute to making human life both possible and worth living (Díaz et al. 2006). They are necessary in order for human well-being to persist." Short descriptions for cultural and provisioning ecosystem services were also given prior to any questioning.

In total, there were 36 closed-ended, 2 open-ended and 1 ranking question in the survey. However, it was unlikely that participants would be brought to all 39 questions due to variation in responses and corresponding branching options within the survey. In total, 138 respondents started the online survey with 101 participants self-identifying with a stakeholder group, of which 93 participants gave responses that were useful for analysis (Supplementary Information S1).

Table 1 Final stakeholder group categorization used for survey analysis and a description of stakeholder groups

Agriculturalist (15 %)	These participants self-identified as agriculturalists with primary occupations being ranching. Many were retired, or still worked part-time at other jobs.
Environmentalist (27 %)	These participants self-identified as environmentalists with primary occupations varying (e.g. artists, science/education), or were retired.
First Nations (7 %)	These participants were members of the Saulteau, Doig and West Moberly First Nations. Two participants were regional biologists for the area.
Government (14 %)	These participants had primary occupations associated with municipal or provincial government, or as a consultant to local government offices.
Hunter/Angler (9 %)	These participants self-identified as being active in hunting and fishing in the area. Most had primary occupations working for local industries (e.g. oil and gas).
Recreationist (13 %)	These participants self-identified with the recreational group in either a motorized or non-motorized category. Participants had primary occupations working or managing for local companies or were retired.
Community (16 %)	These participants were often retired or students without a full-time job, or worked locally for small businesses and companies (e.g. carpenter).

During survey deployment participants self-identified their stakeholder groups, which were subsequently pooled for statistical comparisons. From a total of 100 participants, 93 surveys were deemed usable for final analysis

Data management and statistical analysis

Participants selected and self-identified with 16 stakeholder groups from the original list of 19 options, which were subsequently pooled into seven stakeholder group categories to satisfy statistical assumptions (Table 1). A detailed summary of stakeholder characteristics status based on gender, age, where they reside in the area, and the length of time they have lived in the area is available in Supplementary Information S1. Chi squared tests were used to ensure that socioeconomic characteristics of the participants were not statistically different among the stakeholder groups such that there were no confounding effects of stakeholder group and socioeconomic status (Supplementary Information S1).

Chi square tests of independence were performed to test association between stakeholder group affiliation and ecosystem services indicator use for the 15 questions that solicited a binary (yes/no) or nominal response. Adjusted residual values from the test were further used to explain trends; adjusted residual values higher or lower than $\pm$ 1.96 indicated that the observed value is significantly larger or smaller than expected. Kruskal–Wallis tests were used to determine any significant differences in the frequency of use for specific ecosystem services indicators across stakeholder groups. For significant results of the Kruskal–Wallis test, pairwise comparisons were performed using Dunn's (1964) procedure with a Bonferroni correction for multiple comparisons. For the ranked data, all non-ranked ecosystem services were given an arbitrary value of 10. All ranks were summed within groups across all stakeholders, and the five ecosystem services with the lowest values were selected for further analysis. These were: landscapes used for their aesthetic/scenic values; outdoor (non-motorized) recreation; landscapes for sense of place; freshwater personal use; and wildlife viewing. Average rank of each ecosystem service was analyzed using non-parametric Kruskal–Wallis tests. Software used for all analysis was IBM SPSS Statistics, Version 21 (2012).

Results

Perception of local ecosystem services

The wide majority (66 %) of participants were not familiar with the ecosystem services concept prior to participating in the research project (27 % were familiar; 8 % were unsure). However, after being provided with a definition for ecosystem services, 69 % of participants thought that ecosystem services use should play an important role in major land-use decisions. At the same time, many of participants (47 %) thought there had been a decrease in ecosystem services during the time that they had lived in the study area, while 11 % thought there had been an increase;

31 % felt no change or were unsure. Decreases in ecosystem services were anticipated by 67 % of the participants for the next 10 years due to increased industrial developments (oil/gas, coal mines) and/or specifically, the proposed Site C hydroelectric dam project. For the 9 % of participants that did not perceive any past, or anticipate any future loss of ecosystem services, they cited access to recreational opportunities available through road development into previously inaccessible areas as increasing ecosystem services.

Ecosystem service use and perception across stakeholder groups

Chi square tests revealed five statistically significant relationships between stakeholder group self-affiliation and ecosystem services use (Table 2). These ecosystem services were landscapes used for: historical/cultural heritage, wildlife viewing purposes, hunting/fishing purposes, wild edible plants used for food and/or medicinal use, and use of inspirational landscapes. In all cases, 100 % of First Nations participants claimed use of these five ecosystem services indicators. For landscapes used for historical/cultural heritage and inspirational purposes (e.g. art, song, story-telling, dance, photography, etc.), First Nations participants use was significantly greater than the Recreationalists group: 25 % of Recreationists used landscapes for historical/cultural heritage, while only 17 % of Recreationists used landscapes for inspirational purposes. With respect to landscapes for wildlife viewing, hunting/fishing purposes, and using wild edible plants, First Nations use was greater than Government participants; only 25 % of participants from Government used landscapes for wildlife viewing, 23 % of participants from Government used landscapes for hunting/fishing purposes, while Government used wild edible plants the least across all groups (46 %).

While other Chi Square tests did not reveal significant relationships between stakeholder group and ecosystem services indicators, overall trends were seen that are supported by the adjusted residual values (Table 2). For instance, Agriculturalists had an adjusted residual value > 1.96 suggesting they use land for food, and collect and use freshwater from sources other than from a municipal water system significantly more than other groups (85.7 % and 92.9 %, respectively). Similarly, Hunters/Anglers had a residual value > 1.96 for fishing, suggesting that they fish significantly more than any other stakeholder group (100 %), while using ornamental resources significantly less than other groups (37.5 %). The top three ecosystem services indicators used across all groups were all within the cultural ecosystem services category: landscapes used for aesthetic/scenic beauty, sense-of-place, and recreation (Table 2).

Differences for frequency of ecosystem services indicator use among stakeholder groups

Three cultural ecosystem service indicators (aesthetic/scenic use, recreational use, and sense of place) were cited as the most frequently used ecosystem services indicators across all participating stakeholder groups. Landscapes used to purposefully observe wildlife were used significantly more frequently by Agriculturalists than Government participants ($\chi^2_{6,\,88} = 15.792$. $P = 0.015$), and Agriculturalists cited landscapes for their cultural/historical heritage more frequently than Recreationists ($\chi^2_{6,\,90} = 16.429$, $P = 0.012$). First Nations participants more frequently used landscapes for spiritual or religious purposes than Hunter/Anglers, or Recreationists ($\chi^2_{6,\,90} = 15.406$, $P = 0.017$). Similarly, First Nations had significantly greater use of wild edible plants for food and/or medicinal purposes than all other groups except Agriculturalists and Hunter/Anglers ($\chi^2_{6,\,91} = 17.737$, $P = 0.007$). The frequency of hunting and/or trapping was greatest in the Hunter/Angler group ($\chi^2_{6,\,93} = 16.390$, $P = 0.012$). The top three ecosystem services indicators used most frequently across all stakeholder groups were: (1) aesthetic/scenic landscapes, (2) landscapes used for non-motorized recreation, and (3) landscapes used for sense-of-place (Table 3). Kruskal–Wallis tests for the rank order of the top 5 ecosystem services suggest that only non-motorized outdoor recreation ($H_{7,\,93} = 16.811$, $P = 0.019$) and landscapes that give a sense of place ($H_{7,\,93} = 13.774$, $P = 0.055$) differed among stakeholder groups. Multiple comparison tests did not strongly resolve pairwise stakeholder differences, but suggest that Recreationists differed in their valuation of outdoor recreation differently from First Nations, while Environmentalists ranked landscapes for sense of place higher than Hunter/Anglers.

Table 2 Cultural and provisioning ecosystem service indicator use among seven different stakeholder group categories for the Upper Peace River Watershed, in northeastern British Columbia, Canada

ES indicator (category)	χ^2 (*P*)	Agriculture (n = 14) (%)	Environment (n = 25) (%)	First Nations (n = 6) (%)	Govern (n = 13) (%)	Hunter/Angler (n = 8) (%)	Recreation (n = 12) (%)	Community (n = 15) (%)	Total (n = 93) (%)
Cultural ecosystem service indicators									
Aesthetic/Scenic	5.990 (0.424)	100.0	100.0	100.0	92.3*	100.0	100.0	100.0	98.9
Sense of place	6.573 (0.362)	100.0	100.0	100.0	100.0	100.0	91.7*	100.0	98.9
Cultural/historic heritage	17.069 **(0.009)**	85.7	76.0	**100.0**	61.5	85.7	**25.0**	71.4	70.0
Wildlife for viewing	17.408 **(0.008)**	85.7	76.0	**100.0**	**25.0**	85.7	58.3	57.1	67.4
Educational/scientific	7.437 (0.282)	78.6	80.0	60.0	53.8	71.4	41.7*	64.3	66.7
Spiritual/religious	8.723 (0.190)	71.4	72.0	100.0	61.5	42.9	41.7	50.0	62.2
Inspiration	17.219 **(0.009)**	78.6	64.0	**100.0**	46.2	71.4	**16.7**	42.9	56.7
Recreation	2.053 (0.915)	92.9	88.0	100.0	92.3	100.0	91.7	85.7	91.1
Provisioning ecosystem service indicators									
Ornamental resources	11.125 (0.085)	64.3	76.0	100.0	92.3	37.5*	66.7	57.1	70.3
Wood (for fuel/building)	10.326 (0.112)	85.7	60.0	100.0	61.5	87.5	66.7	46.7	67.7
Freshwater	11.451 (0.075)	92.9*	60.0	80.0	38.5*	75.0	58.3	78.6	67.0
Wild edible plants	15.335 **(0.018)**	92.9*	48.0	**100.0**	46.2	87.5	50.0	64.3	63.7
Fish	8.805 (0.185)	71.4	52.0	83.3	53.8	100.0*	50.0	60.0	62.4
Hunting/fishing/trapping	16.021 **(0.014)**	71.4	44.0	**100.0**	**23.1**	75.0	33.0	53.3	51.6
Food (crops/livestock)	8.687 (0.192)	85.7*	52.0	50.0	38.5	37.5	41.7	46.7	51.6

Numbers contributing to overall significant Chi square tests (P value < 0.05) are highlighted in bold

Numbers with an asterisk represent interest groups with the furthest deviation of the observed count from the expected count according to adjusted residual values of ± 1.96

Stakeholder group names shortened for space

Table 3 Stakeholder group participants self-ordering of 19 ecosystem service indicators for frequency of use

Ecosystem service indicator	Ecosystem service category	Selected #1	Selected #2	Selected #3	Total no. of times selected
Aesthetic/scenic	Cultural	10	17	7	47
Recreation (Non-motorized)	Cultural	12	10	9	41
Sense of place	Cultural	8	5	8	37
Food (Fruit/veg)	Provisioning	6	3	6	31
Wildlife for viewing	Cultural	8	5	4	31
Freshwater	Provisioning	14	5	5	29
Wildlife for food	Provisioning	7	5	5	27
Recreation (motorized)	Cultural	8	5	6	25
Wood (for fuel/building)	Provisioning	1	5	5	24
Educational/scientific	Cultural	0	7	2	21
Fish	Provisioning	3	1	3	18
Inspiration	Cultural	3	3	0	17
Wild edible plants	Provisioning	1	2	6	16
Cultural/historic heritage	Cultural	0	2	2	15
Livestock	Provisioning	1	5	0	14
Spiritual/religious	Cultural	2	1	3	11
Ornamental resources	Provisioning	0	0	1	10
Natural medicines	Provisioning	0	1	0	6

Ecosystem service indicators are listed in order of overall highest to lowest use based on number of times selected as first, second or third frequency of use among all stakeholder group participants

Discussion

Ecosystem services for consideration in land management decisions

Recognizing differences and similarities in ecosystem service use and perception across stakeholder groups is important for understanding priorities during land-use and conservation decision-making processes. We found that the ecosystem services concept was not widely disseminated among the general population, which may limit the public's ability to effectively communicate points-of-view during land management decisions. That said, when provided with the definition of the ecosystem services concept, there was an overwhelming stated understanding for the importance of ecosystem services and for considering them during land-use decisions. This professed importance of the ecosystem services concept may be linked to a stated perceptible decrease in the availability of the cultural and provisioning ecosystem services in the region, which was overwhelmingly attributed to ongoing and proposed industrial activity and development.

Ecosystem service decline has previously been linked to changes in land cover and land management (Reyers et al. 2009). Over-industrialization, and specifically the impending development of a large hydroelectric dam in this study, was cited as the main reason for potential loss of ecosystem services in future years, while the past decrease in available ecosystem services was perceived due to previous natural resource developments (oil and gas cited most frequently), leading to habitat loss, habitat fragmentation, reduced opportunities for other land uses, decreased wildlife populations, and lowered water quality. At the time of survey, public hearings for the proposed hydroelectric development had not occurred. Subsequently, a summary of the Joint Review Panel Report is now available (http://www.ceaa-acee.gc.ca/050/documents/p63919/99173E.pdf), which outlines recommendations based on comments that reflect many results found here; specifically heritage resources, cultural and provisioning use of biodiversity,

recreation, and habitat preservation as an underpinning of regulating and supporting ecosystem services, are important considerations in land-use planning. Acting on outcomes and information generated from public participation in land-use planning (such as the Joint Review Panel) can be instrumental in reducing stakeholder conflict and easing outcomes (Brown and Donovan 2013; Brown et al. 2014) related to potential effects on human well-being due to decreased ecosystem services. However, as trade-offs exist in managing for multiple ecosystem services as well as potential power inequity among stakeholder groups, a more standardized criteria for incorporating public participation is warranted (Fürst et al. 2014), especially when the concept of ecosystem services is not well known.

Ecosystem service trade-offs: within and among stakeholders

Hydroelectric power is often viewed as a provisioning ecosystem service in itself (Guo et al. 2000), derived from natural hydrological cycles, as well as being reliant on other ecosystem services (water quality and prevention of soil erosion) for optimal operations. Hydropower development can come with trade-offs to other industry sectors that also gain benefit from nature such as forestry or agriculture, but the full cost and accounting of economic benefits/trade-offs is not fully understood or incorporated into many land management decisions (Wang et al. 2010). Management decisions such as this evoke trade-offs between ecosystem service types, where there can be many unforeseen and undesired trade-offs considering provisioning ecosystem services against other ecosystem service types (i.e. cultural, regulating or supporting) (Howe et al. 2014). Trade-offs are often amplified when multiple stakeholder groups are considered, when there is discrepancy between competing interests involving financial gains, or where there are stakeholders that act and mobilise at local spatial scales relevant to the management plans (Howe et al. 2014). Further, our work suggests that most participants who perceived an increase in ecosystem services were in favour of increased road development to access ecosystem services. Many previous studies suggest road access is important for many provisioning ecosystem services (Chan et al. 2006; Wang et al. 2010; Fagerholm et al. 2012; Cimon-Morin et al. 2013), yet roads are known to negatively impact regulating and supporting ecosystem services through degradation to plant, animal, soil and hydrologic processes (Benítez-López et al. 2010; Duniway and Herrick 2013).

Different stakeholder groups may have different influence in management decisions despite all having strong interest, value or use of ecosystem services. Garćia-Nieto et al. (2015) suggests that stakeholder groups with links to policy such as environmentalists, government members, or scientists have a stronger potential to influence management decisions compared to stakeholder groups with direct associations to the land base (e.g. farmers, hunters, etc.), and these differences are reflected in ecosystem service use, and the link between different ecosystem service types. We suggest that similar trends can be seen in our study where Environmentalists, Government, and Recreationists stakeholder groups ranked provisioning ecosystem services lower in value, use or perceived use than First Nations, Hunter/Anglers, and Agriculturalists. These differences in regional use may ultimately highlight the specific ecosystem service trade-offs among stakeholder groups that could occur in management decisions in order to bring the most benefit to the greatest number of people (i.e. maintain services that are most important overall).

Avoiding conflict among stakeholder groups is an important part of environmental decision-making for land management (de Chazal et al. 2008; Brown and Donovan 2013; Brown et al. 2014), and consultation with different stakeholder groups can pin-point potential conflicts before they occur, or that might arise from poorly-directed land-use change decisions. Here we demonstrate that stakeholder groups use ecosystem services differently, both in terms of specific ecosystem service indicators, as well as the frequency of specific ecosystem service use. As such, implementing a payment for ecosystem services approach to balance conservation, agricultural and industrial interests (Tallis et al. 2011; Cimon-Morin et al. 2013), may be an appropriate consideration for specific locations within this study area. For instance, a portion of the study area was previously identified as being an ecosystem services hotspot location (Darvill and Lindo 2015); this area of high intensity, richness and diversity of ecosystem services indicated a priority location for ecosystem services delivery, suggesting that it should be considered a conservation priority

area (Martínez-Harms and Balvanera 2012) to maintain human well-being for all stakeholders. Unfortunately this ecosystem services 'hotspot' coincides with the proposed location of the hydroelectric dam project.

Congruence among stakeholders in ecosystem services

Consistently, cultural ecosystem services were cited and ranked as the most important ecosystem services indicators across all participating groups. In particular, landscapes used for their aesthetic and scenic value were highly cited, both in terms of the number of participants using this service, and also in terms of highest frequency of utilization. Despite the recognized importance of cultural ecosystem services, the incorporation of these sometimes intangible services into the ecosystem services approach lags far behind others, with recreation and ecotourism being an exception (Chan et al. 2012a; Plieninger et al. 2013). The high importance of cultural ecosystem services for most stakeholder groups has been observed in other studies (e.g. Raymond et al. 2009; Bryan et al. 2010), further suggesting that neglecting social values during decision-making may result in decisions that exclude the uses, needs and values that matter the most to the majority of people (Schaich et al. 2010).

Even though several cultural ecosystem services ranked highest in use and importance, all provisioning ecosystem services were still heavily used across all groups, especially by First Nations, Hunters/Anglers and Agriculturalists. Lower priority and use frequency by other participants may be due to the ability to purchase substitutes for local products (e.g. water, wood products, food grown elsewhere) in nearby urban centres. The MEA (2005) suggests that the loss of ecosystem services on human well-being will vary across communities, with more serious consequences felt by developing nations, persons with lowered incomes, and those whom are directly reliant upon land-based personal economies. While we did not collect economic or education data in our study, there is a potential economic divide among socioeconomic classes in our study region, as well as other complex factors such as age, individual needs, access to ecosystem services (i.e. rural vs. urban living), and time spent living in the region, which may help explain some of our results. For instance, the Agriculturalists group not only had the highest percentage of people living rurally, they also had the highest number of participants belonging to the 65 and above age category, and many were born in the area. Martín-López et al. (2012) showed that elderly people living rurally had a greater awareness of provisioning ecosystem services as they were more likely to have been dependent on ecosystem services related to traditional farming practices throughout their lifetime.

Limitations, caveats, and future directions

The work presented here follows the basic steps of stakeholder analysis: we identify stakeholder groups, gathered information regarding cultural and provisioning ecosystem service use and perception, and analyse the information gathered to understand whether specific groups differ in frequency and/or priority of ecosystem service use. While we do not incorporate a full stakeholder analysis that would identify which stakeholders have power and leadership abilities to influence outcomes on land-use planning, our analysis does help identify which stakeholder groups could be at risk of being impacted by land-use change in this region with respect to ecosystem service loss.

When the public is uninformed on certain topics, it is harder to elicit and extract reliable information using public participation methods. However, we do not feel that in this case the public was unable to adequately participate in the survey because we provided a standardized definition of ecosystem services to all participants prior to starting the survey, and the survey mostly focused on tangible entities that all participants could understand (e.g. how often do you fish?). That said, participation numbers were not as high as we would have liked, which can be problematic for public participation-based research; despite a huge effort to obtain participants for this study, many groups and residents were standoffish in our attempts to contact them. However, our results are consistent with recent findings from several studies in other countries and study systems (e.g. Brown and Donovan 2013; Raymond et al. 2014; Garćia-Nieto et al. 2015). In particular, the number of First Nations participants was small for this study, but it is clear that First Nations involvement and high use of ecosystem services highlights the importance of including First Nations in discussions regarding land management and land-use planning. First Nations recognition and

use of ecosystem services indicators is not surprising given First Nations long-standing occupancy on the land, their environmental guardianship, strong relationships with the land, and how they pass on traditional ecological knowledge and wisdom from generation to generation (Turner et al. 2000). In a similar case-study of a proposed oil and gas pipeline in north-west Canada, Raymond et al. (2014) found that strong cultural identity of First Nations created unique potential impacts of proposed land-use (i.e. loss of cultural identity and threat to cultural survival).

This study chose to focus on tangible and personalised ecosystem service use and perception that are encapsulated in the provisioning and cultural ecosystem service categories. However, quantifying regulating and supporting ecosystem service use and valuation is much more difficult, especially from a public participation perspective that could be compared across stakeholder groups. Plieninger et al. (2015) suggest that while provisioning ecosystem services are often a tangible focus, cultural ecosystem services could provide proxies of regulating and supporting services as they "incentivize the multifunctionality of landscapes". If multifunctionality is the goal, then returning to a biodiversity conservation perspective may be the key to preserving and enhancing ecosystem services (Hector and Bagchi 2007; Lefcheck et al. 2015). All ecosystem services are intricately linked to biodiversity (MEA 2005), as a regulator of ecosystem processes underpinning ecosystem services (e.g. decomposers), as an ecosystem service itself (e.g. pollinators), or as a direct provisioning ecosystem service (e.g. fish and game) (Mace et al. 2012). While it is unclear how much biodiversity is needed in order to maintain ecosystem function required for delivering ecosystem services (Isbell et al. 2011), there is a significant and growing body of evidence that provides links between biodiversity, ecosystem function and resulting ecosystem services (Balvanera et al. 2014). However, whether biodiversity monitoring can be a surrogate for ecosystem service monitoring still remains unclear (Geijzendorffer and Roche 2013).

Conclusions

The balance between managing habitats for human development interests, conservation, and ecosystem services often involves trade-offs. Since the concept of ecosystem services is based on the ability of humans to interact with natural surroundings and to gain health and well-being directly or indirectly from ecosystems, the full economic and non-market costs of losing habitat has been largely underestimated, largely because resulting ecosystem service losses have historically not been accounted for (Postel and Carpenter 1997). Therefore, in order to support sustainable management and conservation decisions, short-term interests (e.g. electricity generation, oil/gas extraction) need to be accurately weighed and measured according to the long-term impact on all affected stakeholders and their well-being. This includes full cost accounting for all ecosystem services (material and non-material benefits) using stakeholder groups during decision-making processes.

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Executive Summary

Recent technological and economic changes are expected to challenge and transform the electric utility industry. These changes (or "disruptive challenges") arise due to a convergence of factors, including: falling costs of distributed generation and other distributed energy resources (DER); an enhanced focus on development of new DER technologies; increasing customer, regulatory, and political interest in demand-side management technologies (DSM); government programs to incentivize selected technologies; the declining price of natural gas; slowing economic growth trends; and rising electricity prices in certain areas of the country. Taken together, these factors are potential "game changers" to the U.S. electric utility industry, and are likely to dramatically impact customers, employees, investors, and the availability of capital to fund future investment. The timing of such transformative changes is unclear, but with the potential for technological innovation (e.g., solar photovoltaic or PV) becoming economically viable due to this confluence of forces, the industry and its stakeholders must proactively assess the impacts and alternatives available to address disruptive challenges in a timely manner.

This paper considers the financial risks and investor implications related to disruptive challenges, the potential strategic responses to these challenges, and the likely investor expectations to utility plans going forward. There are valuable lessons to be learned from other industries, as well as prior utility sector paradigm shifts, that can assist us in exploring risks and potential strategic responses.

The financial risks created by disruptive challenges include declining utility revenues, increasing costs, and lower profitability potential, particularly over the long-term. As DER and DSM programs continue to capture "market share," for example, utility revenues will be reduced. Adding the higher costs to integrate DER, increasing subsidies for DSM and direct metering of DER will result in the potential for a squeeze on profitability and, thus, credit metrics. While the regulatory process is expected to allow for recovery of lost revenues in future rate cases, tariff structures in most states call for non-DER customers to pay for (or absorb) lost revenues. As DER penetration increases, this is a cost-recovery structure that will lead to political pressure to undo these cross subsidies and may result in utility stranded cost exposure.

While the various disruptive challenges facing the electric utility industry may have different implications, they all create adverse impacts on revenues, as well as on investor returns, and require individual solutions as part of a comprehensive program to address these disruptive trends. Left unaddressed, these financial pressures could have a major impact on realized equity returns, required investor returns, and credit quality. As a result, the future cost and availability of capital for the electric utility industry would be adversely impacted. This would lead to increasing customer rate pressures.

The regulatory paradigm that has supported recovery of utility investment has been in place since the electric utility industry reached a mature state in the first half of the 20th century. Until there is a significant, clear, and present threat to this recovery paradigm, it is likely that the financial markets will not focus on these disruptive challenges, despite the fact that electric utility capital investment is recovered over a period of 30 or more years (i.e., which exposes the industry to stranded cost risks). However, with the current level of lost load nationwide from DER being less than 1 percent, investors are not taking notice of this phenomenon, despite the fact that the pace of change is increasing and will likely increase further as costs of disruptive technologies benefit further from scale efficiencies.

Investors, particularly equity investors, have developed confidence throughout time in a durable industry financial recovery model and, thus, tend to focus on earnings growth potential over a 12- to 24-month period.

So, despite the risks that a rapidly growing level of DER penetration and other disruptive challenges may impose, they are ***not*** currently being discussed by the investment community and factored into the valuation calculus reflected in the capital markets. In fact, electric utility valuations and access to capital today are as strong as we have seen in decades, reflecting the relative safety of utilities in this uncertain economic environment.

In the late 1970s, deregulation started to take hold in two industries that share similar characteristics with the electric utility industry—the airline industry and the telecommunications industry (or "the telephone utility business"). Both industries were price- and franchise-regulated, with large barriers to entry due to regulation and the capital-intensive nature of these businesses. Airline industry changes were driven by regulatory actions (a move to competition), and the telecommunications industry experienced technology changes that encouraged regulators to allow competition. Both industries have experienced significant shifts in the landscape of industry players as a result.

In the airline sector, each of the major U.S. carriers that were in existence prior to deregulation in 1978 faced bankruptcy. The telecommunication businesses of 1978, meanwhile, are not recognizable today, nor are the names of many of the players and the service they once provided ("the plain old telephone service"). Both industries experienced poor financial market results by many of the former incumbent players for their investors (equity and fixed-income) and have sought mergers of necessity to achieve scale economies to respond to competitive dynamics.

The combination of new technologies, increasing costs, and changing customer-usage trends allow us to consider alternative scenarios for how the future of the electric sector may develop. Without fundamental changes to regulatory rules and recovery paradigms, one can speculate as to the adverse impact of disruptive challenges on electric utilities, investors, and access to capital, as well as the resulting impact on customers from a price and service perspective. We have the benefit of lessons learned from other industries to shift the story and move the industry in a direction that will allow for customers, investors, and the U.S. economy to benefit and prosper.

Revising utility tariff structures, particularly in states with potential for high DER adoption, to mitigate (or eliminate) cross subsidies and provide proper customer price signals will support economic implementation of DER while limiting stress on non-DER participants and utility finances. This is a near-term, must-consider action by all policy setting industry stakeholders.

The electric utility sector will benefit from proactive assessment and planning to address disruptive challenges. Thirty year investments need to be made on the basis that they will be recoverable in the future in a timely manner. To the extent that increased risk is incurred, capital deployment and recovery mechanisms need to be adapted accordingly. The paper addresses possible strategic responses to competitive threats in order to protect investors and capital availability. While the paper does not propose new business models for the industry to pursue to address disruptive challenges in order to protect investors and retain access to capital, it does highlight several of the expectations and objectives of investors, which may lead to business model transformation alternatives.

Background

As a result of a confluence of factors (i.e., technological innovation, public policy support for sustainability and efficiency, declining trends in electricity demand growth, rising price pressures to maintain and upgrade the U.S. distribution grid, and enhancement of the generation fleet), the threat of disruptive forces (i.e., new products/markets that replace existing products/markets) impacting the utility industry is increasing and is adding to the effects of other types of disruptive forces like declining sales and end-use efficiency. While we cannot lay out an exact roadmap or timeline for the impact of potential disruptive forces, given the current shift in competitive dynamics, the utility industry and its stakeholders must be prepared to address these challenges in a way that will benefit customers, long-term economic growth, and investors. Recent business history has provided many examples of companies and whole industries that either failed or were slow to respond to disruptive forces and suffered as a result.

Today, a variety of disruptive technologies are emerging that may compete with utility-provided services. Such technologies include solar photovoltaics (PV), battery storage, fuel cells, geothermal energy systems, wind, micro turbines, and electric vehicle (EV) enhanced storage. As the cost curve for these technologies improves, they could directly threaten the centralized utility model. To promote the growth of these technologies in the near-term, policymakers have sought to encourage disruptive competing energy sources through various subsidy programs, such as tax incentives, renewable portfolio standards, and net metering where the pricing structure of utility services allows customers to engage in the use of new technologies, while shifting costs/lost revenues to remaining non-participating customers.

In addition, energy efficiency and DSM programs also promote reduced utility revenues while causing the utility to incur implementation costs. While decoupling recovery mechanisms, for example, may support recovery of lost revenues and costs, under/over recovery charges are typically imposed based on energy usage and, therefore, adversely impact non-participants of these programs. While the financial community is generally quite supportive of decoupling to capture lost revenues, investors have not delved into the long-term business and financial impact of cross subsidization on future customer rates inherent in most decoupling models and the effective recovery thereof. In other words, will non–DER participants continue to subsidize participants or will there be political pressure to not allow cost pass thru over time?

The threat to the centralized utility service model is likely to come from new technologies or customer behavioral changes that reduce load. Any recovery paradigms that force cost of service to be spread over fewer units of sales (i.e., kilowatt-hours or kWh) enhance the ongoing competitive threat of disruptive alternatives. While the cost--recovery challenges of lost load can be partially addressed by revising tariff structures (such as a fixed charge or demand charge service component), there is often significant opposition to these recovery structures in order to encourage the utilization of new technologies and to promote customer behavior change.

But, even if cross-subsidies are removed from rate structures, customers are not precluded from leaving the system entirely if a more cost-competitive alternative is available (e.g., a scenario where efficient energy storage combined with distributed generation could create the ultimate risk to grid viability). While tariff restructuring can be used to mitigate lost revenues, the longer-term threat of fully exiting from the grid (or customers solely using the electric grid for backup purposes) raises the potential for irreparable damages to revenues and growth prospects. This suggests that an old-line industry with 30-year cost recovery of investment is vulnerable to cost-recovery threats from disruptive forces.

Generators in organized, competitive markets are more directly exposed to threats from new technologies and enhanced efficiency programs, both of which reduce electricity use and demand. Reduced energy use and demand translate into lower prices for wholesale power and reduced profitability. With reduced profitability comes less cash flow to invest and to support the needs of generation customers. While every market-driven business is subject to competitive forces, public policy programs that provide for subsidized growth of competing technologies and/or participant economic incentives do not provide a level playing field upon which generators can compete fairly against new entrants. As an example, subsidized demand response programs or state contracted generation additions create threats to the generation owner (who competes based upon free market supply and demand forces).

