34 ASSERTED OR ESTABLISHED ABORIGINAL AND TREATY RIGHTS, ABORIGINAL INTERESTS, AND INFORMATION REQUIREMENTS

BC Hydro’s understanding of how the environment is valued by each potentially affected Aboriginal group for the current use of lands and resources for traditional purposes, including activities conducted in the exercise of asserted or established Aboriginal and treaty rights, and how that current use may be affected by the Project are presented in Volume 3 Section 19 Current Use of Lands and Resources for Traditional Purposes.

34.1 Aboriginal Groups

Table 34.1 lists those Aboriginal groups, which in accordance with Section 20.1 of the EIS Guidelines, BC Hydro was instructed by the Executive Director of the BCEAO and the Federal Minister of Environment that it must consult, given the potential of these groups to be adversely affected by the Project.

**Table 34.1 Aboriginal Groups Potentially Adversely Affected by the Project**

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<tr>
<th>Treaty 8 First Nation Signatories</th>
<th>Alberta</th>
<th>Northwest Territories</th>
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<td>British Columbia</td>
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<td>• Blueberry River First Nations</td>
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<td>• Fort Nelson First Nation</td>
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<td>• McLeod Lake Indian Band</td>
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<td>• Saulteau First Nations</td>
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<td>• Treaty 8 Tribal Association (T8TA):</td>
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<th>British Columbia First Nations</th>
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<td>• Kwadacha First Nation</td>
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<td>• Tsay Keh Dene First Nation</td>
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<th>Métis</th>
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<td>British Columbia</td>
<td>Alberta</td>
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<td>• Métis Nation British Columbia (as directed by the CEA Agency)</td>
<td>• Métis Nation of Alberta – Region 6</td>
<td>• Northwest Territory Métis Nation</td>
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<tr>
<td>• Kelly Lake Métis Settlement Society (as directed by the CEA Agency)</td>
<td>• Paddle Prairie Métis Settlement Society</td>
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<td>• Fort Chipewyan Métis Local 125</td>
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Please note that Section 20.1 of the EIS Guidelines refers to the Fort Chipewyan Métis Local 125 as the Fort Chipewyan Métis Association, to the McLeod Lake Indian Band as the McLeod Lake First Nation, and to the Métis Nation of Alberta – Region 6 as the Métis Nation of Alberta – Zone 6.

34.2 Aboriginal Groups Background Information
The Aboriginal groups whose asserted or established Aboriginal rights and treaty rights and Aboriginal interests may potentially be affected by the Project are identified in Table 34.1. Information related to ethnography, language, land use setting and planning, governance, and economy for each Aboriginal group listed in Table 34.1, and where made available to BC Hydro, maps illustrating the Aboriginal group’s traditional territory, are included in Volume 5 Appendix A Asserted or Established Aboriginal or Treaty Rights, Aboriginal Interests, and Information Requirements Supporting Documentation, Part 1 Community Summary for the 29 Aboriginal groups.

34.3 Asserted or Established Aboriginal and Treaty Rights

34.3.1 Past, Current, and Reasonably Anticipated Future Use of Lands and Resources
An assessment of the potential effects of the Project on the current and reasonably anticipated future use of lands and resources by Aboriginal groups for traditional purposes is provided in Volume 3 Section 19 Current Use of Lands and Resources for Traditional Purposes. With respect to the past use of lands and resources by Aboriginal groups, please see the Aboriginal Land and Resource Use Summaries for the 29 Aboriginal groups included in Part 3 of Volume 5 Appendix A Asserted or Established Aboriginal or Treaty Rights, Aboriginal Interests, and Information Requirements Supporting Documentation.

34.3.2 Asserted or Established Aboriginal Rights and Treaty Rights
As a result of the consultations carried out on the Project to date, and a review of existing case law, BC Hydro has prepared its understanding of the asserted or established Aboriginal rights and treaty rights for the groups identified in Table 34.1.

34.3.2.1 Treaty 8 Rights
The following Aboriginal groups listed in Table 34.1 are signatories or adherents to Treaty 8: Blueberry River First Nations, Fort Nelson First Nation, McLeod Lake Indian Band, Saulteau First Nations, Doig River First Nation, Halfway River First Nation, Prophet River First Nation, West Moberly First Nations, 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, and Salt River First Nation.
Provisions of Treaty 8

Treaty 8 provides, in part:

“AND WHEREAS, the said Commissioners have proceeded to negotiate a treaty with the Cree, Beaver, Chipewyan and other Indians, inhabiting the district hereinafter defined and described, and the same has been agreed upon and concluded by the respective bands at the dates mentioned hereunder, the said Indians DO HEREBY CEDE, RELEASE, SURRENDER AND YIELD UP to the Government of the Dominion of Canada, for Her Majesty the Queen and Her successors for ever, all their rights, titles and privileges whatsoever, to the lands included within the following limits, that is to say:

Commencing at the source of the main branch of the Red Deer River in Alberta, thence due west to the central range of the Rocky Mountains, thence northwesterly along the said range to the point where it intersects the 60th parallel of north latitude, thence east along said parallel to the point where it intersects Hay River, thence northeasterly down said river to the south shore of Great Slave Lake, thence along the said shore northeasterly (and including such rights to the islands in said lakes as the Indians mentioned in the treaty may possess), and thence easterly and northeasterly along the south shores of Christie's Bay and McLeod's Bay to old Fort Reliance near the mouth of Lockhart's River, thence southeasterly in a straight line to and including Black Lake, thence southwesterly up the stream from Cree Lake, thence including said lake southwesterly along the height of land between the Athabasca and Churchill Rivers to where it intersects the northern boundary of Treaty Six, and along the said boundary easterly, northerly and southwesterly, to the place of commencement.

AND ALSO the said Indian rights, titles and privileges whatsoever to all other lands wherever situated in the Northwest Territories, British Columbia, or in any other portion of the Dominion of Canada.

TO HAVE AND TO HOLD the same to Her Majesty the Queen and Her successors forever. ...

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.”
History and Interpretation of Treaty 8

As outlined by the Supreme Court of Canada in *R. v. Badger*, [1996] 1 SCR 771, at para. 39, Treaty 8 is one of numbered treaties concluded between the federal government and various First Nations between 1871 and 1923 in order to facilitate the settlement of the western half of the country. Treaty 8 was entered into on June 21, 1899, and involved the surrender of land covering what is now northwestern Saskatchewan, northern Alberta, northeastern British Columbia, and a southern part of the Northwest Territories.

In exchange for the surrender of the land, the Crown promised to provide the signatory First Nations with reserves, education, annuities, farm equipment, ammunition, and relief in times of famine or pestilence. The Crown also guaranteed the First Nations’ rights to hunt, trap, and fish on the surrendered lands subject to certain government regulations and the right of the Crown to take up the land surrendered from time to time for settlement, mining, lumbering, trading, or other purposes.

In 1930, by authority of an amendment to the *British North America Act*, 1930, 20–21 George V, c. 26 (U.K), Canada and Alberta, and Canada and Saskatchewan entered into Natural Resources Transfer Agreements (NRTA) [*Saskatchewan Natural Resources Act*, 20–21 George V, c. 41 (Can.); *Alberta Natural Resources Act*, 20-21 George V, c. 3 (Can.)], which transferred control over natural resources to the provinces of Alberta and Saskatchewan. The Supreme Court of Canada in *R. v. Horseman*, [1990] 1 SCR 901, and affirmed in *Badger*, found that as a result of these agreements, the treaty protection of the right to hunt commercially was extinguished, but the geographic region in which First Nations could hunt for food was expanded to all unoccupied Crown land in the province and other land to which the First Nations’ have a right to access. As well, the means and practices employed by First Nations to hunt, trap, and fish for food would be beyond provincial regulation (*Horseman*, at 933).

Thus, in Alberta and Saskatchewan the treaty rights to hunt, fish, and trap for food can be exercised throughout each of the provinces but the right to hunt, fish, and trap commercially is extinguished. In British Columbia and the Northwest Territories, treaty rights have not been similarly modified.

Scope of Treaty 8 Rights

In *Mikisew Cree First Nation v. Canada (Minister of Canadian Heritage)*, 2005 SCC 69, the Crown had argued that the “taking up” of a 23 square kilometre area for the construction of a winter road does not infringe a right to hunt across a territory that covers 840,000 square kilometres” (the Treaty 8 territory). However, the Supreme Court of Canada rejected this argument, observing 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” (*Mikisew*, at para. 48).

*Mikisew* also clarified that, while signatory First Nations may exercise their rights to hunt, fish, or trap throughout the “tract surrendered”, the test of whether the Crown has infringed the treaty right by taking up so much land that no meaningful right remains is to be analyzed by reference to their respective traditional territories.
The importance of traditional territories and continuity in traditional patterns to the exercise of treaty rights was also referenced by the B.C. Court of Appeal in West Moberly First Nations v. B.C. (Chief Inspector of Mines), 2011 BCCA 247, affirming 2010 BCSC 359 (leave to appeal to SCC dismissed, 2012 CanLII 8361). The chambers judge characterized the protected treaty right at issue as "the right to hunt caribou in the traditional seasonal round in the territory affected by the [proposed project]" (West Moberly, 2010 BCSC 359, at para. 63). The majority of the Court of Appeal concurred, noting that "while specific species and locations of hunting are not enumerated in Treaty 8, it guarantees continuity in traditional patterns of economic activity and respect for traditional patterns of activity and occupation" (West Moberly, at para. 137, per Finch C.J.B.C.).

The "continuity in traditional patterns" does not equate to a "continuity of nineteenth century patterns of land use" (Mikisew, at para. 32). The Court in Mikisew expressly noted the latter was not promised by the Treaty. The Supreme Court of Canada also commented that "the language of the treaty could not be clearer in foreshadowing change" (Mikisew, at para. 31) and that "none of the parties in 1899 expected that Treaty 8 constituted a finished land use blueprint. Treaty 8 signalled the advancing dawn of a period of transition" (Mikisew, at para. 27).

Incidental Rights Under the Treaty

In Simon v. The Queen, [1985] 2 SCR 387, in considering the Treaty of 1752, the Supreme Court of Canada noted that to be "effective", the right to hunt must "embody those activities reasonably incidental to the act of hunting itself" (Simon, at 403). The courts have recognized that Aboriginal rights, including treaty rights, are not "frozen-in-time" and therefore must be viewed flexibly to permit evolution over time (R. v. Sundown, [1999] 1 SCR 393, at para. 32). Such evolution is limited, however, and traditional practices cannot be transformed into modern rights (Lax Kw’alaams Indian Band v. Canada (Attorney General), 2011 SCC 56).

Geographic Limitations – The Crown’s Right to Take Up Land

The rights to hunt, trap, and fish secured under Treaty 8 are different than other Aboriginal rights. Treaty 8 rights are limited by the Crown’s right to "take up" lands and the Crown’s actions do not have to be justified under the test set out in Sparrow except in the circumstances when the taking up means "no meaningful right to hunt", fish, or trap would remain over a signatory First Nation’s traditional territory (Mikisew, at para. 48). The Supreme Court of Canada in Mikisew (at para. 31) said:

"I agree with Rothstein J.A. that not every subsequent “taking up” by the Crown constituted an infringement of Treaty 8 that must be justified according to the test set out in Sparrow. In Sparrow, it will be remembered, the federal government’s fisheries regulations infringed the aboriginal fishing right, and had to be strictly justified. This is not the same situation as we have here, where the aboriginal rights have been surrendered and extinguished, and the Treaty 8 rights are expressly limited to lands not “required or taken up from time to time for settlement, mining, lumbering, trading or other purposes” [emphasis added]. The language of the treaty
could not be clearer in foreshadowing change. Nevertheless the
Crown was and is expected to manage the change honourably.”

In Badger, the Court also addressed what constitutes a “taking up” under Treaty 8. After
considering both the oral promises made by the representatives of the Crown and the
oral history of the Treaty 8 First Nations, the Court concluded that members of the First
Nations “understood that land would be taken up and occupied in a way which precluded
hunting when it was put to a visible use that was incompatible with hunting” (Badger, at
para. 58). This has become known as the “visible, incompatible use” test.

The Duty to Consult

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 and engage in meaningful
consultation and, if necessary, seek a workable accommodation in relation to its
proposed actions. The honour of the Crown places a positive obligation on the Crown to
inform itself of the impact of the proposed project, communicate this to the signatory
First Nations potentially affected by the project, and undergo meaningful consultation
(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. Consultation, however, does
not necessarily lead to accommodation, and accommodation may not lead to agreement
(Haida Nation v. British Columbia Minister of Forests, 2004 SCC 73 at para. 10; Mikisew,
at para. 66). Recently, In Beckmann v. Little Salmon/Carmacks First Nation, 2010
SCC 53, the Supreme Court of Canada reaffirmed the fact that the duty to consult exists
independent of treaties and also the fact that consultation is a procedural protection,
distinct from the substantive right of accommodation (Beckmann, at para. 14).

First Nations’ Perspectives of Treaty 8 Rights

BC Hydro’s understanding of the rights provided by Treaty 8 is reflected in the sections
above. However, in addition to its review of the Treaty and case law, BC Hydro has also
been provided with submissions from some Treaty 8 First Nations that set out their
perspectives of the rights provided to First Nations under Treaty 8 (Treaty 8 Tribal
Association, Tribal Chief 2011a, pers. comm; Treaty 8 Tribal Association, Tribal
Chief 2011b, pers. comm; Treaty 8 Tribal Association 2012, pers. comm; Devlin Gailus,
legal counsel for Treaty 8 Tribal Association 2012, pers. comm; McLeod Lake Indian
Band, legal counsel 2011, pers. comm; Mikisew Cree First Nation, GIR Director 2012,
pers. comm; Athabasca Chipewyan First Nation, Consultation Coordinator 2012, pers.
comm).

In those submissions, the First Nations assert that the rights guaranteed in Treaty 8 are
“livelihood rights” and that the Crown promised continuity with respect to those rights.
The First Nations also assert that there are important cultural, spiritual, social, and
economic components to Treaty 8 rights, including the ability to transmit their distinct
culture and traditional means of livelihood to future generations. One submission (Letter
from Treaty 8 Tribal Association, dated February 24, 2012, at p. 15) included the
following summary:

“In summary, while Treaty 8 provides the Crown with the power to
take up lands, the Treaty also affirms First Nations’ retention of
comprehensive land-based rights to a “livelihood”, and rights to
maintain control over First Nation peoples’ occupation and use of these lands to support their “way of life” and “usual vocations” in accordance with their natural law, customs and traditions, according to what is known as their traditional seasonal round. The Treaty also establishes an ongoing Crown obligation to secure a continued supply of game and fish for the support and subsistence of the First Nations and this implies ongoing Crown duties to protect fish and wildlife populations within Crown lands traditionally used by Indian peoples as part of their seasonal round, and to protect and safeguard the habitat, including water resources, required to maintain a harvestable surplus of fish and wildlife within lands not taken up.”

In addition, relying on Madam Justice Huddart’s reasons in Halfway River First Nation v. British Columbia (Ministry of Forests), 1999 BCCA 470, at para. 187, the T8TA says its treaty rights are site specific (Devlin Gailus, legal counsel for Treaty 8 Tribal Association 2012, pers. comm).

BC Hydro has been asked to provide its understanding of the asserted and established Aboriginal and treaty rights held by the Aboriginal groups identified in Table 34.1. BC Hydro has provided that understanding, based on the guidance that it has received from the Treaty and the case law. BC Hydro recognizes that there may be differences in interpretation between the Crown and First Nations with respect to the scope of treaty rights and with respect to whether, and to what extent, the Crown has an obligation to secure a continued supply of game and fish for the support and subsistence of the First Nations.