According to the Solar Electric Power Association (SEPA), there were 200,000 distributed solar customers (aggregating 2,400 megawatts or MW) in the United States as of 2011. Thus, the largest near-term threat to the utility model represents less than 1 percent of the U.S. retail electricity market. Therefore, the current level of activity can be "covered over" without noticeable impact on utilities or their customers. However, at the present time, 70 percent of the distributed activity is concentrated within 10 utilities, which obviously speaks to the increased risk allocated to a small set of companies. As previously stated, due to a confluence of recent factors, the threat to the utility model from disruptive forces is now increasingly viable. One prominent example is in the area of distributed solar PV, where the threats to the centralized utility business model have accelerated due to:

- The decline in the price of PV panels from $3.80/watt in 2008 to $0.86/watt in mid-2012[1]. While some will question the sustainability of cost-curve trends experienced, it is expected that PV panel costs will not increase (or not increase meaningfully) even as the current supply glut is resolved. As a result, the all-in cost of PV solar installation approximates $5/watt, with expectations of the cost declining further as scale is realized;
- An increase in utility rates such that the competitive price opportunity for PV solar is now "in the market" for approximately 16 percent of the U.S. retail electricity market where rates are at or above $0.15/kWh[2]. In addition, projections by PV industry participants suggest that the "in the money" market size will double the share of contestable revenue by 2017 (to 33 percent, or $170 billion of annual utility revenue);
- Tax incentives that promote specific renewable resources, including the 30-percent Investment Tax Credit (ITC) that is effective through 2016 and five-year accelerated depreciation recovery of net asset costs;
- Public policies to encourage renewable resource development through Renewable Portfolio Standards (RPS), which are in place in 29 states and the District of Columbia and which call for renewable generation goals within a state's energy mix;
- Public policies to encourage net metering, which are in effect in 43 states and the District of Columbia (3 additional states have utilities with voluntary net metering programs) and which typically allow customers to sell excess energy generated back to the utility at a price greater than the avoided variable cost[3];
- Time-of-use rates, structured for higher electric rates during daylight hours, that create incentives for installing distributed solar PV, thereby taking advantage of solar benefit (vs. time-of-use peak rates) and net metering subsidies; and

[1] Source: Bloomberg New Energy Finance, *Solar Module Price Index*
[2] Source: Energy Information Agency, *Electricity Data Overview*
[3] Source: Database for State Incentives for Renewables and Efficiency, www.dsireusa.org

- The evolution of capital markets' access to businesses that leverage the dynamics outlined above to support a for-profit business model. Examples include tax equity financing, project finance lending, residential PV leasing models (i.e., "no money down" for customers), and public equity markets for pure play renewable resource providers and owners. As an illustration, U.S. tax equity investment is running at $7.5 billion annualized for 2012.[4] Add other sources of capital, including traditional equity, and this suggests the potential to fund a large and growing industry.

Bloomberg New Energy Finance (BNEF) projects that distributed solar capacity will grow rapidly as a result of the competitive dynamics highlighted. BNEF projects 22-percent compound annual growth in PV installations through 2020, resulting in 30 gigawatts (GW) of capacity overall (and approximately 4.5 GW coming from distributed PV). This would account for 10 percent of capacity in key markets coming from distributed resources and even a larger share of year-round energy generated.

Assuming a decline in load, and possibly customers served, of 10 percent due to DER with full subsidization of DER participants, the average impact on base electricity prices for non-DER participants will be a 20 percent or more increase in rates, and the ongoing rate of growth in electricity prices will double for non-DER participants (before accounting for the impact of the increased cost of serving distributed resources). The fundamental drivers previously highlighted could suggest even further erosion of utility market share if public policy is not addressed to normalize this competitive threat.

While the immediate threat from solar PV is location dependent, if the cost curve of PV continues to bend and electricity rates continue to increase, it will open up the opportunity for PV to viably expand into more regions of the country. According to ThinkEquity, a boutique investment bank, as the installed cost of PV declines from $5/watt to $3.5/watt (a 30-percent decline), the targeted addressable market increases by 500 percent, including 18 states and 20 million homes, and customer demand for PV increases by 14 times. If PV system costs decline even further, the market opportunity grows exponentially. In addition, other DER technologies being developed may also pose additional viable alternatives to the centralized utility model.

Due to the variable nature of renewable DER, there is a perception that customers will always need to remain on the grid. While we would expect customers to remain on the grid until a fully viable and economic distributed non-variable resource is available, one can imagine a day when battery storage technology or micro turbines could allow customers to be electric grid independent. To put this into perspective, who would have believed 10 years ago that traditional wire line telephone customers could economically "cut the cord?"

The cost of providing interconnection and back-up supply for variable resources will add to the utility cost burden. If not properly addressed in the tariff structure, the provision of these services will create additional lost revenues and will further challenge non-DER participants in terms of being allocated costs incurred to serve others.

Another outcome of the trend of rising electricity prices is the potential growth in the market for energy efficiency solutions. Combining electricity price trends, customer sustainability objectives, and ratemaking incentives via cross-subsidies, it is estimated that spending on energy efficiency programs will increase by as much as 300 percent from 2010 to 2025, within a projected range of $6 to $16 billion per year[5]. This level of

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[4] Source: Bloomberg New Energy Finance, *Renewable Energy-Research Note*, July 18, 2012

[5] Source: Lawrence Berkeley National Laboratory, *The Future of Utility Funded Energy Efficiency Programs in the United States: Projected Spending and Savings 2010 to 2025*, January 2013

spending on energy efficiency services will have a meaningful impact on utility load and, thus, will create significant additional lost revenue exposure.

The financial implications of these threats are fairly evident. Start with the increased cost of supporting a network capable of managing and integrating distributed generation sources. Next, under most rate structures, add the decline in revenues attributed to revenues lost from sales foregone. These forces lead to increased revenues required from remaining customers (unless fixed costs are recovered through a service charge tariff structure) and sought through rate increases. The result of higher electricity prices and competitive threats will encourage a higher rate of DER additions, or will promote greater use of efficiency or demand-side solutions.

Increased uncertainty and risk will not be welcomed by investors, who will seek a higher return on investment and force defensive-minded investors to reduce exposure to the sector. These competitive and financial risks would likely erode credit quality. The decline in credit quality will lead to a higher cost of capital, putting further pressure on customer rates. Ultimately, capital availability will be reduced, and this will affect future investment plans. The cycle of decline has been previously witnessed in technology-disrupted sectors (such as telecommunications) and other deregulated industries (airlines).

Disruptive Threats—Strategic Considerations

A disruptive innovation is defined as "an innovation that helps create a new market and value network, and eventually goes on to disrupt an existing market and value network (over a few years or decades), displacing an earlier technology. The term is used in business and technology literature to describe innovations that improve a product or service in ways that the market does not expect, typically first by designing for a different set of consumers in the new market and later by lowering prices in the existing market."

Disruptive forces, if not actively addressed, threaten the viability of old-line exposed industries. Examples of once-dominant, blue chip companies/entities being threatened or succumbing to new entrants due to innovation include Kodak and the U.S. Postal Service (USPS). For years, Kodak owned the film and related supplies market. The company watched as the photo business was transformed by digital technology and finally filed for bankruptcy in 2012.

Meanwhile, the USPS is a monopoly, government-run agency with a mission of delivering mail and providing an essential service to keep the economy moving. The USPS has been threatened for decades by private package delivery services (e.g., UPS and FedEx) that compete to offer more efficient and flexible service. Today, the primary threat to USPS' viability is the delivery of information by email, including commercial correspondence such as bills and bill payments, bank and brokerage statements, etc. Many experts believe that the USPS must dramatically restructure its operations and costs to have a chance to protect its viability as an independent agency.

Participants in all industries must prepare for and develop plans to address disruptive threats, including plans to replace their own technology with more innovative, more valuable customer services offered at competitive prices. The traditional wire line telephone players, including AT&T and Verizon, for example, became leaders in U.S. wireless telephone services, which over time could make the old line telephone product extinct. But these innovative, former old-line telephone providers had the vision to get in front of the trend to wireless and lead the development of non-regulated infrastructure networks and consumer marketing skills. As a result, they now hold large domestic market shares. In fact, they have now further leveraged technology innovation to create new products that expand their customer offerings.

The electric utility sector has not previously experienced a viable disruptive threat to its service offering due customer reliance and the solid economic value of its product. However, a combination of technological innovation, public/regulatory policy, and changes in consumer objectives and preferences has resulted in distributed generation and other DER being on a path to becoming a viable alternative to the electric utility model. While investors are eager to support innovation and economic progress, they do not support the use of subsidies to attack the financial viability of their invested capital. Utility investors may not be opposed to DER technologies, but, in order for utilities to maintain their access to capital, it is essential that the financial implications of DER technologies be addressed so that non-DER participants and investors are not left to pay for revenues lost (and costs unrecovered) from DER participants.

Finance 101 - Introduction to Corporate Finance

Investors allocate investment capital to achieve their financial objectives consistent with their tolerance for risk and time horizon. Fixed-income (i.e., bond) investors seek certainty as to (investment) returns through a guarantee by the debt issuer of timely payment of principal and interest. Equity investors seek a higher expected return than debt investors and, accordingly, must accept increased risk. “Expected” return refers to the distinction that equity investor returns are not guaranteed; therefore, equity investors bear a higher level of risk than bondholders. The expected return on equity investment is realized through a combination of dividends received and expected growth in value per share (which is achieved through a combination of growth in earnings and dividends and/or a rerating of return expectations as a result of investment market forces).

Corporate financial objectives focus on enhancing shareholder value through achieving long-term growth consistent with the preservation of the corporate entity. Corporations develop financial policies to support the access to capital to achieve their business plans. For utilities, these financial policies are consistent with investment-grade credit ratings. Since practically all utilities have an ongoing need for capital to fund their capital expenditure programs, the industry has developed financial policies intended to support the access to relatively low-cost capital in (practically) all market environments. Under traditional cost-of-service ratemaking, customers benefit through lower cost of service and, therefore, lower rates.

In order to retain the financial flexibility required to maintain investment-grade credit ratings, the rating agencies prefer policies that promote the retention of corporate cash flow and provide a liquidity cushion to support fixed obligations. Prudent corporate financial management disdains significant fixed commitments to investors—since such commitments limit management flexibility and increase capital-access dependency and risk. While paying dividends to equity investors is not a legal obligation, the rating agencies and investors view dividends as a moral (or intended) obligation that management will not reduce unless it has no viable alternative to preserve long-term corporate value. The corporate financial objective of retaining cash from operations to support credit quality limits the potential to pay dividends to investors. Thus, growth of investment value is required by equity investors (as discussed above) to achieve return expectations warranted by the increased risk taken and investment return expectations relative to fixed income investors.

It is important to highlight that the rating agencies’ rating criteria and associated target corporate credit metrics reflect the credit risk of the industry environment of the corporation being rated. Thus, due to the benefits of a stable regulatory environment, utilities are able to maintain (for a given rating category) significantly more debt relative to cash flow than competitive industries. However, if business risks were to increase for utilities in the future, as we will discuss in the next sections, it would be likely that utility debt leverage (i.e., debt relative to cash flow) would need to be reduced in order to retain credit ratings.

Stable, mature industries—those that have a proven product, stable product demand, and low volatility related to their revenues and cash flow (the "defensive industries")—are attractive to investors as they offer more certainty and fewer business and financial risks. As a result, investors in these stable, defensive industries (such as utilities) will require a lower expected return compared to investors in less mature and more volatile industries. We describe this lower expected return requirement as a lower cost of capital. This lower cost of capital associated with defensive industries is manifested in lower borrowing costs and higher relative share values. In addition, in difficult financial market environments (such as we experienced in October 2008 through March 2009), these stable businesses typically experience less adverse stock price impact due to investors fleeing in order to reduce risk. Thus, in difficult markets, mature companies have demonstrated ongoing financial market access (investor demand) when those in other industries have not. This is the benefit (or the "insurance policy") of an investment-grade credit rating—lower capital costs and more stable access to capital despite market conditions.

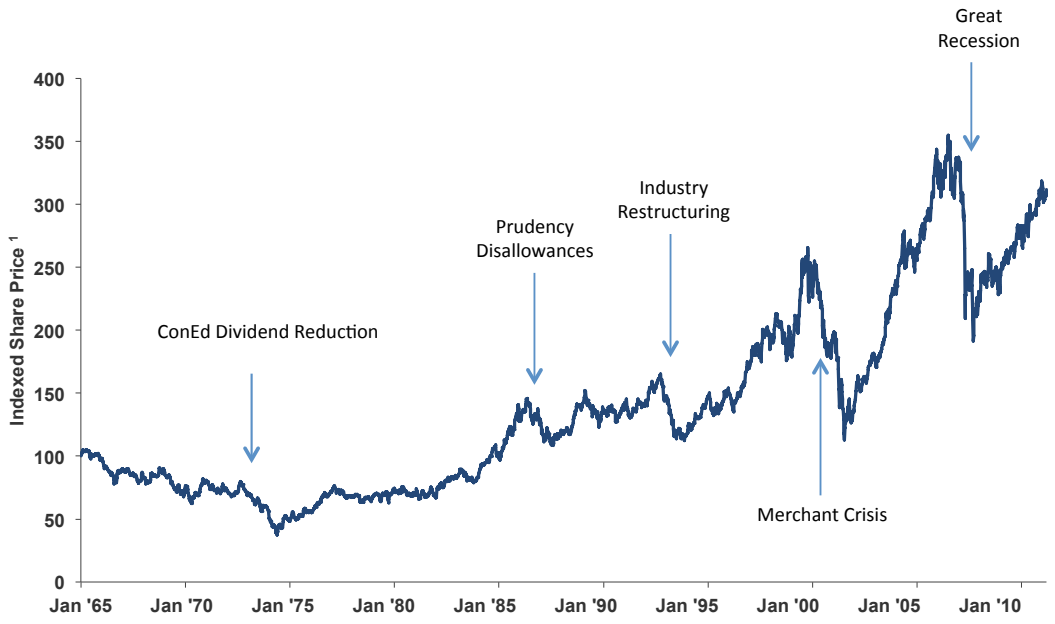
The benefit to customers of cost-of-service rate-regulated utilities is that a lower cost of capital contributes to lower utility rates. Also of importance, but often taken for granted, is the comfort that comes with knowing that utilities will have capital access to support the reliability and growth needs of their service territories and, thus, will not adversely expose customer service needs, including customer growth plans.

Finance 201 - Financial Market Realities

With the exception of a very few periods over the past century, utilities have experienced unfettered access to relatively low-cost capital. Even during challenging financial market environments when many industries have been effectively frozen from capital access, utilities have been able to raise capital to support their business plans. The primary reason for the markets' willingness to provide capital to the utility sector is the confidence that investors place in the regulatory model, particularly the premise that utilities will be awarded the opportunity to earn a fair return on investor capital investment.

However, at times of regulatory model uncertainty, we have seen the financial markets punish utility securities. Examples of periods of investor uncertainty would include the timeframe post the 1973 oil embargo, which was prior to the enactment of fuel adjustment clauses for purchased power; the nuclear power plant abandonments and cost disallowances of the 1980s that led to multiple bankruptcies and financial distress for quite a few utilities; the PURPA cost fallout of the 1990s; and the post-Enron bankruptcy collapse of the merchant power sector in the early 2000s, which challenged merchant energy providers and heavily exposed utility counterparties. These events led to bankruptcies, longstanding financial distress for impacted utilities, and ongoing erosion in credit quality and investor confidence. These examples highlight that regulated businesses are vulnerable to risks related to business model changes, economic trends and regulatory policy changes. When investors focus on these issues as being material risks, the impact on investors and capital formation can be significant.

Exhibit 1
Dow Jones Utility Index: 1965-2012



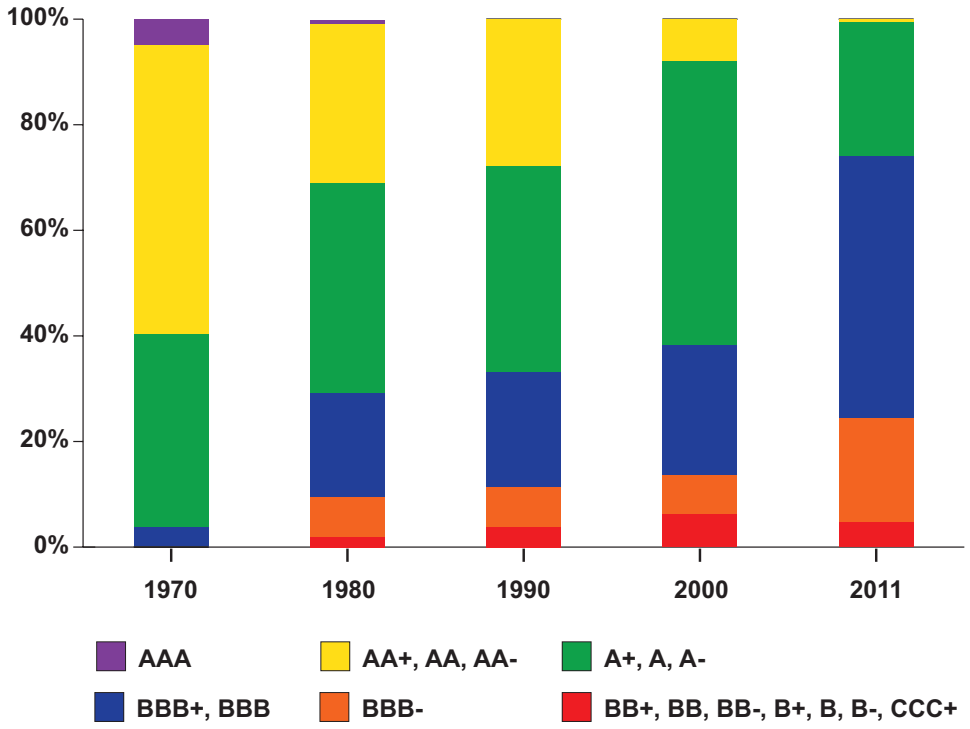
(1) Indexed to 1/2/1970 price

Source: Bloomberg

Prior to the 1980s, the utility sector was dominated by "AA" credit ratings. Power supply-side cost pressures, declining economic and customer growth trends, inflation in cost-of-service provision, and an evolving industry and regulatory model have resulted in steady erosion in credit quality over each of the last five decades. (See Exhibit 2 for a credit-rating history of the electric utility sector.) Investors responded to these periods of significant industry challenge with a rethink of their "blind" faith in the regulatory model and became more focused on company selection as they approached investment strategy. But, for the most part, as utilities and regulation adjusted to political, regulatory, and economic challenges, investor faith in the regulatory model has been restored.

After five decades of decline in industry credit quality, a potential significant concern now is that new competitive forces, which have not been a concern of investors to date, will lead to further credit erosion. The industry cannot afford to endure significant credit quality erosion from current ratings levels without threatening the BBB ratings that are held by the majority of the industry today. Non-investment grade ratings would lead to a significant rerating of capital costs, credit availability, and investor receptivity to the sector. The impact on customers would be dramatic in terms of increased revenue requirements (i.e., the level of revenues required for a utility to cover its operating costs and earn its allowed cost of capital), customer rates, and reduction in the availability of low-cost capital to enhance the system.

Exhibit 2
Electric utility industry credit ratings distribution evolution
(S&P Credit Ratings Distribution, U.S. Shareholder-Owned Electric Utilities)



Source: Standard & Poor's, Macquarie Capital

As we look at the electric utility sector today, investors, for the most part, remain confident that the regulatory model will be applied fairly to provide them with the opportunity to earn a reasonable and fair return on their investment. Those states that have experienced prior upheavals in their regulatory model (e.g., California) have had to tighten their approach to regulatory cost recovery to convince investors that past problems have been addressed. If a state has not been as receptive to addressing its approach to past problems, then investors will be highly reticent to deploy capital in those jurisdictions.

In reviewing recent sector research reports, the majority of security analysts continue to project future earnings levels based on assumed capital-investment levels and projected costs of capital (a bottoms-up approach). While analysts acknowledge that each rate case carries some degree of uncertainty, there appears to be limited focus in their analysis on service area quality, competitiveness of customer pricing, and the drivers for future service territory growth. No other significant industry is analyzed by Wall Street on a bottoms-up basis; the basis for analysis of non-utility industries is competitive position, sales prospects, and sales margins. In addition, the threat of disruptive forces is given no (or almost no) printed lines in utility sector research. This approach to investment analysis is based upon confidence in utilities' ability to earn a fair return on prudent investment. But, it may expose investors to the future economic risks posed by rapid growth in DER. What will happen as technological advancement in the utility sector provides customers with viable competitive alternatives?

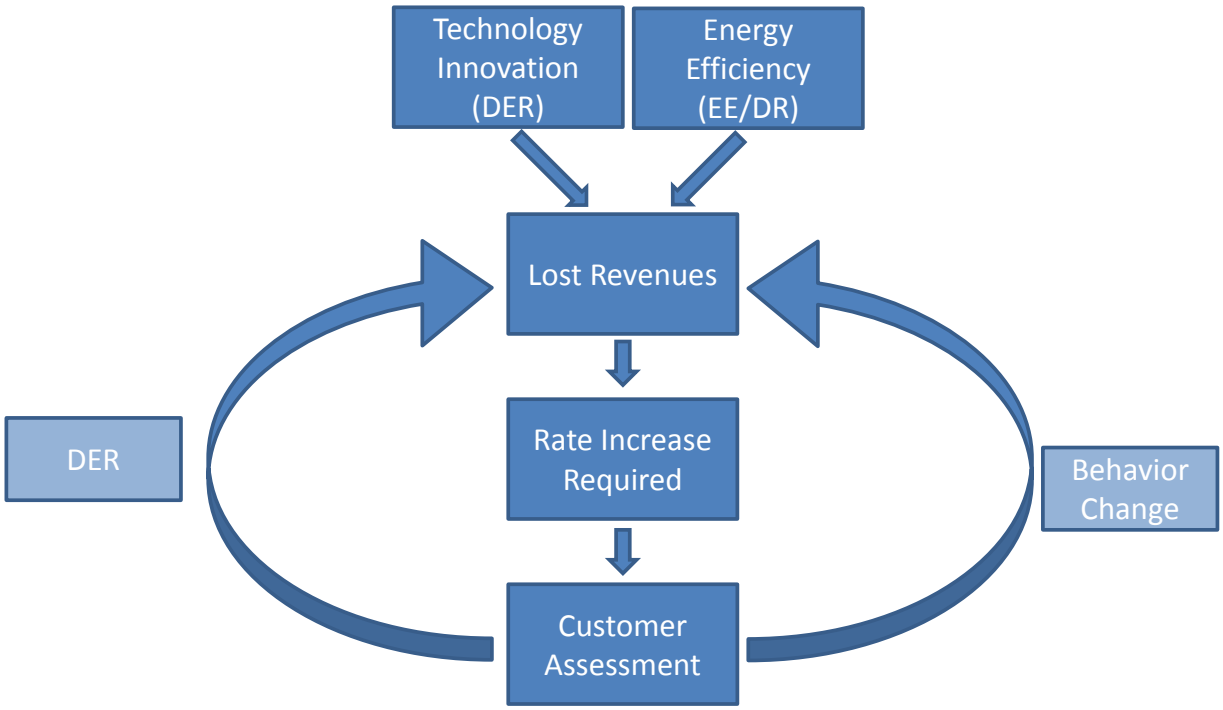
Finance 501 - Financial Implications of Disruptive Forces

As discussed previously, equity investors expect and will value an equity security based upon growth attributes as a major component of the expected total return investors require. Growth in utility earnings has historically been realized by a combination of increased electricity sales (volume), increased price per unit of sales (higher rates), and/or expanded profit margins on incremental revenues achieved between rate cases reflecting the realization of operational/overhead efficiencies. Earnings levels and growth are also impacted by changing costs of capital due to market forces—this is currently a depressant on utility earnings per share (EPS) levels due to the sector-wide decline in authorized returns on equity (ROE) realized over the last several years.

First, let's review the current climate for the utility sector. While valuations are near all-time highs, the headwinds facing the sector are significant. Concerns start with the anemic electricity demand, which has been primarily impacted by the overall economic climate but also impacted by demand-side efficiency programs and the emergence of DER. Next, there is the need to deploy capital investment at almost twice the rate of depreciation to enhance the grid and address various regulatory mandates. Soft electricity demand plus increasing capital investment lead to rate increase needs and the investment uncertainty created by a future active rate case calendar. While sell side analysts are expecting EPS growth of 4 percent to7 percent overall for the regulated sector, this is likely to be quite challenging. If investor expectations are not realized, a wholesale reevaluation of the sector is likely to occur.

So, what will happen when electricity sales growth declines and that decline is not cyclical but driven by disruptive forces, including new technology and/or the further implementation of public policy focused on DSM and DER initiatives? In a cost-of-service rate-regulated model, revenues are not directly correlated to customer levels or sales but to the cost of providing service. However, in most jurisdictions, customer rates are a function of usage/unit sales. In such a model, customer rate levels must increase via rate increase requests when usage declines, which from a financial perspective is intended to keep the company whole (i.e., earn its cost of capital). However, this may lead to a challenging cycle since an increase in customer rates over time to support investment spending in a declining sales environment (due to disruptive forces) will further enhance the competitive dynamics of competing technologies and supply/demand efficiency programs. This set of dynamics can become a vicious cycle (See Exhibit 3) that, in the worst-case scenario, would leave few(er) customers remaining to support the costs of a large embedded infrastructure system, some of which may be stranded investment but most of the costs will continue to be incurred in order to manage the flows between supply and customers.

Exhibit 3
Vicious Cycle from Disruptive Forces



When investors realize that a business model has been stung by systemic disruptive forces, they likely will retreat. When is the typical tipping point when investors realize that the merits of the investment they are evaluating or monitoring has been forever changed? Despite all the talk about investors assessing the future in their investment evaluations, it is often not until revenue declines are reported that investors realize that the viability of the business is in question.

An interesting example is the story of RIM, the manufacturer of the Blackberry handheld information management tool. From its public start in the 1990s thru 2008, RIM was a Wall Street darling. Its share price was less than $3 in 1999 and peaked at $150 in 2008. The company started to show a stall in sales in 2011, and, now, despite a large cash position and 90 million subscribers, the market is questioning RIM's ability to survive and RIM's stock has plummeted from its high.

What happened to this powerful growth company that had dominant market shares in a growth market? The answer is the evolution of the iPhone, which transformed the handheld from an email machine to a dynamic Internet tool with seemingly unlimited applications/functionality. When the iPhone was first released in 2007, it was viewed as a threat to RIM, but RIM continued to grow its position until the introduction of the iPhone 4 in June 2010. The iPhone 4, which offered significant improvements from prior versions, led to a retreat in RIM's business and caused a significant drop in its stock price.

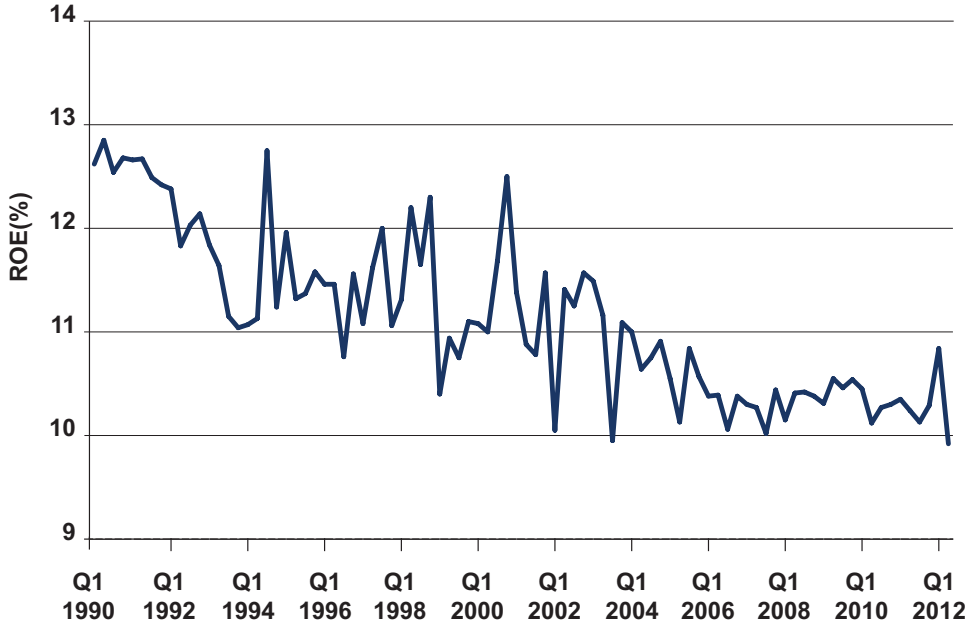
It seems that investors have proven to be reasonably optimistic on selected industries even though the competitive threat is staring them head-on. However, if we can identify actionable disruptive forces to a business or industry, then history tells us that management and investors need to take these threats seriously

and not wait until the decline in sales and revenues has commenced to develop a new strategy or, in the case of investors, realize their loss.

As discussed above, investors in the utility sector seek increased certainty (or less risk) than in other industries and have confidence in the consistent application of ratemaking recovery models to provide a lower degree of investment risk. As a result of this confidence, when instances have occurred in the past that have not provided consistent application of expected cost recovery models, investors have responded and have caused significant adverse impact on entities' ability to raise incremental capital. But, with the exception of the California energy crisis in the early 2000s, these events reflected embedded cost issues that had defined exposures and time frames. Disruptive changes are a new type of threat to the electric utility industry. Disruptive changes lead to declining customer and usage per customer levels that cannot be easily quantified as to the potential threat posed to corporate profitability. This type of problem has not been faced before by the electric industry and, thus, must be understood as to the strategic issues and alternatives that are raised.

The new potential risk to utility investors from disruptive forces is the impact on future earnings growth expectations. Lost revenues within a net metering paradigm, for instance, are able to be recovered in future rate cases. However, without a shift in tariff structures, there is only so much of an increase that can be placed on remaining non-DER customers before political pressure is brought to bear on recovery mechanisms. Once the sustainability of the utility earnings model is questioned, investors will look at the industry through a new lens, and the view from this lens will be adverse to all stakeholders, including investors and customers. While we do not know the degree to which customer participation in DER and behavior change will impact utility earnings growth, the potential impact, based upon DER trends, is considerable (as stated earlier, industry projections propose that 33 percent of the market will be in the money for DER by 2017, assuming current tax and regulatory policies). Today, regulated utilities have seen allowed returns on equity decline to around 10 percent, a multi-decade low point, as a result of declining interest rates (See Exhibit 4). The cost of equity has also been growing. However, the risks in the business have never been higher, due to increasing customer rate pressures from capital expenditures required to upgrade the grid and address environmental mandates, inflation, low/negative demand growth from active customers, and the threat of load lost due to the rapid development of DER and disruptive forces. The impact of declining allowed returns and increasing business risk will place pressure on the quality and value of utility investments. How large of an impact on investment value will be a function of the impact of disruptive forces described herein. But, lower stock prices will likely translate into lower levels of capital spend, lower domestic economic growth, and fewer grid enhancements.

Exhibit 4
History of Allowed ROE's (U.S. Shareholder-Owned Electric Utilities)
(Based on regulatory cases **settled** each quarter)



Source: SNL Financial/Regulatory Research Associates (RRA), EEI Rate Department

Telephone Industry Parallels

There are other examples in other industries that can provide lessons as to the risks of disruptive change confronting the U.S. electric utility industry. The once fully regulated, monopoly telephone industry provides one clear example. The telephone industry experienced significant technological changes that led to deregulation—initially in the long-distance sector and then followed by the local exchange market.

Beginning in the 1970s, the impact of an array of new technologies (e.g., satellite, microwave, and fiber optic technologies) led to increased telephone system capacity and a reduction in the cost of providing telephone service. These technological changes provided the opportunity for competition by new entrants using newer technologies, while the monopoly service provided by AT&T used older analog technology. In 1974, MCI, a new entrant, filed an anti-trust case challenging AT&T's monopoly powers in long-distance telephone service. The U.S. government ruled against AT&T in 1982, which led to a negotiated plan to break up the Bell system, which was completed in 1984. As a result, long-distance telephone service and the Bell Labs' research arms were housed in AT&T. The local provision of phone service (i.e., intrastate regional calls) was to remain regulated and was to be provided by seven Bell Operating Companies ("the Baby Bells"). By 1996, the Telecommunications Act opened the local telephone market to competition and allowed for Internet providers to acquire spectrum services.

Dramatic technological change has evolved over the past 35 years, which has led to the development of a new infrastructure system; new services that are providing abundant transfer of information; and the convergence of voice, data, and entertainment into one combined service from what had previously been

viewed as separate and distinct services and industries. Today, the number of customers who utilize the previously exclusive "copper wire "telephone system represents a rapidly declining percentage of the market for telephone services. (Verizon Communications, for example, has lost approximately 45 percent of its wire line customers over the past five years.) Today, many customers access voice services exclusively through mobile cellular (wireless) phones, a technology that became commercially viable in the mid- to late-1980s. In addition, the advent of cable-based phone service has sped the decline in copper-based services.

This transformation in the telephone sector of pre-1982 to today has not been smooth or easy. Significant capital investment has been made to develop new technologies and related infrastructure—it is estimated of that more than $300 billion has been deployed to build out new telephone infrastructure. New entrants have experienced booms and busts as the supply of capacity outstripped demand, leading to bankruptcies and mergers. The original AT&T, the seven Baby Bells, and several large independent monopolies (e.g., GTE, Citizens, United Telephone and Alltel) have merged into four independent companies. The sector today is dominated by wireless and cable-based technologies.