Accordingly, while the passages that precede this section provide BC Hydro’s understanding of the treaty rights held by the Aboriginal groups that are signatories or adherents to Treaty 8, BC Hydro has endeavoured throughout the EIS to take the First Nations’ perspective of the scope of treaty rights into account when assessing and measuring the potential effects of the Project.

### 34.3.2.2 Aboriginal Rights – 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. In addition, various other First Nations listed in Table 34.1 who are signatory to Treaty 8 have asserted Aboriginal rights in addition to their treaty rights.

BC Hydro’s understanding of the legal test for Aboriginal rights (including title) is set out below. Aboriginal rights that are specific to Métis groups are addressed in the following Subsection (34.2.3).

### Test for Aboriginal Rights

The test for identifying Aboriginal rights in Section 35(1) of the Constitution Act, 1982 was set out by the Supreme Court of Canada in R. v. Van der Peet, [1996] 2 SCR 507 at para. 46: “in order to be an aboriginal right an activity must be an element of a practice, custom or tradition integral to the distinctive culture of the aboriginal group claiming the right.”
Further, it must be a practice, tradition, or custom central to the Aboriginal society that existed in North America prior to contact with Europeans (Van der Peet at para. 44). Claims to Aboriginal rights must be characterized in context, on a specific rather than general basis and must be founded upon an actual practice, custom or tradition of the particular group claiming the right. There is a necessary geographic element of site-specific hunting and fishing rights (R. v. Sappier; R. v. Gray, 2006 SCC 54 at paras. 21, 50-51).

Test for Aboriginal Title

Aboriginal title is a form of Aboriginal right arising where “the connection of a group with a piece of land ‘was of a central significance to their distinctive culture.’” (Delgamuukw v. British Columbia, [1997] 3 SCR 1010 per Lamer C.J.C. (majority) at para. 137, citing R. v. Adams, [1996] 3 SCR 101 at para. 26).

The specific requirements to establish Aboriginal title were set out in Delgamuukw, at para. 143:

“(i) The land over which title is claimed must have been occupied prior to sovereignty;
(ii) If present occupation is relied on as proof of occupation pre-sovereignty, there must be a continuity between present and pre-sovereignty occupation; and
(iii) At sovereignty, that occupation must have been exclusive.”

The date of Crown sovereignty in British Columbia has been determined to be 1846, coinciding with the Oregon Boundary Treaty of 1846 (Delgamuukw at para. 145).

In R. v. Marshall; R. v. Bernard, 2003 SCC 43, at para. 54, the Supreme Court of Canada held that to found a claim in Aboriginal title, possession similar to that associated with title at common law must be demonstrated. In determining if occupation is sufficient to establish title “one must take into account the group’s size, manner of life, material resources, and technological abilities, and the character of the lands claimed” (Delgamuukw at para. 149).

According to the British Columbia Court of Appeal’s interpretation of the Supreme Court of Canada jurisprudence, Aboriginal title cannot be proven based on a limited presence in a broad territory: “[r]ather,…Aboriginal title must be proven on a site-specific basis…. Aboriginal title can only be proven over a definite tract of land the boundaries of which are reasonably capable of definition” (William v. British Columbia, 2012 BCCA 285, at para. 230).

Application to Aboriginal Groups Listed in Table 34.1

BC Hydro is unaware of any established Aboriginal rights or title held by Kwadacha First Nation, Tsay Keh Dene First Nation, or other Aboriginal groups listed in Table 34.1, outside of treaty rights.

BC Hydro has been consulting with Kwadacha and Tsay Keh Dene First Nations regarding the impact of the Project on their asserted Aboriginal rights (see the BC Hydro Consultation Summaries for these First Nations in Volume 5 Appendix A13, Part 2 and in...
Section 34: Asserted or Established Aboriginal and Treaty Rights, Aboriginal Interests, and Information Requirements

### 34.3.2.3 Aboriginal Rights – Métis Groups

Six of the Aboriginal groups listed in Table 34.1 are Métis groups: Métis Nation of Alberta – Region 6, Paddle Prairie Métis Settlement Society, Fort Chipewyan Métis Local 125, Northwest Territories Métis Nation, Métis Nation British Columbia, and Kelly Lake Métis Settlement Society.

#### Test for Métis Rights

Métis people hold Aboriginal rights under Section 35(1) of the *Constitution Act, 1982*, pursuant to Section 35(2). The legal test to determine Métis rights was set out by the Supreme Court of Canada in *R. v. Powley*, 2003 SCC 43. The Court laid out 10 steps in order to determine whether Métis rights exist and have been infringed, the first seven of which are relevant here (the final three relate to the determination of whether a right, once established, has been extinguished or infringed):

1. Characterization of the right
2. Identification of the historic rights-bearing community
3. Identification of the contemporary rights-bearing community
4. Verification of the claimant’s membership in the relevant contemporary community
5. Identification of the relevant time frame
6. Determination of whether the practice is integral to the claimants’ distinctive culture
7. Establishment of continuity between the historic practice and the contemporary right asserted

Métis rights, like all Aboriginal rights, are collectively held and, therefore, grounded in the existence of both a historic and contemporary rights-bearing community. The Supreme Court of Canada defined a Métis community as “a group of Métis with a distinctive collective identity living together in the same geographic area and sharing a common way of life” (*Powley*, at para. 12). A historic community can be identified through demographic evidence, proof of shared customs, traditions, and a collective identity. There must be some continuity and stability with the historic community in order to establish a contemporary rights-bearing community, although this criteria should be viewed with some flexibility.

A present-day Métis right must have been an existing practice at the time when “Europeans effectively established political and legal control” in the area (*Powley*, at paras. 12, 37).
Alberta Métis Groups listed in Table 34.1: Paddle Prairie Métis Settlement Society, Métis Nation of Alberta – Region 6, Fort Chipewyan Métis Local 125

Paddle Prairie Métis Settlement Society

The Paddle Prairie Métis Settlement is a recognized Alberta Métis Settlement under Section 2(1) of the Alberta Métis Settlements Act, RSA 2000, c M-14. In R. v. Lizotte, 2009 ABPC 287, the Alberta Provincial Court made the following observations regarding the Paddle Prairie Métis settlement (at para. 31):

“... In the case of Paddle Prairie I have little evidence before the court but strongly suspect that the Settlement was created from sheer wilderness. Given the notoriety as a fact I judicially note that the major highway to, and through Paddle Prairie, the McKenzie Highway, was itself not completed until 1948. Until that point the Paddle Prairie Settlement would unquestionably have been the most remote and isolated of all of the newly created settlements. By its creation the Métis were given a new haven and doubtlessly migrated from many other locations where they likely did enjoy historic roots to the late 1800s. -

After Lizotte was decided, the Alberta Court of Appeal found that membership in a Metis Settlement created by the Act is not sufficient to establish Metis rights under Section 35 of the Constitution (L’Hirondelle v. Alberta (Sustainable Resource Development), 2013 ABCA12). The Alberta Court of Appeal reinforced the principle that the criteria laid out in Powley are the proper criteria to determine whether a Metis community is a rights-bearing community.

For the purposes of this assessment, BC Hydro has considered Paddle Prairie Metis Settlement Society to be a rights bearing community under Powley.

Métis Nation of Alberta – Region 6

In the report prepared by Public History (Public History 2012), the authors noted evidence of historic Métis communities at Fort Dunvegan, Peace River Crossing and Fort Vermilion, along the Peace River. The report notes there is evidence that members of these communities have been exercising Métis rights for generations. The Métis Nation of Alberta – Region 6 has asserted to the BCEAO and CEAA that it represents the present members of those historic communities (Métis Nation of Alberta, Scientific Regulatory Advisor 2012, pers. comm).

Fort Chipewyan Métis Local 125

The Fort Chipewyan Métis Local 125 asserts rights as a Métis group centred around Fort Chipewyan since 1788 (Fraser, Fred. 2012. Letter to BCEAO and CEAA. August 8, 2012). In its Métis Harvesting in Alberta policy, issued in June 2010, the Province of Alberta recognized Fort Chipewyan as an historic and contemporary Métis community (AESRD 2010, at p. 2).
British Columbia Métis Groups listed in Table 34.1: Métis Nation British Columbia (MNBC) and Kelly Lake Métis Settlement Society (KLMSS)

At the time of filing the EIS, no Métis rights-bearing community in British Columbia has been recognized by a court. In R v. Willison, 2006 BCSC 985, the B.C. Supreme Court was unable to conclude there was a historic Métis community along the fur brigade trail in the southern part of the province. There has not been a judicial determination regarding the existence of a Métis community in northern British Columbia.

Northwest Territory Métis Groups Listed in Table 34.1: Northwest Territory Métis Nation

Members of the NWTMN reside mainly in the communities of Hay River, Fort Smith, Fort Resolution, and Yellowknife in the Northwest Territories, and assert rights as Métis people living in the region since the 1780s. The NWTMN are currently in negotiations with Canada and to enter a land and resources agreement.

### 34.3.3 Assessment of Potential Impacts on the Exercise of Asserted or Established Aboriginal and Treaty Rights

The assessment of potential impacts on the exercise of asserted or established Aboriginal and treaty rights is based on BC Hydro’s understanding of the asserted or established Aboriginal rights and treaty rights set out in Section 34.3.2. While the right to fish, hunt, and trap does not overlap precisely in time and space with the current use of lands and resources for traditional purposes, including fishing, hunting, and trapping, there is a close linkage between the rights discussed in this section and the current uses assessed in Volume 3 Section 19 Current Use of Lands and Resources for Traditional Purposes.

Volume 3 Section 19 presents baseline information on the current use of lands and resources for traditional purposes for each of the Aboriginal Groups listed in Table 34.1. This includes a description of the nature and location of the use or activity (including fishing, hunting and trapping), the species targeted, as well as the traditional use of the harvested species. This information is the basis for the assessment of the potential effects of the Project on current use of lands and resources for traditional purposes, also provided in Volume 3 Section 19. That assessment includes the potential effects of the Project on what may be described as ancillary activities, such as opportunities to harvest berries, herbs and medicinal plants and the establishment of cabins. Some of these ancillary activities may be reasonably incidental to the exercise of the treaty rights to fish, hunt, and trap. Consequently, the results of the assessment in Volume 3 Section 19 are drawn into the assessment of potential impacts on the exercise of asserted or established Aboriginal and treaty rights.

**Potential impacts on the exercise of treaty rights – Treaty 8 First Nations signatories**

It is anticipated that the Project would have no impacts on the exercise of treaty rights of 11 of the 21 First Nations that are signatories to Treaty 8. These are:

- Athabasca Chipewyan First Nation
- Beaver First Nation
- Deninu K'ue First Nation
Section 34: Asserted or Established Aboriginal and Treaty Rights, Aboriginal Interests, and Information Requirements

1. Fort Nelson First Nation
2. Little Red River Cree Nation
3. Mikisew Cree First Nation
4. Salt River First Nation
5. Smith’s Landing First Nation
6. Sturgeon Lake Cree Nation
7. Tallcree First Nation
8. Woodland Cree First Nation

Volume 3 Section 19 Current Use of Lands and Resources for Traditional Purposes concludes that the Project is not expected to have an effect on the current use of lands and resources for traditional purposes (including fishing, hunting and trapping, and ancillary activities) for these Aboriginal groups because there are no predicted interactions between Project activities and the use areas of these groups. Consequently, the Project is not expected to have an impact on the exercise of the treaty rights of these First Nations.

Should additional information regarding current and reasonably anticipated future use of lands and resources within the LAA be received from the First Nations listed above, BC Hydro will incorporate it into the EIS review phase, and consider its relevance to impacts on the exercise of treaty rights.

McLeod Lake Indian Band (MLIB)

Volume 3 Section 19 states that the Project is not expected to have an effect on the current use of or access to lands and resources for traditional purposes for MLIB. Consequently, the Project is not expected to have an impact on the MLIB’s exercise of its treaty rights.

BC Hydro has provided funding for MLIB to undertake a TLUS. Should the TLUS contain additional information regarding current and reasonably anticipated future use of lands and resources within the LAA, BC Hydro will incorporate it into the EIS, as appropriate, during the review phase, and consider its relevance to impacts on the exercise of treaty rights.

The Project may have impacts on the exercise of treaty rights of the following First Nations:

- Blueberry River First Nations
- Dene Tha’ First Nation
- Duncan’s First Nation
- Horse Lake First Nation
- Saulteau First Nations
- Treaty 8 Tribal Association: Doig River First Nation, Halfway River First Nation, Prophet River First Nation, and West Moberly First Nations
Volume 3 Section 19 Current Use of Lands and Resources for Traditional Purposes concluded that Project activities, including construction-related clearing and reservoir filling, would adversely affect the current use of lands and resources for traditional purposes, including hunting, fishing and trapping, of the above Treaty 8 First Nations. As a result, the Project also has the potential to impact the above Treaty 8 First Nations’ exercise of their rights to fish, hunt, and trap on Treaty 8 territory. These potential impacts are assessed below. BC Hydro received general descriptions of the seasonal round practiced by some First Nations. The construction of the Project may affect First Nations ability to undertake activities at particular times during the seasonal round. BC Hydro will continue to consult with First Nations, including consultation on clearing plans and protocols, and will implement a communications plan, as described in Section 34.4.

Blueberry River First Nations (BRFN)

Right to fish

BRFN’s treaty right to fish applies throughout Treaty 8 territory. The Project would reduce the ability of BRFN to exercise its treaty right to fish (Volume 3 Section 19 Current Use of Lands and Resources for Traditional Purposes) in the LAA, during both construction and operation. Opportunities for boat and shore-based river fishing along an 85-kilometre stretch of the Peace will be reduced. Several highly valued fishing areas, where streams and creeks join the Peace, will be inundated, although the confluences of those streams with the new reservoir may develop into good fishing areas. The impact of the creation of the dam will diminish as the reservoir begins to create a new fishery. However, it is not certain when these conditions may occur. As indicated in Volume 3 Section 19, other fishing areas currently used by BRFN would not be affected by the Project, and the reservoir would, in time, create compensatory fishing opportunities for BRFN. No cumulative effects of the Project were identified with respect to fishing for traditional purposes (Volume 3 Section 19 Current Use of Lands and Resources for Traditional Purposes). BRFN members will continue to have the opportunity to exercise their right to fish within the fish and fish habitat LAA, within their traditional territory, and within the wider Treaty 8 territory.

Rights to hunt and trap

BRFN’s treaty rights to hunt and trap apply throughout Treaty 8 territory. The Project would reduce the ability of BRFN to hunt and trap in the wildlife resources LAA during construction and operation (Volume 3 Section 19 Current Use of Lands and Resources for Traditional Purposes). The construction of the Project would have temporary effects on the ability of harvesters to access some parts of the LAA for hunting and trapping via road or river navigation. New access will be created around the reservoir. Opportunities to harvest small game, waterfowl, furbearers, and ungulates will be reduced in the short term. Effects on BRFN hunting and trapping would be temporary and hunting and trapping areas outside the LAA would not be affected by the Project. Several highly valued locations for hunting, trapping and other harvesting (berries, wood, and medicine) will be inundated. No cumulative effects of the Project were identified with respect to hunting and trapping for traditional purposes (Volume 3 Section 19 Current Use of Lands and Resources for Traditional Purposes). BRFN members will continue to have the
opportunity to exercise their rights to hunt and trap, within the LAA, within their traditional
territory, and within the wider Treaty 8 territory.

*Dene Tha’ First Nation (DTFN)*

Right to fish

DTFN’s treaty right to fish applies throughout Treaty 8 territory. The Project is not
expected to affect DTFN’s current use of lands and resources for fishing for traditional
purposes. Consequently, no impact on the DTFN’s treaty right to fish is expected.