Exhibit 5
Verizon Stock Price vs. S&P500 from 2000 to 2012

(1) Indexed to 12/31/1999 price

Source: FactSet

There are important lessons to be learned from the history of the telephone industry. First, at the onset of the restructuring of the Bell System, there was no vision that the changes to come would be so radical in terms of the services to be provided and the technologies to be deployed. Second, the telephone players acted boldly to consolidate to gain scale and then take action to utilize their market position to expand into new services on a national scale. Finally, and most important, if telephone providers had not pursued new technologies and the transformation of their business model, they would not have been able to survive as viable businesses today. So, while the sector has underperformed the overall market since 2000, and as shown in Exhibit 5, even a leading industry participant like Verizon Communications has not been able to perform in-line with

the overall market despite its growth, market share and solid profitability outlook due to the competitive uncertainties inherent in the business. However, those telecom providers that have embraced new technologies and addressed the competitive threats they faced have managed to survive and to protect investors from a "Kodak moment."

Exhibit 6
Credit Capacity of Regulated vs. Competitive Industries

Sector/Segment	Enterprise Value ($bn)	Credit Ratings		Credit Quality Metrics	
		Moody's	S&P	FFO/Debt	Debt/EBITDA
Regulated Utilities					
Southern Company	$63	Baa1	A	25%	3.5x
ConEd	27	Baa1	A-	25%	3.3x
Xcel Energy	24	Baa1	A-	23%	3.8x
Hybrid Utilities					
Exelon Corp	48	Baa2	BBB	55%	3.1x
PSEG Resources	23	Baa2	BBB	38%	2.3x
Telephone					
AT&T	266	A2	A-	54%	2.1x
Verizon Communications	222	A3	A-	63%	1.9x

	DDM COE (1)	Debt / EBITDA	Implied Debt / Capital	Pre-Tax WACC
Regulated Entity	10%	3.5	50%	10.20%
Competitive Telco	12%	2	34%	13.80%
Competitive Sector Cost Premium				3.60%
% Change in WACC				35.00%

(1) "DDM COE" is dividend discount model cost of equity

From being led by a "AAA" rated company with monopoly powers (AT&T), the telecommunications industry looks very different today. Services today are often comprised of a bundle of telephone, Internet, and entertainment options provided on an unlimited basis by a monthly fee (relative to usage-based pricing prior to 1982). The market has seen significant new entrants, capital investment, and boom and bust periods leading to bankruptcies and/or mergers to enhance scale. Due to the increased competitive business risk, the credit-rating agencies have downgraded the credit rating of AT&T from "AAA" in 1981 to "A "today. In addition, due to competitive business dynamics, the credit rating agencies expect to see significantly lower debt leverage (thereby, raising the overall cost of capital) in order to support the credit ratings assigned. To compare with the electric sector, a comparable rating in telecom would bear approximately 50 percent of the leverage level of a regulated electric utility—resulting in an approximately 35 percent higher pre-tax weighted cost of capital for the telephone sector based on credit-ratings metrics (See Exhibit 6).

While customers have benefitted from a proliferation of new services provided at a lower cost, investors have not done as well in financing a transition to a competitive industry. These lessons should be fully

considered as stakeholders shape the approach electric utilities pursue in participating in an environment where disruptive technologies may transform the provision of services and the providers of these new services.

One significant difference between the electric sector and the telecom restructuring example is the value of the respective infrastructure following the disruptive threat. In the telecom situation, the original copper wire phone network is of no/low value in a wireless, Internet protocol, landline world. However, the value of the electric grid to the customer is retained in a distributed generation environment as the grid provides the highway to sell power generated by the DER and the back-up resource infrastructure to deliver power required when the DER is not meeting the load obligation of its provider. In essence, while a wireless user does not need a landline, an electric consumer-generator will not be able to and will not necessarily want to achieve full independence from the "wired" utility grid. So, while the telecom example is a tale of responding to the threat of obsolescence, the near-term challenge to the electric sector is providing the proper tariff design to allow for equitable recovery of revenue requirements to address the pace of non-economic sector disruption.

Strategic Implications of Distribution 2020 Disruptive Forces

The threats posed to the electric utility industry from disruptive forces, particularly distributed resources, have serious long-term implications for the traditional electric utility business model and investor opportunities. While the potential for significant immediate business impact is currently low (due to low DER participation to date), the industry and its stakeholders must begin to seriously address these challenges in order to mitigate the potential impact of disruptive forces, given the prospects for significant DER participation in the future.

One example of a significant potential adverse impact to utility investors stems from net metering. Utilities have witnessed the implementation of net metering rules in all but a handful of states. Lost revenues from DER are being recovered from non-DER customers in order to encourage distributed generation implementation. This type of lost revenue recovery drives up the prices of those non-participating customers and creates the environment for ongoing loss of additional customers as the system cost is transferred to a smaller and smaller base of remaining customers.

Utility investors are not being compensated for the risks associated with customer losses resulting from increasing DER. It is difficult to identify a rate case in which the cost-of-capital implications of net metering were considered. At the point when utility investors become focused on these new risks and start to witness significant customer and earnings erosion trends, they will respond to these challenges. But, by then, it may be too late to repair the utility business model.

DER is not the only disruptive risk the industry faces. Energy efficiency and DSM programs that promote lower electricity sales pressure earnings required to support capital investment. Without a tariff structure that properly allocates fixed vs. variable costs, any structure for lost revenues would come at a cost to non-participating customers, who will then be more motivated to find alternatives to reduce their consumption. While it is not the objective of this paper to outline new business model alternatives to address disruptive challenges, there are a number of actions that utilities and stakeholders should consider on a timely basis to align the interests of all stakeholders, while avoiding additional subsidies for non-participating customers.

These actions include:

Immediate Actions:

- Institute a monthly customer service charge to all tariffs in all states in order to recover fixed costs and eliminate the cross-subsidy biases that are created by distributed resources and net metering, energy efficiency, and demand-side resources;
- Develop a tariff structure to reflect the cost of service and value provided to DER customers, being off-peak service, back-up interruptible service, and the pathway to sell DER resources to the utility or other energy supply providers; and
- Analyze revision of net metering programs in all states so that self-generated DER sales to utilities are treated as supply-side purchases at a market-derived price. From a load provider's perspective, this would support the adoption of distributed resources on economically driven bases, as opposed to being incentivized by cross subsidies.

Longer-term Actions:

- Assess appropriateness of depreciation recovery lives based on the economic useful life of the investment, factoring the potential for disruptive loss of customers;
- Consider a stranded cost charge in all states to be paid by DER and fully departing customers to recognize the portion of investment deemed stranded as customers depart;
- Consider a customer advance in aid of construction in all states to recover upfront the cost of adding new customers and, thus, mitigate future stranded cost risk;
- Apply more stringent capital expenditure evaluation tools to factor-in potential investment that may be subject to stranded cost risk, including the potential to recover such investment through a customer hook-up charge or over a shorter depreciable life;
- Identify new business models and services that can be provided by electric utilities in all states to customers in order to recover lost margin while providing a valuable customer service—this was a key factor in the survival of the incumbent telephone players post deregulation; and
- Factor the threat of disruptive forces in the requested cost of capital being sought.

Investors have no desire to sit by and watch as disruptive forces slice away at the value and financial prospects of their investment. While the utility sector provides an important public good for customers, utilities and financial managers of investments have a fiduciary responsibility to protect the value of invested capital. Prompt action to mitigate lost revenue, while protecting customers from cross-subsidization better aligns the interests of customers and investors.

As growth in earnings and value is a major component of equity investment returns, what will investors expect to see as a strategic response from the industry to disruptive forces? The way to realize growth in earnings is to develop profit streams to counterbalance the impact of disruptive forces. Examples of new profit sources would include ownership of distributed resources with the receipt of an ongoing service fee or rate basing the investment and financial incentives for utilities to encourage demand side/energy efficiency benefits for customers. From an investor perspective, this may be easier said than done because the history of the electric utility industry in achieving non-regulated profits/value creation streams has not been a pleasant experience. So, investors will want to see very clear cut programs to capture value that are consistent with the core strengths of utilities: ability to execute construction projects, to provide dependable service with high reliability, and to access relatively low-cost capital.

Summary

While the threat of disruptive forces on the utility industry has been limited to date, economic fundamentals and public policies in place are likely to encourage significant future disruption to the utility business model. Technology innovation and rate structures that encourage cross subsidization of DER and/or behavioral modification by customers must be addressed quickly to mitigate further damage to the utility franchise and to better align interests of all stakeholders.

Utility investors seek a return on investment that depends on the increase in the value of their investment through growth in earnings and dividends. When customers have the opportunity to reduce their use of a product or find another provider of such service, utility earnings growth is threatened. As this threat to growth becomes more evident, investors will become less attracted to investments in the utility sector. This will be manifested via a higher cost of capital and less capital available to be allocated to the sector. Investors today appear confident in the utility regulatory model since the threat of disruptive forces has been modest to date. However, the competitive economics of distributed energy resources, such as PV solar, have improved significantly based on technology innovation and government incentives and subsidies, including tax and tariff-shifting incentives. But with policies in place that encourage cross subsidization of proactive customers, those not able or willing to respond to change will not be able to bear the responsibility left behind by proactive DER participating customers. It should not be left to the utility investor to bear the cost of these subsidies and the threat to their investment value.

This paper encourages an immediate focus on revising state and federal policies that do not align the interests of customers and investors, particularly revising utility tariff structures in order to eliminate cross subsidies (by non-DER participants) and utility investor cost-recovery uncertainties. In addition, utilities and stakeholders must develop policies and strategies to reduce the risk of ongoing customer disruption, including assessing business models where utilities can add value to customers and investors by providing new services.

While the pace of disruption cannot be predicted, the mere fact that we are seeing the beginning of customer disruption and that there is a large universe of companies pursuing this opportunity highlight the importance of proactive and timely planning to address these challenges early on so that uneconomic disruption does not proceed further. Ultimately, all stakeholders must embrace change in technology and business models in order to maintain a viable utility industry.

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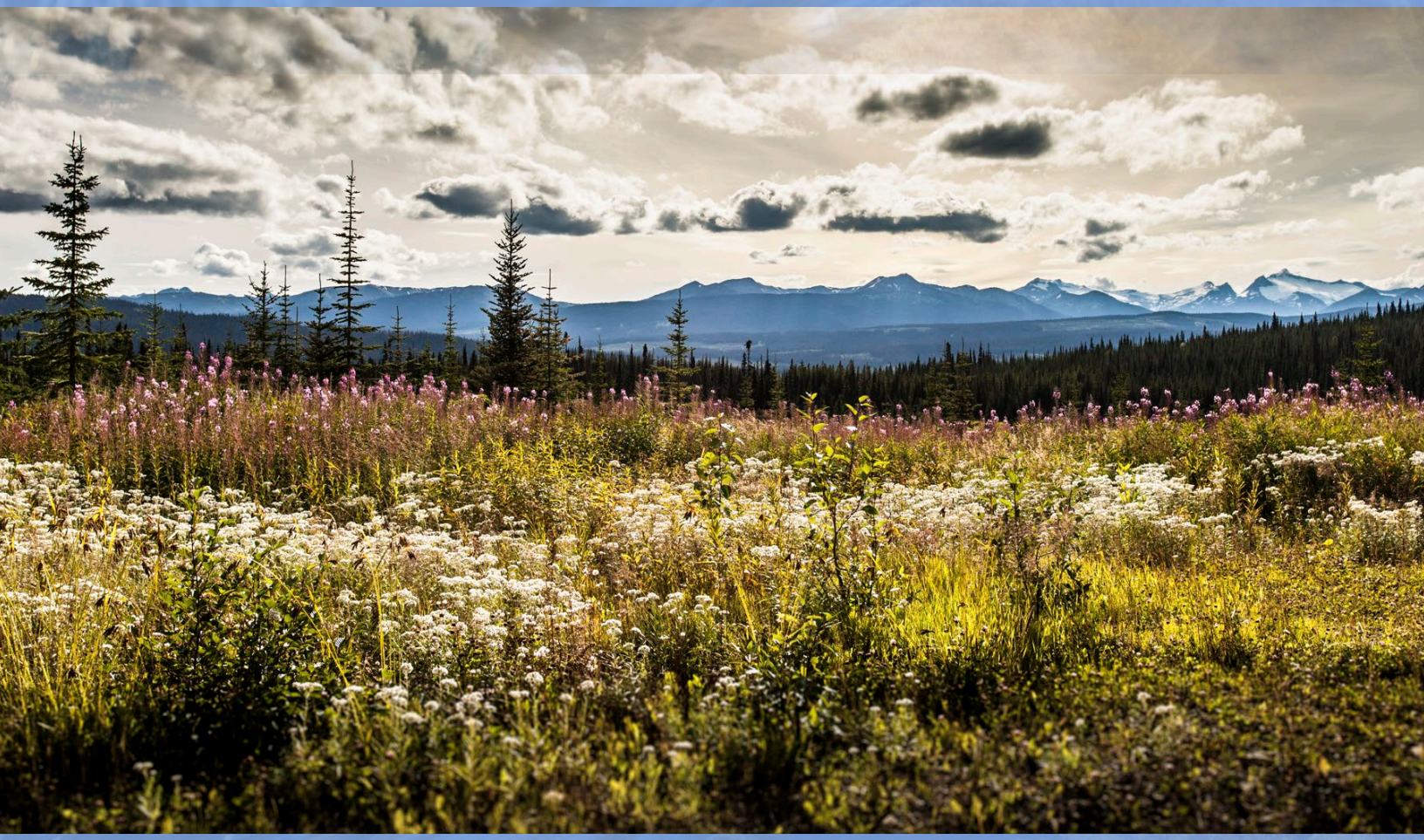
The Peace Dividend

ASSESSING THE ECONOMIC VALUE OF ECOSYSTEMS IN B.C.'s PEACE RIVER WATERSHED



David
Suzuki
Foundation

THE PEACE DIVIDEND: ASSESSING THE ECONOMIC VALUE OF ECOSYSTEMS IN B.C.'S PEACE RIVER WATERSHED

2014

by Sara J. Wilson, Natural Capital Research & Consulting

Foreword by Dr. Faisal Moola, Director General of David Suzuki Foundation's Ontario and Northern Canada Department

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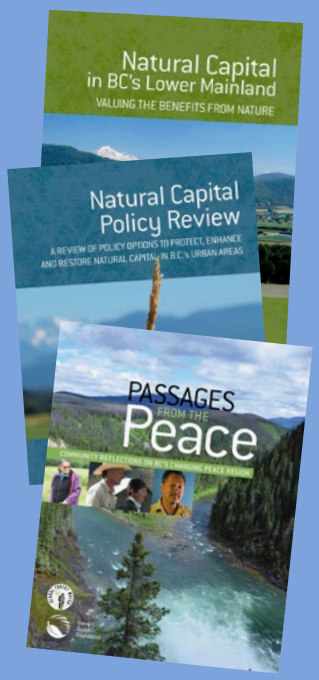
The author would like to thank the David Suzuki Foundation, West Moberly First Nation, Doig River First Nation, and Treaty 8 Tribal Association for their support and interest in pursuing natural capital and ecosystem services research. In particular, I would like to thank Rachel Plotkin, Amy Hu and Faisal Moola for their commitment, interest in and contributions to the report. Thank you to Mark Anielski, Kai Chan, Brian Churchill, Andrea Morrison, Jillian Ridington, Robin Ridington and Amy Taylor for their time in providing comments on the report. Thanks to Ryan Cheng of Global Forest Watch Canada for the spatial data and mapping undertaken for this project.

DISCLAIMER

This study should be considered a baseline and coarse-scale natural capital account for the B.C. portion of the Peace River Watershed. It is a first step toward a more comprehensive accounting of natural capital assets in the region and the ecosystem services provided by its ecosystems and natural areas. More Canadian research is required to determine a full range of ecosystem service values relevant to Canadian ecoregions and land cover types. This work is intended to encourage others to consider the value of natural capital assets and ecosystem services and to stimulate dialogue on the values of natural capital, ecosystem services, stewardship and conservation.

The content of this study is the responsibility of its author and does not necessarily reflect the views and opinions of those acknowledged above. Every effort has been taken to ensure the accuracy of the information contained in this study. However, it is important to acknowledge that ecosystems have many values that cannot be monetized and that ecosystem service research and valuations are approximations with inherent uncertainty. It is also important to remember that although we can place a monetary value on ecosystems and ecosystem services, we cannot replace the ecosystems provided by the Earth.



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FOREWORD

Over the past 20 years, we at the David Suzuki Foundation have learned a lot about the importance of maintaining healthy ecosystems in order to sustain the health and wellbeing of communities.

PHOTO COURTESY KYLEWITH/ FLICKR CREATIVE COMMONS

ACCORDING TO A STUDY PUBLISHED several years ago in the research journal *Science*, few places on our planet have been untouched by modern humans.

From Arctic tundra to primeval rainforest to arid desert, our natural world has been fragmented by ever-expanding towns and cities, crisscrossed with roads, transmission lines and pipelines, and pockmarked by pump jacks, flare stacks, and other industrial infrastructure used to drill, frack, and strip-mine fossil fuels from the ground.

The need to supply food, fibre, fuels, shelter, freshwater and energy to more than seven billion of us now inhabiting the planet is driving the wholesale conversion of forests, wetlands, grasslands, and other ecosystems, including in sensitive areas such as the Peace Region of northeastern British Columbia.

Earlier research published by the David Suzuki Foundation has revealed that the pace and scale of industrial development in the Peace Region is massive. From the air, this vast area of rich boreal forest and rolling farmland now appears as a fractured landscape of clearcuts, seismic lines, oil and gas wells, roads, pipelines and fragmented fields. If future development proceeds as proposed, including the flooding of the Peace River for the Site C dam project, the result will be even greater cumulative changes in a region of Canada that is already under significant pressure and where little protected habitat has been set aside for wildlife and other ecological values.

Over the past 20 years, we at the David Suzuki Foundation have learned a lot about the importance of maintaining healthy ecosystems in order to sustain the health and wellbeing of communities. These ecosystems, or "natural capital," form the life-support systems of our planet, providing clean air, clean water, healthy food to eat, and a plethora of other ecological benefits, including contributing to the cultural and traditional ways of First Nations.

For example, ecological economists have conservatively estimated that Canada's massive boreal forest provides a staggering $570 billion a year, an average of $3,400 per hectare, in ecological benefits such as climate regulation, flood protection, water regulation, waste treatment, and pollination. Furthermore, these benefits are worth over 13.5 times more societal economic value than the GDP generated by natural capital extraction industries such as mining, oil and gas development, and forestry.

It is our hope that our natural capital valuation study of the Peace Region will help to cultivate a deeper appreciation among the public and policy-makers of the true value of the region's natural and managed ecosystems and thereby help to ensure this sensitive area of Canada is carefully managed now and well into the future.

— Dr. Faisal Moola, PhD
David Suzuki Foundation Director General,
Ontario and Northern Canada

Executive Summary

THE PEACE RIVER WATERSHED in northeastern British Columbia is a valuable ecological and cultural region. First Nations and their ancestors have lived in the area for more than 10,000 years. The unique warm microclimate and productive farmland soils of the Peace River Valley provide the best growing conditions in northern B.C. The valley also provides key habitat for moose, elk and deer and is an essential corridor for migratory birds, caribou and grizzly bear populations.

The region, however, has experienced widespread change due to industrial development and ecological fragmentation. Logging, mining, oil and gas development, large-scale hydro dams, roads, pipelines and other industrial developments have impacted most of the watershed's ecosystems.[1] Between 1974 and 2010 land-use change and ecological fragmentation had an ecological impact on approximately 67 per cent of the watershed.[2]

Local First Nations and other residents are concerned that the cumulative impacts of ongoing industrial and resource development will cause further decline in wildlife habitat and community well-being. The region has widespread tenure concessions for future exploration and development. In addition, a third major hydroelectric development project (Site C) is proposed for the Peace River Valley. The proposed dam would flood important historical and spiritual First Nations sites, highly productive agricultural lands and wildlife habitat.[3,4]

This report assesses the economic values for the ecosystem services provided by natural capital within the B.C. portion of the Peace River Watershed (approximately 5.6 million hectares).

Our study found that forests were the dominant ecosystem type, covering about 64 per cent of the study area.[5] The other land cover types included wetlands (9%), grasslands (8%), snow cover, rock and exposed

Local First Nations and other residents are concerned that the cumulative impacts of ongoing industrial and resource development will cause further decline in wildlife habitat and community well-being.

PHOTO COURTESY DON HOFFMANN

1 Lee, P., and Hanneman, M. 2012. *Atlas of land cover, industrial land uses and industrial-caused land change in the Peace Region of British Columbia*. Global Forest Watch Canada report #4.

2 Ibid. The physical impact included physical changes on the landscape from industrial development, and infrastructure changes to the study area, such as oil and gas wellsites, clearcuts, mines, roads and pipelines, agricultural clearings and golf courses. The ecological footprint was measured with a 500-metre buffer around all land-use impacts.

3 Fawcett, M. 2010. "The Case Against the Site C Dam." TheTyee.ca http://thetyee.ca/Opinion/2010/04/05/CaseAgainstSiteC/

4 Chillborne Environmental. 2009. *The Living Peace River Valley: An Overview of the Peace River Valley's Natural and Cultural Values*. West Moberly First Nations and Peace Valley Environment Association.

5 The forest cover was predominantly coniferous forest (73%), with smaller areas of broadleaf forest (24%) and mixed-wood forest (3%).

MAP OF THE B.C. PEACE RIVER WATERSHED STUDY AREA

This study was undertaken to provide information for local communities regarding the importance of the area's ecosystems for the well-being of the Peace River Watershed and its people.

lands (5%), perennial croplands and pastures (4%), shrublands (4%), annual croplands (2%), water (1%) and developed land (0.1%). An additional 2% of the study area could not be classified in any land cover type because of technical issues such as cloud cover and shadowing in satellite images.

Ecosystem service (ES) values were developed based on land cover data, forest age class and socio-economic information from the Peace River region and other valuation studies. If local or regional data were not available, values were transferred from other relevant studies. Values were transferred either by assigning an average value from global meta-analysis studies, or by adjusting the transfer value by our study area's population. The approach was documented for each valuation in the results section.

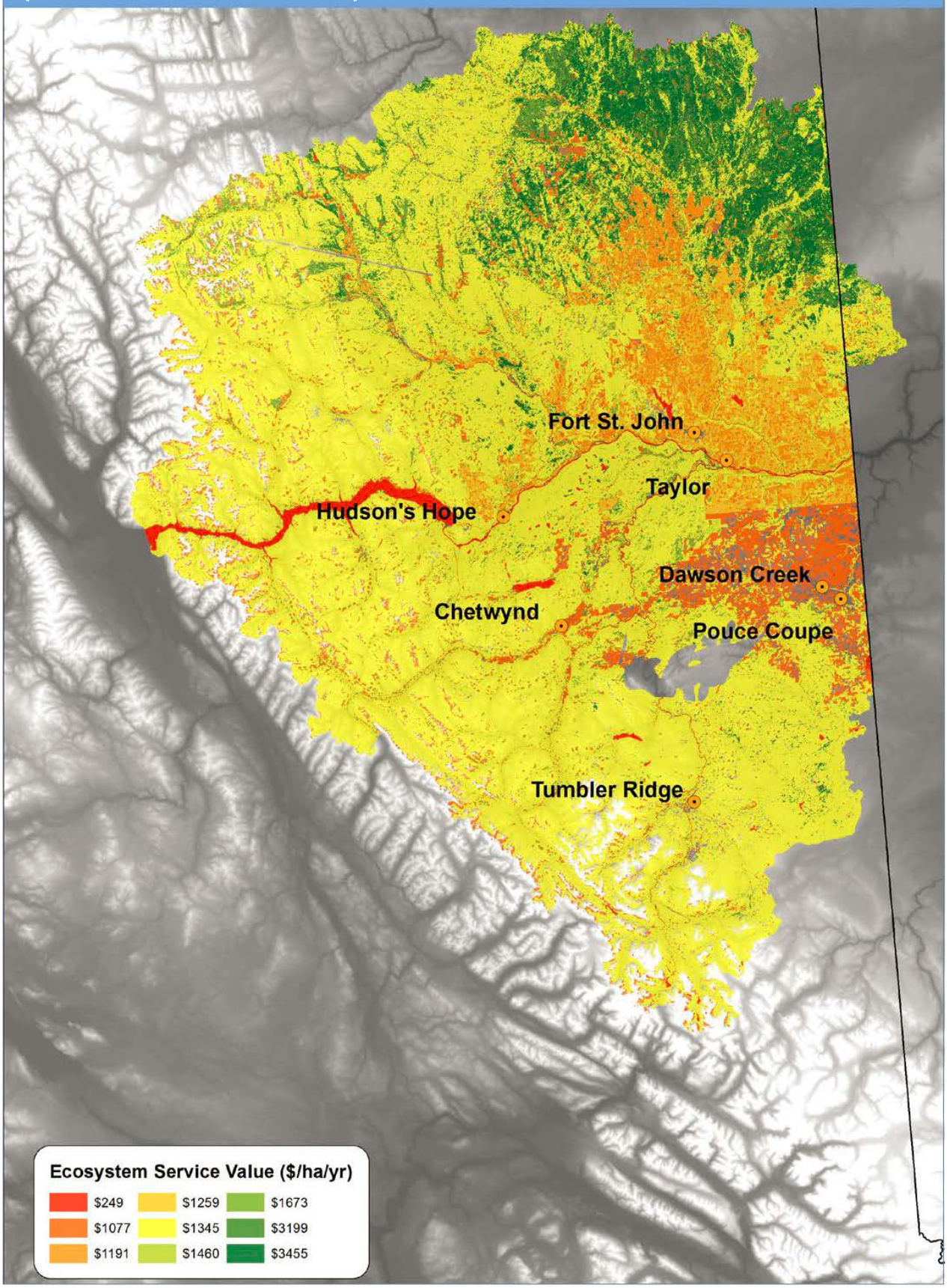
Economic values were developed for water supply, air filtration, carbon storage, carbon sequestration, flood control, water filtration, erosion control, habitat, recreational and cultural services. The greatest values were for carbon storage. Since carbon storage helps regulate the climate, which is a global system, the benefits of stored carbon reach beyond the local population to regional, national and even international beneficiaries.

The total annual value for carbon stored in the Peace River Watershed was estimated at $6.7 billion to $7.4 billion per year (central values); and the total value for the other ecosystem service values was estimated to range from $879.4 million to $1.74 billion per year in economic benefits.[6]

6 The total land cover area used for valuation excludes: unclassified land, snow/ice, rock/rubble, exposed land, developed land and cloud cover area (366,429 hectares).

SUMMARY OF THE ECOSYSTEM SERVICES VALUES FOR THE PEACE RIVER WATERSHED STUDY AREA		
Ecosystem service	**Annual value $/hectare/year (2012 Cdn$)**	**Total annual value $/year (2012 Cdn$)**
Water supply	$32.60	$2,502,441
Air filtration by trees	$3.51	$12,684,230
Forest ecosystem carbon storage (1.14 billion tonnes based on BC VRI forest age/carbon analysis; 948.6 million tonnes using average/ha and AAFC data)	Central value $1,175.69 ($4.48/tC) $460.19 (treed wetland – aboveground biomass only)	Range from $1.56 billion to $8.5 billion; central value $4,425,760,501 to $5,092,465,112
Wetland soil carbon storage (253.9 million tonnes)	$715.24 to $2,453.85	Range from $401 million to $1.89 billion; central value of $1,137,249,649
Other soil carbon storage (261.9 million tonnes)	$921.32 (grassland) $1,073.77 (pasture) $1,552.03 (shrubland) $1,181.55 (cropland)	Range from $413.5 million to $1.95 billion; central value of $1,172,829,309
Carbon sequestration	$138.08 (forest) $33.42 (wetland) $56.20 (shrubland/ grassland/ perennial cover)	Range from $285.5 million to $1.15 billion; central value of $620,855,368
Wetland flood control, water supply, nutrient recycling	$256.67 (wetland)	$133,157,316
Water filtration	$6.23 (forest, treed wetland)	$22,529,524
Erosion control/Sediment retention	$6.60 (grassland/perennial cover)	$4,467,440
Waste treatment	$27.93 (perennial cover/grassland) $54.10 (wetland)	$46,970,791
Pollination	$43.63 (shrubland/ grassland, perennial cover/pasture)	$39,895,056
Habitat	$379.43 (wetlands) $41 (perennial cover/pasture)	$206,744,044
Recreation	$21.47 (forest, wetland, shrubland, grassland) $215.97 (water)	$119,738,498
Cultural values	$9.38 (farmlands) $0.39 (protection of forest, wetland)	$5,258,881

AVERAGE ECOSYSTEM SERVICE VALUES BY LAND COVER TYPE IN THE B.C. PEACE RIVER WATERSHED (INCLUDES FOREST CARBON VALUES)



It is hoped that this report will encourage discussion about how natural capital in B.C. and Canada is valued — and undervalued.

PHOTO COURTESY WAYNE SAWCHUCK/PICTURE BC

Over a 50-year period, the central net present value (NPV) was $204.6 billion (with a range from $83.7 billion to $333.7 billion), including all ES values.[7] Based on the population of the study area, the central NPV per person was estimated at $3.9 million per person (central value at 3 per cent discount rate) (see textbox on discount rates on page 31).

The intent of this report was to provide a baseline assessment for the ecosystem services provided by the Peace River Watershed at the regional scale. The total ES value is a partial estimate because it was not possible to quantify and value all of the ecosystem services provided by the study area's ecosystems. The values are incomplete at this stage but they do deliver a meaningful estimate of the magnitude of the existing ecosystem values for local communities, First Nations and policy decision-makers to reflect on the cost of land-use change and ecological fragmentation in the study area. The values also reflect the economic benefits of protecting and restoring the region's ecosystems, farmlands and cultural heritage. Detailed site valuations for specific ecosystem functions should be undertaken to provide more precise values of marginal changes resulting from site-level ecosystem alteration, destruction or investment.

It is hoped that this report will encourage discussion about how natural capital in British Columbia and Canada is valued – and undervalued. Decision-makers and the public are encouraged to use this report to inform policy, land use planning, and resource management discussions about how best to protect and restore the region's ecological integrity and ensure a sustainable future.

7 A range of NPVs were reported from a low of $162.6 billion to a high of $236.8 billion based on a range of carbon values and discount rates.

PART 1

Introduction

There are concerns among local First Nations and other residents that additional industrial development will cause further ecological degradation, resulting in a decline in community well-being and unique wildlife habitat.

PHOTO COURTESY ANDREW TYLOSKY/PICTURE BC

BRITISH COLUMBIA'S PEACE REGION, located in the northeast corner of the province, has experienced widespread change due to industrial development and ecological fragmentation. Most of the Peace River Watershed's ecosystems have felt the impacts of logging, mining, oil and gas development, large-scale hydro dams, roads, pipelines and other industrial developments.[8] According to a recent satellite-based analysis, land-use change occurred across 20 per cent of the Peace River Watershed, but had an ecological impact, in terms of ecosystem fragmentation and habitat degradation, on approximately 67 per cent of the watershed.[9]

There are concerns among local First Nations and other residents that additional industrial development will cause further ecological degradation, resulting in a decline in community well-being and unique wildlife habitat. The region features widespread tenure concessions for future mineral exploration and development, logging and oil and gas development, as well as a proposed third major hydroelectric development project (Site C) along the Peace River Valley. Local First Nations, farmers, environmentalists and other residents have voiced their opposition to Site C.[10] Treaty 8 First Nations in the region have presented a joint declaration to the British Columbia government, requesting that further research on the cumulative impacts of industrial development in the region be undertaken before any further development takes place.[11]

This report gives an assessment of the ecosystem services provided by natural capital within the B.C. portion of the Peace River Watershed (PRW). It identifies the ecosystem services supplied by the study area's ecosystems based on the PRW's land cover and land use. This study was undertaken to provide information for local communities regarding the importance of the area's ecosystems for the well-being of the Peace River Watershed and its people. Another objective was to provide information to support decision-making at the policy level in hopes of maintaining the study area's environmental assets. The management of landscapes for the provision of ecosystem services requires information about the amount and location of

8 Lee and Hanneman, supra note 1.

9 Ibid. The physical impact included physical changes on the landscape from industrial development, and infrastructure changes to the study area, such as oil and gas wellsites, clearcuts, mines, roads and pipelines, agricultural clearings and golf courses. The ecological footprint was measured with a 500-metre buffer around all land-use impacts.

10 Fawcett, supra note 3.

11 *Treaty 8 First Nations Declaration on the Site C Dam Proposal*. Sept. 17, 2010. http://fathertheo.wordpress.com/2011/03/09/treaty-8-first-nations-declaration-on-the-site-c-dam-proposal/

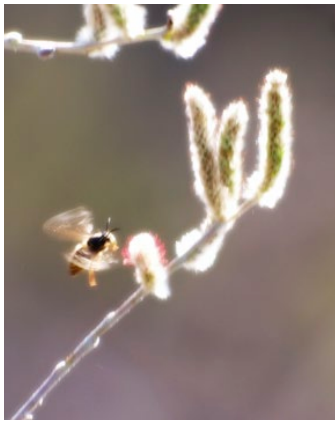
natural capital so that the impacts of land-use change, on both natural capital and the ecosystem services provided, can be assessed.

1.1 Natural Capital and Ecosystem Services

Natural capital refers to the Earth's land, water, atmosphere and resources. Organized and bundled within the Earth's natural ecosystems, this capital provides resources and flows of services to support all life. Natural capital is critical to the economic and social well-being of Canadians. Our landscapes consist of forests, wetlands, grasslands, lakes, rivers, estuaries and marine environments that provide ecosystem services for local communities and industries, regional and global processes, as well as biodiversity and habitat.

Among the numerous services ecosystems provide are storage of floodwaters, water capture and filtration, absorption and treatment of pollution from water and air, and climate regulation resulting from carbon storage in trees, plants, soils, sediments and marine habitats. However, since populations do not pay directly for these services, they are undervalued in our market economy.

Communities and governments are beginning to recognize the essential ecosystem services supplied by their natural capital, a trend emerging at the global, national and regional levels. For example, a 1997 study estimated that the total value of the world's ecosystems goods and services was between US$18 trillion and $61 trillion (2000 $),[12] an amount similar to the size of the global economy. A follow-up study estimated that global habitat loss costs about $250 billion each year (2002 $).[13] In 2005, the United Nations Millennium Ecosystem Assessment (MA) reported on the condition of the world's ecosystems and their ability to provide services. The MA found that over the past 50 years, humans have changed the Earth's ecosystems more rapidly and extensively than in any other period in human history. The assessment concluded that 60 per cent of the world's ecosystem services are being degraded or used unsustainably (e.g., provision of freshwater, purification of air and water, and regulation of regional and local climate).[14]



Communities and governments are beginning to recognize the essential ecosystem services supplied by their natural capital, a trend emerging at the global, national and regional levels.

PHOTO COURTESY BRUCE MCKAY/FLICKR CREATIVE COMMONS

1.2 Why is it Important to Measure and Value Natural Capital and Ecosystem Services?

Human life depends on the continuing ability of the natural environment to function and provide its many benefits. Yet economic growth generally focuses on the development of land and the extraction of resources for human use. In order to recognize the value of natural capital, it is essential that governments begin to identify, measure and monitor the state of our natural capital and the changes in quantity and quality of these assets. Without comprehensive values for ecosystems and the services they provide, these essential assets will continue to be undervalued and even disregarded in land-use and natural-resource policies.

The loss of ecosystems such as forests and wetlands results in a decreased stock of natural capital and a reduction in the flow of ecosystem services for human communities. This loss can lead to costs such as reduced water quality and the resulting effects on human health, the need to replace or restore water resources, and damages caused by an increase in flooding and an unstable climate.

12 Costanza, R. et al. 1997. "The value of the world's ecosystem services and natural capital." *Nature*. 387:253-259.

13 Balmford, A. et al. 2002. "Economic Reasons for Conserving Wild Nature." *Science*. 297: 950-953.

14 Millennium Ecosystem Assessment. 2005. "Ecosystems and Human Well-being: Synthesis." Island Press. Washington, D.C.

However, in general, the full costs of losses in natural capital are not paid for when land-use change occurs. Natural capital and ecosystem services are mostly viewed as public goods, so their values are not counted as internal costs by companies and governments.[15]

Communities are now facing cumulative environmental problems resulting from human impacts on ecosystems. These problems include: a destabilized climate due to increased concentrations of carbon dioxide in the atmosphere; a decline in clean and reliable water supplies due to pollution and the overuse of water; and degraded land cover resulting in increased flooding. Further declines in natural capital have been predicted if businesses and communities continue along the same path of economic growth without reducing their impacts on the environment. If companies were required to pay for the full cost of the effects of their activities on the environment, they would likely change their practices to minimize the loss of ecosystem services.

For example, the environmental cost of all global human activity was estimated at US$6.6 trillion in 2008, equivalent to 11 per cent of global gross domestic product (GDP).[16] The largest single cost was due to greenhouse gas emissions, which accounted for more than half of the total. Other major costs included the effects on health of air pollution particulates, and the damage caused by the overuse and degradation of freshwater. The world's largest 3,000 companies caused US$2.15 trillion of these total costs. These environmental costs are predicted to increase to an estimated US$28.6 trillion by 2050 (18 per cent of GDP) if "business as usual" continues.[17]

Natural capital and ecosystem services are mostly viewed as public goods, so their values are not counted as internal costs by companies and governments.

PHOTO COURTESY TUCHODI/ FLICKR CREATIVE COMMONS

15 UK National Ecosystem Assessment. 2011. *The UK National Ecosystem Assessment: Synthesis of the Key Findings*. UNEP-WCMC. Cambridge, U.K.

16 Garfunkel, A. (ed.). 2011. *Universal Ownership: Why Environmental Externalities Matter to Institutional Investors*. Trucost Plc, PRI Association and UNEP Finance Initiative. www.unepfi.org/fileadmin/documents/universal_ownership_full.pdf

17 Ibid.

PART 2

Overview of the Study Area

2.1 Location and Description of the Study Area

The study area comprises the B.C. portion of the Peace River Watershed in the northeast corner of the province (approximately 5,611,799 hectares). The study boundary was defined using the Water Survey of Canada's drainage basins (i.e., watersheds), and the British Columbia-Alberta border (Figure 1). It includes five drainage basins that contribute to the Peace River within British Columbia: Upper Peace-Halfway, Upper Peace-Kiskatinaw, Pine, Beatton and eastern Williston Lake.

The study area comprises the B.C. portion of the Peace River Watershed in the northeast corner of the province (approximately 5.6 million hectares)

GOOGLE EARTH SATELLITE MAGE

2.2 Ecology of the Study Area

The Peace region is recognized as an important ecological and cultural region in Canada. The topography of the area varies from Rocky Mountains in the west to prairies in the east. The landscape includes coniferous forests, deciduous forests, grasslands, shrublands, rivers, streams and wetlands that provide critical habitat for wildlife. The Peace River Valley and its uplands support more than 300 wildlife species and 400 plant species. The area also provides a major wildlife corridor that is critical to maintaining the biodiversity of the valley and its surrounding regions.

The Peace River, the main river within the study area, flows east from the Rocky Mountains through much of northern Alberta into Lake Athabasca, and eventually into the Arctic Ocean. The Peace River was originally called "Wonchiigli" or "Chu Nachii" in the First Nation Beaver language.[18]

18 According to the report *The Living Peace River Valley: An Overview of the Peace River Valley's Natural and Cultural Values* (supra note 4), the Peace River was originally called "Wpchiigli," meaning big river. However, J. Ridington and R. Ridington report that the Peace River was called "Wonchiigli," which does not translate to English, as well as "Chu Nachii," which means "big river" in the Beaver language (pers. comm.).

FIGURE 1: MAP OF THE B.C. PEACE RIVER WATERSHED STUDY AREA

The Peace River Watershed supports 188 sensitive species such as grizzly bears, wolverine, bighorn sheep, woodland caribou, short-eared owl and bull trout.[19] The region provides critical wintering habitat for a diverse range of animals including moose, elk and deer. Important moose calving grounds are located along the riverbanks and on small islands throughout the river. The Peace River Valley also provides a corridor for migrating birds, as well as for wide-ranging species such as caribou, wolverine, lynx and grizzly bear.

The valley hillsides are covered in grasslands and montane shrublands that provide important wintering habitat and food sources for ungulates such as moose, elk, mule deer and white-tailed deer. The river's riparian habitats are also critical to ungulates and provide prime migratory waterfowl breeding grounds in spring and fall. Bald eagles, raptors and migratory neotropical songbirds nest within the broadleaf forests along the river.

Mountain and boreal woodland caribou populations in the Peace region have declined over the past several decades and are now listed in the region as threatened with extinction.[20] The primary cause of their decline is habitat loss and degradation, primarily due to industrial resource extraction and the ensuing shift in predator/prey dynamics.[21]

19 Pearson, M., and Healey, M.C. 2012. Species at Risk and Local Government: a Primer for B.C. Stewardship Centre for British Columbia, Courtenay B.C. www.speciesatrisk.bc.ca/advancedsearch?district=PRRD

20 Species at Risk Public Registry. Schedule 1: List of Wildlife Species at Risk. Species at Risk Act. Government of Canada. http://www.registrelep.gc.ca/species/schedules_e.cfm?id=1 (accessed March 2014).

21 COSEWIC Assessment — Woodland Caribou. Species at Risk Public Registry. Government of Canada. www.sararegistry.gc.ca/document/default_e.cfm?documentID=228

2.3 Economy of the Study Area

Among the main economic drivers within the study area are agriculture, tourism, manufacturing, petroleum exploration and development, hydroelectric power generation, forestry and mining. The Peace Region produces 90 per cent of B.C.'s grain, 38 per cent of its hydroelectric power, has more than 10,000 wells drilled, employs about 2,300 workers in forestry jobs and hosts more than 320,000 tourists each year. The Peace region, along with most northern areas of the western provinces, is part of the Western Canada Sedimentary Basin, which holds one of the largest reserves of petroleum and natural gas in the world. In the southern part of the Peace region, 99 oil and gas companies operate within an area that holds between 77 and 176 trillion cubic feet of marketable gas.[22] The Peace Forest District covers more than 4 million hectares of land across the Peace River Regional District. The district includes two Timber Supply Areas (TSA): the Fort St. John TSA and the Dawson Creek TSA. At the Peace River coal fields (west and south of Tumbler Ridge), there are 10 coal mining projects either in operation or proposed. According to the South Peace Economic Development Commission, coal mining contributes about $2 billion of the Peace Region's $6.6 billion in GDP.

The warm microclimate, fertile soils and longer daylight hours during the growing season provide the region, especially the Peace River Valley, with some of the best growing conditions in the province. The study area, which is located within the Peace River Regional District (PRRD), has 121,759 hectares of annual croplands and 241,471 hectares of perennial croplands and pasture. Many of these lands are classified as part of the B.C. Agricultural Land Reserve (ALR).[23]

The agricultural capability of the Peace River Valley is considered high, according to the Canada Land Inventory, meaning it is among the best in all of Canada for agriculture.[24] The Peace River Valley boasts a unique microclimate that is warmer than the surrounding upland areas. This climate and the rich valley soils provide prime agricultural terrain. In the Canada Land Inventory, lands are grouped into seven classes depending on their potential and limitations for agricultural use. The basic criteria for this classification are the inherent soil, climate and landform characteristics. Approximately 10 per cent of the Peace River Valley is classified as Class 1 land (2,464 hectares), and 50 per cent is classified as Class 2 land (12,502 hectares).[25] Class 1 land is described as having optimum potential, and is capable of producing a full range of crops. Soil and climate conditions are ideal, resulting in easy management. Class 2 land is capable of producing a wide range of crops, with some minor restrictions of soil or climate that may reduce capability but pose no major difficulties in management. For example, in the Peace River Valley, many Class 2 lands are limited because of lower moisture levels, which can be supplemented by using irrigation.

Seven main field crops are grown in the region: wheat, oats, barley, alfalfa, other tame hay and fodder crops, canola and forage seed. Alfalfa, tame hay and fodder are the predominant crops grown, and the most common livestock include cattle, poultry, sheep, horses, bison and bees.

The Peace Region produces 90 per cent of B.C.'s grain, 38 per cent of its hydroelectric power, has more than 10,000 wells drilled, employs about 2,300 workers in forestry jobs and hosts more than 320,000 tourists each year.

PHOTO COURTESY KYLEWITH / FLICKR CREATIVE COMMONS

22 South Peace Economic Development Commission. "Energy – Oil and Gas Industry." www.southpeacebc.ca/industries/energy/oil_and_gas.php

23 There are 1.28 million hectares of land within the PRRD that are classified as part of the Agricultural Land Reserve (ALR), comprising 27 per cent of the province's total ALR lands. The ALR is a provincial land zoning that recognizes agriculture as the priority land use and controls non-agricultural uses of these lands. 2004. State of the Agricultural Land Reserve. Smart Growth BC. www.smartgrowth.bc.ca

24 Harris, R. 1982. *Vegetable Production in the Peace Valley: Submission by Dr. R.E. Harris to the B.C. Utilities Commission on behalf of the B.C. Institute of Agrologists regarding the B.C. Hydro and Power Authority Site C Energy Project*. Hearing No. 95. Exhibit 349B. Vancouver, B.C: British Columbia Utilities Commission. Cited in: Feinstein, A. 2010. *B.C.'s Peace River Valley and Climate Change: The Role of the Valley's Forests and Agricultural Land in Climate Change Mitigation and Adaptation*. Chillborne Environmental.

25 Lions Gate Consulting Inc. 2002. Site C Lands: Economic Opportunities Assessment Impact Assessment. Prepared for the BC Hydro Site C Impact Assessment. www.bchydro.com/content/dam/hydro/medialib/internet/documents/policies/pdf/sitec_05_lions_gate_consulting_site_c_impact_assessment.pdf

First Nation peoples and their ancestors have lived in the area for more than 10,000 years.

PHOTO: THREE GENERATIONS OF BEAVER WOMEN AT MOBERLY LAKE, BC, COURTESY GLENBOW MUSEUM

Elders report that traditional land use in the area included hunting, fishing, gathering, habitation and travelling (e.g., by boat and foot). Traditional territories of the local First Nations were used as travel corridors to access riparian areas along the tributaries of the Peace River. Traplines were worked along these tributaries during the fall and winter months, and in the summer months First Nations hunted, fished, and gathered berries and medicines.[26]

2.4 History of Settlement

First Nation peoples and their ancestors have lived in the area for more than 10,000 years. First Nations traditionally roamed throughout the region from the Rocky Mountains to the plains of Alberta following animal migrations and the availability of other foods. Algonquin Cree migrated from further east at the beginning of the fur trade. Sekani, Dane-zaa and Cree settled along the valley and the rivers that flow into the Peace River, setting up more permanent camps as fur traders and homesteaders moved into the area.

The first European settlement, Rocky Mountain Fort, was established near present-day Fort St. John in 1794, one year after Sir Alexander Mackenzie of the North West Company travelled through the Peace River Pass to reach the Pacific Coast.[27] This led to the establishment of fur trading posts in the Peace River Region, including Fort St. John, which was established in 1805. Charles Horetzky first documented the agricultural potential of the area in 1873, during a survey for the Canadian Pacific Railway.[28]

The Canadian government negotiated a series of treaties with indigenous peoples across Canada, geared to allow settlers' rights to natural resources and lands to build a national railway.[29] In 1899, the eighth treaty between First Nations and the Canadian government was signed. Treaty 8, as it was called, allowed for the sharing of lands and resources in northeastern B.C., northern Alberta and northwestern Saskatchewan.

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26 Ridington, A. 2013. *Heritage Values Summary: McLeod Lake Indian Band Traditional Land Use Study for BC Hydro's Proposed "Site C Clean Energy Project" on the Peace River, BC*. Site C Joint Review Panel Presentation (Dec. 18, 2013). www.ceaa-acee.gc.ca/050/documents/p63919/97206E.pdf

27 Chillborne Environmental, supra note 4.

28 Don Cameron Associates. 2013. *Regional Agricultural Plan Draft Background Report: Peace River Regional District*. B.C. Ministry of Agriculture.

29 Chillborne Environmental, supra note 4.

The federal government opened up the "Peace River Block" to homesteaders between 1907 and 1912, during which farmers came to the region to settle on agricultural lands.[30] These farmers cultivated grains, vegetables and forage for cattle and horses. An influx of settlers moved to the region after the Second World War as a result of easier access to the northeast via the newly built Alaska Highway, and land grants provided to returning veterans.

Most of the study area's population now resides in the municipalities of Fort St. John, Dawson Creek, Tumbler Ridge, Chetwynd, Hudson's Hope, Taylor and Pouce Coupe. In addition, there are eight Treaty 8 First Nation Reserves within the study area including East Moberly Lake 169, West Moberly Lake 168A, Beaton River No. 204 (North Parcel), Beaton River 204 (South Parcel), Halfway River 168, Blueberry River No. 205, Doig River 206 and Finlay Bay Indian Reserve No. 21.[31]

2.5 Human Impacts on Natural Capital in the Watershed

The Peace River region has experienced widespread changes due to industrial and human development. Many of the area's natural landscapes have been impacted by activities such as logging, mining, oil and gas development, water withdrawals and stream crossings, large-scale hydro development and agricultural conversion.[32] Cumulative changes were mapped and analyzed in an earlier study that examined human impacts on ecosystems in the Peace River watershed within B.C. from 1974 to 2010. Impacts on the PRW lands included 16,267 oil and gas wellsites (each averaging one hectare in size), 8,517 petroleum and natural gas facilities, 284 km^2 of oil and gas pipeline rights-of-way, 28,587 km of pipelines, 2,296 river/stream crossings due to oil and gas development, 3,868 km^2 of coal tenures, 243 km^2 of mineral tenures, 4 coal mines, 45,293 km of roads, and 1,163 km of transmission lines. The physical footprint of the total land change was approximately 1.1 million hectares (20.2 per cent of the study area), including roads, pipelines, reservoirs, clearcuts, mines, urban development and agricultural conversion. The ecological impact of the cumulative changes was estimated using a 500-metre buffer that demonstrated that about 66.9 per cent of the watershed had been disturbed by human activities.[33]

The Peace River region has experienced widespread changes due to industrial and human development.

PHOTO COURTESY BC MINISTRY OF TRANSPORTATION/FLICKR CREATIVE COMMONS

The upper reaches of the Peace River have been developed for hydropower, including the W.A.C. Bennett and Peace Canyon hydroelectric dams, which produce more than 30 per cent of British Columbia's hydroelectric power.[34] A third large-scale dam called Site C is currently under review. The proposed Site C dam faces significant opposition because it would flood important historical and spiritual First Nations sites, highly productive agricultural lands and wildlife habitat including breeding, calving, migration and wintering sites.[35] For example, the Dane-zaa are concerned about the impact that the Site C dam will have on their traditional territory. The proposed dam will flood hundreds of acres of their territory near Attachie and Bear Flats, including islands that provide important wildlife birthing habitat, traditional habitation and hunting areas, and traditional grave sites. The proposed dam will affect the rights of First Nations under Treaty 8, which states that First Nations have the right to continue with their way of life without interference.[36]

In addition, there are local concerns over the growing number of development projects in the oil and gas industry and the increase in forestry operations, which have contributed to widespread ecological fragmentation.

30 Don Cameron Associates, supra note 28.
31 Lee and Hanneman, supra note 1.
32 Ibid.
33 Ibid.
34 BC Ministry of Environment. "Peace River." www.env.gov.bc.ca/bcparks/heritage_rivers_program/bc_rivers/peace_river.html
35 Chillborne Environmental, supra note 4.
36 Ridington, R., and Ridington, J. 2013. *Where Happiness Dwells: A history of the Dane-Zaa First Nations in collaboration with Elders of the Dane-Zaa First Nations*. UBC Press. Vancouver, B.C.

PART 3

Land Cover in the Peace River Watershed

To develop an inventory of the ecosystems and land use across the study area, several sources of geographically referenced data were reviewed.

PHOTO COURTESY TUCHODI/ FLICKR CREATIVE COMMONS

LAND COVER IS THE OBSERVED BIOPHYSICAL COVER on the earth's surface, such as the observed data from Landsat satellite imagery. Thematic land cover maps are commonly produced through the classification of such earth observation data, using remote sensing image processing techniques called geographic information systems (GIS). These maps can include land cover classes or land cover types such as water, forests, urban lands and wetlands. To develop an inventory of the ecosystems and land use across the study area, several sources of geographically referenced data were reviewed.

Land cover data for the study area were identified and classified based on data clipped from Agriculture and Agri-Food Canada's (AAFC)'s Land Cover for Agricultural Regions of Canada GIS dataset.[37] This dataset was produced from Landsat satellite imagery compiled by AAFC to provide land cover mapping that can be used to support a range of land-use programs and activities, such as land-use decision-making and impacts on ecosystem services. Land cover types were tabulated in spreadsheets by area in hectares for each land cover class within the boundary of the study area. The land cover types in hectares and per cent cover for the total PRW study area, along with the PRW area used for ecosystem valuation, are provided in Table 1.

The land cover analysis indicates that forests are the dominant ecosystem type, covering about 64.4 per cent of the study area.[38] The other land cover types include wetlands (9.2%), grasslands (7.8%), snow cover, rock and exposed lands (4.6%), perennial croplands and pastures (4.3%), shrublands (4.2%), annual croplands (2.2%), water (1.4%) and developed land (0.1%). Another 101,711 hectares of land is unclassified (2%) because of technical issues such as cloud cover and shadowing. The area used for ecosystem valuation excludes snow/rock/exposed lands, developed lands and unclassified lands. Therefore, the total PRW area used in the ecosystem valuation analysis is 5,245,371 hectares.

37 Land Cover for Agricultural Regions of Canada, circa 2000 (Version 1.2, 2013 revision). Agri-Geomatics Service. Agriculture and Agri-Food Canada. Government of Canada. A 30-metre resolution raster format land cover classification produced from Landsat satellite imagery. AAFC compiled land cover mapping for agricultural regions across Canada. http://geodiscover.cgdi.ca/wes/CSWSearchClient/OWSResults/DisplayFullMetadata.jsp;jsessionid=F7A2013ABF77FBE857F4660F2335A17E.gdp2?id=F1E6A665-C15B-F64B-FC6D-4472BBA89F55&recordLocale=en_US#top

38 The forest cover is predominantly made up of coniferous forest (72.9%), with smaller areas of broadleaf forest (23.9%) and mixedwood forest (3.2%).

The land cover analysis indicates that forests are the dominant ecosystem type, covering about 64.4 per cent of the study area.

TABLE 1: LAND COVER BY AREA, B.C. PEACE RIVER WATERSHED STUDY AREA

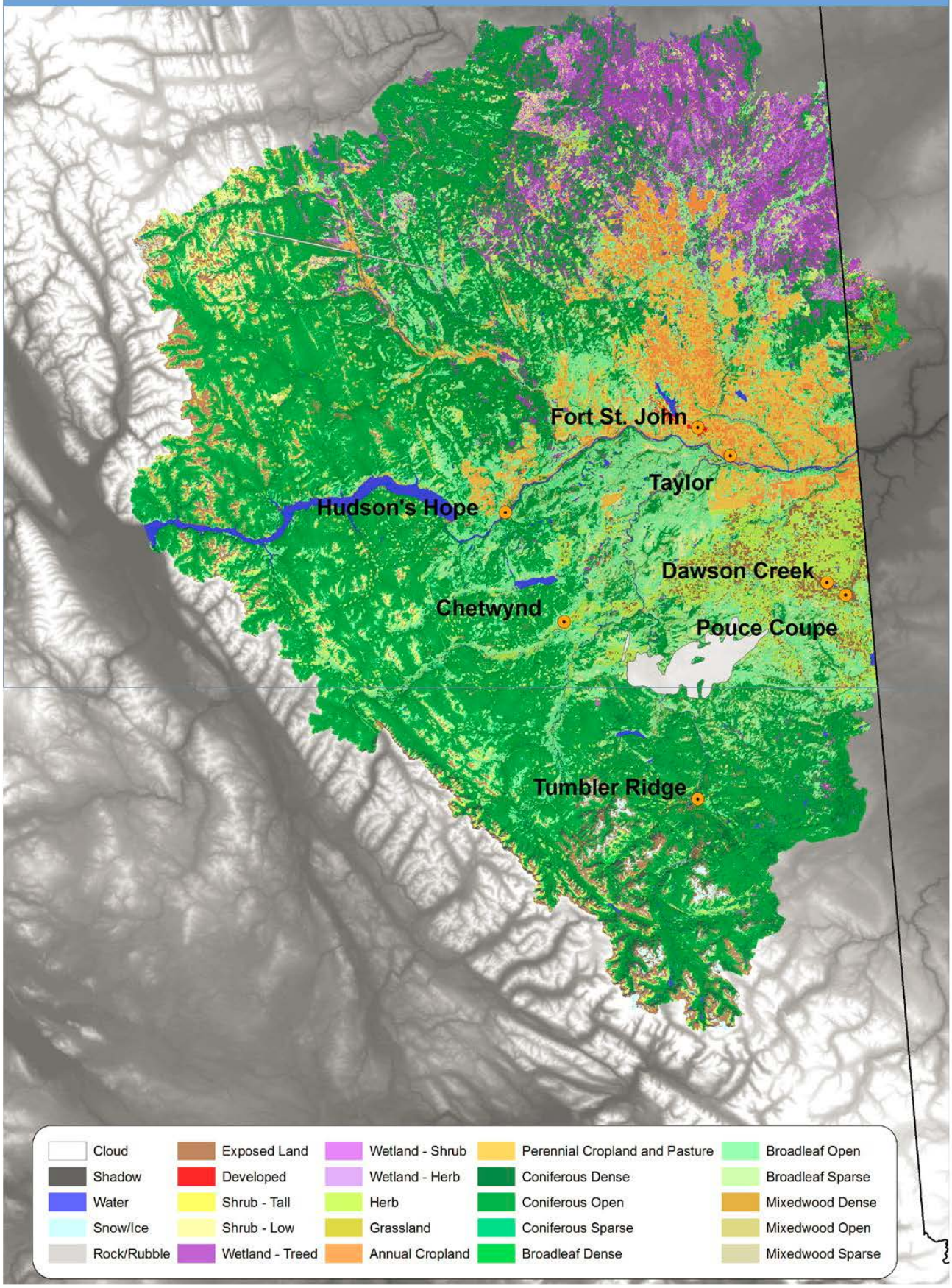
Land cover type	Total area (ha)	% of total land cover	Area for ecosystem valuation[a]
Forest	3,613,741	64.4%	3,613,741
Wetland	518,788	9.2 %	518,788
Grassland	435,414	7.8%	435,414
Snow/Rock/ Exposed land	259,954	4.6%	(not included)
Perennial cropland/ Pasture	241,471	4.3%	241,471
Shrubland	237,447	4.2%	237,447
Annual cropland	121,759	2.2%	121,759
Water	76,751	1.4%	76,751
Developed lands	4,764	0.1%	(not included)
Unclassified lands	101,711	1.8 %	(not included)
Total	5,611,799	100%	5,245,371

Note: [a]The Peace River Watershed study area excluded snow/rock/exposed lands, developed lands and unclassified lands from the ecosystem valuation.

Source: Land Cover for Agricultural Regions of Canada, circa 2000 (Version 1.2). Agriculture and Agri-Food Canada. Government of Canada.

The distribution of land cover types across the study area is illustrated in Figure 2 on page 22. The land cover map shows a large concentration of predominantly treed wetlands in the northeastern portion of the study area (in purple); a large expanse of agricultural croplands and pasture fanning out along the Peace River lowlands (in orange); and coniferous forest covering the western portion of the study area.

FIGURE 2: LAND COVER MAP FOR THE B.C. PEACE RIVER WATERSHED STUDY AREA



PART 4

Methodological Approach for Identification and Valuation

4.1 Identification of Spatial Land Cover and the Quantification of Ecosystem Types

The spatial land cover data presented in Section 3 were used to identify land cover ecosystem types and land use for the study area. Ecosystem types and land use were then used to identify the ecosystem services (ES) provided by the area's natural capital. Figure 3 below outlines the steps undertaken from identifying the study area's land cover data to the valuation of ecosystem services.

The spatial land cover data presented in Section 3 were used to identify land cover ecosystem types and land use for the study area.

PHOTO COURTESY DON HOFFMANN

FIGURE 3: STEPS TAKEN TO IDENTIFY ECOSYSTEM SERVICES

4.2 Classification of Ecosystem Services

Ecosystem services have been defined as the benefits provided by ecosystems. ES are dependent on ecosystem functions, which include the ecological processes and attributes that maintain ecosystems. ES include provisioning services (e.g., food, water), regulating services (e.g., water purification, climate regulation), habitat services and cultural services (e.g., recreation).[39] The Economics of Ecosystems and Biodiversity (TEEB) initiative has classified 22 ES according to these four categories. Table 2 provides a list of TEEB's classification of ecosystem services, including an example for each ES.

39 TEEB (2012). *The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations*. Edited by Pushpam Kumar. Routledge, Abingdon and New York.

TABLE 2: CLASSIFICATION OF ECOSYSTEM SERVICES	
Provisioning Services	
Food	Food, fish and meat for human consumption.
Water supply	Water for human consumption, irrigation and industrial use.
Raw materials	Timber, fuelwood, etc.
Genetic resources	Plant genetic diversity for crop improvement and medicinal purposes
Medicinal resources	Providing drugs, pharmaceuticals, tests, tools and assay organisms.
Ornamental resources	Resources for fashion, jewelry, handicraft, worship and decoration.
Regulating Services	
Gas regulation	Providing clean, breathable air, disease prevention and planet habitability.
Climate regulation	Providing a stable climate and preventing increased climatic variability, glacial and permafrost melt, increased storm frequency and force, and global sea rise.
Disturbance prevention	Preventing and mitigating natural hazards such as floods, storm surges, hurricanes, fires and droughts.
Soil retention	Retaining arable land, slope stability and coastal integrity.
Water regulation	Providing water supply for natural irrigation, drainage, groundwater recharge, river flows and navigation.
Biological control	Providing pest and disease control.
Waste treatment	Absorption of organic waste, natural water filtration and pollution reduction.
Soil formation	Creating soils for agricultural and ecosystems integrity.
Pollination	Providing pollination of wild and domestic plant species.
Nutrient regulation	Promoting healthy soils, and gas, climate and water regulating services.
Habitat Services	
Habitat and biodiversity	Maintaining habitat for genetic and biological diversity, the basis for most other functions.
Nursery	Providing habitat for spawning and nesting for reproduction.
Cultural and Amenity Services	
Esthetic	Enjoying and appreciating the scenery, sounds and smells of nature.
Recreation and tourism	Experiencing outdoor activities in natural ecosystems.
Science and education	Learning and research activities in natural ecosystems.
Cultural and artistic	Experiencing nature through art, film, folklore, books, cultural symbols, architecture, religion, spiritual activities and media.

Source: TEEB (2012). *The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations*. Edited by Pushpam Kumar. Routledge, Abingdon and New York.

Ecosystem services are often referred to as ecosystem goods and services or ecological goods and services (EG&S), however, this study focused on the non-market ecosystem services, so the term ecosystem services will be used throughout the report. For example, timber market values were not assessed.

4.3 Identification of Ecosystem Services by Land Cover Type

To identify the ES provided by the Peace River Watershed, the ES were categorized by ecosystem types based on the typical ES associated with each land cover type as reported by TEEB.[40] The potential ES provided by each ecosystem type were then compiled based on TEEB's classification, and a review of the study area's ecosystems and socio-economic information. The result was a list of ES provided by the ecosystems and land cover types across the study area (Appendix 3).

4.4 Ecosystem Service Valuation Approach

The study's ecosystem service valuation approach was based on the Total Economic Value (TEV) framework. TEV is the sum of ES values provided by natural capital in a specific region. The TEV framework includes use and non-use values. This framework includes direct use values such as food and water, indirect use values such as climate regulation, and non-use values such as existence values (i.e., protection of biodiversity; see Appendix 4). The ES values reported in this study are mostly direct and indirect-use values (see Table 4, Section 5).

ES values can be estimated from: 1) market-based methods; 2) indirect or surrogate market-based methods (i.e., revealed preference methods); and 3) non-market, survey-based methods (i.e., stated preference methods).[41] Table 3 provides examples for each of these valuation methods.