Rights to hunt and trap

DTFN’s treaty rights to hunt and trap apply throughout Treaty 8 territory. The Project
would reduce the ability of DTFN to hunt and trap in the wildlife resources (Volume 3
Section 19 Current Use of Lands and Resources for Traditional Purposes). However,
these impacts would be temporary and other areas available to DTFN both within the
LAA and within the wider Treaty 8 territory that will not be affected by the Project. No
cumulative effects of the Project were identified with respect to hunting and trapping for
traditional purposes (Volume 3 Section 19 Current Use of Lands and Resources for
Traditional Purposes). DTFN members will continue to have the opportunity to exercise
their rights to hunt and trap, within the LAA, within their traditional territory, and within the
wider Treaty 8 territory.

*Duncan’s First Nation (DFN)*

Right to fish

DFN’s treaty right to fish applies throughout Treaty 8 territory. The Project would reduce
the ability of DFN to engage in current use of lands and resources for fishing in the fish
and fish habitat LAA (Volume 3 Section 19 Current Use of Lands and Resources for
Traditional Purposes). Opportunities for boat and shore-based river fishing along an
85-kilometre stretch of the Peace will be reduced. Several highly valued fishing areas,
where streams and creeks join the Peace, will be inundated, although the confluences of
those streams with the new reservoir may develop into good fishing areas. The impact of
the creation of the dam will diminish as the reservoir begins to create a new fishery.
However, it is not certain when these conditions may occur. As indicated in Volume 3
Section 19, other fishing areas currently used by DFN would not be affected by the
Project, and the Reservoir would, in time, create compensatory fishing opportunities for
DFN. Downstream of the dam, in stretches of the Peace River favored by DFN, fishing
opportunities will remain for the most part unchanged, except that cold water species will
also be present. No cumulative effects of the Project were identified with respect to
fishing for traditional purposes (Volume 3 Section 19 Current Use of Lands and
Resources for Traditional Purposes). DFN members will continue to have the opportunity
to exercise their right to fish within the LAA, within their traditional territory, and within the
wider Treaty 8 territory.

Rights to hunt and trap

DFN’s treaty rights to hunt and trap apply throughout Treaty 8. The Project would reduce
the ability of DFN to hunt and trap in the wildlife resources LAA during construction and
operation (Volume 3 Section 19 Current Use of Lands and Resources for Traditional
Purposes). The construction of the Project will have temporary effects on the ability of
harvesters to access some parts of the LAA for hunting and trapping via road or river navigation. New access will be created around the reservoir. Opportunities to harvest small game, waterfowl, furbearers, and ungulates will be reduced in the short term. Effects on DFN hunting and trapping would be temporary and hunting and trapping areas outside the LAA would not be affected by the Project. No cumulative effects of the Project were identified with respect to hunting and trapping for traditional purposes (Volume 3 Section 19 Current Use of Lands and Resources for Traditional Purposes). DFN members will continue to have the opportunity to exercise their rights to hunt and trap, within the LAA, within their traditional territory, and within the wider Treaty 8 territory.

**Horse Lake First Nation (HLFN)**

**Right to fish**

HLFN’s treaty right to fish applies throughout Treaty 8 territory. The Project would reduce the ability of HLFN to engage in current use of lands and resources for fishing in the LAA for fish and fish habitat (Volume 3 Section 19 Current Use of Lands and Resources for Traditional Purposes). Opportunities for boat and shore-based river fishing along an 85-kilometre stretch of the Peace will be reduced. Several highly valued fishing areas, where streams and creeks join the Peace, will be inundated. The impact of the creation of the dam will diminish as the reservoir begins to create a new fishery. However, it is not certain when these conditions may occur. Downstream of the dam, in stretches of the Peace River favoured by HLFN, fishing opportunities will remain for the most part unchanged, except that cold water species will also be present. No cumulative effects of the Project were identified with respect to fishing for traditional purposes (Volume 3 Section 19 Current Use of Lands and Resources for Traditional Purposes). HLFN members will continue to have the opportunity to exercise their right to fish within the LAA, within their traditional territory, and within the wider Treaty 8 territory.

**Rights to hunt and trap**

HLFN’s treaty rights to hunt and trap apply throughout Treaty 8 territory. The Project would reduce the ability of HLFN to hunt and trap in the wildlife resources LAA during construction and operation (Volume 3 Section 19 Current Use of Lands and Resources for Traditional Purposes). The construction of the Project will have temporary effects on the ability of harvesters to access some parts of the LAA for hunting and trapping via road or river navigation. New access will be created around the reservoir. Opportunities to harvest small game, waterfowl, furbearers, and ungulates will be reduced in the short term. Effects on HLFN hunting and trapping would be temporary and hunting and trapping areas outside the LAA would not be affected by the Project. No cumulative effects of the Project were identified with respect to hunting and trapping for traditional purposes (Volume 3 Section 19 Current Use of Lands and Resources for Traditional Purposes). HLFN members will continue to have the opportunity to exercise their rights to hunt and trap within the LAA, within their traditional territory, and within the wider Treaty 8 territory.
Saulteau First Nations (SFN)

Right to fish

SFN’s treaty right to fish applies throughout Treaty 8 territory. The Project would reduce the ability of SFN to exercise its treaty right to fish (Volume 3 Section 19 Current Use of Lands and Resources for Traditional Purposes) in the LAA, during both construction and operation. Opportunities for boat and shore-based river fishing along an 85-kilometre stretch of the Peace will be reduced. Several highly valued fishing areas, where streams and creeks join the Peace, will be inundated, although the confluences of those streams with the new reservoir may develop into good fishing areas. The impact of the creation of the dam will diminish as the reservoir begins to create a new fishery. However, it is not certain when these conditions may occur. As indicated in Volume 3 Section 19 Current Use of Lands and Resources for Traditional Purposes, other fishing areas currently used by SFN would not be affected by the Project, and the Reservoir would, in time, create compensatory fishing opportunities for SFN. No cumulative effects of the Project were identified with respect to fishing for traditional purposes (Volume 3 Section 19 Current Use of Lands and Resources for Traditional Purposes). SFN members would continue to have the opportunity to exercise their right to fish within the LAA, within their traditional territory and within the wider Treaty 8 territory.

Rights to hunt and trap

SFN’s treaty rights to hunt apply throughout Treaty 8 territory. The Project would reduce the ability of SFN to hunt and trap in the wildlife resources LAA during construction and operation (Volume 3 Section 19 Current Use of Lands and Resources for Traditional Purposes). The construction of the Project would have temporary effects on the ability of harvesters to access some parts of the LAA for hunting and trapping via road or river navigation. New access will be created around the reservoir. Opportunities to harvest small game, waterfowl, furbearers, and ungulates will be reduced in the short term. Effects on SFN hunting and trapping would be temporary and hunting and trapping areas outside the LAA would not be affected by the Project. Several highly valued locations for hunting, trapping and other harvesting (berries, wood, and medicine) would be inundated. No cumulative effects of the Project were identified with respect to hunting and trapping for traditional purposes (Volume 3 Section 19 Current Use of Lands and Resources for Traditional Purposes). SFN members will continue to have the opportunity to exercise their rights to hunt and trap within the LAA, within their traditional territory, and within the wider Treaty 8 territory.

Treaty 8 Tribal Association: Doig River First Nation, Halfway River First Nation, Prophet River First Nation, and West Moberly First Nations (T8TA)

Right to fish

T8TA’s treaty right to fish applies throughout Treaty 8 territory. The Project would reduce the ability of T8TA to exercise its treaty right to fish (Volume 3 Section 19 Current Use of Lands and Resources for Traditional Purposes) in the LAA, during both construction and operation. Opportunities for boat and shore-based river fishing along an 85-kilometre stretch of the Peace will be reduced. Several highly valued fishing areas, where streams and creeks join the Peace, will be inundated. The impact of the creation of the dam will diminish as the reservoir begins to create a new fishery. However, it is not certain when
these conditions may occur. As indicated in Volume 3 Section 19, other fishing areas currently used by T8TA would not be affected by the Project, and the Reservoir would, in time, create compensatory fishing opportunities for T8TA. No cumulative effects of the Project were identified with respect to fishing for traditional purposes (Volume 3 Section 19 Current Use of Lands and Resources for Traditional Purposes). T8TA members would continue to have the opportunity to exercise their right to fish within the LAA, within their traditional territories, and within the wider Treaty 8 territory.

Rights to hunt and trap

T8TA’s Treaty rights to hunt and trap apply throughout Treaty 8. The Project would reduce the ability of T8TA to hunt and trap in the Project wildlife resources LAA during construction and operation (Volume 3 Section 19 Current Use of Lands and Resources for Traditional Purposes). The construction of the Project will have temporary effects on the ability of harvesters to access some parts of the LAA for hunting and trapping via road or river navigation. New access will be created around the reservoir. Opportunities to harvest small game, waterfowl, furbearers, and ungulates will be reduced in the short term. Effects on T8TA hunting and trapping would be temporary, and hunting and trapping areas outside the LAA would not be affected by the Project. Several highly valued locations for hunting, trapping and other harvesting (berries, wood, and medicine) will be inundated. No cumulative effects of the Project were identified with respect to hunting and trapping for traditional purposes (Volume 3 Section 19 Current Use of Lands and Resources for Traditional Purposes). T8TA members will continue to have the opportunity to exercise their rights to hunt and trap within the LAA, within their traditional territories (see Figures 7, 10-12, 14-18 of Volume 5 Appendix A06 Part 3), and within the wider Treaty 8 territory.


It is anticipated that the Project would have no impacts on the asserted Aboriginal rights of the following BC First Nations:

- Kwadacha First Nation
- Tsay Keh Dene First Nation

As described in Section 34.3.2.2 neither Kwadacha nor Tsay Keh Dene First Nations has asserted that they exercise Aboriginal rights or hold Aboriginal title in the current use of lands and resources LAA (see Aboriginal Land and Resource Use Summaries in Volume 5 Appendix A13, Part 3 Kwadacha First Nation, and Volume 5 Appendix A27, Part 3 Tsay Keh Dene First Nation.)

Potential impacts on the Exercise of Asserted Rights – Métis Groups

Métis Nation British Columbia

MNBC asserts that it uses the Peace River valley and the LAA for current use activities including hunting, trapping, and fishing, but has not provided sufficient specific information to enable an effects assessment on current use or asserted rights.

Kelly Lake Métis Settlement Society

Kelly Lake Métis Settlement Society asserts that it uses the Peace River valley and the LAA for current use activities including hunting, trapping, and fishing, but has not
provided sufficient specific information to enable an effects assessment on current use or asserted rights. Should additional information regarding current and reasonably anticipated future use of lands and resources within the LAA be received from the Métis groups listed above, BC Hydro will incorporate it into the EIS review phase, and consider its relevance to impacts on asserted or treaty rights.

Métis Nation of Alberta—Region 6, Paddle Prairie Métis Settlement Society, Fort Chipewyan Métis Local 125 and Northwest Territory Métis Nation Volume 3 Section 19 Current Use of Lands and Resources for Traditional Purposes states that the Project is not expected to have an effect on the current use of lands and resources for traditional purposes (including fishing, hunting and trapping, and ancillary activities) for these Métis groups because there are no predicted interactions between Project activities and the use areas of these groups. As the Project will not adversely affect the ability of these groups to fish, hunt and trap, and pursue ancillary activities, the Project is not expected to have an impact on any Métis harvesting rights that these groups may have.

34.4 Aboriginal Accommodation

34.4.1 Summary of Mitigation Measures for Potential Adverse Impacts on the Exercise of Asserted or Established Aboriginal and Treaty Rights

Table 34.2 sets out the mitigations applicable to the potential adverse impacts on the exercise of treaty rights identified in Section 34.3.3 and mitigations applicable to the potential adverse impacts on ancillary activities including those activities reasonably incidental to the exercise of the identified treaty rights.

These mitigations, in addition to others, are also found in the mitigations included in Volume 3 Section 19 Current Use of Lands and Resources for Traditional Purposes, and in the follow-up measures identified in Volume 5 Section 39 Complete Lists of Mitigation and Follow-Up Measures.
### Table 34.2 Mitigation Measures for Potential Adverse Impacts on the Exercise of Treaty Rights

<table>
<thead>
<tr>
<th>Impact on Exercise of Treaty Right</th>
<th>Mitigation Measures to Be Implemented</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hunting and Trapping</strong></td>
<td></td>
</tr>
<tr>
<td>Consult with Aboriginal groups respecting the development of wildlife habitat compensation projects that align with BC Hydro compensation programs.</td>
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</tr>
<tr>
<td>Seek input from Aboriginal groups respecting mitigation strategies, such as mitigation measures related to trap lines in the Project activity zone.</td>
<td></td>
</tr>
<tr>
<td>Continue to consult with Aboriginal groups on clearing plans and protocols.</td>
<td></td>
</tr>
<tr>
<td>Develop a communications program to inform harvesters of planned or unplanned events related to construction activities that may affect hunting opportunities or access.</td>
<td></td>
</tr>
<tr>
<td>BC Hydro will 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 hunting and trapping 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 wildlife species.</td>
<td></td>
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<tr>
<td><strong>Fishing</strong></td>
<td></td>
</tr>
<tr>
<td>Consult with Aboriginal groups respecting the development of fish habitat compensation projects that align with BC Hydro compensation programs.</td>
<td></td>
</tr>
<tr>
<td>Seek input from Aboriginal groups respecting mitigation strategies.</td>
<td></td>
</tr>
<tr>
<td>Continue to consult with Aboriginal groups on clearing plans and protocols.</td>
<td></td>
</tr>
<tr>
<td>Develop a communications program to inform harvesters of planned or unplanned events related to construction activities that may affect fishing opportunities or access.</td>
<td></td>
</tr>
<tr>
<td>Develop a communications program to inform harvesters of longer-term changes in fish community composition.</td>
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</tr>
<tr>
<td>BC Hydro will 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 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 species.</td>
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</tbody>
</table>
### Impact on Exercise of Treaty Right

<table>
<thead>
<tr>
<th>Ancillary Activities</th>
<th>Mitigation Measures to Be Implemented</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work with Aboriginal groups to groundtruth traditional land use information for specific areas within the Project activity zone prior to commencing construction, e.g., when determining the exact location of an access road.</td>
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</tr>
<tr>
<td>Continue to consult with Aboriginal groups regarding clearing plans and protocols.</td>
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<tr>
<td>Develop a communications program to inform harvesters of planned or unplanned events that may affect opportunities to harvest plants, berries, and other resources.</td>
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</tr>
<tr>
<td>Consult with Aboriginal groups respecting the development of habitat compensation projects that align with BC Hydro compensation programs.</td>
<td></td>
</tr>
<tr>
<td>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 Section 24.4.9.1 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.</td>
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</tr>
<tr>
<td>Work with Aboriginal groups to identify potential sites for relocation of medicinal and food plants to compensate for areas that will be inundated.</td>
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</tr>
<tr>
<td>Use only indigenous and/or non-invasive plants and grasses in revegetation programs associated with the Project.</td>
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<tr>
<td>Engage with Aboriginal groups around any reclamation phase that may present opportunities to restore ecological communities that support species of high traditional use value.</td>
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<tr>
<td>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.</td>
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</tr>
</tbody>
</table>

### 34.4.2 Summary of Mitigation Measures Suggested by Aboriginal Groups

As of the submission of the EIS, Aboriginal groups have provided BC Hydro with a few specific suggestions for measures to avoid, reduce, or otherwise mitigate the potential adverse impacts of the Project, which are set out below, along with BC Hydro’s response to these suggestions.

- **Location of 500 kV transmission line**: Treaty 8 Tribal Association (Doig River, Halfway River, Prophet River, and West Moberly First Nations) and Saulteau First Nations expressed concern with expanding the 138 kV transmission line on the south side of the Peace River, which runs through the Peace Moberly Tract, an area of importance to the First Nations. Saulteau First Nations and Treaty 8 Tribal Association suggested a preference to pursue an alternate route for the transmission line, in particular a 500 kV corridor on the north side of the Peace River. Saulteau First Nations also suggested that the transmission line be run by submarine cable...
along the length of the reservoir. The alternatives considered for connecting the Project substation to the Peace Canyon substation are discussed in Section 4.3.3.2 Transmission Line Alternatives Considered in Volume 1 Project Description.