TABLE 3: TYPICAL ECOSYSTEM SERVICE VALUATION METHODS BY VALUE TYPE

Valuation Approach	Methods	Examples of Value Type
Market-based Valuation: Price-based	Market prices	Food Recreation
Market-based Valuation: Cost-based	Avoided cost Replacement cost Mitigation/Restoration cost	Climate regulation Habitat
Revealed preference	Travel cost method Hedonic pricing	Recreation Urban green space
Stated preference	Contingent valuation Choice modelling Contingent ranking Deliberative group valuation	Biodiversity Protection of cultural value

Adapted from: TEEB (2012). *The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations*. Edited by Pushpam Kumar. Routledge, Abingdon and New York.

40 Ibid.
41 Ibid.

The ES values reported in this study were developed based on land cover data, forest age class data, socio-economic information available for the Peace River region and other ecosystem service valuation studies. The specific approach for each ES valuation is described in the valuation results section. Sources for local or regional socio-economic data and descriptive information were researched and used for valuations where possible. If local or regional data were not available, values were transferred from other relevant ES valuation studies. This was done either by adopting average values from meta-analysis studies (i.e., an average based on values compiled for a specific ecosystem service from an overview of all existing studies in the literature), or from a site-specific study, adjusted by population size, that was a best match for the study area, based on its relevance to the region's ecosystem, location, demographics and/or habitat types.

Several of the ES valuations were based on the avoided cost or replacement cost because they provided values comparable to real market prices that were not dependent on survey respondents' perceptions (i.e., survey-based methods) and were more easily replicable in other contexts.[42] Moreover, avoided costs may be useful for local administrators who must use public funds to repair ecosystem damages resulting from development.

All values are reported in 2012 Canadian dollars. Values reported as U.S. dollars were converted to Canadian dollars using an average annual exchange rate from the Bank of Canada currency converter.[43] Values were inflated to 2012 dollars using the Bank of Canada inflation calculator.[44] The values reported in the text are rounded figures.

PHOTO COURTESY TUCHODI/FLICKR CREATIVE COMMONS

42 de Groot, R.S., et al. 2002, "A typology for the classification, description and valuation of ecosystem functions, goods and services." *Ecological Economics*. 41: 393-408. Farber, S. et al. 2006. "Linking ecology and economics for ecosystem management." *Bioscience*. 56:121-133.

43 Bank of Canada. "10-Year Currency Converter." www.bankofcanada.ca/rates/exchange/10-year-converter/

44 Bank of Canada. "Inflation Calculator." www.bankofcanada.ca/rates/related/inflation-calculator/

PART 5

Ecosystem Service Valuations

The following results provide a first estimate for the average economic values of ecosystem services provided by natural capital within B.C.'s Peace River Watershed. The ES valued in this study are listed in Table 4. The study provides a baseline for the region's ecosystem services values. Given the lack of current land cover data and the lack of local socio-economic information regarding ES, the results do not provide a comprehensive valuation because not all the ecosystem services for each land cover type have been valued in this study.

While water is a provisioning service itself, it also contributes to the production of food, regulating services such as nutrient cycling and cultural services such as recreation.

PHOTO COURTESY PROVINCE OF BC/FLICKR CREATIVE COMMONS

5.1 Provisioning Services

5.1.1 DRINKING WATER SUPPLY

Water is fundamental to the survival of humans, farm animals and wildlife. While water is a provisioning service itself, it also contributes to the production of food, regulating services such as nutrient cycling and cultural services such as recreation. In addition, water is important as an input for many industries including food processing, energy production and forestry.

The Peace River Watershed includes the Upper Peace-Halfway, Upper Peace-Kiskatinaw, Pine, Beatton and eastern Williston Lake watersheds. Watersheds provide critical natural "green" infrastructure that collect, capture, filter and deliver water to communities. Forests, wetlands, grasslands, lakes, rivers and streams play important roles in the supply of water by providing water filtration, detoxification and nutrient retention services, as well as water supply storage and transportation.

The total water cover in the Peace River Watershed is 76,751 hectares according to the land cover spatial data used in this study. The value of the drinking water provided by the PRW's rivers and streams was estimated using a willingness to pay (WTP) for residential water quality improvements, which was transferred from a study undertaken in the Grand River watershed in southern Ontario. There were no similar studies undertaken in western Canada. The average WTP per household ranged from $4.56/household/month to $9.42/household/month (1994 $). These values were converted to 2012 dollars, and multiplied by 12 to estimate an annual value. The average value, therefore, was $119.54/hhld/year (2012 $). This value was then multiplied by the

TABLE 4: ECOSYSTEM SERVICES VALUED FOR THE B.C. PEACE RIVER WATERSHED

Ecosystem services assigned value	Valuation approach	Type of value	Valuation method used
Water supply	Average global value	Direct use	Transfer value per hectare from global average study (38 original studies)
Air filtration (gas regulation)	Avoided cost value	Indirect use	Transfer value from Lower Mainland study adjusted by population (original analysis based on average removal rates of pollutants by tree canopy cover and avoided costs)
Carbon storage (climate regulation)	Avoided cost value	Indirect use	Quantified carbon storage using forest age/carbon analysis; annualized social carbon cost value based on average of U.S. and Canadian government social cost of carbon (SCC) (marginal SCC values from climate models)
Carbon sequestration (climate regulation)	Avoided cost value	Indirect use	Quantified forest carbon sequestration based on forest age/carbon analysis. Social carbon cost value based on average of U.S. and Canadian government SCC (marginal SCC values from climate models)
Flood control/water regulation (disturbance prevention: wetlands)	Meta regression analysis value for Canada	Indirect use	Average value for Canada: from study that evaluated the value of wetlands in agricultural landscapes using a meta regression analysis reported by country
Erosion control (soil retention: perennial cropland/pasture)	Avoided cost value	Indirect use	Value based on avoided water treatment costs to remove sediment provided by conservation of natural cover or conversion of annual cropland to permanent cropland/pasture cover
Waste treatment	Replacement cost value	Indirect use	Average removal rates of excess nutrients per wetland hectare from academic literature and average excess runoff from agricultural statistics and cropland area; average value based on cost to treat/remove excess nutrients from water system
Water filtration (forests)	Avoided cost value	Direct use	Avoided cost of water treatment costs based on current forest cover in PRW and local cost of water treatment in PRW.
Pollination	Market-based value	Indirect use	Estimated as 30 per cent of reported pollinator value for B.C. crops
Habitat and biodiversity	Market-based value/average meta-analysis value	Indirect use / non-use	Estimated net value for increased wildlife viewing on conserved land or cropland restored to natural cover (grassland/pasture); average habitat value from wetland values meta-analysis
Recreation	Survey-based value/travel cost	Direct use	Estimated economic value of outdoor recreation from several recreational surveys
Cultural/ aesthetic	Survey-based	Indirect use/ non-use	1) Willingness to pay to maintain rural scenic views 2) Willingness to pay to protect wilderness/biodiversity

estimated number of households in the study area (25,845.6 hhlds) to estimate the total value of $3.1 million per year.[45] The total value was then divided by the total water cover in the study area, resulting in an estimate for the value of water of $40.25/ha/year. This provides a proxy value for the supply of good quality water, so although a survey could not be undertaken to determine whether households in the study area would be willing to pay the same amount, we can estimate that it represents a conservative value for the benefits Canadians place on having a good water quality supply[46]

Therefore, the average value of $40.25/ha/year (2012 $) from the above study was used to estimate a value for water supply in the study area. The PRW provides water for approximately 64,614 people within B.C., including the populations of Fort St. John, Dawson Creek, Chetwynd, Hudson's Hope, Pouce Coupe, Taylor and Tumbler Ridge.[47] Several additional communities benefit from the supply of water downstream from the B.C. border.

5.2 Regulating Services

5.2.1 AIR QUALITY REGULATION — FORESTS

Trees are essential for good air quality because they produce oxygen. Trees also provide improvements to air quality by capturing air pollutants and retaining or absorbing them with their leaves. By absorbing and filtering out nitrogen dioxide (NO_2), sulfur dioxide (SO_2), ozone (O_3), carbon monoxide (CO) and particulate matter (PM_{10}), trees perform a vital air cleaning service that directly affects the well-being of humans. For example, studies have shown that trees can remove eight to 12 grams of air pollutants per square metre of tree canopy.[48]

An analysis in the B.C. Lower Mainland used CITYgreen software to assess the amount of air pollutants removed from the air by the tree canopy cover. The analysis used average rates from several U.S. studies to estimate the amount of carbon monoxide, nitrogen dioxide, particulate matter and sulphur dioxide that trees absorb. The value of air filtration provided by trees in the B.C. Lower Mainland watersheds was $408.9 million, an average of $495 per hectare of forest cover. In order to transfer the value for this study, the total value for the Lower Mainland was adjusted by its population (2,194,377 people) to estimate the value per person ($186.36 per person). The value per person was then multiplied by the population within the study area (64,614 people) resulting in an estimate of the total value for the PRW of $12 million. This adjusted value was applied to the forest cover area within the PRW, which resulted in a per hectare value estimate of $3.51/ha/year (2012 $).

Ecosystems regulate the Earth's climate by adding and removing greenhouse gases, such as carbon dioxide, from the atmosphere.

PHOTO COURTESY DON HOFFMANN

5.2.2 CLIMATE REGULATION

Ecosystems regulate the Earth's climate by adding and removing greenhouse gases (GHG), such as carbon dioxide (CO_2), from the atmosphere. Forests, grasslands, wetlands and other land-based ecosystems store more carbon than is in the air. Carbon dioxide is stored in trees, plant biomass, debris and soils, thereby keeping it out of the atmosphere. Ecosystems accumulate carbon in their plants and soils over time, adding or "sequestering" additional carbon each year. As a result, the management of ecosystems has a direct impact on climate regulation.

45 The number of households was estimated based on the assumption that there are approximately 2.5 persons on average per household. The total population in the study area was 64,614, which divided by 2.5 equals 25,845.6 households.

46 Brox, J.A., Kumar, R.C., Stollery, K.R. 2003. "Estimating Willingness to Pay for Improved Water Quality in the Presence of Item Non Response Bias." *American Journal of Agricultural Economics*. 85:414-428.

47 The population does not include rural unincorporated areas, and several First Nations communities.

48 Nowak, D.J., Wang, J., and Endreny, T. 2007. "Environmental and Economic Benefits of Preserving Forests within Urban Areas: Air and Water Quality." In: *The Economic Benefits of Land Conservation*. The Trust for Public Land. San Francisco, Calif.

Economic Value of Stored Carbon

The economic analysis for stored carbon (C) focused on its social value in terms of the avoided costs of higher levels of carbon dioxide in the atmosphere. In general, policy makers determine a social cost of carbon (SCC) to assess the economic benefits of mitigating climate change. The SCC is based on climate change models that provide outputs based on different climate change scenarios.[49] The social cost of carbon was used because it measures the marginal benefit of avoiding the release of each additional tonne of carbon into the atmosphere. Carbon prices were used for comparison purposes because they are determined by government policies, regulations and subsidies, rather than the true value of the service to society.[50]

Because ecosystems hold an annual value for each year that the carbon is not released into the atmosphere, this was reported as an annual value.

PHOTO COURTESY BC MINISTRY OF TRANSPORTATION/FLICKR CREATIVE COMMONS

An average SCC value was calculated for the study's purposes based on two sources: 1) the U.S. government SCC estimates based on three climate change models, which were developed for cost-benefit analysis; and 2) Environment Canada's SCC estimates. The U.S. marginal values ranged from $11 to $52 as the cost for each incremental metric tonne of carbon dioxide equivalent (CO_2e) released into the atmosphere (2013 update; 2007 US dollars).[51] The range of estimates varied depending on the assumptions across the climate change models and the discount rate used (e.g., 2.5%, 3% and 5%, respectively). (See textbox on discount rates on page 31).The central value was $33 per metric tonne of carbon dioxide, based on a three per cent discount rate. This amount was converted to US dollars per tonne of carbon ($121.11/tC),[52] and then converted to 2012 Canadian dollars ($134.97/tC).[53] The second value was from Environment Canada's SCC central estimate of $25 per tonne of CO_2e (2010 $), which is equal to $95.50 per tonne of carbon (2012 $).[54]

Based on the American and Canadian SCC central values, an average value of $115.23/tC was used as the study's central SCC value, equivalent to $31.40/t$CO_2$ (2012 $). The average central value was similar to the 2012 B.C. carbon tax rate of $30 per tonne of CO_2, or $110.10 per tonne of carbon (2012 $).[55]

In order to report a range of values for sensitivity analysis, the low and high SCC values from the U.S. government estimates were used ($11 and $52 per tonne of CO_2, respectively). These values were used to provide a range to account for the uncertainties associated with predicting climate change impacts. The values were converted from dollars per tonne of CO_2 to dollars per tonne of carbon. Therefore, a low value of $40.63 per tonne of carbon and a high value of $192.06 per tonne of carbon (2012 C$) were used in the carbon valuations.

The amount of carbon stored in an ecosystem is gauged at a fixed point in time, rather than an annual accumulation. However, because ecosystems hold an annual value for each year that the carbon is not released into the atmosphere, this was reported as an annual value. In order to estimate an annual value for our reporting purposes, the central SCC value was converted to a carbon annuity, based on the carbon annuity

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49 Price, R., Thornton, S., and Nelson, S. 2007. *The Social Cost of Carbon and the Shadow Price of Carbon: What they are, and how to use them in economic appraisal in the UK*. Department for Environment, Food and Rural Affairs (U.K.).

50 Murray, B., Sohngen, B., and Ross, M. 2007. "Economic consequences of consideration of permanence, leakage and additionality for soil carbon sequestration projects." *Climatic Change*. 80:127-143. Other carbon valuation methods that have been used include: 1) the replacement cost to replace the stored carbon; or 2) the market price set by carbon markets.

51 Interagency Working Group on the Social Cost of Carbon. 2013. *Technical Support Document: Technical Update of the Social Cost of Carbon For Regulatory Impact Analysis*. Executive Order 12866. United States Government. www.whitehouse.gov/sites/default/files/omb/inforeg/social_cost_of_carbon_for_ria_2013_update.pdf

52 $33/t$CO_2$ * 3.67= $121.11/tC; 1 tonne of carbon (C) equals 3.67 tonnes of carbon dioxide (CO_2).

53 The value per tonne of CO_2 was converted to U.S. dollars per tonne of carbon (1 tC = 3.67 tCO_2e), then inflated to 2012 U.S. dollars (www.usinflationcalculator.com), and then converted to Canadian dollars using the average of the low and high exchange rate from the Bank of Canada (www.bankofcanada.ca/rates/exchange/10-year-converter).

54 Regulatory Impact Analysis Statement. Feb. 26, 2011. Sensitivity values ranging from $10 to $100 per tonne of CO_2e, equal to $36.70 to $367 per tonne of carbon. www.gazette.gc.ca/rp-pr/p1/2011/2011-02-26/html/reg3-eng.html. This value was converted to dollars per tonne of carbon (1 tC = 3.67 tCO_2), then inflated to 2012 Canadian dollars per tonne of carbon (using Bank of Canada online inflation calculator) www.bankofcanada.ca/rates/related/inflation-calculator/

55 B.C. Ministry of Finance, "How the Carbon Tax Works," www.fin.gov.bc.ca/tbs/tp/climate/A4.htm. This value was converted to dollars per tonne of carbon (1 tC = 3.67 tCO_2).

PHOTO COURTESY ZACK EMBREE, *FRACTURED LAND* DOCUMENTARY

DISCOUNT RATE

Discount rates are commonly used to assess the economic benefits of investment for decision-making. Benefits are discounted over time to reflect that people generally value immediate benefits over benefits in the future; and that manufactured capital depreciates over time resulting in lower values in the future.

The use of discount rates for natural capital has been widely debated because ecosystems do not depreciate over time. In fact they often appreciate over time, and natural capital will be worth more in the future because as the population grows, the earth's remaining ecosystems will become more valuable. In the case of a service that increases in value in the future, a negative discount rate would be used to capture the net present value. However, there is there is considerable controversy around the use of negative discount rates, so a range of positive social discount rates to estimate the NPV was used.

The NPV for the BC PRW ecosystem services value was calculated over a 50-year period using three different discount rates. A zero per cent discount rate was used to reflect the fact that natural capital does not depreciate over time; a 3 per cent discount rate was used because it is commonly used in socio-economic studies; and a 5 per cent discount rate was used as the high rate because it is a more conventional rate.

account (CAA) concept.[56] The annual carbon annuity value was calculated based on three per cent earnings over 50 years to estimate the annual value for carbon stored by ecosystems. Therefore, the annual values used were: a central value of $4.48/tC/year ($1.22/tCO_2/year); a low-end value of $1.58/tC/year ($0.43/tCO_2/year); and a high-end value of $7.46/tC/year ($2.03/tCO_2/year).[57]

Carbon Stored in Forests

More than half of the carbon stored in land-based ecosystems is currently stored in forests — in tree and root biomass, forest floor debris and soils. Trees remove carbon dioxide from the atmosphere through photosynthesis and convert it into organic carbon such as cellulose and lignin — the main components of wood. About half of each kilogram of wood is carbon, and every kilogram of carbon that is in a tree represents about 3.7 kilograms of carbon dioxide removed from the atmosphere. So forests have the ability to store enormous amounts of carbon, thereby reducing the buildup of carbon dioxide in the atmosphere that is contributing to global climate change.[58]

Forests have the ability to store enormous amounts of carbon, reducing the buildup of carbon dioxide in the atmosphere that is contributing to global climate change.

PHOTO COURTESY TUCHODI/ FLICKR CREATIVE COMMONS

Carbon storage refers to the carbon held in forest biomass and soils. As a result, carbon storage is reported as a weight, such as tonnes of carbon per hectare. B.C.'s forests store significant amounts of carbon, with coastal forests storing up to 1,300 tonnes of carbon per hectare.[59] Forests cover approximately 60 million hectares of the province, with 54 per cent of B.C.'s forests found in the Montane Cordillera ecozone, and smaller forest areas in the Pacific Maritime, Boreal Cordillera, Taiga Plains and Boreal Plains ecozones.[60]

The forest cover in the study area falls within the Montane Cordillera ecozone and the Boreal Plains ecozone. A national study reported that, on average, Boreal Plains ecozone forests store 220 tonnes of carbon per hectare, and Montane Cordillera forests store 255 tonnes of carbon per hectare (an average of 238 tC/ha).[61] In order to estimate stored carbon for each forest age class, a range of carbon estimates from several site-based studies were used. For example, a field study in north-central B.C., near the study area, found that old-growth forests (greater than 140 years old) store an average of 325 to 423 tonnes of carbon (tC) per hectare (fine and coarse soil sites, respectively), and that second-growth forests under 20 years old store about 200 tC per hectare.[62] In another north-central B.C. study, forest carbon content estimates ranged from 174 tC per hectare (under 20 years old) to 292 tC per hectare (175 years and older). Based on the three references cited above, this study used carbon content estimates for each forest age class ranging from 174 tC/ha for forest cover under 20 years old to a high of 423 tC/ha for forest cover more than 250 years old (Table 5 on page 33).

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56 A CAA (carbon annuity account) is an account where the full carbon value is placed directly into an annuity account, and as long as the sink remains in place, the carbon provides an annual earning/value from the annuity account. Swingland, I. (ed). 2003. *Capturing Carbon and Conserving Biodiversity: The Market Approach*. Earthscan Publications. London, U.K. http://books.google.ca/books?id=oPz8P6cZKUQC&printsec=frontcover#v=onepage&q&f=false; Feng, H. et al. 2002. "The Time Path and Implementation of Carbon Sequestration." *American Journal of Agricultural Economics*. 84:134-149.

57 Calculations: ($115.23/tC * 0.03887; $40.63 * 0.03887; $192.06 * 0.03887). The 3% rate over 50 years was used because a 3% discount rate is commonly used for socio-economic studies; and a 50-year timeline is a common length of time used for discount rate periods.

58 Pregitzer, K.S., and Euskirchen, E.S. 2004. "Carbon cycling and storage in world forests: biome patterns related to forest age." *Global Change Biology*. 10:2052-2077.

59 Keith, H., Mackey, B.G., and Lindenmayer, D.B. 2009. *Re-evaluation of Forest Biomass Carbon Stocks and Lessons from the World's Most Carbon-Dense Forests*. PNAS. 106:11635-11640.

60 Canadian Forest Ecosystem Classification. www.nrcan.gc.ca/forests/canada/classification/13179

61 Stinson, G. et al. 2011. "An inventory-based analysis of Canada's managed forest carbon dynamics, 1990 to 2008." *Global Change Biology*. 17: 2227-2244.

62 Fredeen, A.L. et al. 2005. "Comparison of coniferous forest carbon stocks between old-growth and young second-growth forests on two soil types in central British Columbia, Canada." *Canadian Journal of Forest Research*. 35: 1411-1421.

TABLE 5: CARBON STORED BY FOREST AGE CLASS IN THE STUDY AREA	
Forest age class	**Carbon stored per hectare (tC/ha)**
Less than 20 years	174
21 to 40 years	209
41 to 60 years	226
61 to 80 years	238
81 to 100 years	238
101 to 120 years	285
121 to 140 years	309
141 to 250 years	339
Greater than 250 years	423
Standing dead tree cover	160

Using these forest carbon content estimates, the amount of carbon stored in forest ecosystems across the study area was estimated based on the forest age class cover data from the B.C. Vegetation Resources Inventory (VRI) geospatial dataset (Figure 4 on page 36).[63] Because of the impact of insect damage due to mountain pine beetle infestation on some of the area's forests, the carbon content per hectare was adjusted for the forest cover area identified as standing dead trees (6.5 per cent of the forest area as reported by the B.C. VRI dataset).[64] Although standing dead trees do store carbon, they will decompose over time. We were unable to model the carbon transfer to the forest soils, so only the soil carbon (160 tC/ha) was included for the forest area identified as standing dead trees (282,956 hectares across all age classes; Table 6 on page 35).

The total forest area reported by the B.C. VRI dataset (4,331,485 hectares) was greater than the forest cover reported by the AAFC land cover dataset (3,613,741 hectares of forest cover plus 384,922 hectares of treed wetland; see Section 3). The difference in forest cover area may be explained by the area (101,711 hectares) that was unclassified (i.e., reported as cloud or shadow) in the land cover dataset and the possible misclassification of some of the snow/ice, rock/rubble and exposed land in the land cover dataset. The BC VRI dataset was used to infer the carbon stored by the forests in the study area; this data was then used to estimate the forest carbon storage based on AAFC dataset forest land cover.

Based on the forest age carbon analysis, the total carbon stored was an estimated 1.14 billion tonnes of carbon (Table 7 on page 35).

63 Ministry of Forests, Lands and Natural Resource Operations. VRI Forest Vegetation Composite Polygons and Rank 1 Layer. Forest Analysis and Inventory Branch. (2013 update). https://apps.gov.bc.ca/pub/geometadata/metadataDetail.do?recordUID=47574&recordSet=ISO19115

64 The total forest area reported by the B.C. VRI dataset was 4,331,485 hectares (332,823 more hectares than reported by the land cover dataset cited above for land cover).VRI forest area was used for the forest age/carbon analysis to estimate the total carbon stored by the study area because the forest age data provides a greater characterization of the forest land cover. However, for the overall ecosystem values, the average carbon per hectare was used to estimate the total value based on the total forest cover area as reported by the land cover dataset (3,613,741 plus 384,922 treed wetland; see Section 3).

TABLE 6: TOTAL FOREST AREA INCLUDING DEAD STANDING TREE AREA (B.C. VRI DATASET)

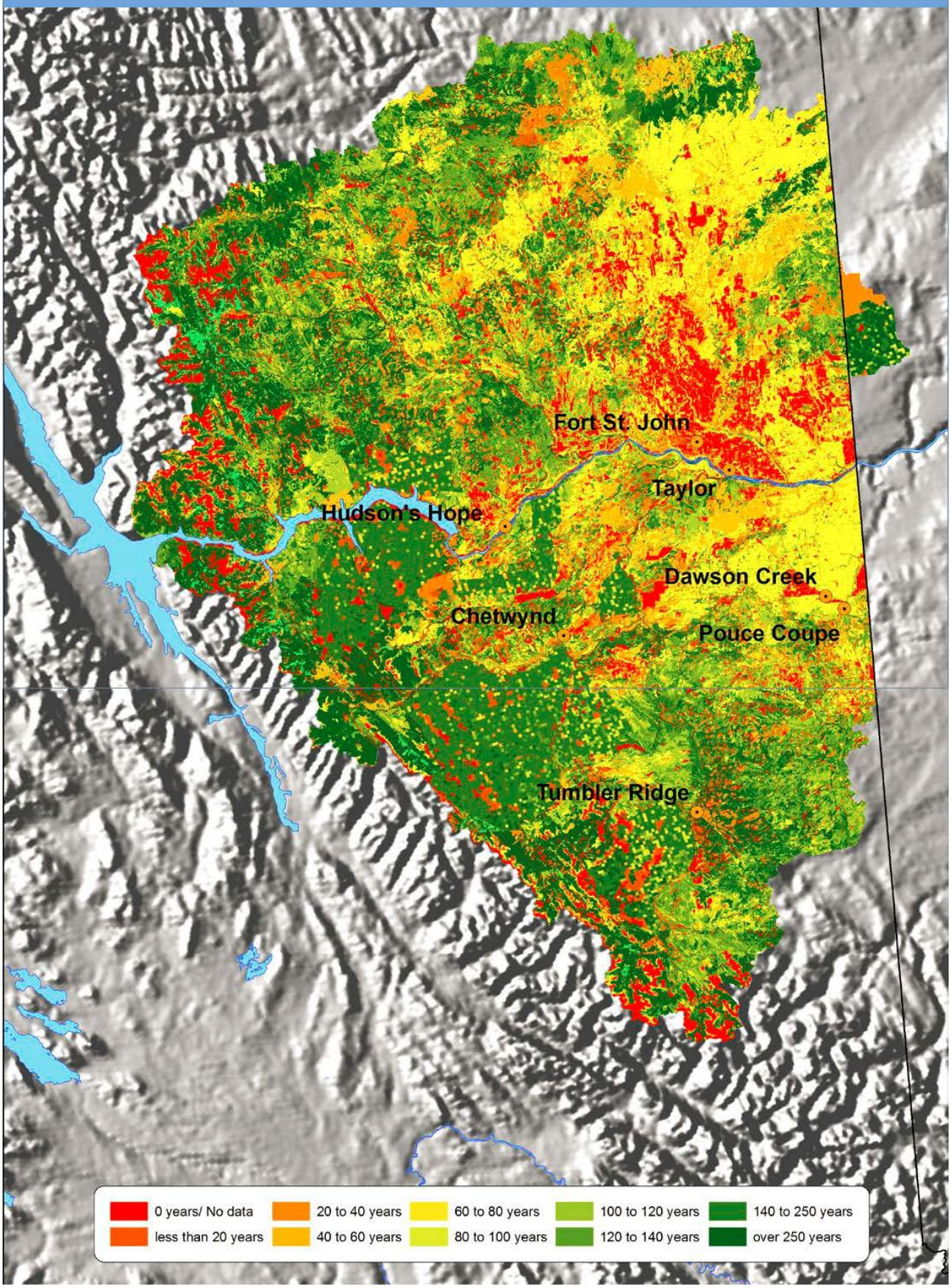
Forest age class	Total forest area* (ha)	Dead standing tree area (ha)	Total forest area excluding dead standing tree area (ha)
Less than 20 years	110,485	236	110,250
21 to 40 years	211,917	1,573	210,344
41 to 60 years	401,995	4,078	397,917
61 to 80 years	897,959	20,749	877,211
81 to 100 years	627,322	65,315	562,007
101 to 120 years	685,939	80,403	605,537
121 to 140 years	556,109	61,696	494,413
141 to 250 years	793,600	48,572	745,028
Greater than 250 years	46,158	335	45,823
Total	4,331,485	282,956	4,048,529

Source: Ministry of Forests, Lands and Natural Resource Operations. VRI Forest Vegetation Composite Polygons and Rank 1 Layer. Forest Analysis and Inventory Branch. (2013 update).

TABLE 7: TOTAL CARBON STORED BY FOREST ECOSYSTEMS IN THE STUDY AREA (B.C. VRI DATASET)

Forest age class	Carbon stored per hectare (tC/ha)	Total area (ha)	Total carbon stored (tC)	Annual value $/ha/year	Total value $/year
Less than 20 years	174	110,250	19,183,437	$779.15	$85,915,563
21 to 40 years	209	210,344	43,919,809	$933.51	$196,700,675
41 to 60 years	226	397,917	90,008,850	$1,010.05	$403,116,542
61 to 80 years	238	877,211	208,337,495	$1,055.63	$933,067,033
81 to 100 years	238	562,007	133,476,663	$1,027.42	$597,792,894
101 to 120 years	285	605,537	172,577,921	$1,210.66	$772,913,049
121 to 140 years	309	494,413	152,649,970	$1,308.75	$683,663,088
141 to 250 years	339	745,028	252,316,300	$1,467.72	$1,130,031,930
Greater than 250 years	423	45,823	19,383,321	$1,885.91	$86,810,767
Standing dead tree cover	160	282,956	45,204,330	$715.49	$202,453,572
Total		4,331,485	1,137,058,097		$5,092,465,112

FIGURE 4: MAP OF FOREST AGE DISTRIBUTION IN THE PEACE RIVER WATERSHED STUDY AREA



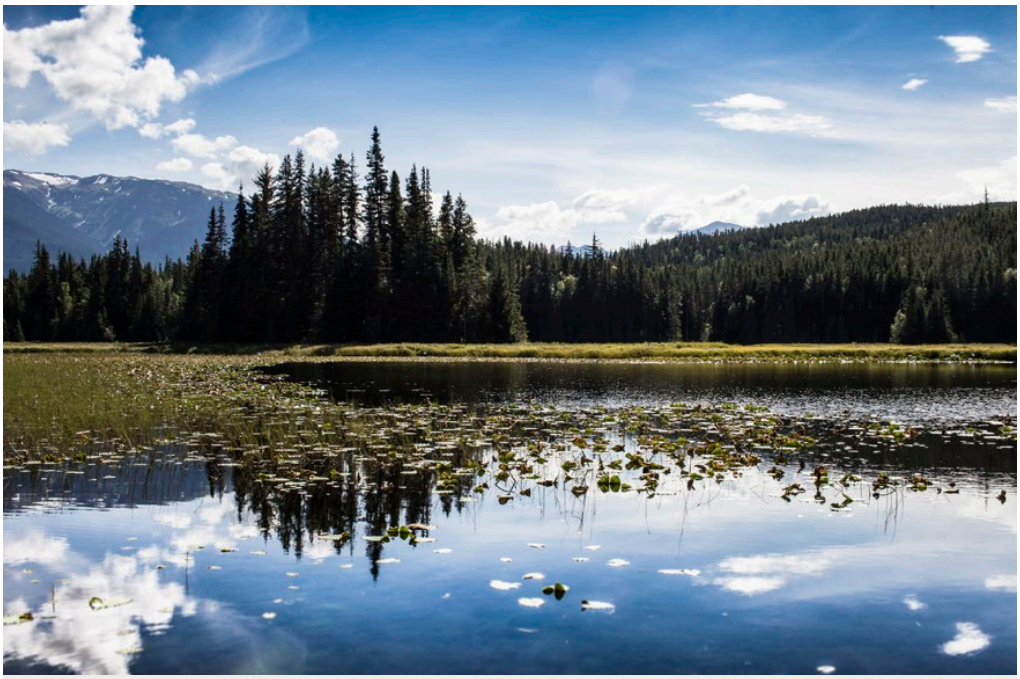


PHOTO COURTESY ZACK EMBREE, *FRACTURED LAND* DOCUMENTARY

STORED CARBON ANNUAL VALUE

The amount of carbon stored in an ecosystem is measured at a fixed point in time. In order to estimate an annual value for our reporting purposes, the central SCC value was converted to a carbon annuity, based on the carbon annuity account (CAA) concept. A CAA (carbon annuity account) is an account where the carbon value is placed into an annuity account, and as long as the sink remains in place, the carbon provides an annual earning/value from the account.[a] Annual carbon values were calculated based on three per cent earnings over 50 years to estimate a range of annual values for carbon stored by ecosystems. Therefore, the annual values used were: a central value of $4.48/tC/year ($1.22/tCO2/year); a low-end value of $1.58/tC/year ($0.43/tCO2/year); and a high-end value of $7.46/tC/year ($2.03/tCO2/year).