- **Alternative means**: Treaty 8 Tribal Association (Doig River, Halfway River, Prophet River, and West Moberly First Nations) and Smith’s Landing First Nation expressed an interest in alternatives that did not develop all the head between the Project and Peace Canyon, including the potential for lower head facilities at the Project location or further upstream of Wilder Creek. Interest was also expressed by these groups regarding the determination of the constraint to develop the entire head between Peace Canyon and the Project. BC Hydro’s considerations for alternative means of carrying out the Project are set out in Volume 1 Section 6 Alternative Means of Carrying out the Project and in Volume 1 Appendix E Dam Alternative Means Report. Section 5.3 Purpose of the Project in Volume 1 Section 5 Need for, Purpose of, and Alternatives to the Project includes a discussion of the objective to cost-effectively maximize the development of the hydroelectric potential of the Site C Flood Reserve.

- The historic dam design had included a proposal to construct an operations and maintenance bridge across the Peace River about 4 km downstream of the dam site. The upgraded design set out in the EIS provides the opportunity to access the generating station from across the dam and, as a result, there is no longer the need for a permanent bridge. Some Aboriginal groups had expressed concern that public access over the bridge would enlarge the project footprint and increase activity on the south bank of the river where they exercise their treaty rights to hunt and trap. The decision not to build the bridge in effect mitigated concerns expressed by those Aboriginal groups respecting increased public access to the south bank that could result from the permanent crossing.

Consultation with Aboriginal groups is ongoing throughout the environmental assessment process. Where consultation agreements have been reached, the agreements include a mutual commitment to identify and consider strategies or measures to mitigate the impacts of the Project.

In its Culture and Traditions Study Public Report (see Volume 5 Appendix A23 Part 5), Saulteau First Nations indicated an interest in working cooperatively with BC Hydro to explore options for mitigation. BC Hydro is committed to continuing consultation with all interested Aboriginal groups potentially affected by the Project to cooperatively explore options for mitigation. Suggestions made to BC Hydro through this Aboriginal consultation process will be incorporated into the EIS prior to the submission of the EIS to the Joint Review Panel.

**34.4.3 Summary of Environmental Mitigation Measures that Serve to Mitigate Impacts on the Exercise of Asserted or Established Aboriginal or Treaty Rights**

Many of the mitigation measures proposed for environmental VCs can also serve to mitigate potential impacts on the exercise of asserted or established Aboriginal or treaty rights and mitigations applicable to the potential adverse impacts on ancillary activities.
including those activities reasonably incidental to the exercise of the identified treaty rights.

These mitigations include the following:

- For impacts to the exercise of the treaty right to fish, implementation of all mitigation measures set out in Volume 2 Section 12 Fish and Fish Habitat, 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.

- For impacts to the exercise of the treaty rights to hunt and trap, implementation of all mitigation measures set out in Volume 2 Section 14 Wildlife Resources, and all mitigation measures set out in Volume 3 Section 24 Harvest of Fish and Wildlife Resources pertaining to trapping.

- For impacts related to the impacts to other activities, implement all mitigation measures set out in Volume 2 Section 13 Vegetation and Ecological Communities.

### 34.4.4 Other Accommodations

As discussed in Section 34.7.1, Volume 5 Asserted or Established Aboriginal Rights and Treaty Rights, Aboriginal Interests and Information Requirements, the Project may impact the exercise of treaty rights to hunt, fish and trap. BC Hydro is prepared to address and accommodate the potential for the Project to do so by entering into arrangements set out in Impact Benefit Agreements. Those agreements may provide for lump sum cash payments, payment streams over time, the transfer of Crown lands to the affected Aboriginal groups in fee simple, potential land protection measures or the establishment of special management zone designations. BC Hydro has offered to enter into initial discussions with Aboriginal groups that are likely to be impacted by the Project and to date, three Aboriginal groups have accepted BC Hydro’s offer to enter into discussions. Those arrangements, if entered into, could, in addition to accommodating the potential impact on the exercise of treaty rights, further avoid, reduce, or compensate for the potential residual adverse effects of the Project on the current use of lands and resources for traditional purposes.

### 34.5 Outstanding Aboriginal Issues

The potential adverse impacts on the exercise of Treaty 8 rights have been identified and assessed in Section 34.3.3. Section 34.4 contains a description of proposed mitigations and accommodations for these potential adverse impacts, including BC Hydro’s willingness to continue to consult and enter into impact benefit agreement (IBA) negotiations with First Nations that, in BC Hydro’s view, are likely to be adversely impacted by the Project and where BC Hydro considers that accommodation beyond the other mitigations listed in the EIS is warranted. BC Hydro anticipates that after these mitigation and accommodation measures are applied, adverse impacts to Treaty 8 rights would be mitigated or accommodated. No other potential adverse impacts on asserted or established Aboriginal and treaty Rights have been identified.
34.6 Other Interests of Aboriginal Groups

34.6.1 Aboriginal Interests: Social, Economic, Health, Physical, and Cultural Heritage Effects of the Project

An Aboriginal Issues, Concerns, and Interests Tracking Table is included in Volume 1 Appendix H Aboriginal Information Distribution and Consultation Supporting Documentation. The table presents, in summary form, a high-level description of the issues, concerns, and interests identified by Aboriginal groups in consultation activities with BC Hydro between November 1, 2007 and November 30, 2012, including those identified in meetings, phone calls, letters, emails, and reports (e.g., Traditional Land Use Studies, Community Assessments), as well as those identified during the comment periods for the EIS Guidelines. The table specifies which Aboriginal group(s) identified each issue, concern, or interest, and outlines BC Hydro’s consideration or response to each issue, concern, or interest, or provides a reference to where the issue, concern, or interest is considered or responded to in the EIS.

34.6.2 Consideration of Effects on Identified Interests in Assessment of Potential Effects on VCs or Otherwise

The issues described in Volume 1 Appendix H Aboriginal Information Distribution and Consultation Supporting Documentation were provided to technical staff for consideration in their effects assessment. Many of the issues identified in the table are included in the VC-specific key issues tables in Volumes 2, 3 and 4 in Sections 12 through 33 of the EIS.

Additionally, and as described in Section 9.2 in Volume 1 Section 9 Information Distribution and Consultation, formal agreements to complete TLUS reports were concluded with: Treaty 8 Tribal Association (representing Doig River, Halfway River, Prophet River, and West Moberly First Nations), Duncan’s First Nation, Saulteau First Nations, Blueberry River First Nations, Horse Lake First Nation, and Dene Tha’ First Nation. As of the filing of the EIS, all of the TLUS reports referenced above have been completed and shared with BC Hydro, including technical staff responsible for conducting the wildlife resources, vegetation and ecological communities, fish and fish habitat, and heritage resources effects assessments.

Volume 3 Appendix B First Nations Community Baseline Reports, Part 1 Approach to Gathering and Integrating Community Baseline Information describes how BC Hydro approached the use of information collected in First Nation community baseline reports, and how the information was integrated into the social effects assessment for the EIS.

Consultation with respect to the Project is ongoing, and BC Hydro will continue to track new issues, concerns, or interests identified by Aboriginal groups. As these are identified, BC Hydro will continue to make the information available to its technical staff for consideration in the EIS review phase and prior to submission of the EIS to the Joint Review Panel.
34.6.3 Proponent’s Approach to Building Capacity

The following sets out BC Hydro’s approach to building capacity among Aboriginal groups that may be affected by the Project.

34.6.3.1 BC Hydro Aboriginal Procurement Policy

BC Hydro is committed to increasing Aboriginal participation in providing goods and services to the organization. In order to achieve this objective, BC Hydro has adopted an Aboriginal Contract and Procurement Policy.

BC Hydro’s Aboriginal Contract and Procurement Policy defines the criteria for being considered an Aboriginal Business.

An Aboriginal Business is a business that meets the following criteria:

a) If the business is a sole proprietorship, it must be wholly owned by an Aboriginal person

b) If the business is a corporation, it must have at least 51% of the equity (including any common or voting shares) owned by one or more Aboriginal Businesses or Aboriginal People

c) If the business is a partnership or joint venture, it must have at least 51% of the ownership rights (including any voting rights) directly held by one or more Aboriginal Businesses or Aboriginal People

d) As determined by the Owner in its sole discretion from time to time, any other business with a substantial amount of ownership rights held by one or more Aboriginal Businesses or Aboriginal Peoples

BC Hydro’s Aboriginal Contract and Procurement Policy also identifies several procurement tools that enable increased Aboriginal participation. The procurement tools contemplated under the Aboriginal Contract and Procurement Policy may include set-asides, direct awards, select tenders, and the inclusion of Aboriginal content as an evaluation criterion in bidding documents. The use of these tools is balanced against BC Hydro’s mandate to provide value for its ratepayers.

34.6.3.2 Capacity Building

The Site C team has sought to support capacity building opportunities for Aboriginal people in the planning and construction phases of the Project through the directed procurement, support for education and training, and business outreach activities described below.

Directed Procurement for Stage 3 General Contractor Work

Since 2010 and in accordance with BC Hydro’s Aboriginal Contract and Procurement Policy, BC Hydro has sought to engage Aboriginal businesses in work on the Project.

To support the field investigation work on the Project, BC Hydro issued an RFP for general contractor support that included a requirement for at least one of the selected contractors to be an Aboriginal business. As a result of the process, two Aboriginal businesses were successful in receiving contracts: Renegade Construction Inc.
by a Doig River First Nation member), and Dunne-za Ventures (a West Moberly First
Nations company).

During this RFP process, BC Hydro awarded additional contracts to carry out early
season work in advance of the award of contracts under the RFP to two Aboriginal
businesses: Blueberry River Enterprises (a Blueberry River First Nations company), and
4 Evergreen Resources (a Saulteau First Nations company).

All four companies provided general contractor support for the engineering field
investigation program throughout the Project area. Some of the components of work
included:

- Tree clearing and mulching, general labour
- First aid
- Provision of jet boat
- Heavy equipment operation, road construction
- Support to drilling investigation

Northern Lights College Bursary

On September 20, 2012, the Honourable Rich Coleman, Minister of Energy, Mines and
Natural Gas announced that BC Hydro would contribute $1 million in funding to support
trades and skills training bursaries at Northern Lights College. The funding will be
disbursed over a five-year period to support the development of skilled workers in the
north, targeting those students who may not otherwise have access to post-secondary
education. Fifty per cent of the funding for bursaries will be dedicated to Aboriginal
students, and applications will start being accepted in early 2013, with bursaries being
awarded for the fall 2013 school year. The bursaries would be available to students
pursuing the following programs:

- Aircraft Maintenance Engineering
- Automotive Service Technician Foundation and Apprenticeship
- Carpentry Foundation (Residential Construction) and Apprenticeship
- Commercial Transport Technician Apprenticeship
- Cook Training
- Electrician Foundation and Apprenticeship
- Heavy Duty Equipment Technician Apprenticeship
- Heavy Duty/Commercial Transport Technician Foundation
- Industrial Instrumentation Mechanic Foundation and Apprenticeship
- Millwright Foundation and Apprenticeship
- Plumber Foundation and Apprenticeship
- Practical Nursing Diploma
Welding Level C, B, A and Apprenticeship

These programs are offered at Northern Lights College’s campuses in northeast B.C.

Northern Opportunities

In July 2011, BC Hydro entered into a three-year funding agreement with Northern Opportunities, a partnership of the school districts of Fort Nelson (SD #81), Peace River North (SD #60), and Peace River South (SD #59), Northern Lights College, local First Nations, industry, and local communities, with an objective of providing young people with a seamless learning pathway from secondary school to post-secondary training, leading to career success. A dual-credit program offered in the Peace Region combines high school, college studies, and work-based training, enabling students to earn both a high school diploma and advanced credit in post-secondary and/or industry certification at the same time. The program covers academic, trades and apprenticeship, and vocational programs, and is open to both Aboriginal and non-Aboriginal students.

Between 2006 and 2010 and across all three school districts, 784 students participated in the dual-credit and apprenticeship programs supported by Northern Opportunities, of which 614 graduated (Northern Opportunities 2011). Aboriginal students represented 121 participants, and 83 graduates. For Aboriginal students, this participation represents an overall graduation rate of 75.8% of those participating in the dual-credit program, versus 53.4% for those participating in traditional high school programs. As a Northern Opportunities Partner, BC Hydro sits as a member of the Northern Opportunities’ Community Learning Council.

Partnerships with the North East Native Advancing Society (NENAS)

Working in partnership with the NENAS, BC Hydro assisted in developing a proposal to secure funding from the Industry Training Authority (ITA) that would support an essential skills and pre-trades training program, North East Aboriginal Trades Training (NEATT). NENAS was successful in securing funding from the ITA for a two-year program, which began its first intake in the spring of 2012. NEATT offers two key streams: an eight-week Essential Skills for Apprenticeship program that is tailored to an individual learner’s needs, and an eight-week Pre-Apprenticeship Exploration program that prepares individuals to enter into formal trades training.

In December 2012, BC Hydro announced that it would contribute $100,000 over two years to NENAS in support of advancing NEATT participants into trades training not currently offered by Northern Lights College for those trades that are of interest to BC Hydro for the Site C Project, such as heavy duty equipment operators. The funding would be used to defray tuition and related costs for those students who are pursuing trades training.

In 2011 and 2012, BC Hydro contributed funding to the annual Go Karts for Girls event in Fort St. John. This event is organized by NENAS and aims to promote the interest and involvement of Aboriginal girls in science, engineering, and trades as career options.

Heritage Program

As described in the Volume 4 Appendix C Heritage Resource Assessment Report, the heritage program for the Site C Project provided employment and capacity building opportunities for 163 Aboriginal people during the 2010–2012 field seasons.
34.6.3.3 Engagement with Aboriginal Businesses

BC Hydro has actively pursued opportunities to engage directly with the Aboriginal business community, in the Peace Region and beyond:

- In February 2012, BC Hydro sponsored and participated in the inaugural Aboriginal Business Match Conference in Prince George. This event aims to bring together top business and economic development decision-makers from more than 150 First Nations and Tribal Councils with businesses, investors, customers, and suppliers looking to do business in First Nation communities. With the unique conference format, representatives from the Site C team were able to have one-on-one meetings with Aboriginal businesses and to build an awareness of regional First Nation suppliers and promote potential upcoming opportunities arising from the Site C project. BC Hydro and the Site C team will sponsor and attend this event again in February 2013.

- As outlined in Section 3.3 of Volume 1 Appendix F Project Benefits Supporting Documentation, BC Hydro held business information sessions targeted at the contracting and business community in several communities in the Northeast Development Region. The First Nations Engagement team notified First Nation groups and several Aboriginal businesses of the sessions. Notification was also provided to those businesses registered with the BC Hydro Aboriginal business directory. The presentation included information about BC Hydro’s Aboriginal Procurement Policy and related processes.

- On request from Aboriginal groups, BC Hydro’s procurement and Aboriginal Business staff have attended consultation and community meetings to review BC Hydro’s Aboriginal Contact and Procurement Policy, and assist Aboriginal businesses with registration with the BC Hydro/Site C Aboriginal Business Directory. Additionally, regular check-in meetings were held with Aboriginal businesses doing work on the project to understand their capacity and interests with respect to ongoing work for the Project, should it proceed to construction.

34.7 Aboriginal Consultation and Engagement

34.7.1 Impact Benefit Agreements

In early March 2012, BC Hydro secured a mandate to enter into impact benefit agreement (IBA) negotiations with First Nations that, in BC Hydro’s view, are likely to be adversely affected or impacted by the Project and where BC Hydro considers that accommodation beyond the mitigations listed in the EIS is warranted.

Between March 19, 2012 and April 27, 2012, BC Hydro advised seven First Nations that it had secured a mandate to negotiate an IBA, and that it was prepared to engage in initial discussions with those First Nations that were interested.

In advising First Nations of the mandate, BC Hydro outlined potential elements that could be included in an IBA, including:

- Lump sum cash payments
- Payment streams over time
• Cash equivalents – e.g., commitments to investments in community infrastructure
• Special purpose funds – set aside amounts designed for initiatives such as education, training, heritage, or cultural projects
• Environmental mitigation measures
• The inclusion of provincial Crown lands

With respect to the process for inclusion of provincial Crown lands, BC Hydro provided the following information:
• Crown lands would be negotiated in collaboration with B.C.
• Crown lands could be transferred to First Nations in fee simple
• Sub-surface resources would not be included in any land transfers
• Any third-party interests on those lands would have to remain in place
• In collaboration with B.C., BC Hydro would be prepared to engage in discussions respecting potential land protection and special management zone designations

In describing the potential elements of an IBA available under its mandate instructions, BC Hydro noted that two topics could not be included in a potential IBA. The first was that the resolution of any historical grievances regarding previous projects could not be included in an IBA for the Project. BC Hydro explained that any historical grievances would need to be raised with the Aboriginal Relations and Negotiations group within BC Hydro, which is responsible for the management of historic grievances related to prior BC Hydro projects. The second topic that could not be included in an IBA was an option of equity in the Project. BC Hydro explained that such an option was not available given the provisions prohibiting the sale of “heritage assets” included in the Clean Energy Act. Under the Act, a “heritage asset” includes a generation or storage asset included in Schedule 1 to the Act. The Project is one of the generation and storage assets named in Schedule 1.

Three First Nations (Blueberry River First Nations, Saulteau First Nations, and McLeod Lake Indian Band) accepted BC Hydro’s offer to enter into initial discussions toward an IBA. As of the filing of the EIS, impact benefit agreement offers have been made to the three First Nations. BC Hydro remains prepared to enter into discussions with the four remaining First Nations.

### 34.7.2 Consultation and Engagement Methods

This information has been provided in Section 9.2 Aboriginal Group Information Distribution and Consultation in Volume 1 Section 9 Information Distribution and Consultation. An issues tracking table is included in Volume 1 Appendix H Aboriginal Information Distribution and Consultation Supporting Documentation. Consultation summaries respecting BC Hydro’s engagement with each Aboriginal group identified in Table 34.1 are included, by Aboriginal group, in Part 2 of Volume 5 Appendix A Asserted or Established Aboriginal or Treaty Rights, Aboriginal Interests, and Information Requirements Supporting Documentation.
34.8 Aboriginal Summary

Pursuant to the direction included in Section 20.8 of the EIS Guidelines, BC Hydro has prepared an Aboriginal Summary for each of the 29 Aboriginal groups identified in Table 34.1. These Aboriginal Summaries are included in Volume 5 Appendix A Asserted or Established Aboriginal or Treaty Rights, Aboriginal Interests, and Information Requirements Supporting Documentation, as Part 4 of that Appendix for each Aboriginal group. BC Hydro sent a copy of the Aboriginal Summary to each of the Aboriginal groups identified in Table 34.1 on January 25, 2013.

The summaries identify the Aboriginal group and provide BC Hydro’s understanding of the following:

- The asserted Aboriginal or treaty rights of that Aboriginal group
- The concerns with respect to the Project identified by that Aboriginal group
- The potential adverse effects of the Project on the asserted or established Aboriginal rights, treaty rights, and interests. This information is informed by the assessment carried out pursuant to Sections 19 and 34.3.3. Where adverse effects have been identified, the summary will also include information with respect to potential mitigation options, and any residual effects.
References

Cases
1. Beckmann v. Little Salmon/Carmacks First Nation, 2010 SCC 53
3. Haida Nation v. British Columbia (Minister of Forests), 2004 SCC 73
5. Lax Kw’alaams Indian Band v. Canada (Attorney General), 2011 SCC 56
6. L’Hirondelle v Alberta (Sustainable Resource Development), 2013 ABCA 12
7. Mikisew Cree First Nation v. Canada (Minister of Canadian Heritage), 2005 SCC 69
12. R. v. Lizotte, 2009 ABPC 287
17. R v. Willison, 2006 BCSC 985

Literature Cited

Internet Sites
Personal Communications


Statutes and Treaties

9. Alberta Natural Resources Act, 20-21 George V, c. 3 (Can)


12. Saskatchewan Natural Resources Act, 20-21 George V, c. 41 (Can)

13. Treaty No. 8 (1899)
35 SUMMARY OF ENVIRONMENTAL MANAGEMENT PLANS

35.1 Environmental Management Framework

In this section of the EIS, the framework for the environmental management of the Project is discussed. The framework is consistent with existing BC Hydro policies and practices, and is based on standard environmental management principles.

The purpose of implementing an effective environmental management framework would be to protect the environment surrounding the Project. The objectives of the environmental management framework are to ensure that:

- Necessary mitigation measures are implemented
- The conditions upon which an Environmental Assessment Certificate may be issued, or upon which a decision under Section 53 of the *Canadian Environmental Assessment Act* is made, are met
- Any conditions of permits and authorizations are met
- Any other legal requirements are adhered to
- BC Hydro policies are complied with
- Monitoring and reporting requirements are fulfilled

The environmental management framework is illustrated in Figure 35.1. Environmental Management Plans and Safety Management Plans would be prepared by qualified professionals retained by BC Hydro to address key aspects of environmental and safety management. The Environmental Management Plans and Safety Management Plans would provide guidance to all contractors retained by BC Hydro regarding the environmental and safety management requirements and the performance expectations related to construction and operation. Detailed procedures of how work activities would be carried out in accordance with the requirements of management plans would be developed by contractors prior to the start of work. BC Hydro would also develop an oversight program prior to construction that would describe the requirements for monitoring of contractor performance.

Prior to construction, BC Hydro would identify the management structure and human resources required to implement and manage this framework. All supervisors and workers would be required to be aware of, and competent to carry out, their responsibilities associated with the environmental management framework.

35.1.1 Environmental Management Plans

Environmental Management Plans and Safety Management Plans would be developed according to the following outline:

- **Objectives** – Each management plan would outline the objectives specific to that plan. The objectives of each proposed management plan are described in the subsections that follow.
• **Statutory Requirements** – Each management plan would describe the relevant statutory policy requirements, including:
  - The applicable conditions upon which an Environmental Assessment Certificate may be issued or upon which a decision under Section 53 of the *Canadian Environmental Assessment Act* is made
  - Any applicable conditions of permits and authorizations
  - Other applicable legislation

  Applicable guidelines adopted by the Canadian Council of Ministers of the Environment (CCME) would also be taken into account.

• **BC Hydro Policies** – Each management plan would describe the relevant BC Hydro policy requirements. Corporate policies are subject to change from time to time. Any particular management plan would be developed in consideration of the relevant corporate policy in effect at the particular time.

• **Voluntary Commitments** – Each management plan would describe the relevant standard practices and voluntary commitments

• **Project Effects, Mitigation, and Environmental Protection Measures** – Each management plan would describe the applicable potential Project effects and clearly document all measures to be implemented and actions to be taken to mitigate those potential effects. Documentation would include:
  - Relevant Restricted Activity Zones (areas of the project where construction activities are restricted to a specified list) and Environmental Protection Zones (areas of the project where no construction activities are allowed)
  - Standard codes of practice and management practices applicable to the plan

• **Training and Human Resource Planning** – Each management plan would describe the worker qualifications and training requirements pertaining to the plan

• **Monitoring and Reporting** – Each management plan would describe the requirements for tracking, monitoring and reporting pertaining to the plan

Contingency planning for accidents would be addressed in the construction phase Emergency Response Plan (Section 35.2.1.1) and the operations phase Emergency Response Plan (Section 35.3.1.1).

### 35.1.2 Environmental Oversight

An Environmental Oversight Program would be developed by BC Hydro prior to beginning construction activities. The environmental obligations of contractors would be included in contract documents.

BC Hydro's roles and responsibilities would include:

- Preparing and maintaining Environmental Management Plans
- Reviewing and assessing draft contractor work plans, worker training programs, and supervision plans
- Monitoring contractor performance and compliance with requirements
• Conducting environmental monitoring as required
• Reviewing and assessing contractor monitoring reports
• Reporting monitoring results as required
• Reporting and investigating incidents, and ensuring corrective actions are implemented

Contractor roles and responsibilities would include:
• Preparing and maintaining work plans
• Ensuring workers are trained, competent, and adequately supervised
• Retaining qualified environmental monitor(s) with the authority to stop work in the event of non-compliance with conditions and requirements of commitments, regulatory approvals, management plans, or applicable legislative requirements
• Conducting environmental monitoring and reporting of the results as required
• Reporting and investigating incidents, and implementing corrective actions

The oversight program would also contain the following elements:
• Incident (events of non-compliance with the requirements of a management plan) response: the requirements for responding to, reporting, documenting, investigating, and correcting incidents
• Plan maintenance: the requirements for reviewing and updating management plans to ensure that they remain current

35.2 Construction Phase
Prior to construction, BC Hydro would develop Environmental Management Plans and Safety Management Plans that would provide performance-based requirements to be met by contractors in conducting work on the Project. These requirements would be included as part of the contract tender process. Contractors would be required to develop work plans that specify how the contractor would meet the requirements established in Environmental Management Plans. Sections 35.2.1 and 35.2.2 provide more detail on the management plans that would be developed for the construction phase of the Project.

35.2.1 Construction Safety Management Plans

35.2.1.1 Emergency Response Plan

Objectives
The objective of the Emergency Response Plan would be to provide a framework for effectively managing emergencies involving chemical or fuel spills, fire, medical, flood, or other emergencies.
Statutory Requirements

Emergency response is regulated under a variety of provincial legislation, including the B.C. Emergency Program Act, B.C. Environmental Management Act, B.C. Fire Code, B.C. Wildfire Act, B.C. Workers Compensation Act and B.C. Spill Reporting Regulation. Applicable federal legislation includes the Canadian Environmental Protection Act and the Environmental Emergencies Regulation.

BC Hydro Policies

The applicable corporate policies are the Environmental Responsibility Policy (BC Hydro 2010a) and Safety Policy (BC Hydro 2006b).

Voluntary Commitments


Project Effects, Mitigation, and Safety Measures

The Emergency Response Plan would include the requirements for the following:

- Emergency response procedures, including first response, containment, evacuation, and cleanup
- Emergency response equipment
- Groundwater and surface water protection
- Response to a hazardous materials spill
- Notification and communication procedures
- Emergency contact information

Training and Human Resource Planning

All project workers would be trained on the procedures for reporting emergencies. All personnel with identified responsibilities in the emergency command structure would be trained and competent to carry out the assigned tasks. First responders would receive appropriate first response training.

Monitoring and Reporting

Protocols for reporting of emergencies would be established in accordance with applicable legislation.

35.2.1.2 Fire Hazard and Abatement Plan

Objectives

The objective of the Fire Hazard and Abatement Plan would be to identify the requirements for fire prevention during construction. Fire prevention requirements would be based on the risk associated with construction activities.
35.2.1.3 Public Safety Management Plan

Objectives
The objective of the Public Safety Management Plan would be to minimize and manage public safety risks.

Statutory Requirements
Not applicable.

BC Hydro Policies
The applicable corporate policies are the Safety Policy (BC Hydro 2006b), the Policy Statement on Dam Safety (BC Hydro 2011) and OSH 701 Public Safety Management Standard (BC Hydro 2006a).

Voluntary Commitments
The Public Safety Management Plan would describe relevant management practice guidelines such as the Guidelines for Public Safety Around Dams (CDA 2011).
Project Effects, Mitigation, and Safety Measures

Various construction activities have the potential to affect public safety, including vehicles, Highway 29 realignment, clearing, blasting, and reservoir filling. The plan would define the communication requirements, communication methods, timing, and information distribution methods to ensure that the public is aware of ongoing project activities as well as of specific activities that may directly affect them.

Public safety aspects of blasting would be addressed in the Blasting Management Plan (Section 35.2.2.3). Public safety aspects of increased traffic volumes would be addressed in the Traffic Management Plan (Section 35.2.1.4). Public safety aspects of ice management would be addressed in the Ice Management Plan (Section 35.2.2.15).

Training and Human Resource Planning

Employees responsible for reporting to the public would receive appropriate training regarding the communications protocols and procedures.

Monitoring and Reporting

The effectiveness of the communications protocols would be monitored regularly and adjusted as needed.

35.2.1.4 Traffic Management Plan

Objectives

The objective of the Traffic Management Plan would be to ensure that traffic is managed in and around the construction sites in a manner that protects wildlife, maximizes worker and public safety, and minimizes effects on productivity.

Statutory Requirements

Traffic management is regulated under a variety of legislation and bylaws, including the federal Transportation of Dangerous Goods Act, the B.C. Transportation of Dangerous Goods Act and the B.C. Workers Compensation Act.

BC Hydro Policies

The applicable corporate policy is the Safety Policy (BC Hydro 2006b).

Voluntary Commitments

Relevant management practice guidelines include the Traffic Management Guidelines for Work on Roadways (B.C. Ministry of Transportation 2001).

Project Effects, Mitigation, and Safety Measures

Increased traffic volumes as a result of the Project have the potential to affect wildlife and the public. There is also a potential for increased fog on the Taylor Bridge. The Traffic Management Plan would include the following topics:

- Site-specific training regarding potential wildlife conflicts (e.g., deer crossings) and reporting of wildlife sighting
- Public safety measures (including requirements for flagging)
- Transportation and access routes
Section 35: Summary of Environmental Management Plans

- Speed limits
- Traffic control measures
- Management of Project-induced traffic delays
- Brake checks
- Runaway lanes
- Lighting and signage on the Taylor Bridge
- Access restrictions

Communication with the public regarding traffic-related subjects would be addressed in the Public Safety Management Plan (Section 35.2.1.3).

Training and Human Resource Planning

Drivers of vehicles and equipment would receive appropriate site-specific training.
Flaggers would require appropriate certification. Qualified engineers or technologists would implement traffic control programs.

Monitoring and Reporting

A program to monitor compliance with speed limits and traffic control measures would be established. A program to monitoring of traffic delays at intersections would be implemented, and appropriate control changes made as required.

35.2.1.5 Worker Safety and Health Management Plan

Objectives

The objective of the Worker Safety and Health Management Plan would be to minimize and manage risks to workers’ safety and health.

Statutory Requirements

Worker Safety and Health is regulated by Workers Compensation Act and its associated regulations.

BC Hydro Policies

The applicable corporate policy is the Safety Policy (BC Hydro 2006b).

Voluntary Commitments

Not applicable.

Project Effects, Mitigation, and Safety Measures

The Worker Safety and Health Management Plan would outline specific procedures and protocols for working in and around the active construction site. Required personal safety devices, proper protocols for working in and around machinery, and the location of existing structures, utilities, and potential hazards associated with the work site would be addressed.

Worker safety aspects of blasting would be addressed in the Blasting Management Plan (Section 35.2.2.3).
Training and Human Resource Planning

All Project workers would receive appropriate training on the risks and hazards of the work they would be involved in and the required measures to reduce the risks, including the use of personal protective equipment.

Monitoring and Reporting

BC Hydro would implement a program to audit compliance with safety requirements.

35.2.2 Construction Environmental Management Plans

35.2.2.1 Acid Rock Drainage-Metal Leachate Management Plan

The Acid Rock Drainage-Metal Leachate Management Plan is provided in Part 4 of Volume 2 Appendix B Geology, Terrain Stability and Soil Reports.