[a] Swingland, I. (ed). 2003. *Capturing Carbon and Conserving Biodiversity: The Market Approach.* Earthscan Publications. London, U.K. http://books.google.ca/books?id=oPz8P6cZKUQC&printsec=frontcover#v=onepage&q&f=false; Feng, H. et al. 2002. "The Time Path and Implementation of Carbon Sequestration." *American Journal of Agricultural Economics.* 84:134-149.

The carbon stored and its value is at a fixed point in time. Therefore, in order to estimate an annual value for our reporting purposes, the central SCC value was converted to a carbon annuity, based on the carbon annuity account (CAA) concept.[65] The annual value was calculated based on three per cent earnings over 50 years to estimate the annual value for carbon stored by forests ($4.48/tC/year or $1.22/t$CO_2$/year).[66] Therefore, the first estimate of the total annual value for carbon storage by forests was an estimated $5.09 billion per year, or $1,175.69/ha/year.[67]

Forest carbon storage was also estimated using the forest land cover from the AAFC land cover dataset reported in Section 3. In order to estimate the carbon stored by forests using the AAFC forest land cover area, the average carbon per hectare derived from the forest age carbon analysis (262.5 tC per hectare; 1.14 billion tC / 4.3 million hectares) was applied to each hectare of forest land cover, as well as a partial amount for the tree biomass reported as treed wetland.

According to the AAFC land cover dataset, the total forest cover in the study area was 3,613,741 hectares, plus 384,922 hectares of treed wetland. Using the average carbon stored per hectare of forest derived from the above analysis (262.5 tC/ha), the carbon stored by forest cover was an estimated 948.6 million tonnes. In addition, there were 384,922 hectares of treed wetlands in the study area. The aboveground carbon stored in the tree biomass was estimated at 102.8 tonnes of carbon per hectare.[68] As a result, an additional 39.6 million tonnes of carbon was stored by trees on wetlands, worth $177.1 million per year ($460.19/ha/year). Therefore, the second estimate of total forest carbon in the study area was 988.2 million tonnes of carbon, worth an estimated $4.43 billion per year (total forest carbon multiplied by the annual value of $4.48/tC/year).[69]

The annual value for carbon stored by forests, in terms of the avoided costs of carbon emissions to the atmosphere, ranged from an estimated $4.43 billion to $5.09 billion per year.

Thus, the annual value for carbon stored by forests, in terms of the avoided costs of carbon emissions to the atmosphere, ranged from an estimated $4.43 billion per year (based on the average carbon per hectare derived from the forest age carbon analysis and the AAFC land cover dataset forest area), to $5.09 billion per year (based on the forest carbon estimates per forest age class and the B.C. VRI dataset forest area).

The low and high SCC values from the U.S. estimates were used for sensitivity analysis (in order to capture the uncertainties of climate change impacts). The low-end value ($40.63/tC) and the high-end value ($192.06/tC) were reported in the preceding section on the economic value of stored carbon (2012 C$). These values were converted to annual values as a carbon annuity. Therefore, the low-end value was an estimated $1.58/tC/year and the high-end value was $7.46/tC/year. Based on the low and high annual SCC estimates, the total value for carbon stored by forests ranged from: 1) $1.8 billion per year ($414.51/ha/year) to $8.5 billion per year ($1,959.52/ha/year), based on the B.C. VRI forest area; and 2) $1.56 billion to $7.38 billion per year, based on the AAFC forest and tree-covered wetland cover area.[70]

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65 A CAA is an account where the full carbon value is placed directly into an annuity account, and as long as the sink remains in place, the carbon provides an annual earning/value from the annuity account. Swingland, I. (ed). 2003. *Capturing Carbon and Conserving Biodiversity: The Market Approach*. Earthscan Publications. London, U.K. http://books.google.ca/books?id=oPz8P6cZKUQC&printsec=frontcover#v=onepage&q&f=false; Feng, H. et al. 2002. "The Time Path and Implementation of Carbon Sequestration." *American Journal of Agricultural Economics*. 84:134-149.

66 Calculation: ($30,250 x 0.03887). The 3% rate over 50 years was used because a 3% discount rate is commonly used for socio-economic studies; and a 50-year timeline is a common length of time used for discount rate periods.

67 Calculation: 1,137,058,097 tonnes of carbon multiplied by $4.48/tC/year.

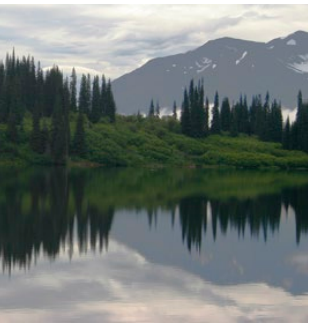
68 The above-ground stored carbon for treed wetlands was estimated as 102.8 tC/ha using the forest ecosystem carbon storage average of 262.5 tC/ha, minus the average soil carbon storage for forests (159.8 tC/ha) from the analysis of the study area's soil organic carbon storage by land cover type. The soil organic carbon data was extracted from: Tarnocai, C., and Lacelle, B. 1996. *Soil Organic Carbon Database of Canada*. Eastern Cereal and Oilseed Research Centre, Research Branch, Agriculture and Agri-Food Canada, Ottawa, Canada. The carbon stored in treed wetland soils is reported in the wetlands soils carbon storage section.

69 The total forest carbon included the aboveground tree biomass carbon for treed wetland areas. The soil carbon stored in treed wetland areas was included in the wetland carbon section.

70 Included the aboveground tree biomass from treed wetland. The above-ground carbon stored in treed wetlands ranged from a low of $62.5 million to a high of $295.2 million.

In summary, the value for stored carbon ranged from $1.8 billion to $8.5 billion per year, and from $1.56 billion to $7.38 billion per year, based on the B.C. VRI dataset and the AAFC land cover dataset, respectively. The central value for carbon stored by forests was estimated to range from $4.43 billion to $5.09 billion per year depending on the dataset input.

For comparison purposes, the value of carbon was estimated based on the 2012 B.C. Carbon Tax rate of $30 per tonne of CO_2 ($110.10/tC), or an annual value of $4.28/tC/year. The total annual value of carbon, using the provincial carbon tax rate, was $4.06 billion to $4.87 billion ($1,123.30/ha/year), based on the B.C. VRI dataset and the B.C. land cover dataset, respectively. The range in value based on the carbon tax rate was close in value to the central estimates above.



Wetlands globally cover only six to nine per cent of the Earth's surface, but contain about 35 per cent of global land-based carbon

PHOTO COURTESY JEAN-GUY DAILLAIRE/FLICKR CREATIVE COMMONS

The value of forest carbon was also estimated based on the price set by the B.C. government for the purchase of carbon offsets, which had been offered by the Pacific Carbon Trust (the former Crown Corporation was taken over by the Climate Investment Branch of the Ministry of Environment in March 2014). The price to sell carbon offsets was set at $25 per tonne of carbon dioxide equivalent ($91.75/tC), and the average price paid to forestry and energy companies for offset projects was $11.30/t$CO_2$e in 2012 ($41.47/tC).[71] The annualized values were estimated at $3.57/tC/year and $1.61/tC/year, respectively, based on an annuity approach (see Section 5.2.2.1). Therefore, the estimated value based on the provincial offset prices ranged from $1.5 billion to $3.4 billion per year—values also within the range of the annual SCC values reported above.

The carbon values reported here are average values per forest age class aggregated across the study area. This study also considered how these values might be adopted at a smaller scale for land-use decision making. For example, using the forest age carbon analysis, it was estimated that the cost of clearing one hectare of forest for other land use would result in a loss of stored carbon ranging from approximately 14.3 tC/ha (for a 10- to 20-year-old forest) to 263.3 tC/ha (for a 250-year-old or greater forest). Thus, the cost was estimated to range from $1,641.23/ha to $30,334.53/ha (depending on forest age), based on the social costs incurred due to the release of carbon ($115.23/tC; see Section 5.2.2.1), and $590.65/ha to $10,916.93/ha based on the option of a carbon offset price.

The annual rate of carbon accumulation referred to as carbon sequestration is often included as an ecosystem service value for forests. The estimates for average carbon sequestered per year were based on the forest age carbon analysis (excluding soil carbon). The average aboveground carbon sequestered per year was 1.18 tC/ha/year, worth an estimated $138/ha/year. This average value could be used when interpreting the costs of land-use change for forest lands. For example, the cost of clearing one hectare of forest could be estimated at $138/ha/year in terms of forgone annual carbon sequestration, based on the annual social costs incurred ($115.23/tC; see Section 5.2.2.1).

Carbon Stored in Wetland Soils

Wetlands play an important role in landscape function, including cycling of carbon, water and nutrients, purification of water, regulation of water flows and provision of habitats. In particular, wetlands store significant amounts of carbon in their rich organic soils and peat. For example, wetlands globally cover only six to nine per cent of the Earth's surface, but contain about 35 per cent of global land-based carbon, and may currently provide an annual net carbon sink of about 830 Mt each year.[72] In the study area, freshwater wetlands covered a total of 518,788 hectares. This included treed wetlands (384,922 ha), shrub-covered wetlands (131,523 ha) and grass-covered wetlands (2,344 ha).

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71 Pacific Carbon Trust. www.pacificcarbontrust.com. "BC Carbon Offset Program To Be Folded Into Climate Action Secretariat As Pacific Carbon Trust Winds Down." (Nov. 26, 2013). www.mondaq.com/canada/x/277426/Climate+Change/BC+Carbon+Offset+Program+to+be+Folded+into+Climate+Action+Secretariat+as+Pacific+Carbon+Trust+Winds+Down; "Pacific Carbon Trust's growing surplus approaches $30 million, fuelling calls for its elimination." (July 12, 2013). The Vancouver Sun. www.vancouversun.com/business/Pacific+Carbon+Trust+growing+surplus+approaches+million+fuelling+calls+elimination/8649076/story.html

72 Mitsch, W.J. et al. 2013. "Wetlands, Carbon and Climate Change." *Landscape Ecology*. 28: 583-597.

The carbon stored in wetland soils was determined using the Canadian Soil Organic Carbon Database (CSOCD).[73] The soil organic carbon data was extracted by land cover type from this geo-referenced database. According to CSOCD, the carbon stored in wetland soils in the study area was an estimated 253.9 million tonnes.

In order to estimate the value for carbon stored by wetland soils, the annual central social cost of carbon (SCC) value ($4.48/tC/year; see Section 5.2.2.1), was multiplied by the soil carbon stored per hectare of wetland (159.7 tC/ha for grass-covered wetlands, 471.5 tC/ha for treed wetlands and 547.9 tC/ha for shrub-covered wetlands).[74] The estimated annual values for soil carbon storage were $715/ha/year for grass wetlands, $2,112/ha/year for treed wetlands and $2,454/ha/year for shrub wetlands.[75]

The total value for carbon stored in wetland soils was therefore an estimated $1.14 billion per year. Using the low-end and high-end SCC values to take into account the uncertainty associated with the impacts of climate change, the total value was estimated to range from $400.9 million to $1.9 billion per year.

The annual carbon sequestration rate was calculated based on the average forest carbon sequestration rates for boreal freshwater wetlands, reported by Mitsch et al. (2013). Using the average rate for net carbon retention (0.29 tonnes per hectare per year), the annual rate of net carbon uptake was worth an estimated $33.42 per hectare (0.29 tC/ha multiplied by $115.23), or $17.3 million per year.

Also considered were the marginal value of losses due to the drainage of wetland, and the benefits of restoring wetlands. For example, a study on the restoration of prairie wetlands found that restoration results in a net increase of 0.89 tonnes of soil carbon per hectare per year (3.25 tCO_2e/ha/year). The same study reported that approximately 89 tonnes of soil carbon per hectare is lost when seasonal or permanent wetlands are drained. The results from this study were used to estimate a value for changes in wetland area. Thus, the value for restored wetland area was estimated at $102.05/ha/year (0.89 tC/ha/year multiplied by $115.23), and the cost of losses in wetland area was estimated at $10,256 per hectare, or $398.60/ha/year as an annualized value over 50 years (see Section 5.2.2.1 for economic value of stored carbon).

The total value for carbon stored in wetland soils was estimated at $1.14 billion per year.

PHOTO COURTESY TODD PIERSON/FLICKR CREATIVE COMMONS

Carbon Stored in Grassland, Shrubland and Cropland Soils

The amount of carbon stored in grassland, shrubland and cropland soils was determined using data from the Canadian Soil Organic Carbon Database.[76] Data was extracted spatially from this geo-referenced database for each land cover type. To estimate the value of the carbon stored by each land cover type, the average carbon per hectare was calculated from the CSOCD data, then multiplied by the annualized dollar value per tonne of carbon ($115.23/tC annualized to $4.48/tC/year; see Section 5.2.2.1).

The average carbon stored by grassland soils was 205.7 tC/ha, worth an estimated $921.32/ha/year. The average carbon stored by shrubland soils was 346.5 tC/ha, worth an estimated $1,552.03/ha/year. The average carbon stored by perennial cropland and pasture was 239.8 tC/ha, worth an estimated $1,073.77/ha/year. The average carbon stored by annual cropland soils was 263.8 tC/ha, worth an estimated $1,181.55/ha/year (Table 8).

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73 Tarnocai, C., and Lacelle, B. 1996. *Soil Organic Carbon Database of Canada*. Eastern Cereal and Oilseed Research Centre, Research Branch, Agriculture and Agri-Food Canada, Ottawa, Canada.

74 See Section 5.2.2.1 for explanation of annual value for SCC. A CAA is an account where the full carbon price is made directly into an annuity account, and as long as the sink remains in place, the carbon provides an annual earning/value from the annuity account; Swingland, I. (ed). 2003. *Capturing Carbon and Conserving Biodiversity: The Market Approach*. Earthscan Publications. London, U.K. http://books.google.ca/books?id=oPz8P6cZKUQC&printsec=frontcover#v=onepage&q&f=false; Feng, H. et al. 2002. "The Time Path and Implementation of Carbon Sequestration." *American Journal of Agricultural Economics*. 84:134-149.

75 The annuity coefficient applied to the full carbon value was based on 3% earnings over 50 years to estimate the annual value of the carbon storage. Calculation: (tC/ha * $4.48/tC/year). The 3% rate over 50 years was used because a 3% discount rate is a commonly used rate for socio-economic studies; and a 50-year timeline is a common length of time used for discount rate periods.

76 Tarnocai and Lacelle, supra note 73.

TABLE 8: CARBON STORED IN GRASSLAND, SHRUBLAND, PASTURE AND CROPLAND SOILS				
Land cover type	Average soil carbon (tC/ha)	Total carbon stored (tC)	Annual value ($/ha/year)	Total value ($/year)
Grassland	205.7	89,571,084	$921.32	$401,155,950
Shrubland	346.5	82,284,931	$1,552.03	$368,523,951
Perennial cropland/pasture	239.8	57,893,795	$1,073.77	$259,285,021
Annual cropland	263.8	32,122,393	$1,181.55	$143,864,388
Total		261,872,204		$1,172,829,309

It is important to note that these values do not reflect the impact of land use on soil carbon, because the CSOCD provides general soil organic carbon content based on soil types, climate and land capability. The higher carbon storage rate reported for annual cropland was likely a result of crop cultivation taking place on the carbon-rich, highly productive soils in the Peace River valley.

The total carbon stored by all four cover types in Table 8 was an estimated 261.9 million tonnes. The cumulative value for soil carbon storage by grassland, shrubland, perennial cropland/pasture and annual cropland was therefore approximately $1.17 billion per year (261,872,204 tC multiplied by $4.48). Using the low and high SCC values for sensitivity analysis (see Section 5.2.2.1), to account for the uncertainties of climate change, the cumulative value was estimated to range from $413.5 million to $1.95 billion per year.

The annual carbon sequestration rates were included for grassland, shrubland and perennial cropland and pasture. Carbon sequestration rates were based on the marginal increase in carbon sequestration resulting from the conservation of natural cover. Smith et al. (2001) reported that conservation measures that maintained a natural cover such as grassland and perennial cover resulted in an increase of 0.49 tonnes of carbon per hectare per year.[77] The average SCC from Section 5.2.2.1 ($115.23/tC) was used in this study; the value was not annualized because carbon sequestration rates are reported per annum. Thus, the annual carbon sequestration was an estimated $56.20/ha/year. The cumulative value for annual carbon sequestration by the three natural cover types was an estimated $51.4 million per year (including $13,345,501 per year by shrublands, $24,472,049 per year by grasslands and $13,571,667 per year by perennial crop lands and pasture).

5.2.3 FLOOD CONTROL AND WATER SUPPLY — WETLANDS

Wetlands provide many ecosystem services that contribute to human well-being, including: providing food, fuelwood and water; maintaining flood control, water supply and water quality; and habitat and cultural services such as the provision of nesting areas and recreation. Wetland systems throughout watersheds affect the health and productivity of downstream human communities and the productivity of freshwater ecosystems. In regions where agricultural land use is present, wetlands can reduce the levels of excess nutrients flowing into rivers and lakes. Wetlands recharge water supplies to aboveground water bodies such as lakes and rivers as well as groundwater, and control floods by storing large amounts of water and regulating its flow.

77 Smith W.N. et al. 2001. "Estimated changes in soil carbon associated with agricultural practices in Canada." *Canadian Journal of Soil Science*. 81:221-227.

Wetlands recharge water supplies to aboveground water bodies such as lakes and rivers as well as groundwater, and control floods by storing large amounts of water and regulating its flow.

PHOTO COURTESY WAYNE SAWCHUCK/PICTURE BC

Local studies on the economic value of wetland ecosystem services in the study area could not be found. As a result, the value of flood control and water supply provided by wetlands was transferred from a global study that provided average values for Canada.[78] The study is the most recent meta-analysis for wetland values in agricultural landscapes of North America and Europe. It reports average values for three regulating services: flood control, water supply and nutrient recycling. A meta-analysis synthesizes the results of multiple studies that examine similar ecosystems (in the case of ecosystem services), synthesizes site results for transfer valuations, and uses statistical analyses to identify and quantify characteristics that define variations in the values.

The overall average values reported for wetlands from 66 separate value estimates were: $7,971/ha/year for flood control services; $3,902/ha/year for water supply; and $6,664/ha/year for nutrient recycling services (2012 C$). However, only the results based on estimates from studies in Canada were used, totalling US$256.67/ha/year (2007 $) for all three ecosystem services. The most common valuation methods used to estimate these ecosystem services were the cost of replacing the service with constructed infrastructure (i.e., the cost of constructing flood control measures equal to the protection provided by one hectare of wetland). Regional estimates for transfer values were provided by further analysis using a statistical model (meta-regression model), and a GIS-based analysis of population size surrounding each wetland, the total area of wetlands (i.e., value per hectare was lower in larger wetlands) and wetland abundance (i.e., as the area of other wetlands increases, the per-hectare value decreases).

The results of the meta-analysis were reported by country. The estimated average value for Canada for all three services was US $223/ha/year (2007 $). This value was an average based on analysis of 3,560 wetland sites across Canada (8 million hectares in area). This value was converted to 2012 Canadian dollars ($256.67/ha/year), then multiplied by the total wetland area (518,788 ha). The total value was therefore an estimated $133.2 million per year.

78 Brander, L., Brouwer, R., and Wagtendonk, A. 2013. "Economic valuation of regulating services provided by wetlands in agricultural landscapes: A meta-analysis." *Ecological Engineering*. 56: 89-96.

5.2.4 WASTE TREATMENT — WETLANDS

Wetlands absorb nutrients, such as nitrogen (N) and phosphorus (P), which occur naturally in the environment. These nutrients are present in excessive amounts in the runoff from agricultural areas, both in livestock manure and because of the large amounts of fertilizers applied to croplands. The amount that a wetland can absorb varies depending on its type, size, plants and soils. Estimates range from 80.3 to 770 kilograms per hectare per year for phosphorus removal, and 350 to 32,000 kilograms per hectare per year for nitrogen removal.[79] These are important functions because excessive nutrients and sediments can reduce the availability of oxygen in water, which in turn can kill fish, reduce recreational opportunities and habitat for waterfowl, and affect drinking water quality.

The low-end wetland nutrient removal rates were applied to wetland cover in the study area to estimate the area's capacity to absorb nutrients. The results showed that the study area's wetlands have the capacity to remove 41.7 million kilograms of phosphorus and 181.6 million kilograms of nitrogen each year (across 518,788 hectares of wetlands).[80]

Wetlands absorb nutrients present in excessive amounts in runoff from agricultural areas, both in livestock manure and because of the large amounts of fertilizers applied to croplands.

PHOTO COURTESY ZACK EMBREE, FRACTURED LAND DOCUMENTARY

Residual soil nitrogen (RSN) is the amount of nitrogen that has been applied to soils but not removed by the harvested portion of crops. In other words, it is the difference between all nitrogen inputs, including fertilizers, manure and natural processes, and the nitrogen removed by the crops harvested and through natural processes such as volatilization and denitrification.[81] According to an Agriculture and Agri-Food Canada report, the majority of farmland in British Columbia in 2006 was in the very low to moderate categories in terms of the residual soil nitrogen on farmlands (0 to 30 kg N/ha; average of 20 kg N/ha). The risk of contamination of water was determined by the ability of natural ecosystems to regulate, filter and absorb nutrients in runoff.[82] In B.C., the majority of farmland (88 per cent) was in the very low to low risk classes (0.1 to 9.9 kg of N/ha) in terms of the risk of contamination.[83] This information was verified visually using the AAFC report's online map display for the Peace River Watershed, which illustrated that the majority of the PRW had very low risk in both categories.[84]

Based on the estimated average residual soil nitrogen and the risk of water contamination by nitrogen indicators, the estimated nitrogen loss from the primary study area's agricultural lands was 608,794 kilograms per year, based on an annual loss of an average 5 kilograms N/ha (i.e., very low risk of contamination). The total excess nitrogen was evenly distributed across the wetland area for valuation purposes. Therefore, it was estimated that an average of 1.17 kg of excess nitrogen was treated per hectare of wetland.

The capacity for phosphorus removal by the study area's wetlands (41.7 M kg P) was calculated using a low-end estimate from the literature (80.3 kg/ha/year) multiplied by the wetland area (518,788 hectares). The average excess phosphorus for British Columbia agricultural lands (4 kg/ha/yr) was then used to estimate the total excess phosphorus for the study area. Based on the B.C. average excess phosphorus, the total excess phosphorous from agricultural lands was an estimated 487,035 kg/year. The total excess phosphorous was evenly distributed across the wetlands in the study area for valuation purposes. Therefore, it was estimated that an average 0.94 kg of excess phosphorous was treated per hectare of wetland.

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79 Olewiler, N. 2004. *The Value of Natural Capital in Settled Areas of Canada*. Ducks Unlimited and Nature Conservancy of Canada.

80 Calculation: 518,788 hectares of wetlands multiplied by the low-end estimates of removal rates of 80.3 kg/ha/year of phosphorus and 350 kg/ha/yr of nitrogen.

81 Eilers, W., MacKay, R., Graham, L., and Lefebvre, A. (eds). 2010. *Environmental Sustainability of Canadian Agriculture: Agri-Environmental Indicator Report Series — Report #3*. Agriculture and Agri-Food Canada, Ottawa, Canada. http://publications.gc.ca/collections/collection_2011/agr/A22-201-2011-eng.pdf (accessed January 2014).

82 Ibid.

83 Across Canada, the average nitrate loss from agricultural lands increased by 25% from 6 kilograms per hectare in 1981 to 7.6 kilograms per hectare in 2001, and nitrate concentration in water was 24% higher in 2001 than in 1981.

84 Agriculture and Agri-Food Canada. Agri-Environmental Indicators application. Modified Jan. 9, 2013. http://atlas.agr.gc.ca/agmaf/index_eng.html#context=aei-iae_en.xml

The replacement costs for removing nitrogen (N) and phosphorus (P) by waste treatment plants were estimated as $6.82 per kilogram of nitrogen and $49.10 per kilogram of phosphorus (2012 $).[85] The respective average replacement costs were used as a proxy for the value of wetland waste treatment services for excess nitrogen and phosphorous. The average annual value for excess nitrogen removal by the study area's wetlands was thus estimated as $8 per hectare (1.17 kg/ha/year multiplied by $6.82), and the average annual value for excess phosphorous removal was estimated as approximately $46.10 per hectare (0.94 kg/ha/year multiplied by $49.10).

The two average replacement values for excess nitrogen and phosphorus removal were tallied to estimate the total value of waste treatment by wetlands as $28.1 million per year ($54.10/ha/year).

5.2.5 WASTE TREATMENT AND SEDIMENT REDUCTION — GRASSLAND AND PERENNIAL COVER

Treatment of phosphorus and sediment removal were evaluated as ecosystem services provided by grasslands and perennial cover/pasture. The values were transferred from a study undertaken in the Grand River watershed in Ontario.[86] This study reported the net value of conserving natural cover or restoring tiled lands to natural cover. The average values (converted to 2012 $) were $27.93/ha/year for phosphorus reduction and $6.60/ha/year for sediment reduction. The net values reflected the avoided costs for water treatment for each type of service. These values were applied to the grassland and the perennial/pasture in the study area. The annual value for grasslands was $12.2 million for the avoided costs of phosphorus treatment, and $2.9 million for the avoided costs of sediment removal. The annual value for perennial cropland/pasture was $6.7 million for the avoided costs of phosphorus treatment, and $1.6 million in avoided costs of sediment removal.

Forests and wetlands can help purify water sources by filtering, storing and transforming pollutants as rain falls and as water moves across the landscape to rivers, streams and lakes.

PHOTO COURTESY JONATHAN BRENNECKE/FLICKR CREATIVE COMMONS

5.2.6 WATER FILTRATION — FORESTS

A safe and reliable source of water is critical for all living things. Poor water quality degrades water supplies, fish habitat and recreational areas. Forests and wetlands can help purify water sources by filtering, storing and transforming pollutants as rain falls and as water moves across the landscape to rivers, streams and lakes.

Forested watersheds are vital for a clean and regular supply of drinking water. Protected forests provide higher-quality water with less sediment and fewer pollutants than water from watersheds with unprotected forests.[87] A U.S. study found that the cost of treatment for surface water supplies varies depending on the percentage of forest cover in the water source area.[88] This analysis showed that a 10 per cent loss in forest cover across a watershed resulted in a 20 per cent increase in water treatment costs. In other words, as forest cover declined, water treatment costs grew. Similarly, a study undertaken in France demonstrated that an increase in forest land cover led to a decrease in water treatment costs. This study found that one hectare of restored forest would generate an average savings of 138 per year (C$209.24) on household

85 Olewiler, supra note 79. The costs of removing nitrogen (N) and phosphorus (P) by waste treatment plants were reported to range from $3 to $8.50 per kilogram of nitrogen and $22 to $61 per kilogram of phosphorus based on rates in Metro Vancouver (2003 $).

86 Ibid.

87 Dudley, N., and Stolton, S. 2003. *Running Pure: The importance of forest protected areas to drinking water*. World Bank/WWF Alliance for Forest Conservation and Sustainable Use. Washington, D.C.

88 Ernst, C., Gullick, R., and Nixon, K. 2007. "Protecting the Source: Conserving forest to protect water." In *The Economic Benefits of Land Conservation*. The Trust for Public Land. www.tpl.org/protecting-source

water bills in the region studied, based on a decrease in the cost of drinking water supply of 0.015 per cubic metre of water when afforestation took place on agricultural lands.[89]

The statistical relationship between forest cover and cost of water treatment established by the U.S. study was used to estimate the value of water filtration services provided by forest cover in the study area. Therefore, the economic value of water filtration services was calculated based on the avoided costs provided by the current level of forest cover.[90]

First, the current proportion of forest cover in the study area's watershed was assessed (approximately 70 per cent forested lands). Then the current cost of water treatment was researched, based on the cost of water treatment in Fort St. John ($2.78 per cubic metre).[91] The annual residential water used in the PRW (3.4 million cubic metres) was estimated based on the number of households in the B.C. PRW (20,935 households; an estimate based on the current population) and the average daily water use by households in Fort St. John (450 litres/day).[92] As a proxy value for the total forested area, it is estimated that the total value of the avoided costs of water treatment was $24.7 million per year ($6.23/ha/year). This calculation was based on a model that calculated the avoided costs for each 10 per cent loss in forest cover, based on the correlation between water treatment costs and forest cover.

A marginal cost for this value was also calculated, based on our economic model. If forest cover were to decline from 70 per cent to 60 per cent, the cost for water treatment was estimated to increase from $2.78 to $3.34 per cubic metre, resulting in an additional annual cost of $1.9 million per year. Used as a proxy to value the water filtration services provided by forests, the marginal value of a 10 per cent loss was an estimated $4.83/ha/year (or a total value of $1.9 million). If forest cover declined by one per cent, the estimated marginal value was $2.96/ha/year.

It is useful for comparison to consider the total replacement cost for water. If daily residential water use in the PRW had to be replaced by bottled water, the daily cost would be $14.1 million (9.4 million litres at $1.50 per litre), or the equivalent of $5.2 billion per year.

5.2.7 POLLINATION

About 30 per cent of the world's food production comes from crops that depend on pollinators such as bees, insects, bats and birds.[93] The value of bee pollination for crops in Canada has been conservatively estimated at $1.42 billion per year (2012 $).[94]

Honeybees provide about 90 per cent of managed pollination services, but wild bees add significant value to crops. For example, the contribution of wild pollinator services in the United States is estimated to be more than $3 billion annually.[95] Visits by bumblebees can increase tomato fruit set by 45 per cent and fruit weight by 200 per cent; and wild pollinators produce larger and more symmetrical apples in orchards, increasing

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89 Abildtrup, J., Garcia, S., and Stenger, A. 2013. "Effect of forest land use on cost of drinking water supply: a spatial econometric analysis." *Ecological Economics*. 92:126-136.

90 Ernst, C., Gullick, R., and Nixon, K. 2007. "Protecting the Source: Conserving forest to protect water." In *The Economic Benefits of Land Conservation*. The Trust for Public Land. www.tpl.org/protecting-source

91 Fisher, E. 2013. "Fort St. John water treatment plant could reach capacity in 5 to 10 years." Energetic City. http://energeticcity.ca/article/news/2013/06/25/fort-st-john-water-treatment-plant-could-reach-capacity-in-5-to-10-years

92 Municipal water use per person was reported by the Conference Board of Canada from municipal statistics from Environment Canada. See: www.conferenceboard.ca/hcp/details/environment/water-consumption.aspx

93 Klein, A.-M., et al. 2007. "Importance of pollinators in changing landscapes for world crops." *Proceedings of the Royal Society B*. 274:303-313.

94 Environment Canada. 2003. "Protecting Plant Pollinators." *Envirozine*. Issue 33 (June 26, 2003). www.ec.gc.ca/EnviroZine/english/issues/33/feature3_e.cfm (accessed February 2008)

95 Losey, J.E., and Vaughan, M. 2006. "The Economic Value of Ecological Services Provided by Insects." *BioScience*. 56:311-323.

The proximity of natural habitat to cropland is significant for optimum yields and increases farm production.

PHOTO COURTESY KYLEWITH/ FLICKR CREATIVE COMMONS

returns by $250 per hectare.[96] The proximity of natural habitat to cropland is significant for optimum yields and increases farm production. For example, a Canadian study demonstrated that increases in canola yield were correlated to the close proximity of uncultivated areas providing nectar. Similarly, studies that examined pollination services and the surrounding land use found that natural habitat near farms increased pollination services.[97]

Many pollinators are in decline because of habitat destruction and pesticide use. Diverse habitats that are home to a variety of flowers provide the best forage for pollinators. Flower-rich field borders, windbreaks such as hedgerows, forests and riparian buffers encourage a wide variety of pollinators.[98]

According to the B.C. government, the Peace River valley is unique in offering ideal climate conditions and nectar forage availability for honeybees during the summer. This area is among the most productive honey-producing regions in the world. Average honey yield per colony often exceeds 200 pounds, and individual colonies may sometimes produce in excess of 400 pounds in one season.[99]

The B.C. Ministry of Agriculture estimated the value of pollination in the province at $391.3 million in 2008 (2012 $), however, pollination values were not provided by district.[100] For the PRW, it was estimated that approximately 31 per cent of the provincial pollination value was attributable to the Peace River Regional District, and about 43.7 per cent of the district's pollination value was attributable to the study area. Thus, the pollination value for the study area was an estimated $39.9 million. The total pollination value for the study area was attributed to the land cover types that provide pollinator habitat and nectar, including grasslands, shrublands and perennial croplands/pasture (total of 914,332 ha). Therefore, the value per hectare was $43.62/ha/year ($39,885,653 / 914,332 hectares).