35.2.2.2 Air Quality Management Plan

Objectives

The objectives of the Air Quality Management Plan would be to minimize emissions to air of criteria air contaminants and greenhouse gases from project activities, ensure that project emissions meet applicable standards, and control construction activities that produce dust.

Statutory Requirements

Air quality protection is regulated under a variety of legislation, including the provincial Environmental Management Act and Greenhouse Gas Reduction Targets Act.

Other non-statutory guidance developed by governments includes the Air Quality Guidelines for the Protection of Human Health and the Environment (CCME 1998) and the British Columbia Air Quality Objectives and Standards (B.C. Ministry of Environment 2009).

BC Hydro Policies

The applicable corporate policy is the Environmental Responsibility Policy (BC Hydro 2010a).

Voluntary Commitments

Air quality objectives and guidelines relevant to the project include the Best Management Practices for the Reduction of Air Emissions from Construction and Demolition Activities (Cheminfo Services Inc. 2005).

Project Effects, Mitigation, and Environmental Protection Measures

Emissions of criteria air contaminants from project activities have the potential to affect human health. Topics that would be addressed in the plan include:

- Reduction and control of emissions and dust from clearing
- Reduction and control of emissions and dust from operating vehicles and equipment
- Reduction and control of emissions and dust from extracting, transporting, stockpiling, processing, and placing construction materials
Road dust control

Reduction of greenhouse gas emissions through reduced fuel use and increased fuel efficiency

Burning and incineration controls would be addressed in the Smoke Management Plan (Section 35.2.2.2). Dust from blasting would be addressed in the Blasting Management Plan (Section 35.2.2.3).

Training and Human Resource Planning

All Project workers would receive training in the sources of criteria air contaminants from the work they are undertaking and the appropriate control measures. Air quality monitoring and modelling would be done by qualified professionals.

Monitoring and Reporting

Monitoring of fine particulate matter (PM$_{10}$ and PM$_{2.5}$), wind speed, and wind direction would take place on the north and south banks of the dam construction site. The locations of the monitors would be determined based on air dispersion modelling. Particulate monitoring would also take place near the Hudson’s Hope shoreline protection construction area. Results would be reported to stakeholders in accordance with the Construction Communication Plan and to regulators on a regular basis.

35.2.2.3 Blasting Management Plan

Objectives

The objective of the Blasting Management Plan would be to ensure that blasting is done safely and to minimize the effects associated with blasting during construction. These effects may include noise, ground vibration, air blast overpressure, fly rock, and dust.

Statutory Requirements

Potential blasting-related effects are regulated under a variety of legislation. For example, blasting carried out near water is regulated by the Fisheries Act.

Voluntary Commitments

Relevant management practice guidelines include Guidelines for the Use of Explosives in or Near Canadian Fisheries Waters (Wright and Hopky 1998).

BC Hydro Policies

The applicable corporate policies are the Environmental Responsibility Policy (BC Hydro 2010a), Safety Policy (BC Hydro 2006b).

Project Effects, Mitigation, and Environmental Protection Measures

Dust, noise, and vibration from blasting have the potential to affect human health. The plan would address the following topics:

- Worker safety
- Public safety
- Explosive storage
- Control of blast debris and dust
• Control of blasting-induced noise and vibration

Training and Human Resource Planning
Workers involved with blasting would be appropriately qualified. They would also receive training on Project-specific controls and protocols.

Monitoring and Reporting
Monitoring of dust from blasting would be included in the particulate monitoring described in the Air Quality Management Plan (Section 35.2.2.2). Noise and vibration from blasting would be included in the monitoring described in the Noise and Vibration Management Plan (Section 35.2.2.16).

35.2.2.4 Borrow and Quarry Sites Reclamation Plan
Borrow and quarry site reclamation would be incorporated into the Soil Management, Site Restoration, and Revegetation Plan (Section 35.2.2.19).

35.2.2.5 Construction Communication Plan
The Construction Communication Plan is described in Chapter 9.1.4.

35.2.2.6 Contaminated Sites Management Plan
Objectives
The objective of the Contaminated Site Management Plan would be to provide a framework for managing contaminated, or potentially contaminated, sites that may be affected by the Project. Potentially contaminated sites within the Project activity zones have been identified in the Contaminated Sites Report (in Part 3 in Volume 2 Appendix B Geology, Terrain Stability, and Soil Reports).

Statutory Requirements
In British Columbia, a contaminated site is defined as an area of land in which the soil or underlying groundwater or sediment contains a hazardous waste or substance in an amount or concentration that exceeds provincial environmental quality standards. Contaminated sites are regulated under a variety of legislation, including the provincial Environmental Management Act and the Contaminated Site Regulation.

BC Hydro Policies
The applicable corporate policy is the Environmental Responsibility Policy (BC Hydro 2010a).

Voluntary Commitments
Project Effects, Mitigation, and Environmental Protection Measures

Contaminated sites may affect groundwater quality and surface water quality when the reservoir is inundated. Five out of 40 of the identified potentially contaminated sites’ properties may experience adequate water table rise to potentially influence groundwater quality. The Contaminated Site Management Plan would include:

- The requirements for sampling and testing programs for the five properties to determine the level of contamination, if any
- Procedures for sampling and handling potentially contaminated soil
- Procedures for identifying contaminated site safety hazards
- Procedures for determining site remediation methods
- Procedures for determining disposal methods of contaminated soil
- Directions for monitoring a site once remediation measures are in place
- Procedures to be followed if additional potentially contaminated soils are discovered during construction

Training and Human Resource Planning

Qualified professionals would be retained to evaluate potentially contaminated sites and, if required, to develop and implement remediation plans.

Monitoring and Reporting

Soil sampling and testing programs would be developed as part of any site remediation plan. Groundwater quality monitoring and surface water quality monitoring would be described in the Groundwater Protection Plan (Section 35.2.2.12) and the Fisheries and Aquatic Habitat Management Plan (Section 35.2.2.10) respectively.

35.2.2.7 Dust Control Plan

The Dust Control Plan would be incorporated into the Air Quality Management Plan (Section 35.2.2.2).

35.2.2.8 Environmental Training Management Plan

The requirements for worker training and qualifications would be addressed in each management plan. These requirements would be compiled into a project environmental training plan. The objective of this plan would be to provide the necessary training to all workers so that they are competent to carry out their work with minimum effect on the environment.

35.2.2.9 Erosion Prevention and Sediment Control Plan

Objectives

The objective of the Erosion Prevention and Sediment Control Plan would be to avoid or minimize adverse effects of erosion and sedimentation on land uses (such as agriculture) and on receiving waters.
Statutory Requirements

Erosion and sediment control are addressed in a variety of legislation, including the federal Fisheries Act and provincial Water Act.

Other non-statutory guidance developed by governments includes the Water Quality Guidelines for the Protection of Aquatic Life (CCME 2012).

BC Hydro Policies

The applicable corporate policy is the Environmental Responsibility Policy (BC Hydro 2010a).

Voluntary Commitments

Relevant guidelines include the Land Development Guidelines for the Protection of Aquatic Habitat (Fisheries and Oceans Canada 1992) and A Users’ Guide to Working In and Around Water: Understanding the Regulation under British Columbia’s Water Act (B.C. Ministry of Environment 2005b).

Project Effects, Mitigation, and Environmental Protection Measures

Sediment would be released during construction of the Site C dam. Other Project construction activities such as relocation of Highway 29, clearing, and transmission line construction may also release sediment to watercourses. Sediment has the potential to affect fish and riparian habitat and surface water quality. The Erosion Prevention and Sediment Control Plan would include:

- Identification of erosion and sedimentation-prone areas
- Construction-related activities prone to erosion or sedimentation
- Erosion and sediment control measures
- Removal and disposal of temporary erosion and sediment control measures
- Storm event protection
- Site drainage management
- Required setbacks from riparian areas and surface water bodies

Revegetation of eroded areas would be addressed in the Soil Management, Site Restoration, and Revegetation Plan (Section 35.2.2.19).

Training and Human Resource Planning

All Project workers would receive training in the sediment control measures appropriate for the work they would be undertaking. Qualified professionals would be retained to evaluate the erosion and sedimentation risks of work areas.

Monitoring and Reporting

Four turbidity sensors have been installed in the Peace River, two upstream of the Site C dam site, and two downstream. These monitors would assist in determining the magnitude of sediment releases from dam construction activities. A sampling program for monitoring sediment releases from construction activities would be implemented. Results would be reported to regulators on a regular basis.
35.2.2.10 Fisheries and Aquatic Habitat Management Plan

Objectives
The objective of the Fisheries and Aquatic Habitat Management Plan would be to avoid or minimize adverse effects of construction activities on fish and aquatic habitat.

Statutory Requirements
Fisheries and aquatic habitat protection is regulated under a variety of legislation including the federal *Fisheries Act* and provincial *Fish Protection Act*.

BC Hydro Policies
The applicable corporate policy is the Environmental Responsibility Policy (BC Hydro 2010a).

Voluntary Commitments

Project Effects, Mitigation, and Environmental Protection Measures
Construction activities may affect aquatic habitat and riparian areas. The plan would include the following topics:

- Aquatic habitat and riparian areas avoidance plans and mitigation methods
- Criteria for watercourse crossings
- In-stream works
- Timing windows
- Work area isolation
- Fish salvage and relocation

Erosion and sedimentation would be addressed in the Erosion Prevention and Sediment Control Plan (Section 35.2.2.9). Vibration would be addressed in the Blasting Management Plan (Section 35.2.2.3) and in the Noise and Vibration Management Plan (Section 35.2.2.16). Clearing in and near riparian areas is addressed in Volume 1 Appendix A Project Vegetation, Clearing, and Debris Management Plan.

Training and Human Resource Planning
All Project workers would receive training in the aquatic habitat and riparian area protection measures appropriate for the work they would be undertaking. Qualified professionals would be retained to design watercourse crossings and for fish salvage and relocation.
Monitoring and Reporting

Monitoring programs that would be implemented during the construction phase include:

- Monitoring of habitat compensation measures upstream and downstream of the dam site
- Monitoring fish passage during diversion
- Collection of baseline physical environment information – water temperatures and flows
- Collecting of baseline aquatic productivity information – water quality, nutrients, and primary and secondary productivity
- Collection of additional baseline fisheries information to confirm fish community trends during construction

35.2.2.11 Fuel Handling and Storage Management Plan

Objectives

The objective of the Fuel Handling and Storage Management Plan would be to minimize the risk of fuel spills through the implementation of appropriate preventive measures.

Statutory Requirements

Fuel handling and storage is regulated under a variety of legislation, including the federal Transportation of Dangerous Goods Act, Canadian Environmental Protection Act and Environmental Emergencies Regulation. Provincial legislation includes the Transportation of Dangerous Goods Act, the Environmental Management Act, and Spill Reporting Regulation.

Other non-statutory guidance developed by governments includes the Environmental Code of Practice for Aboveground Storage Tank Systems Containing Petroleum Products (CCME 1994).

BC Hydro Policies

The applicable corporate policies are the Environmental Responsibility Policy (BC Hydro 2010a), Safety Policy (BC Hydro 2006b).

Voluntary Commitments


Project Effects, Mitigation, and Environmental Protection Measures

Mishandling of fuels could affect groundwater and surface water quality, and fish and wildlife habitat. Spilled fuels would create a fire hazard. The Fuel Handling and Storage Management Plan would include the following topics:

- Bulk storage
- Secondary containment
- Fuelling of vehicles and equipment
• Transportation on the construction site
• Distances to be maintained from riparian areas and watercourses
• Spill kits
• Inspection of storage tanks and transfer piping

Training and Human Resource Planning
All Project workers would receive training in fuel handling and storage appropriate for the work they would be undertaking. Qualified professionals would be retained to design fuel storage facilities. An inspection program for fuel storage tanks and transfer piping would be developed by a qualified professional.

Monitoring and Reporting
Fuel spills would be reported in accordance with the B.C. Spill Reporting Regulation.

35.2.2.12 Groundwater Protection Plan

Objectives
The objective of the Groundwater Quality Management Plan would be to avoid or minimize impacts to groundwater quality and to protect groundwater quality resources that have the potential to be affected by the Project.

Statutory Requirements
Groundwater quality is regulated under a variety of legislation, including the Contaminated Sites Regulation within the Environmental Management Act.

BC Hydro Policies
The applicable corporate policy is the Environmental Responsibility Policy (BC Hydro 2010a).

Voluntary Commitments

Project Effects, Mitigation, and Environmental Protection Measures
Groundwater quality could be affected by spills of fuel, chemicals, or hazardous materials; inundation of contaminated sites that have not been remediated; inundation of infrastructure such as septic fields; inundation of land on which residual pesticides and herbicides are present; and contact with new geologic units. Contaminated groundwater could affect drinking water and irrigation sources. Mitigation measures and management practices contained in the Groundwater Quality Management Plan would include the following topics:

• Identification and protection of springs and groundwater seepage sites
• Construction activities that may affect groundwater
• Potential Project-related groundwater contaminants
Groundwater protection measures

Managing infrastructure prior to inundation

Hazardous waste management would be addressed in the Hazardous Waste Management Plan (Section 35.2.2.13), response to spills that may affect groundwater quality would be addressed in the Emergency Response Plan (Section 35.2.1.1), and remediation of contaminated sites would be addressed in the Contaminated Sites Management Plan (Section 35.2.2.6).

Training and Human Resource Planning

All Project workers would receive training in groundwater protection appropriate for the work they would be undertaking. Qualified professionals would be retained to manage infrastructure that would be inundated and to develop a groundwater monitoring program.

Monitoring and Reporting

A groundwater monitoring plan would be developed and implemented, and results would be reported to stakeholders in accordance with the Construction Communication Plan and to regulators on a regular basis.

35.2.2.13 Hazardous Waste Management Plan

Objectives

The objective of the Hazardous Waste Management Plan would be to ensure that hazardous waste management is undertaken in a way that avoids potential effects on human health and the environment, and is compliant with environmental legislation.

Statutory Requirements

Hazardous waste is regulated under a variety of legislation, including the provincial Hazardous Waste Regulation in the Environmental Management Act.

BC Hydro Policies

The applicable corporate policies are the Environmental Responsibility Policy (BC Hydro 2010a), Safety Policy (BC Hydro 2006b).

Voluntary Commitments


Project Effects, Mitigation, and Environmental Protection Measures

Hazardous waste that is spilled could affect surface water quality, air quality, fish habitat, or wildlife habitat. The Hazardous Waste Management Plan would include the following topics:

- Hazardous waste storage, labelling, containment, transport, and disposal
- Hazardous waste reduction initiatives and measures
- Tracking and documentation procedure for hazardous waste
Training and Human Resource Planning

All Project workers would receive hazardous waste training appropriate for the work they would be undertaking.

Monitoring and Reporting

Hazardous waste spill response and reporting procedures would be addressed in the Emergency Response Plan (Section 35.2.1.1).

35.2.2.14 Heritage Resources Management Plan

Objectives

The objective of the Heritage Resource Management Plan would be to ensure the proper management of archaeological, historical, and paleontological (heritage) resources during construction, including procedures for the inadvertent discovery of heritage resources (i.e., a chance find).

Statutory Requirements

In British Columbia, the management of archaeological and historical resources is governed under the Heritage Conservation Act, the Coroner’s Act and the Cremation, Interment and Funeral Services Act. There is currently no provincial or federal legislation that protects paleontological resources.

BC Hydro Policies

Relevant BC Hydro policies include the Environmental Best Practices for Managing Heritage Resources (BC Hydro 2004).

Voluntary Commitments

Relevant management practices include the B.C. Fossil Management Framework (B.C. Ministry of Forests, Lands and Natural Resource Operations 2012).

Project Effects, Mitigation, and Environmental Protection Measures

Construction activities that disturb land could affect heritage resources. The Heritage Resource Management Plan would include the following topics:

• Mapping of high potential heritage areas overlapping Project activity zones
• Types of heritage resources that may be encountered (e.g., artifacts, culturally modified trees, human remains, fossils)
• Monitoring at known heritage sites
• Step-by-step chance find procedures, designed to avoid or mitigate disturbance of heritage resources

Training and Human Resource Planning

All Project workers would receive training in the types of heritage resources that may be found and chance find procedures appropriate for the work they would be undertaking. A qualified professional would be retained for any mitigation planning and implementation for chance finds.
Monitoring and Reporting

Shoreline erosion of heritage resources within the reservoir would be monitored for a period of not less than the first five years of operation. Predicted rates of sedimentation and erosion affecting shoreline heritage resources would be confirmed through shoreline monitoring.

35.2.2.15 Ice Management Plan

Objectives

The objectives of the Ice Management Plan would be to:

- Ensure that ice hazards such as ice jams, and ice accumulation on the construction headpond and downstream of the project are managed during construction in consideration of worker and public safety
- Establish protocols for managing ice on the construction headpond so that water levels are maintained at a safe level below the top of temporary cofferdams

Statutory Requirements

Not applicable.

BC Hydro Policies and Voluntary Commitments

BC Hydro operates its existing Peace River facilities under a joint agreement between the provinces of B.C. and Alberta. The Project would be operated in accordance with the agreement. One of the management objectives of the joint agreement is to control flows from BC Hydro’s facilities in a way that avoids downstream flooding during ice formation and breakup. Existing ice management practices would continue during the construction phase of the Project.

Project Effects, Mitigation, and Environmental Protection Measures

The Ice Management Plan would discuss the protocols for managing releases from BC Hydro’s upstream facilities to control the timing and rate of ice formation on the construction headpond and downstream of the Site C dam.

Training and Human Resource Planning

Not applicable.

Monitoring and Reporting

An ice monitoring program would be developed and implemented by a qualified professional.

35.2.2.16 Noise and Vibration Management Plan

Objectives

The objectives of the Noise and Vibration Management Plan would be to mitigate construction-related noise effects on sensitive receptors (i.e., residential developments, schools, hospitals, sensitive wildlife) and to mitigate potential vibration effects on infrastructure and other receptors near the Project site.
Statutory Requirements
Noise and vibration are regulated under a variety of legislation, including the federal \emph{Fisheries Act} and the provincial \emph{Wildlife Act}.

BC Hydro Policies
The applicable corporate policy is the Environmental Responsibility Policy (BC Hydro 2010a).

Voluntary Commitments

Project Effects, Mitigation, and Environmental Protection Measures
Noise and vibration from Project activities may affect human health and disturb wildlife movement. The Noise and Vibration Management Plan would include the following topics:

- Identification of sensitive human and wildlife receptors
- Identification of Project activities that may affect noise and vibration at sensitive receptors, including blasting
- Identification of Project activities that produce noise and vibration that may affect fish and aquatic habitat
- Noise and vibration reduction controls
- Timing of noise- and vibration-related works

Noise and vibration aspects of blasting would be addressed in the Blasting Management Plan (Section 35.2.2.3).

Training and Human Resource Planning
All Project workers would receive training in noise and vibration controls appropriate for the work they would be undertaking. A qualified professional would be retained for the development of a noise and vibration monitoring program.

Monitoring and Reporting
A noise and vibration monitoring program would be implemented to measure noise levels at receptors near the 85th Avenue Industrial Lands, near construction of the Hudson’s Hope shoreline protection, and near Highway 29 construction locations. Results would be reported to stakeholders in accordance with the Construction Communication Plan and to regulators on a regular basis.

35.2.2.17 Project Vegetation, Clearing, and Debris Management Plan
The Project Vegetation, Clearing, and Debris Management Plan is provided in Volume 1 Appendix A.
35.2.2.18 Smoke Management Plan

Objectives

The objective of the Smoke Management Plan would be to minimize smoke resulting from the burning of Project clearing debris.

Statutory Requirements

Burning of clearing debris and smoke management are regulated under the provincial Environmental Management Act and the Open Burning Smoke Control Regulation.

BC Hydro Policies

The applicable corporate policy is the Environmental Responsibility Policy (BC Hydro 2010a).

Voluntary Commitments

Not applicable.

Project Effects, Mitigation, and Environmental Protection Measures

Burning of clearing debris would release fine particulate and other air contaminants that may affect human health and wildlife. The Smoke Management Plan would include the following topics:

- Reduction of open burning activities
- Low-emission incineration technologies
- Burning pile construction and seasoning
- Burn plans
- Sensitive time periods
- Set back distances and sensitivity zones
- Venting index
- Ignition criteria

Training and Human Resource Planning

All Project workers involved in debris burning would receive training in smoke management appropriate for the work they would be undertaking.

Monitoring and Reporting

Throughout the burn season, air quality in and around the Project area would be monitored. Air quality advisories or burn bans would be implemented should particulate matter concentrations approach or exceed provincial objectives (based on provincial policy). If an advisory or burn ban is issued, burn operators would be required to adhere to the terms of the advisory or burn ban.

Monitoring of fine particulate matter (PM10 and PM2.5) would take place on the north and south banks of the dam construction site. The locations of the monitors would be determined based on air dispersion modelling. Results would be reported to
stakeholders in accordance with the Construction Communication Plan and to regulators on a regular basis.

35.2.2.19 Soil Management, Site Restoration, and Revegetation Plan

Objectives

The objective of the Soil Management, Site Restoration, and Revegetation Plan would be to effectively manage disturbed soils, and to reclaim and revegetate disturbed construction areas to a safe and environmentally acceptable condition. In areas with agricultural use or potential use, the objective would be to reclaim areas to an agricultural capability equivalent to or better than the pre-disturbance capability.

Statutory Requirements

Restoration of disturbed sites is governed under a variety of legislation, including the provincial Environmental Management Act, Contaminated Sites Regulation, and Hazardous Waste Regulation.

BC Hydro Policies

The applicable corporate policy is the Environmental Responsibility Policy (BC Hydro 2010a).

Voluntary Commitments


Project Effects, Mitigation, and Environmental Protection Measures

Excavation and site preparation would disturb natural vegetation and contouring, and may affect agricultural capability of the land. Unvegetated areas would be prone to erosion. The Soil Management, Site Restoration, and Revegetation Plan would include the following topics:

- Timing of restoration and reclamation activities
- Soil salvage, storage and reapplication
- Site drainage
- Decommissioning of temporary access
- Materials and waste removal
- Grading and re-contouring
- Re-establishment of ground cover and native vegetation
- Restoration of soils and drainage characteristics on agricultural lands
- Restoration of sensitive and listed ecosystems

Considerations in developing restoration plans would include rare plants and invasive plants.
Sediment and erosion control would be addressed in the Erosion Prevention and Sediment Control Plan (Section 35.2.2.9). Vegetation and invasive plant management would be covered in the Vegetation and Invasive Plant Management Plan (Section 35.2.2.22).

**Training and Human Resource Planning**

All Project workers involved in excavation and site preparation would receive training in soil management appropriate for the work they would be undertaking. Specific site restoration, revegetation and drainage plans would be developed by qualified professionals.

**Monitoring and Reporting**

Reporting of restored and revegetated sites would occur in accordance with Project approvals and permits.

35.2.2.20 **Solid Waste Management Reduction and Recycling Plan**

Solid Waste Management Reduction and Recycling would be addressed in the Waste Management Plan (Section 35.2.2.23).

35.2.2.21 **Surface Water Quality Management Plan**

Surface water quality management would 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).

35.2.2.22 **Vegetation and Invasive Plant Management Plan**

**Objectives**

The objectives of the Vegetation and Invasive Plant Management Plan would be to protect ecosystems, plant habitats, plant communities, and vegetation during construction and to manage non-native invasive, noxious, or nuisance plants (invasive plants) during construction.

**Statutory Requirements**

Certain vegetation is afforded provincial and federal regulatory protection under a variety of legislation, including the federal *Species at Risk Act*. Invasive plants are regulated in British Columbia under the B.C. *Weed Control Act* and listed in the B.C. Weed Control Regulation.

**BC Hydro Policies**

Voluntary Commitments


Project Effects, Mitigation, and Environmental Protection Measures

Site preparation may affect rare plant species and habitats. Invasive plants may populate disturbed areas. Vehicles may transport seeds of invasive plants to a non-infested area. The Vegetation and Invasive Plant Management Plan would include the following topics:

- Protection of rare plants and rare plant habitats
- Invasive plant control measures, including equipment and vehicle cleaning and inspection

Training and Human Resource Planning

All Project workers would receive training in vegetation and invasive plant management appropriate for the work they would be undertaking. Invasive plant control plans would be developed by qualified professionals.

Monitoring and Reporting

Invasive plant surveys would continue for the duration of the construction period. Where invasive plant infestations have occurred, post-treatment inspections for efficacy would be done. Pesticide treatment would be reported as required. Annual reports would be prepared.

35.2.2.23 Waste Management Plan

Objectives

The objective of the Waste Management Plan would be to establish guidelines for the effective reduction, storage, management, and disposal of non-hazardous construction waste.

Statutory Requirements

Non-hazardous waste is regulated under a variety of legislation, including the provincial Environmental Management Act, and the associated Waste Discharge Regulation.

BC Hydro Policies

The applicable corporate policy is the Environmental Responsibility Policy (BC Hydro 2010a).
Voluntary Commitments


Project Effects, Mitigation, and Environmental Protection Measures

Project waste could affect the life of landfills in the area. The Waste Management Plan would address the following topics:

- Expected sources and quantities of construction waste
- Waste reduction initiatives and measures
- Approved disposal methods and facilities
- Criteria for approving disposal facilities
- Waste storage, handling, recycling, and disposal procedures
- Tracking and documentation procedures for waste, recycling, and reuse
- Waste transportation

Hazardous waste management would be addressed in the Hazardous Waste Management Plan (Section 35.2.2.13).

Training and Human Resource Planning

All Project workers would receive training in waste management appropriate for the work they would be undertaking. Waste storage, handling, recycling, and disposal procedures would be developed by qualified professionals.

Monitoring and Reporting

Reporting of waste quantities would occur in accordance with Project approvals and permits.

35.2.2.24 Wildlife Management Plan

Objectives

The objective of the Wildlife Management Plan would be to protect wildlife species and ecosystems during the Project’s construction phase.

Statutory Requirements

Wildlife species are afforded provincial and federal regulatory protection under a variety of legislation, including the federal Migratory Birds Convention Act and Species at Risk Act and the provincial Wildlife Act.

BC Hydro Policies

The applicable corporate policy is the Environmental Responsibility Policy (BC Hydro 2010a).

Voluntary Commitments

Applicable management practice guidelines include Develop with Care 2012: Environmental Best Management Practices for Urban and Rural Land Development in

**Project Effects, Mitigation, and Environmental Protection Measures**

Construction activities could alter or fragment wildlife habitat, disturb or displace wildlife, or directly or indirectly cause individual mortality. The Wildlife Management Plan would include the following topics:

- Identification and protection of sensitive wildlife habitats and important wildlife areas
- Wildlife hazards
- Wildlife protection
- Work timing windows
- Minimization of vehicle collisions with wildlife
- Storage and treatment of garbage
- Restrictions on hunting

**Training and Human Resource Planning**

All Project workers would receive training in wildlife management appropriate for the work they would be undertaking.

**Monitoring and Reporting**

For the duration of the construction phase, the following monitoring programs would be implemented:

- Evaluation of the effectiveness of mitigation measures for bald eagles and amphibians
- Ungulate movement pattern and habitat use
- Evaluation of the effect of the reservoir on fisher movement

**35.3 Operations Phase**

As BC Hydro’s third dam on the Peace River, the Site C facilities would be operated in accordance with system management practices and agreements and policies. The facilities would be operated and maintained by BC Hydro in accordance with corporate policies, procedures, and standards. Conditions of Project certification and approval would be included in operating requirements.

Prior to commissioning, BC Hydro would develop Environmental Management Plans and Safety Management Plans that would provide performance-based requirements to be met by operators of the facilities. Sections 35.3.1 and 35.3.2 provide more detail on the management plans that would be developed for the operations phase of the Project.
35.3.1 Operations Safety Management Plans

35.3.1.1 Emergency Response Plan

Objectives
The objective of the Emergency Response Plan would be to provide a framework for effectively managing emergencies involving chemical or fuel spills, fire, medical, or other emergencies.

Statutory Requirements
Emergency response is regulated under a variety of provincial legislation, including the B.C. Emergency Program Act, B.C. Environmental Management Act, B.C. Fire Code, B.C. Wildfire Act, B.C. Workers Compensation Act and B.C. Spill Reporting Regulation. Applicable federal legislation includes the Canadian Environmental Protection Act and the Environmental Emergencies Regulation.

BC Hydro Policies
The applicable corporate policies are the Environmental Responsibility Policy (BC Hydro 2010a) and Safety Policy (BC Hydro 2006b).

Voluntary Commitments

Project Effects, Mitigation, and Environmental Protection Measures
The Emergency Response Plan would include requirements for the following:

- Emergency response procedures, including first response, containment, evacuation and cleanup
- Emergency response equipment
- Groundwater and surface water protection
- Response to a hazardous materials spill
- Notification and communication procedures
- Emergency contact information

Training and Human Resource Planning
All workers in the operations phase would be trained on the procedures for reporting emergencies. All personnel with identified responsibilities in the emergency command structure would be trained and competent to carry out the assigned tasks. First responders would receive appropriate first response training.

Monitoring and Reporting
Protocols for reporting of emergencies would be established in accordance with applicable legislation.
35.3.1.2 Public Safety Management Plan

Objectives

The objective of the Public Safety Management Plan would be to minimize and manage public safety risks.

Statutory Requirements

Not applicable.

BC Hydro Policies

The applicable corporate policies are the Safety Policy (BC Hydro 2006b), the Policy Statement on Dam Safety (BC Hydro 2011) and OSH 701 Public Safety Management Standard (BC Hydro 2006a).

Voluntary Commitments

The Public Safety Management Plan would describe relevant management practice guidelines such as the Guidelines for Public Safety Around Dams (CDA 2011).

Project Effects, Mitigation, and Environmental Protection Measures

Specific procedures and protocols for managing public safety risks would be developed prior to operation. In addition, the plan would define the communication requirements, communication methods, timing, and information distribution methods to ensure that the public is aware of specific operating activities that may directly affect them.

A key component of the Public Safety Management Plan would be the Reservoir Shoreline Monitoring and Management Plan. The objective of this plan would be to identify the requirements for regular monitoring of shoreline conditions, including groundwater levels, shoreline erosion rates and landslide activity.

Training and Human Resource Planning

Employees responsible for reporting to the public would receive appropriate training regarding the communications protocols and procedures. The Reservoir Shoreline Monitoring and Management Plan would be developed by a qualified professional.

Monitoring and Reporting

The Reservoir Shoreline Monitoring and Management Plan would include the following aspects:

- Geotechnical drilling and instrumentation to facilitate expanded baseline monitoring of groundwater conditions and slope movements. Priority would be given to locations where Highway 29 or other infrastructure is (or would be) located within the impact lines and to slopes where a potential landslide-generated wave hazard has been identified.
- Prior to diversion, installation and testing of the necessary instrumentation and telemetry at locations where real-time groundwater and slope movement data acquisition and transmission are required
- Prior to diversion, determination of the instrumentation monitoring and visual inspection frequency, based on predictions of the degree of change caused by river diversion and the impoundment of the reservoir. The frequency of instrumentation
monitoring and visual inspection would be adjusted based on the nature of the
changes in collected data and shoreline conditions that are observed. The
instrumentation monitoring and visual inspection program would be integrated into
BC Hydro’s system-wide operation and dam safety programs.