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96 Greenleaf, S.S., and Kremen, C. 2006. "Wild bee species increase tomato production and respond differently to surrounding land use in Northern California." *Biological Conservation*. 133:81-87; Kevan, P.G. 1997. "Honeybees for better apples and much higher yields: study shows pollination services pay dividends." *Canadian Fruitgrower*. (May 1997): 14, 16. (cited by FAO)

97 Greenleaf and Kremen, supra note 96; Greenleaf, S.S., and Kremen, C. 2006. "Wild bees enhance honey bees' pollination of hybrid sunflower." *Proceedings of the National Academy of Sciences*. 103:13890-13895.

98 Environment Canada. 2003. "Protecting Plant Pollinators." *Envirozine*. Issue 33 (June 26, 2003).

99 Apiculture Factsheet 101. www.agf.gov.bc.ca/apiculture/factsheets/101_hist.htm

100 Estimated annual value of Honeybee and Bumblebee Pollination in BC (2008). B.C. Ministry of Agriculture and Lands. www.agf.gov.bc.ca/apiculture/statistics/pollin.value2008.pdf

5.3 Habitat Values

Habitat refers to the biological and physical space and processes in which wild species meet their needs. Ecosystems provide physical structure, adequate food availability, a suitable climate and temperature, and protection from predators. Habitat also provides refuge and nursery functions. The biological diversity of habitat creates the physical structure and complexity of ecosystems that provide resiliency and ecosystem services.

The Peace River is home to important sport fish species, as well as key habitat for nesting and migratory birds, along the river and in upland areas. Twelve species of fish are common in the Peace River, downstream of the Peace Canyon Dam between Hudson's Hope and Fort St. John. The most abundant fish species are mountain whitefish, Arctic grayling, rainbow trout, lake whitefish and walleye. Bull trout, Kokanee and northern pike are also present, but in lower numbers. The Peace River valley and uplands provide habitat for nesting and migratory waterfowl. Songbirds, some of which are rare in British Columbia, regularly migrate through the area. In addition, the south-facing banks of the Peace River and its major tributaries provide extensive areas of critical ungulate (deer, moose) wintering habitat.

The Peace River is home to key habitat for nesting and migratory birds, along the river and in upland areas.

PHOTO COURTESY RICK LECHE/ FLICKR CREATIVE COMMONS

Given that the study area offers important habitat for migratory birds, a value for the habitat provided by wetlands was included. The value was transferred from a 2004 wetland meta-analysis, which used 246 individual wetland valuations based on several different valuation approaches and metrics (e.g., willingness to pay for wetlands, marginal value per acre). About 60 per cent of the study's values were from the U.S., Canada, Australia and Europe. According to these results, the average value for wetland habitat was $379.43 per hectare per year (converted to 2012 C$).[101] This average value was transferred to the wetlands in the study area. Thus, the total value for habitat provided by wetlands was an estimated $196.8 million per year ($379.43 multiplied by 518,788 hectares of wetlands).

Despite the importance of the study area for numerous species (e.g., caribou and grizzly bears), other habitat values were not included because of a lack of available ecosystem services valuation information.

5.4 Recreation Values

The Peace River Valley and its greater watershed attract visitors from within British Columbia as well as tourists from across Canada and other countries. The area provides beautiful landscapes, recreational opportunities and wildlife viewing. Recreational activities include hiking, swimming, camping, hunting, fishing, kayaking, canoeing, river boating, horseback riding, geocaching, birding and photography.

According to an Environment Canada survey, B.C. residents spent $1.9 billion in 1996, equivalent to $2.59 billion in 2012, on recreational activities associated with natural areas.[102] This survey is likely an underestimate of the economic impact of outdoor recreation in the province. For example, a B.C. government study reported that wildlife viewers spent $6.2 billion on wildlife viewing activities in the province in 1996.[103] In addition, recreational users were asked how much more money they were willing to pay to maintain their recreational activities. In B.C., the willingness to pay beyond expenditures was a total of $342 million in 1996, equivalent to $465 million in 2012 dollars.

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101 Brander, L., and Schuyt, K. 2004. *Economic Values of the World's Wetlands*. Institute for Environmental Studies and WWF-International. Gland, Switzerland/Amsterdam, the Netherlands. Meta-analysis refers to a quantitative analysis of statistical summary indicators reported in a series of similar empirical studies.

102 Duwors, E. et al. 1999. *The Importance of Nature to Canadians: The Economic Significance of Nature-Related Activities*. Environmental Economics Branch. Environment Canada. Ottawa, Canada.

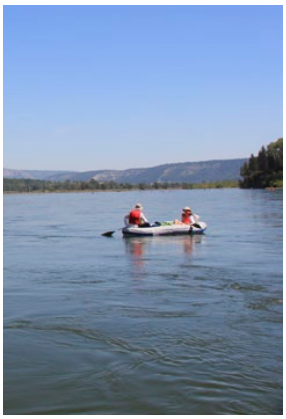
103 *1998 Economic Value of Wildlife Activities in B.C.* Wildlife Branch. Ministry of Environment, Lands and Parks. (reported in Tourism B.C. Wildlife Viewing Product Overview. April 2009. www.destinationbc.ca/getattachment/Research/Research-by-Activity/Land-based/Wildlife_Viewing_Sector_Profile.pdf.aspx)

This included outdoor activities in natural areas, wildlife viewing and recreational fishing and hunting. The average yearly amount spent per participant by activity was $1,225.79 (2012 $) per year for outdoor activities, and $570.77 (2012 $) per year for wildlife viewing. The above figures were used to estimate values for outdoor activities in natural areas and wildlife viewing for the study area. In order to interpret these values, it was estimated that the number of residents within the study area participating in outdoor recreation was 47,627 people (91 per cent of the population).[104] The rate of participation was taken from a recent outdoor recreation survey undertaken in British Columbia, which reported that 91 per cent of B.C. residents participate in outdoor recreation.[105] As a result, it was estimated that the direct economic value for outdoor activities in natural areas and wildlife viewing was $85.6 million ($58.4 million and $27.2 million, respectively).[106]

The value of freshwater recreational fishing was estimated based on a 2010 study commissioned by the Freshwater Fisheries Society of BC. This study reported that more than 3.8 million freshwater angling days took place in B.C. in 2010, which had a direct economic impact of $545.7 million per year.[107] We calculated that, on average, each angling day had a value of $143.03 ($545.7 million / 3,815,416). According to the same report, 64,186 of the total annual angling days took place within the Peace region. It was therefore estimated that the economic impact of freshwater angling in the Peace region was approximately $9.2 million. The boundaries of the Peace region within the above report were not specified, but we estimated that about 82.5 per cent ($7.6 million) could be attributed to the study area, based on the fact that the majority of the greater Peace district's population resides within the study area.[108] The value per hectare of freshwater in the study area was therefore estimated at $98.67/ha/year for recreational fishing.

The marginal value for nature-related recreation for the study area was also estimated. The 1996 study from Environment Canada reported that the willingness to pay (WTP) beyond current expenditures for nature-related recreational activities was $224.64 per year for outdoor activities in natural areas, $144.87 per year for wildlife viewing and $189.03 per year for recreational fishing (2012 $). Thus, the marginal value for recreation in the study area was an estimated $32.2 million per year in terms of the economic value placed on outdoor recreational experiences beyond current expenses paid.

The total value of nature-related recreation within the study area was therefore an estimated $119.7 million per year (2012 $), including $85.6 million for outdoor activities and wildlife viewing in natural areas (plus $17.6 million in contingent WTP economic value), and $7.6 million for recreational fishing (plus $9 million in contingent WTP economic value). The annual values were attributed to the study area's land cover as $21.13 per hectare for outdoor activities and wildlife viewing in forest, wetland, grassland and shrubland cover (4,882,140 hectares), and $215.97 per hectare for freshwater fishing (angling) in freshwater areas (76,751 hectares).



The average yearly amount spent per participant was $1,226 for outdoor activities and $571 for wildlife viewing.

PHOTO COURTESY DON HOFFMANN

104 Total population of residents participating in outdoor recreation was calculated as 91% of the estimated population for the study area based on the Peace River Regional District's total population. The total population was estimated as 52,337 as reported by B.C. 2012 statistics (includes Fort St. John, Dawson Creek, Chetwynd, Hudson's Hope, Pouce Coupe, Tumbler Ridge, Taylor, and 50% of unincorporated areas).

105 Sorensen-Lawrence, L. et al. 2013. *2009/10 Outdoor Recreation Study: BC Resident Participation*. Prepared by NRG Research Group, and B.C. Ministry of Jobs, Tourism and Skills Training. Tourism BC. www.destinationbc.ca/getattachment/Research/Research-by-Activity/Other/Outdoor-Recreation-for-Distribution-14Jan13-FINAL-DRAFT-%282%29.pdf.aspx

106 Values were calculated using the estimated number of participants in the study area multiplied by the average amount spent annually on each activity.

107 Bailey, M., and Sumaila, U.R. 2012. *Freshwater Angling and the B.C. Economy*. Report prepared for Freshwater Fisheries Society of BC. (Summary report is available at: http://www.gofishbc.com/documents/pdf/news-and-events/2013_BC_Freshwater_Sport_Fishing_Economic_Impact_Report.pdf)

108 Percent of Peace River Regional District population located within the study area was estimated using B.C. 2012 statistics.

5.5 Cultural and Spiritual Values

5.5.1 ANCESTRAL AND CURRENT FIRST NATIONS CULTURAL VALUES

The Peace River valley boasts a culturally rich history. Indigenous peoples have lived in the Peace River region for centuries.

The study area is located within the boundaries of Treaty 8, which was the eighth treaty signed between First Nations and the Canadian government in 1899. The treaty allowed for the sharing of lands in northeastern B.C., northern Alberta and northwestern Saskatchewan. The First Nations Reserves within the study area (11,443 hectares), include East Moberly Lake 169, West Moberly Lake 168A, Beaton River No. 204 (North Parcel), Beaton River 204 (South Parcel), Halfway River 168, Blueberry River No. 205, Doig River 206 and Finlay Bay Indian Reserve No. 21.[109]

For First Nations in the region, the land and waters of the Peace Valley are an integral part of their identity, their stories, their songs and their language. The valley is shared among First Nations groups for historic, cultural and subsistence purposes. Communities continue to share their culture with younger generations through trapping, fishing, hunting, the collection of medicinal plants, crafts, ceremonies, canoes and drums.

While some studies have been done to estimate the economic value of wilderness to First Nations, such as a willingness-to-pay study conducted for aboriginal communities in Saskatchewan and a study on food replacement costs from other northern communities in western Canada (see *First Nations Cultural Values* on page 50), this study provides instead an overview of the cultural and spiritual values of the Peace region to the local First Nations, as described in their own words in a Traditional Land Use Study (TLUS) prepared by the Treaty 8 Tribal Association in 2012 for BC Hydro's Proposed Site C project.[110] The TLUS identified 796 site-specific use values that were mapped in the Peace River Valley, mostly clustered along the low-lying Peace River flats and adjacent streams. The cultural and spiritual values included:

- Spiritual places
- Burials
- Medicine collection areas
- Teaching areas
- Ceremonial and prayer offering places
- Locations associated with place names and oral histories
- Habitat areas
- Movement corridors
- River crossing areas for ungulates and large carnivores (i.e., grizzly bears)
- Winter fish habitat and spawning areas
- Bear dens
- Moose and ungulate calving areas and winter browse

109 Lee and Hanneman, supra note 1.

110 Candler, C. 2012. *Doig River First Nation, Prophet River First Nation, Halfway River First Nation and West Moberly First Nations Traditional Land Use Study Data and Methodology Report for BC Hydro's Proposed Site C Project*. Prepared on behalf of the four participating First Nations (Doig River First Nation, Prophet River First Nation, West Moberly First Nations and Halfway River First Nation). Submitted to Treaty 8 Tribal Association (T8TA).

Communities continue to share their culture with younger generations through trapping, fishing, hunting, the collection of medicinal plants, crafts, ceremonies, canoes and drums.

- Temporary and permanent or regularly used camping/habitation areas
- Gathering places including locations used for generations
- Fish harvesting sites (i.e., bull trout, dolly varden, rainbow trout, grayling, whitefish)
- Preferred harvesting areas for berries, plant foods and wood materials
- Preferred drinking water sources
- Kill sites for moose, deer, black bear, small birds and furbearers
- Transportation values including trails, horse crossings and boat crossings
- Water routes by canoe and motorboat

Key sites identified included Lynx Creek, Peace River Islands, Bear Flats, Cache Creek, Bison Jump, Halfway River, Moberly River and Hudson's Hope.[111]

Lynx Creek was an ancestral gathering place for Dane-zaa families prior to and after the signing of Treaty 8. It includes permanent camping and habitation areas, preferred hunting and fishing areas, important wildlife habitat and associated oral histories.

Peace River Islands provide wildlife habitat and are considered sacred refuge areas for animals, especially moose and deer during calving and rearing. Hunting for subsistence is restricted. The islands also have specific histories associated with spiritual and cultural importance.

Bear Flats and Cache Creek, located along the river valley, were, like Lynx Creek, ancestral gathering places for Dane-zaa families. These locations are still regularly used for camping and habitation, ceremonies, sacred areas, preferred fishing and hunting sites, significant wildlife habitat, freshwater springs, trail and transportation routes, as well as oral histories.

111 Ibid.

FIRST NATIONS CULTURAL VALUES

Cultural values are irreplaceable, so it is difficult to place a monetary value on them. Since they are vital to First Nations, they are considered invaluable. However, studies have reported non-use values for aboriginal communities. For example, a Saskatchewan study surveyed aboriginal and non-aboriginal households to assess their willingness to pay (WTP) for the protection of wilderness.[a] The aboriginal households on average were willing to pay $84.62/hhld/year (1991 $) in terms of an existence or non-use value (i.e., recreational value was reported as a separate value). If we transferred this value to the First Nation populations in our study area, the WTP of $125.13/hhld/year in 2012 dollars would be multiplied by the estimated number of aboriginal households in the Peace River watershed (2,794 hhlds). The cultural non-use value could then be estimated at $349,613 per year.

In addition, the subsistence values such as wood harvesting, hunting, fishing, trapping, food gathering and the use of natural materials for crafts and medicines for First Nations lands have also been evaluated in other regions of Canada. For example, in a northern Alberta study, the replacement value of subsistence foods and materials was estimated to range from $6,875 to $15,126 (2012 $) per household for northern communities.[b] The replacement cost depends on the amount of subsistence food and materials collected and used by First Nations and the local prices of purchasing food and materials. If we transferred this value for our study area, based on the estimated number of FN households the potential subsistence values for First Nations ranges from $19.2 million to $42.3 million per year. It would be valuable to undertake a study in the future to document subsistence products and values for the PRW region. The WTP and subsistence values were not included in the overall ES total values, but they are reported here for as illustrative examples.

However, this accounting fails to take into account the cultural and spiritual values of subsistence hunting—which often form the fabric of a community's identity. As noted in report *The Cultural and Ecological Value of Boreal Woodland Caribou Habitat*,[c] released in 2013 by the David Suzuki Foundation and the Assembly of First Nations, hunting is often integral to many First Nations as much for its role in strengthening knowledge and relationships, as for providing nutrition and recreation, meaning, health and wellness.

As the report notes: "...[T]he sharing of the harvest is an important source of nutrition and satisfaction for recipients, and a source of respect for generous harvesters.... Economic valuation of this sharing would almost certainly underestimate the true value and motivations for such social institutions."

[a] Kulshreshtha, S.N., and Loewen, K.G. 1997. "Value of Wilderness Protection in Saskatchewan: A Case Study of Existence Values." In: Sustainable Forests: Global Challenges and Local Solutions. Haworth Press.

[b] M.K.Haener and W.L.Adamowicz, "Regional Forest Resource Accounting; a northern Alberta case study," Canadian Journal of Forest Research 30 (2000).

[c] The Cultural and Ecological Value of Boreal Woodland Caribou Habitat, davidsuzuki.org/publications/downloads/2012/Report-Caribou.pdf

In a 2012 northern Alberta study, the replacement value of First Nations land subsistence foods and materials was estimated to range from $6,875 to $15,126 per household for northern communities.

PHOTO COURTESY ZACK EMBREE, *FRACTURED LAND* DOCUMENTARY

Halfway River is an ancestral gathering place for Dane-zaa families that is still used regularly. Traditional use of the area includes cultural sites for permanent camping and habitation, burials, sacred areas, oral histories, preferred fishing areas for bull trout and significant ungulate winter range.

Moberly River values include ancestral gathering places that are still used on both sides of the river, including camping and habitation areas, trails and associated oral histories.

Hudson's Hope was another ancestral gathering place for Dane-zaa families, especially for Halfway River and West Moberly First Nations (formerly the Hudson's Hope Band). It was and still is used as a permanent camping and habitation area. There are multiple burial sites, sacred and ceremonial sites, preferred fishing areas and associated oral histories, including the signing of Treaty 8.

These cultural values are irreplaceable, so it is difficult to place a monetary value on them.

5.5.2 FARMLAND LANDSCAPE CULTURAL VALUES

The value of farmland landscapes was reported for the Fraser Valley in a 2007 study in Abbotsford, B.C. Abbotsford residents indicated that they were willing to pay $113 (2012 $) per hectare per year to protect farmland landscapes.[112] In order to transfer a value for the study area, the total value reported in the original study ($6.4 million/year) was converted to a per-household value ($162.83/hhld/year), based on the number of households in the original study area of Abbotsford. The per-household value was then transferred to the study area, and adopted as the cultural value for farmland landscapes in the Peace River Watershed. The number of households in the study area (20,935 households) was estimated based on the study area's approximate population. Therefore, the total value was an estimated $3.4 million (20,935 hhlds multiplied by $162.83), or an annual value of $9.38 per hectare of farmland ($3,408,781 / 363,230 ha), including annual cropland and perennial cropland and pasture.

112 *Public Amenity Benefits and Ecological Services Provided by Farmland to Local Communities in the Fraser Valley: A Case Study in Abbotsford, B.C.* 2007. Strengthening Farming Report. File Number 800.100-1. B.C. Ministry of Agriculture and Lands.

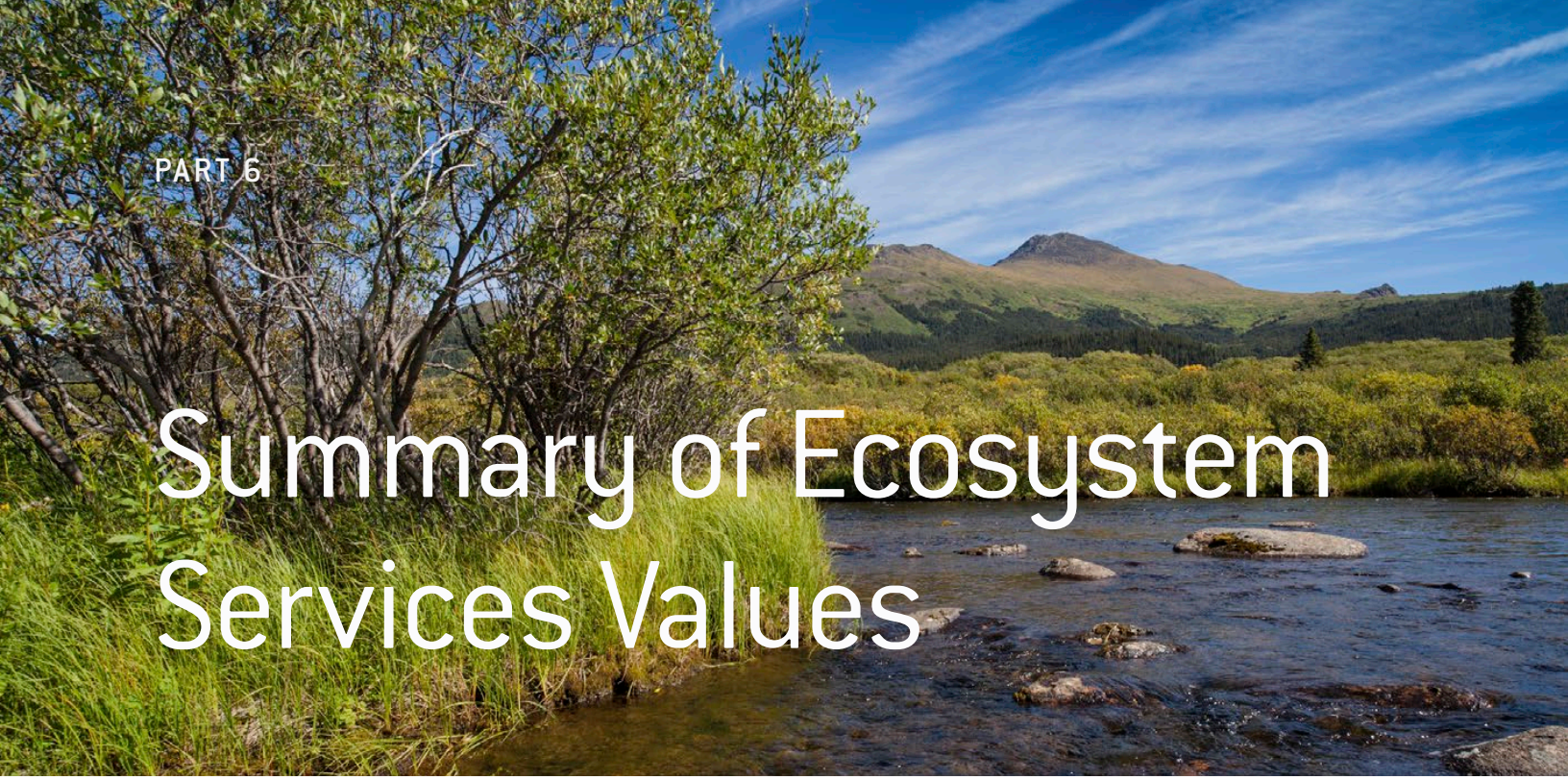
5.5.2 WILDERNESS PROTECTION CULTURAL VALUE

Non-use existence values for the protection of wilderness were considered within the study area. The results of a B.C. province-wide mail survey that was undertaken to determine the value that residents place on wilderness protection were used.[113] The survey asked a referendum-type question regarding how much more taxes and fees households would be willing to pay to double protected wilderness terrain (defined as roadless, undeveloped areas) across the province. This survey found that B.C. households were willing to pay, on average, between $108 and $130 annually ($138 to $166/year in 2012 $). An average of the two values, $152/hhld/year (2012 $), was used, with an estimate that about 50 per cent of the population of the PRW would be willing to pay this amount (approximately 54 per cent of residents returned their survey). Given the average value of $152/hhld/year, it was estimated that the willingness to protect additional wilderness in the PRW was a conservative $1.6 million per year, based on only 50 per cent of the population, or $0.76/ha/year (for the forests greater than 100 years old; 2,081,807 hectares).

It was estimated that the value of the willingness of B.C. residents to pay to protect additional wilderness in the Peace River Watershed was a conservative $1.6 million per year.

PHOTO COURTESY DON HOFFMANN

113 Reid, R., Stone, M., and Whiteley, T. 1995. *Economic Value of Wilderness Protection and Recreation in B.C.* WP-6-012. BC Ministry of Environment, Lands and Parks.



PART 6

Summary of Ecosystem Services Values

THE TOTAL ECOSYSTEM SERVICES VALUE reported is incomplete because it was not possible to quantify and value all of the ES provided by the study area's ecosystems. However, using the ecological and economic data that were available, several values were estimated for key ES. The ES values included in this valuation were water supply, air filtration, carbon storage, carbon sequestration, flood control, water filtration, erosion control, habitat, recreational and cultural services. The total annual value for carbon stored in the study area was estimated at $6.7 billion to $7.4 billion per year (central values). The total annual value for all the other ecosystem services was estimated to range from $879.4 million per year ($167.65/ha/year) to $1.74 billion per year ($332.73/ha/year), with a central value of $1.2 billion per year ($231.60/ha/year) (Table 9 on page 54).[114] Carbon storage, carbon sequestration and the habitat value of wetlands accounted for the greatest value per hectare. Carbon storage was reported separately because while it is an ecosystem service, it is a fixed asset that was annualized for reporting purposes. This value will inevitably become more mainstream as reducing degradation and deforestation develops as a financial mechanism to mitigate climate change.

The total annual ecosystem services values by land cover type are provided in Table 10 on page 55. The values by land cover type range from $249 per hectare for water to $3,455 per hectare for treed wetlands, based on our reported central values. Table 10 provides the annual values excluding the carbon storage annual value, ranging from $9 per hectare for annual cropland to $883.21 per hectare for treed wetlands.

Figure 5 on page 56 illustrates the distribution of ecosystem service values across the Peace River Watershed, as valued in the study. The values in Table 10 were used as the average annual value per hectare for each land cover type.

In finance, the net present value (NPV), or net present worth, is the total value of incoming annual value over a set amount of time, discounted over the time period at a set rate. In other words, the NPV compresses a stream of future benefits into a single present value amount. The NPV can be calculated for a specific time period using different discount rates. Discount rates are commonly used to assess the economic benefits of investment for decision-making. Benefits are discounted over time to reflect: 1) that people generally value

The ecosystem service values included in this valuation were water supply, air filtration, carbon storage, carbon sequestration, flood control, water filtration, erosion control, habitat, recreational and cultural services.

PHOTO COURTESY ZACK EMBREE, *FRACTURED LAND* DOCUMENTARY

114 Each annual value per hectare was calculated by dividing the total ES value by the total land cover area (e.g., for central value: $7.42 billion / 5,245,370 hectares). The total land cover area used for valuation excludes: unclassified land, snow/ice, rock/rubble, exposed land, developed land and cloud cover area (366,429 hectares).

TABLE 9: SUMMARY OF THE ECOSYSTEM SERVICES VALUES FOR THE PEACE RIVER WATERSHED STUDY AREA

Ecosystem service	Annual value $/hectare/year (2012 Cdn$)	Total annual value $/year (2012 Cdn$)
Water supply	$32.60	$2,502,441
Air filtration by trees	$3.51	$12,684,230
Forest ecosystem carbon storage (1.14 billion tonnes based on BC VRI forest age/carbon analysis; 948.6 million tonnes using average/ha and AAFC data)	Central value $1,175.69 ($4.48/tC) $460.19 (treed wetland – aboveground biomass only)	Range from $1.56 billion to $8.5 billion; central value $4,425,760,501 to $5,092,465,112
Wetland soil carbon storage (253.9 million tonnes)	$715.24 to $2,453.85	Range from $401 million to $1.89 billion; central value of $1,137,249,649
Other soil carbon storage (261.9 million tonnes)	$921.32 (grassland) $1,073.77 (pasture) $1,552.03 (shrubland) $1,181.55 (cropland)	Range from $413.5 million to $1.95 billion; central value of $1,172,829,309
Carbon sequestration	$138.08 (forest) $33.42 (wetland) $56.20 (shrubland/ grassland/ perennial cover)	Range from $285.5 million to $1.15 billion; central value of $620,855,368
Wetland flood control, water supply, nutrient recycling	$256.67 (wetland)	$133,157,316
Water filtration	$6.23 (forest, treed wetland)	$22,529,524
Erosion control/Sediment retention	$6.60 (grassland/perennial cover)	$4,467,440
Waste treatment	$27.93 (perennial cover/grassland) $54.10 (wetland)	$46,970,791
Pollination	$43.63 (shrubland/ grassland, perennial cover/pasture)	$39,895,056
Habitat	$379.43 (wetlands) $41 (perennial cover/pasture)	$206,744,044
Recreation	$21.47 (forest, wetland, shrubland, grassland) $215.97 (water)	$119,738,498
Cultural values	$9.38 (farmlands) $0.39 (protection of forest, wetland)	$5,258,881

TABLE 10: SUMMARY OF THE ECOSYSTEM SERVICES VALUES BY LAND COVER TYPE (2012 $)		
Land Cover Type	Annual value (excluding carbon storage values) $/hectare/year	Annual Value (including carbon storage values) $/hectare/year
Forest	$169.34	$1,345
Shrubland	$121.35	$1,673
Grassland	$155.88	$1,077
Treed wetlands	$883.21	$3,455
Shrub wetlands	$745.13	$3,199
Grass/herb wetlands	$745.13	$1,460
Water	$248.57	$249
Annual cropland	$9.38	$1,191
Perennial cropland/pasture	$184.75	$1,259

immediate benefits over benefits in the future; and 2) manufactured capital depreciates over time resulting in lower values in the future.

Over a 50-year period at 3 per cent, the central NPV was $204.6 billion (a low of $83.7 billion to a high of $333.7 billion); at zero per cent, the central NPV was $397.5 billion (a low of $162.6 billion to a high of $648.5 billion); and at five per cent, the central NPV was $145.1 billion (a low of $59.4 billion to a high of $236.8 billion). The central NPV per person was estimated at $3.9 million per person (central value at 3% discount rate), with a range of $2.8 million to $7.6 million per person (central value at 5% and 0% respectively). Without carbon storage included, the central NPV was 31.3 billion at 3 per cent, 60.7 billion at zero per cent, and $22.1 billion at 5 per cent. Therefore, the central NPV per person was 597,283 , with a range from 423,792 per person to $1.2 million (central value at 5% and 0% respectively).

FIGURE 5: AVERAGE ECOSYSTEM SERVICE VALUES BY LAND COVER TYPE IN THE B.C. PEACE RIVER WATERSHED (INCLUDES FOREST CARBON VALUES)

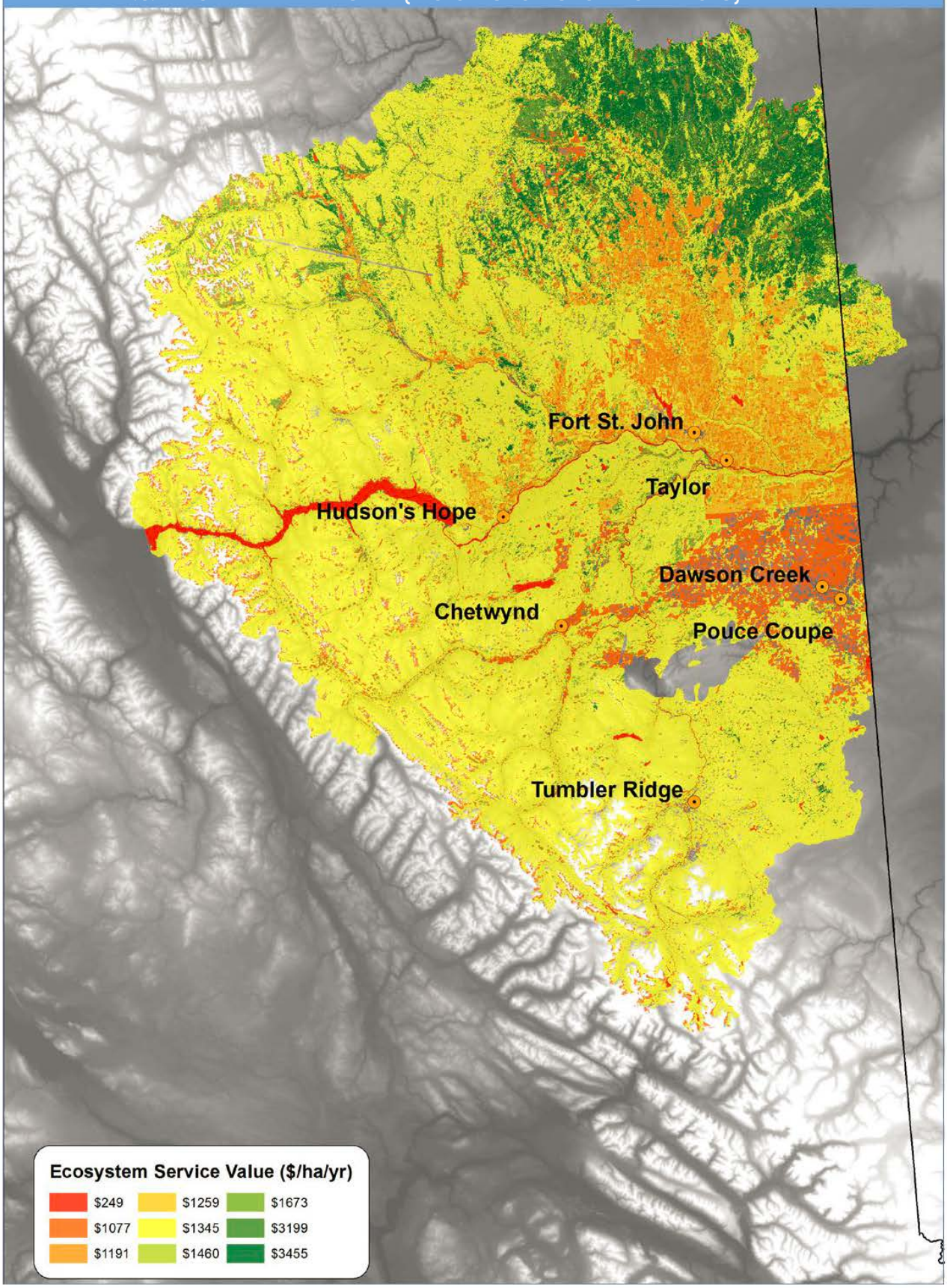
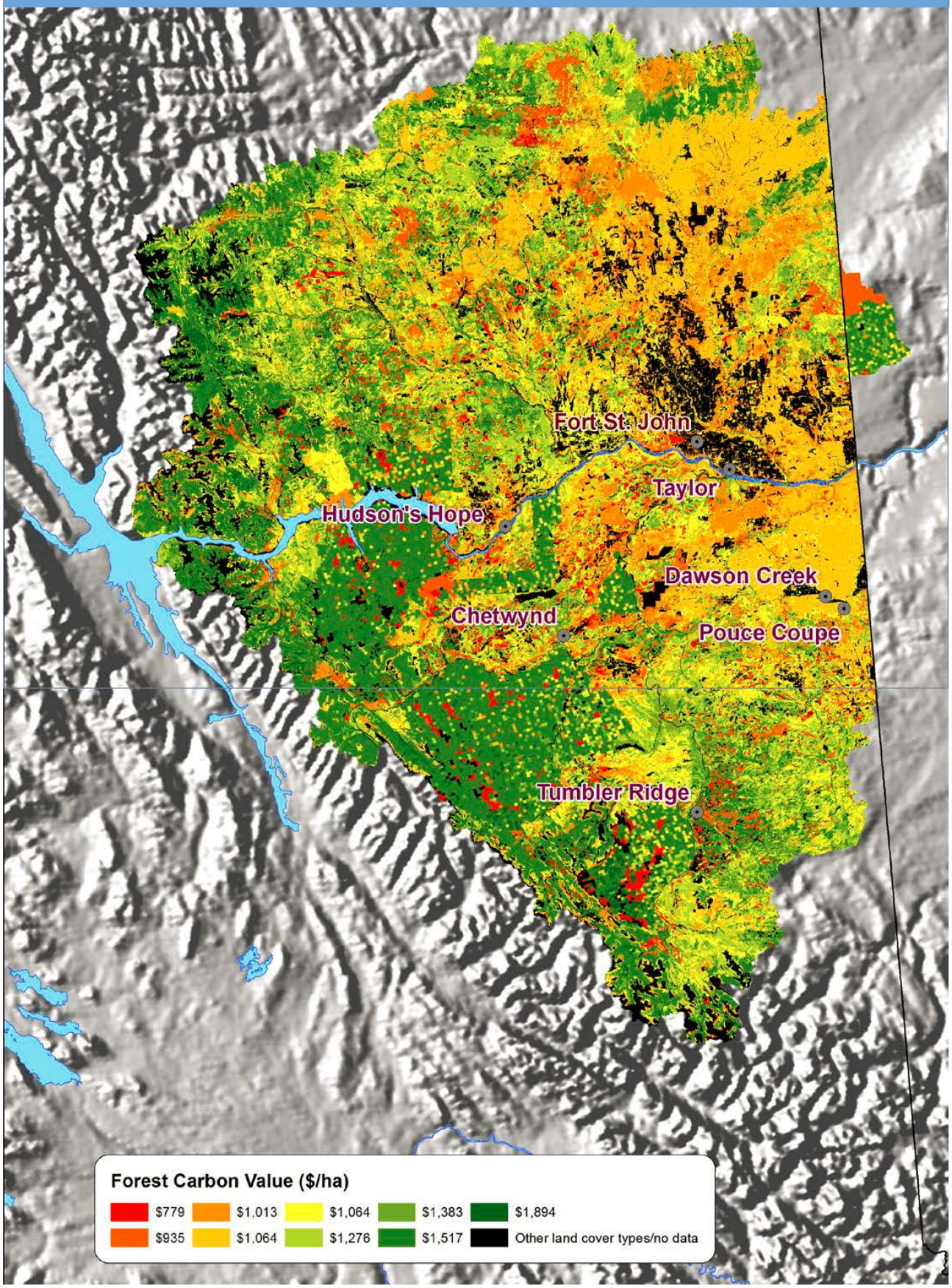
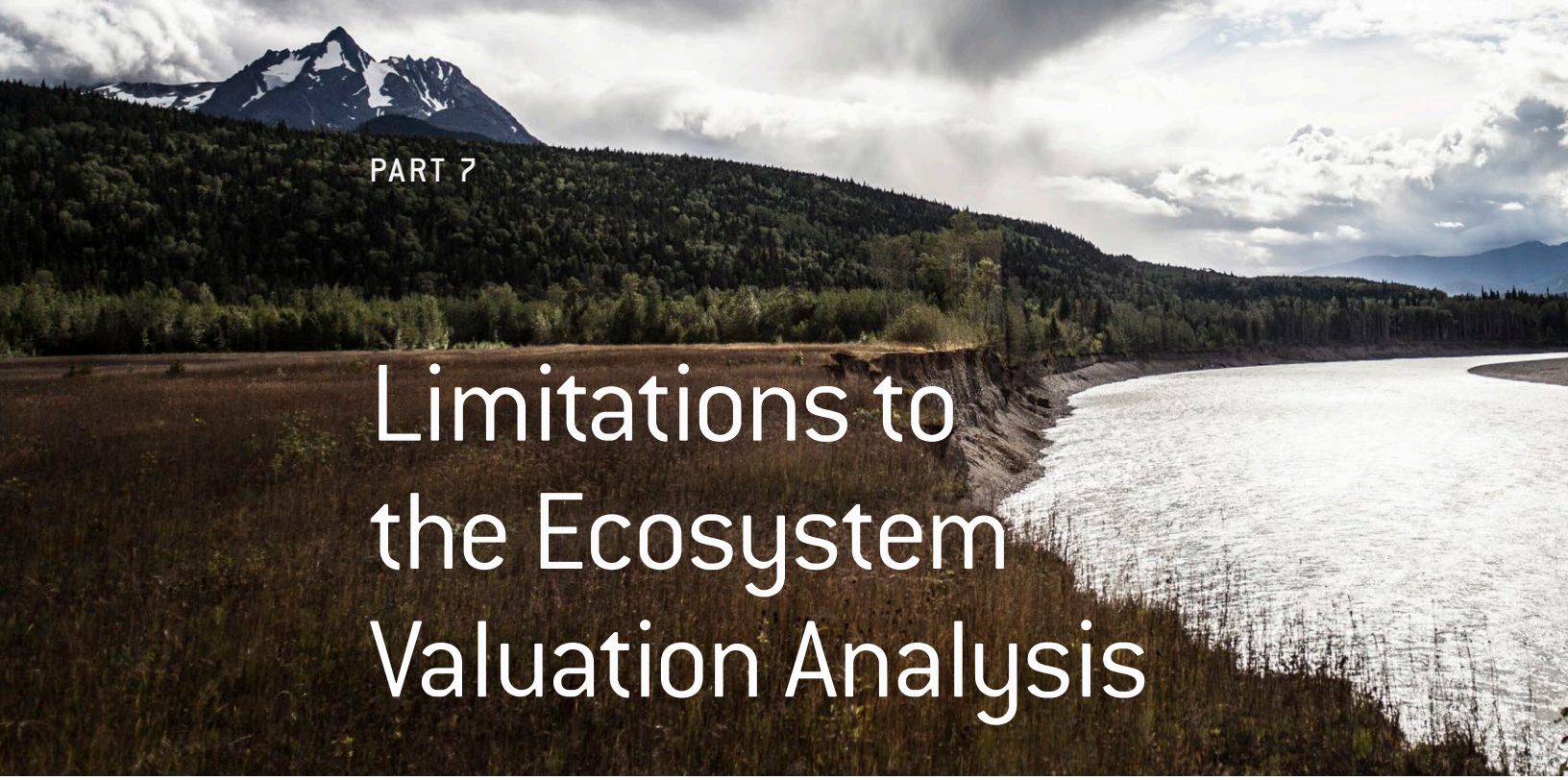


FIGURE 6: CARBON VALUES BY FOREST AGE CLASS FOR B.C. PEACE RIVER WATERSHED





PART 7

Limitations to the Ecosystem Valuation Analysis

In this report, the final estimates are not precise. However, they are much better estimates than the alternative of assuming that ecosystem services have zero value.

PHOTO COURTESY ZACK EMBREE, *FRACTURED LAND* DOCUMENTARY

THE RESULTS OF THIS FIRST ATTEMPT to assign monetary value to the ecosystem services provided by the PRW in B.C. have important and significant implications for the region's future land-use planning, cumulative effects analysis and the restoration and management of the area's natural capital. Ecosystem services produce enormous economic value to society, although valuation exercises do have limitations that must be noted. In this report, the final estimates are not precise. However, they are much better estimates than the alternative of assuming that ecosystem services have zero value.

Valuation techniques in general are uncertain, resulting from gaps in knowledge about ecosystem dynamics, ecosystem function and services, and technical issues. In the case of a value transferred from a previous study or meta-analysis, the analysis estimates the economic value of a given ecosystem (e.g., wetlands). Like any economic analysis, this methodology has strengths and weaknesses. For example, per-hectare values assessed for one location may be different based on the type of ecosystem, the web of biodiversity and species present, the climate, the population size and the human preferences for use and non-use values.

According to economic theory, even within a single ecosystem, the value per hectare depends on the size of the ecosystem. For example, the theory of supply and demand applied to ecosystem services would mean that as the size of the ecosystem or the flow of ecosystem services decreases, the per hectare value would be expected to increase and vice versa. In other words, the marginal cost per hectare is generally expected to increase as the quantity supplied decreases. However, it is important to remember that ecosystems do not behave like markets. When we value ecosystem services, we are valuing ecosystem functions. Ecosystems generally do not function well as they diminish in size and quality. So, although the value for the demand of an ecosystem service may go up as the availability of an ecosystem type dwindles, it does not necessarily reflect the true value of the ecosystem service supplied since the quality or integrity of the service may have diminished. In fact, the functionality of ecosystems is dependent on inter-relationships within functional units such as watersheds, which are compromised once below a certain threshold of ecosystem cover (e.g., percentage of forest cover in a watershed).

This study reports average values per hectare and aggregated total values. Gathering the information needed to estimate all of the specific values for each ecosystem service for every ecosystem within the study area was not feasible. Therefore, the full value of all the wetlands, forests and other ecosystem types in the study area could not be ascertained.

In general, valuations of ecosystems in a large geographic area cannot be undertaken in terms of an exchange value, because it is improbable that a transaction would result in selling or buying the whole area. Therefore, the average value estimates for large areas, as opposed to marginal unit values per hectare, are more comparable to national income account aggregates and not exchange values.[115] For example, the GDP calculates aggregate values for public goods for which no market transaction is possible. The value of ecosystem services in large geographic areas is comparable to these kinds of aggregates. A large, complex area such as the Peace River Watershed is suited to this approach. The use of average ecosystem values has also been criticized based on the argument that ecosystems vary from region to region. Although each forest or wetland ecosystem is unique in some way, ecosystems of a given type have many similar characteristics.

7.1 Geographical Information Data Limitations

This valuation approach involves assigning values to land cover types, which are reliant on the quality, accuracy and categorical precision of land cover datasets. GIS data layers are increasingly accurate, but are generally not current given the time and expense of updating data sources. Therefore, they may be out of date due to land-use changes that occurred after the data was sourced, inaccurate satellite readings and other factors.

The ecological integrity and level of ecosystem functionality is difficult to measure using GIS data. It is possible that ecosystems identified in land cover data may have greater or diminished ecological integrity, and therefore may provide higher or lower values than those assumed by this analysis or by the primary study's valuation in the case of transferred values. This factor could result in an underestimate or overestimate of the current values. However, because we were unable to value many of the ecosystem services in this study, the overall values would be an underestimate.

Many ecosystem services valuations assume spatial homogeneity of services within ecosystems. In other words, by applying an average value across a landscape, the analysis is based on the assumption that each hectare of a land cover type, such as forest, produces the same ecosystem services. Although this is not true, it is important to note that average values often reflect a mid-range of services that takes this into account, especially when meta-analysis values are used. However, there is a need for more dynamic spatial analyses for ecosystem services that include variance across the landscape. For example, this study used forest age class spatial data to assign a range of carbon storage values based on the forest area for each age class.

One of the greatest limitations in ecosystem valuations is the lack of ecosystem services studies, especially at the regional and site-specific level. This results in a significant underestimate of the value of ecosystem services. More complete valuation coverage would increase the values shown in this report.

Willingness to pay (WTP) survey-based values were used for some of the valuations in this report. There are limitations to WTP estimates because they are based on the current willingness to pay or proxies, which are limited by people's incomes, perceptions and knowledge base. This places a bias in the valuation output.

One of the greatest limitations in ecosystem valuations is the lack of ecosystem services studies, especially at the regional and site-specific level. This results in a significant underestimate of the value of ecosystem services.

IMAGE: GOOGLE EARTH SATELLITE

115 Farber, S., and Howarth, R.B. 2002. "The Dynamics and Value of Ecosystem Services: Integrating Economic and Ecological Perspectives: Accounting for the Value of Ecosystem Services." *Ecological Economics*. 41:421-429.

PART 8

Conclusions

The total annual value for carbon stored in the Peace River Watershed was estimated at $6.7 billion to $7.4 billion per year (central values); and the total value for the other ecosystem service (ES) values was estimated to range from $879.4 million to $1.74 billion per year in economic benefits.

PHOTO COURTESY ZACK EMBREE, FRACTURED LAND DOCUMENTARY

THE PEACE RIVER WATERSHED is a region rich in culture, history and natural capital. Its natural areas provide a plethora of ecosystem services that are essential to local communities, First Nations, farmers, and wildlife. These services include freshwater supply, water regulation, clean air, wildlife habitat, climate regulation, food production, cultural well-being and recreational activities.

However, the cumulative effect of resource development across the watershed has had an impact on a large proportion of the area's ecosystems. For example, ecological fragmentation between 1974 and 2010 had an impact on approximately 67 per cent of the watershed. The strain on the region's natural capital will only increase as oil and gas exploration and development, road building, pipeline expansion and logging continue across the landscape. In addition, the proposed large-scale Site C dam would impose a third dam site on the Peace River. The proposed hydroelectric development would flood a significant portion of the valley, affecting critical wildlife habitats for local and migratory species, the highly productive farmlands provided by the valley's unique microclimate, as well as ancestral and culturally significant First Nations lands.

This study examined the B.C. Peace River Watershed's ecosystems, including its forests, fields, wetlands and waterways, and developed economic values for many of the key ecosystem services (ES) they provide. The total annual value for carbon stored in the study area was estimated to range from $6.7 billion to $7.4 billion per year (central values); and the total value for the other ES values was estimated to range from $879.4 million ($167.65/ha/year) to $1.7 billion ($332.73/ha/year), with a central value of $1.2 billion per year in economic benefits, ($231.60/ha/year). Over a 50-year period, the net present value of the total ecosystem services values was estimated at a central rate of $204.6 billion at a discount rate of 3 per cent; $3.9 million per person. (The value per person is high because the area has low population density.) The greatest value among the ES valuations was for carbon storage. Benefits from the carbon stored in the Peace River Watershed's ecosystems reach beyond the local population to regional, national and international beneficiaries since carbon storage is a global system that helps regulate the climate.

The ecosystem services values are average values per hectare aggregated across the study area. We also considered how these values might be adopted at a smaller scale for land-use decision-making. For example, using our forest age carbon analysis, it was estimated that the cost of clearing one hectare of forest for other land use would result in a loss of stored carbon ranging from approximately 14.3 tC/ha (for a 10- to 20-year-old forest) to 263.3 tC/ha (for a 250-year-old or greater forest). Thus, the cost was estimated to range from $1,641.23/ha or $30,334.53/ha (depending on forest age), based on the social costs incurred due to the release of carbon ($115.23/tC; see Section 5.2.2.1), or $590.65/ha to $10,916.93/ha based on the option of a carbon offset price. In addition, the average aboveground carbon sequestered per year was estimated at 1.18 tC/ha/year, worth an estimated $138.08/ha/year, based on the average SCC, or $49.03/ha/year based on the option of a carbon offset price. Thus, the additional cost for clearing one hectare of forest could be estimated to be from $49.03 to $136/ha/year in terms of forgone annual carbon sequestration.

A marginal cost for the loss of forest cover was also calculated in terms of water quality, based on the economic model used in this study. For example, if forest cover across the PRW declined by 10 per cent, the cost for water treatment for local communities was estimated to increase to $3.34 from $2.78 per cubic metre. Used as a proxy to value the water filtration services provided by forests, the marginal value of a 10 per cent loss was an estimated $4.83/ha/year. If forest cover declined by one per cent, the estimated marginal value was $2.96/ha/year.

The intent of this report was to give a baseline assessment of the ecosystem services provided by the Peace River Watershed within B.C. The values are incomplete but they do deliver a meaningful estimate of the magnitude of the existing ecosystem values that local communities, First Nations and policy decision-makers can use to reflect on the cost of land-use change and ecological fragmentation in the study area. The values also reflect the economic benefits of protecting and restoring the region's ecosystems, farmlands and cultural heritage. Detailed site valuations for specific ecosystem functions should be undertaken to provide more precise values of marginal changes due to site-level ecosystem alteration, destruction or investment.

It is hoped that this report will encourage discussion about how natural capital in British Columbia and Canada is valued — and undervalued. Decision-makers and the public are encouraged to use this report, and other natural capital valuations, to inform discussion on how best to protect and restore the Peace River Watershed region's ecological integrity and ensure a sustainable future.

Future research will further consider the marginal values of changes in land use in the Peace River Watershed.

Decision-makers and the public are encouraged to use this report, and other natural capital valuations, to inform discussion on how best to protect and restore the Peace River Watershed region's ecological integrity and ensure a sustainable future.

PHOTO COURTESY DANDYFSJ/ FLICKR CREATIVE COMMONS

PART 9

Future Research Recommendations

Given the rapid development across the PRW, it would be prudent to establish natural capital accounts that provide a yearly account of the change in land cover/land use and the impacts of industrial development.

PHOTO COURTESY KYLEWITH/ FLICKR CREATIVE COMMONS

1. Spatial analysis of the human impacts on ecosystems and the supply of ecosystem services should be undertaken using the Global Forest Watch Canada and David Suzuki Foundation report *Atlas of Land Cover, Use and Changes Study*[116] and the baseline valuation study reported here. This should focus on establishing the specific land cover types that have been affected by industrial and human activities within the Peace River Watershed (PRW) in B.C.
2. Research should be undertaken to further develop the marginal values for changes in land use within the PRW. These values will be helpful for site-level project-based management.
3. Further analysis could be undertaken to evaluate different future scenarios and the supply of ecosystem services using GIS-based tools such as InVest.
4. The resolution and detail for land cover data could be improved. It is recommended that a more detailed, high-resolution land cover dataset for the province be developed to enable more detailed study on the current distribution of habitat, ecosystems, land use types, recreational areas and land cover.
5. The state or ecological integrity of the ecosystems or land cover types could not be assessed. It would be helpful in the future to include a rating of the fragmentation or another measure of ecological integrity within GIS land cover datasets.
6. Cultural studies should be undertaken to document the traditional uses of the natural ecosystems within the PRW by First Nations. In addition, it would be helpful to document the subsistence uses and products utilized by the study area's populations.
7. Given the rapid development across the PRW, it would be prudent to establish natural capital accounts that provide a yearly account of the change in land cover/land use and the impacts of industrial development. The total and marginal value for ecosystem services could be part of this account, based on this baseline study.

116 Lee and Hanneman, supra note 1.

APPENDIX 1

Policy Recommendations

by Dr. Faisal Moola, Director General of David Suzuki Foundation's Ontario and Northern Canada Department

1. This study demonstrates the great value that natural areas provide in terms of ecosystem services and natural capital assets. The following policy changes are therefore recommended:

   a. Restoration of natural ecosystems should occur to benefit habitat services, recreational and cultural values. For example, the protection and restoration of wildlife habitat threatened by industrial development would help threatened species in the Peace Region, such as woodland caribou, recover.

   b. The existing network of protected areas in the region should be expanded from 4 per cent to ensure that protected areas represent the diversity of ecosystems within the region, serve as ecological benchmarks and as safeguards against climate change.

   c. Future protected areas should include the establishment of K'ih tsaa?dze Tribal Park and other important areas identified by local First Nations for careful management, such as the Peace Moberly Tract (PMT) and the Area of Critical Community Interest (ACCI) in the Peace River Valley.

   d. Existing and future industrial activities in the Peace Region must be managed through a cumulative impacts planning approach that ensures that the cumulative impacts of development do not impair ecosystems such that they are no longer able to function and provide a full suite of ecosystem services.

   e. The cumulative impacts of ongoing industrial and human development, the cultural values of farming communities, the legal and cultural interests of First Nations, the ecosystem values of the PRW and the unique opportunities for farmland resources in the Peace River Valley need to be seriously considered in making an informed decision regarding the proposed Site C Dam.

Related Ecosystem Service Valuation Studies

1) A report for the B.C. Lower Mainland assessed the total value provided by the study area's natural capital at an estimated $5.4 billion per year, or about $3,959 per hectare.[117] This is an estimated value of $2,449 per person or $6,368 per household each year, based on statistics from the 2006 census.[118] The top three benefit values provided by the study area's ecosystem services were: 1) climate regulation resulting from carbon storage by forests, wetlands, grasslands, shrublands and agricultural soils; 2) water supply due to water filtration services by forests and wetlands; and 3) flood protection and water regulation provided by forest land cover. Climate regulation provided an estimated value of $1.7 billion per year, while water supply provided an estimated $1.6 billion per year, and flood protection and water regulation provided an estimated $1.2 billion per year. The other values determined for the study area included the following benefits: clean air, waste treatment, pollination, salmon habitat, recreation and local food production.

2) Two Canadian studies assessed the economic value of natural capital for Canada's boreal region. The non-market value for the Mackenzie Region's natural capital was estimated at $570 billion per year (an average of $3,426 per hectare), 13.5 times the market value of the region's natural resources.[119] The carbon stored by the Mackenzie watershed was estimated at a value of $339 billion ($820/ha/year).

3) Two recent studies assessed the importance of having farmlands in close proximity to communities. In 2007, a case study by the B.C. Ministry of Agriculture surveyed Abbotsford residents on the value of the benefits provided by farmland in their community. The study found that the present value of the stream of public benefits and ecological services provided by each hectare of farmland was an estimated $29,490 per acre ($72,814 per hectare).[120] This value was estimated to be significantly greater than the value of public benefits from industrial land use ($14,000 per acre), or residential land use ($13,960 per acre). A similar study was undertaken in 2009 to estimate the value of benefits provided by farmland in Metro Vancouver (formerly the Greater Vancouver Regional District). The study

117 Wilson, S. 2010. Natural Capital in B.C.'s Lower Mainland: Valuing the benefits from nature. David Suzuki Foundation and Pacific Parklands Foundation. Vancouver, Canada.

118 Analysis of the 2006 census reported that 2.2 million people live within the study area. Number of households was estimated based on total population from the 2006 census, assuming that there are approximately 2.6 people on average per household.

119 Anielski, M., and Wilson, S. 2007. *The Real Wealth of the Mackenzie Region: Assessing the Natural Capital Values of a Northern Boreal Ecosystem*. (2009 Update). Canadian Boreal Initiative. Ottawa, Canada.

120 *Public Amenity Benefits and Ecological Services Provided by Farmland to Local Communities in the Fraser Valley: A Case Study in Abbotsford, B.C*. 2007. Strengthening Farming Report. File Number 800.100-1. B.C. Ministry of Agriculture and Lands.

was based on a household survey and evaluated the public value of wildlife habitat and groundwater recharge. The results estimated that the value of farmland in Metro Vancouver was about $58,000 per acre per year; this is about 10 times greater than the market value of farm products ($5,750 per acre).[121]

4) In 2008, Earth Economics undertook a study to assess the value of the goods and services provided by the Puget Sound Basin's natural capital. Puget Sound is located south of British Columbia's Lower Mainland region in Washington state. The net present value for drinking water, food, wildlife, climate regulation, flood protection, recreation and esthetics, among other ecosystem services, was between $305 billion and $2.6 trillion (at a 3 per cent discount rate over 100 years).[122] The total area of the Basin is reported as 10.6 million acres (4.3 million hectares), so the net present value per hectare was approximately $71,000 to $605,000 per hectare.

5) In Central Canada, two regional studies have assessed the non-market values of natural capital. One report quantified the value of the ecosystem services provided by southern Ontario's Greenbelt. This report estimated the value of the region's natural capital at $2.6 billion annually (an average of $3,500 per hectare) and almost $8 billion since the Greenbelt was established.[123] A similar report for the Credit Valley Watershed reported that the watershed provides at least $371 million each year for local residents.[124]

121 Robbins, M., Olewiler, N., and Robinson, M. 2009. *An Estimate of the Public Amenity Benefits and Ecological Goods Provided by Farmland in Metro Vancouver*. Fraser Basin Council and Simon Fraser University. B.C. Ministry of Agriculture and Lands.

122 Batker, D., and Kocian, M. 2010. *Valuing the Puget Sound Basin: Revealing our Best Investments*. Earth Economics. Tacoma, Wash.

123 Wilson, S.J. 2008. *Ontario's Wealth, Canada's Future: Appreciating the Value of the Greenbelt's Eco-Servi*ces. Greenbelt Foundation and David Suzuki Foundation.

124 Kennedy, M., and Wilson, J. 2009. *Natural Credit: Estimating the Value of Natural Capital in the Credit River Watershed*. The Pembina Institute and Credit Valley Conservation.

APPENDIX 3

Land Cover Types and Associated Services

ECOSYSTEM/LAND COVER TYPES AND ASSOCIATED ECOSYSTEM SERVICES		
Ecosystem/ land cover class	Associated ecosystem services (typology of ES from TEEB)	
Wetlands	Food Water supply Carbon storage Flood control Waste processing Storage of freshwater Regulation of water flows	Waste treatment Maintenance of life cycles of migratory species Habitat Recreation Cultural/heritage conservation
Lakes & Rivers	Food Water supply Waste treatment Erosion prevention Habitat	Maintenance of life cycles of migratory species Recreation Cultural/heritage conservation Cultural services
Forests	Food Water supply Air quality regulation Carbon storage Flood control Water filtration	Erosion prevention Soil fertility Pollination Biological control Habitat Recreation Cultural services
Grassland & Shrubland	Food Water supply Air quality regulation Carbon storage Flood control Water filtration	Erosion prevention Soil fertility Pollination Biological control Habitat Recreation Cultural services
Agricultural lands	Food Carbon storage Flood control Erosion prevention Soil fertility	Pollination Biological control Habitat Recreation Cultural services

APPENDIX 4

Total Economic Value Framework

Within the Total Economic Value (TEV) framework, values for ES are derived from market values provided by market transactions that are directly related to the ES where available (i.e., direct market valuation approaches). If direct market value is not available, monetary value information can be obtained from other market transactions that are indirectly associated with the ES (i.e., revealed preference approaches). If both direct and indirect price information on ES are unavailable, survey-based information based on a hypothetical market or demand for an ES may be created to determine values (i.e., stated preferences approaches).[125]

TOTAL ECONOMIC VALUE FRAMEWORK FOR EG&S

Market valuation approaches are mostly used for provisioning services such as food, water and raw materials. This is because many of these goods are sold in markets. Cost-based approaches for valuation are based on the costs incurred if ES decline or diminish due to a loss or damage to natural capital (i.e., ecosystems, natural land covers). These approaches include: 1) avoided cost methods, which refer to the costs that would be incurred if ES decline due to degradation or removal of natural land cover; 2) replacement cost methods, which refer to the replacement cost of ES with artificial technology; and 3) mitigation or restoration cost methods, which is the cost of mitigating the effects of or restoring lost ES.

Production function-based approaches estimate how much an ES contributes to a marketed good or service (e.g., maintenance of water quality provides a certain amount of fish for fisheries). These types of valuations are related to the contribution of an ES to either income or productivity.[126] This approach generally uses scientific information on an ES and then examines the impacts of a change in the supply of the ES on economic activities.

Revealed preference valuation techniques are based on values that are "revealed" by people's choices. There are two main approaches: 1) the travel cost method (TC); and 2) the hedonic pricing approach (HP). The TC method is most likely to be used to value recreational activities related to natural areas. This value is based on the costs associated with recreation (i.e., direct expenses and opportunity costs of time, etc.). The HD approach accesses market-related information regarding the impact of proximity to environmental attributes on increased value (e.g., the higher value of houses near green space or waterfront).

Stated preference approaches create a hypothetical market and demand for ES using surveys that provide options in terms of changes in a particular ES. These methods can be used for use and non-use values. There are three main types, including: 1) contingent valuation method (CV); 2) choice modelling (CM); and 3) group valuation (GV). The CV method uses questionnaires to gather information on how much people would be willing to pay to increase or enhance the provision of an ES, or how much they would be willing to accept for the loss or degradation of an ES. CM models the decisions of individuals who are asked to make trade-offs, with two

125 TEEB (2012). *The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations*. Edited by Pushpam Kumar. Routledge, Abingdon and New York.

126 Barbier, E.B. et al. (2009). "The Valuation of Ecosystem Services", in Naeem, S. et al. (eds). *Biodiversity, Ecosystem Functioning, and Human Well-being: An Ecological and Economic Perspective*. Oxford University Press. Oxford, U.K.

or more choices, between options with shared attributes of the ES to be valued. GV combines CV or CM with processes that integrate socio-political issues such as social justice, and non-human values. Stated preference methods are often the only way to estimate non-use values.

LIMITATIONS TO THESE VALUATIONS INCLUDE THE FOLLOWING:

1. Direct market values can be distorted because of subsidies or other aspects that make the market uncompetitive. The result is prices can be inaccurate or underestimated and therefore unreliable for decision-making.
2. Revealed preference values such as travel cost and hedonic pricing can be misleading as they rely on markets providing accurate values as well as the assumption that the values represent the Ecosystem Goods and Services (EG&S) and the pseudo-market value assessed.
3. Stated preference values are based on hypothetical choices and therefore may not be accurate because people might not make the same choices if faced with the same changes or costs in real life.

In order to estimate ES values, value transfer is often adopted because the ecological and economic studies necessary to provide non-market valuations are often not available for each study area. Such studies are limited because of the cost of undertaking them given the expense and time required. Value transfer is the process whereby an ES value is estimated using a valuation for the same EG&S transferred from another study area. Value transfers are taken from study sites that are close matches in terms of socio-economics, demographics and/or ecology.

Value transfers (VT) can take the form of: 1) unit VT; 2) adjusted unit VT; 3) value function transfer; and 4) meta-analytical function transfer. Unit VT involves estimating the value by multiplying the mean unit value from the original site by the quantity of the ES at the transfer site (e.g., value/household or value/unit area). Adjusted unit transfer involves making adjustments to transfer values that reflect variance at the transfer site. Value function transfer involves transferring travel cost, hedonic pricing or stated preference values, with adjustments based on the transfer site plugged into these values (i.e., population, distance, market prices). Meta-analytical function transfer uses values based on multiple study results with adjustments for the characteristics of the transfer site. These values are based on a collection of studies for a particular ES or ecosystem type. They include a more varied sample of values that take into account different site characteristics and valuation approach methods compared to a value transferred from a single study.

PHOTO COURTESY DON HOFFMANN

British Columbia's Peace River Watershed is a vast region of boreal forest, rushing rivers, and rich farmland. It is also the ancestral home of the Dane-Zaa First Nations and several farming and resource-dependent communities. The well-being of the region's communities are intimately tied to the health of the Peace river and its surrounding ecosystems, which provide ecological benefits such as flood control, hunting and fishing opportunities, pollination services, nutrient cycling, and other ecosystem services.

This report provides the first-ever valuation of the PRW's ecosystem services and makes recommendations on how the region's natural capital should be stewarded and sustained into the future.

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