- Review of the reservoir impact lines would take place following the first five years
reservoir operations and would consider all survey, monitoring and inspection data
available at the time

35.3.1.3 Reservoir Shoreline Monitoring and Management Plan

The Reservoir Shoreline Monitoring and Management Plan would be described in the
Public Safety Management Plan (Section 35.3.1.2).

35.3.1.4 Worker Safety and Health Management Plan

Objectives

The objective of the Worker Safety and Health Management Plan would be to minimize
risks to workers’ safety and health.

Statutory Requirements

Worker Safety and Health is regulated by the *Workers Compensation Act* and its
associated regulations.

BC Hydro Policies

The applicable corporate policy is the Safety Policy (BC Hydro 2006b).

Voluntary Commitments

Not applicable.

Project Effects, Mitigation, and Environmental Protection Measures

The Worker Safety and Health Management Plan would outline specific procedures and
protocols for working in and around the operating facilities. Required personal safety
devices, proper protocols for working in and around machinery, and potential hazards
associated with the work site would be addressed.

Training and Human Resource Planning

All workers in the operations phase would receive appropriate training on the risks and
hazards of the work they would be involved in and the required measures to reduce the
risks, including the use of personal protective equipment.

Monitoring and Reporting

BC Hydro would implement a program to audit compliance with safety requirements.
35.3.2 Operations Environmental Management Plans

35.3.2.1 Hazardous Waste Management Plan

Objectives
The objective of the Hazardous Waste Management Plan would be to ensure that hazardous waste management is undertaken in a way that avoids potential effects on human health and the environment, and is compliant with environmental legislation.

Statutory Requirements
Hazardous waste is regulated under a variety of legislation, including the provincial Hazardous Waste Regulation in the Environmental Management Act.

Voluntary Commitments

BC Hydro Policies
The applicable corporate policy is the Environmental Responsibility Policy (BC Hydro 2010a).

Project Effects, Mitigation, and Environmental Protection Measures
Hazardous waste that is spilled could affect surface water quality, air quality, fish habitat, or wildlife habitat. The Hazardous Waste Management Plan would include the following topics:

- Hazardous waste storage, labelling, containment, transport, and disposal
- Hazardous waste reduction initiatives and measures
- Tracking and documentation procedure for hazardous waste

Training and Human Resource Planning
All workers in the operations phase would receive hazardous waste training appropriate for the work they would be undertaking.

Monitoring and Reporting
Hazardous waste spill response and reporting procedures would be addressed in the Emergency Response Plan (Section 35.2.1.1).

35.3.2.2 Ice Management Plan

Objectives
The objective of the Ice Management Plan would be to ensure that ice hazards such as ice jams, and ice accumulation on the reservoir itself and downstream of the Project are managed during operation in consideration of worker and public safety.

Statutory Requirements
Not applicable.
BC Hydro Policies and Voluntary Commitments

BC Hydro operates its existing Peace River facilities under a joint agreement between the provinces of B.C. and Alberta. The Project would be operated in accordance with the agreement. One of the management objectives of the joint agreement is to control flows from BC Hydro’s facilities in a way that avoids downstream flooding during ice formation and breakup. Existing ice management practices would continue during the operation phase of the Project.

Project Effects, Mitigation, and Environmental Protection Measures

The Ice Management Plan would discuss the protocols for managing releases from BC Hydro’s upstream facilities to control the timing and rate of ice formation on the reservoir and downstream of the Site C dam.

Training and Human Resource Planning

Not applicable.

Monitoring and Reporting

An ice monitoring program would be developed and implemented by a qualified professional.

Materials Management Plan

Materials management would be addressed in the Hazardous Waste Management Plan (Section 35.3.2.1) and the Waste Management Plan (Section 35.3.2.5).

Vegetation and Invasive Plant Management Plan

Objectives

The objectives of the Vegetation and Invasive Plant Management Plan would be to protect ecosystems, plant habitats, plant communities, and vegetation during operation and to manage non-native invasive, noxious, or nuisance plants (invasive plants) during operation.

Statutory Requirements

Certain vegetation is afforded provincial and federal regulatory protection under a variety of legislation, including the federal Species at Risk Act. Invasive plants are regulated in British Columbia under the B.C. Weed Control Act and listed in the B.C. Weed Control Regulation.

BC Hydro Policies


Voluntary Commitments

Some invasive plants are designated by provincial and federal agencies, such as the Invasive Plant Council of BC, and targeted for control. Applicable management practice

**Project Effects, Mitigation, and Environmental Protection Measures**

Maintenance of vegetation in the transmission line right-of-way may affect rare plant species and habitats. Invasive plants may populate disturbed areas. Vehicles may transport seeds of invasive plants to a non-infested area. The Vegetation and Invasive Plant Management Plan would include the following topics:

- Protection of rare plants and rare plant habitats
- Invasive plant control measures

**Training and Human Resource Planning**

All workers in the operations phase would receive training in vegetation and invasive plant management appropriate for the work they would be undertaking. Invasive plant control plans would be developed by qualified professionals.

**Monitoring and Reporting**

Pesticide treatment would be reported as required. Annual reports would be prepared.

**35.3.2.5 Waste Management Plan**

**Objectives**

The objective of the Waste Management Plan would be to establish guidelines for the effective reduction, storage, management, and disposal of non-hazardous operations waste.

**Statutory Requirements**

Non-hazardous waste is regulated under a variety of legislation, including the provincial *Environmental Management Act*, and the associated Waste Discharge Regulation.

**BC Hydro Policies**

The applicable corporate policy is the Environmental Responsibility Policy (BC Hydro 2010a).

**Voluntary Commitments**

Not applicable.

**Project Effects, Mitigation, and Environmental Protection Measures**

Waste from the operating facilities could affect the life of landfills in the area. The Waste Management Plan would address the following topics:

- Expected sources and quantities of operations waste
- Waste reduction initiatives and measures
- Approved disposal methods and facilities
Site C Clean Energy Project Environmental Impact Statement
Section 35: Summary of Environmental Management Plans

- Waste storage, handling, recycling, and disposal procedures
- Tracking and documentation procedures for waste, recycling, and reuse
- Waste transportation

Hazardous waste management would be addressed in the Hazardous Waste Management Plan (Section 35.3.2.1).

**Training and Human Resource Planning**

All workers in the operations phase would receive training in waste management appropriate for the work they would be undertaking. Waste storage, handling, recycling, and disposal procedures would be developed by qualified professionals.

**Monitoring and Reporting**

Reporting of waste quantities would occur in accordance with Project approvals and permits.

### 35.3.2.6 Water Management Plan

**Objectives**

The objective of the Water Management Plan would be to manage water flows during operations within the constraints of regulatory requirements.

**Statutory Requirements**

Water flows at Site C would be regulated by the Project’s water licence.

**BC Hydro Policies and Voluntary Commitments**

The Peace Water Use Plan, developed in 2007, guides BC Hydro in managing its existing operations on the Peace River, and would also provide guidance for the operation of Site C.

**Project Effects, Mitigation, and Environmental Protection Measures**

Considerations in the plan include:

- Minimum allowable discharges
- Spill management
- Reservoir operating range

**Training and Human Resource Planning**

Workers in the operations phase involved in water management would receive training appropriate with the work they would be undertaking.

**Monitoring and Reporting**

Reporting of water flows and releases would occur in accordance with Project water licence.
References

Literature Cited


BC Hydro. 2006b. Safety Policy. Vancouver, B.C.


Internet Sites


Section 35: Summary of Environmental Management Plans


36 COMPLIANCE REPORTING

An overview of the Environmental Oversight Program is provided in Section 35.1.2 in Volume 5 Section 35 Summary of Proposed Environmental Management Plans. Specific aspects of the Program are described in this Section and a schematic is shown in Figure 36.1. Key members of the Project team, including the Environmental Monitors and Environmental Officer(s), would have specific responsibilities for reporting environmental performance and compliance.

36.1 Environmental Monitors

Each contractor engaged for the Project would be required to retain one or more qualified Environmental Monitors who would have the 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. BC Hydro would also retain one or more qualified Environmental Monitors who would have the same authority.

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. One Environmental Monitor would be on-site whenever there is elevated potential risk to the environment, and would be periodically on-site during low-risk activities. Other roles and responsibilities of the Environmental Monitors would include the following:

- Developing an understanding of all aspects of the Project as they relate to conditions, federal and provincial permits, management plans, applicable legislative requirements, BC Hydro policies, and Project environmental management documentation
- Liaising with regulatory agencies and other key stakeholders
- Providing technical assistance on environmental matters to construction personnel
- Documenting construction activities with field notes and photographs
- Suspending construction activities that are causing, or potentially causing, risk of environmental damage
- Preparing environmental monitoring summary reports to summarize activities and actions taken to minimize potential effects during each phase of construction
- Reporting the results of environmental monitoring as required and in accordance with Project reporting protocols
- Reporting non-compliance with conditions, federal and provincial permits, management plans, applicable legislative requirements, and BC Hydro policies, in accordance with Project reporting protocols
36.2 Environmental Officers

BC Hydro would retain one or more Environmental Officers to inspect and evaluate the work of contractors’ Environmental Monitors and to report to regulators. Roles and responsibilities of the Environmental Officers would include the following:

- Communicating potential Project effects and mitigation requirements to contractors
- Auditing the training of contractors’ staff and field crews regarding project effects and mitigation requirements
- Liaising with regulatory agencies as required
- Reporting the results of environmental monitoring as required and in accordance with Project reporting protocols
- Reporting environmental incidents (an event that causes or has the potential to cause environmental damage or adverse effects on fish, wildlife, or other environmental resources) to regulators as required and in accordance with Project reporting protocols
- Reviewing the environmental compliance records to be produced by contractors or by the contractors’ Environmental Monitors
- Auditing and evaluating compliance of contractor work practices and procedures
- Evaluating the effectiveness of mitigation measures during construction
- Assisting in emergency situations to minimize adverse environmental effects
- Suspending construction activities that are causing, or potentially causing, risk of environmental damage
- Ensuring that corrective actions are implemented in the event of an environmental incident or non-compliance with conditions, federal and provincial permits, management plans, applicable legislative requirements, and BC Hydro policies
- Reviewing and updating management plans to ensure that they remain current
- Providing technical assistance on environmental matters to construction personnel

36.2.1 Environmental Monitoring Plan

The Environmental Monitors would evaluate and report on activities associated with the construction of the Project with respect to conditions, federal and provincial permits, management plans, applicable legislative requirements, and BC Hydro policies. 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 the activity.
37 REQUIREMENTS FOR THE FEDERAL ENVIRONMENTAL ASSESSMENT

Federal requirements for the environmental assessment of the Project are addressed, as required by Section 23 of the EIS Guidelines, in various sections of the EIS as presented in Table 37.1.

Table 37.1 Federal Requirements for the Environmental Assessment of the Project

<table>
<thead>
<tr>
<th>Federal Requirement</th>
<th>Relevant Section of the EIS</th>
</tr>
</thead>
</table>
| Indirect Effects: Section 5 of the CEAA requires an assessment of the environmental effects of the Project, including certain indirect effects | The requirements to assess the following indirect effects are found in the sections of the EIS referred to below:  
  • Volume 3 Economic and Land and Resource Use Effects Assessment Sections 16–27  
  • Volume 3 Section 19 Current Use of Lands and Resources for Traditional Purposes  
  • Volume 4 Social Effects Assessment Sections 28–31  
  • Volume 4 Section 33 Human Health Effects Assessment  
  • Volume 4 Section 32 Heritage Resources (Any structure, site, or thing that is of historical, archaeological, paleontological, or architectural significance, and physical and cultural heritage) |
| Alternatives to and Alternative Means                    | Volume 1 Section 5.3 Alternatives to the Project  
  Volume 1 Section 4 Alternative Means of Carrying Out the Project |
| Need for and Purpose of the Project                      | Volume 1 Sections 5.1 and 5.2 Need for and Purpose of the Project |
| Species at Risk Act                                      | Volume 2 Section 12 Fish and Fish Habitat, Section 13 Vegetation and Ecological Communities, and Section 14 Wildlife Resources |
| Comments From the Public and Aboriginal Persons          | Volume 1 Section 9 Information Distribution and Consultation |
| Current Use of Lands and Resources for Traditional Purposes | Volume 3 Section 19 Current Use of Lands and Resources for Traditional Purposes |
| Effects of the Environment on the Project                | Volume 5 Section 37.1 Effects of the Environment on the Project |
| Potential Accidents and Malfunctions                     | Volume 5 Section 37.2 Potential Accidents and Malfunctions |
| Cumulative Effects                                       | Volume 2 Sections 12–15, Volume 3 Sections 16–27, Volume 4 Sections 28–33, and Volume 5 Section 37.3 Summary of Cumulative Effects |
| Capacity of Renewable Resources                          | Volume 5 Section 37.4 Capacity of Renewable Resources |
| Requirements of any Follow-Up Program                    | Volume 2 Sections 12–15, Volume 3 Sections 16–27, Volume 4 Sections 28–33, Volume 5 Section 37.5 Requirements of Any Follow-Up Program, and Volume 5 Section 39 Complete List of Mitigation and Follow-Up Measures |

The federal considerations required by Section 23 of the EIS Guidelines are the following:

- Changes to the environment
37.1 Effects of the Environment on the Project

37.1.1 Introduction

Local conditions and natural hazards, such as severe or extreme weather conditions and external events, could adversely affect the Project. This section identifies the potential effects of the environment on the Project and describes the planning, design, and construction strategies to avoid or minimize those potential effects.

The following environmental factors that would potentially affect the Project are described:

- Extreme weather events
- Sedimentation of the reservoir
- Seismic activity
- Wildfire
- Flooding
- Low flow or drought conditions
- Slope stability and mass wasting events
- Climate change

The environmental factors listed above could adversely affect the Project by:

- Causing an accident or malfunction (the potential effects of accidents and malfunctions on the environment are described in Section 37.2)
- 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
- Causing damage to infrastructure that is not economically or technically feasible to repair
To mitigate these potential effects, risk assessments are undertaken to select the appropriate return period or recurrence interval for the natural hazards that are used in the design. In assessing risk, the return period for a natural hazard is typically selected based on the potential financial, social, and environmental consequences of a malfunction or accident that could result from the hazard. A return period, also known as a recurrence interval, is an estimate of the interval of time between events such as an earthquake or flood of a certain intensity or size. A return period is a statistical measurement denoting the average recurrence interval over an extended period of time.

The selection of the return period also considers the longevity of a structure. For example, a lower return period may be selected for the design of a temporary construction infrastructure that would be in service for fewer seasons than a permanent infrastructure. In addition, lower return period events may be used for temporary works, as construction equipment is at hand to undertake any additional mitigation works and to make any necessary repairs.

In describing the probability of natural hazards, the term annual exceedance frequency is sometimes used. An event with an annual exceedance frequency of 1/10,000 has a return period of 10,000 years and has a 1% probability of occurring in a 100-year period.

37.1.2 Environmental Data

This section identifies the sources of data that were used to characterize baseline conditions at the Project, used to select the return periods for natural hazards, and used in the design to mitigate the potential effects of the environment on the Project.

37.1.2.1 Climate Data

Local and regional climate data were collected from Environment Canada, the Alberta Government, BC Hydro, the Western Regional Climate Center, the National Climatic Data Center, U.S. National Oceanic and Atmospheric Administrative Forecast Systems, and radiosonde facilities in Edmonton and Montana to understand and assess local and regional data. The locations of the local and regional meteorological stations are shown in Figure 37.1.

Local climate data were used to determine design parameters such as wind intensity and direction, precipitation as both rain and snow, and temperature.

Regional climate data were required to determine probable maximum events, which include both flooding and precipitation. As described in Section 37.1.9, regional climate data were used to identify probable maximum precipitation and the probable maximum flood.

37.1.2.2 Flow Data

Refer to Volume 2 Section 11.4 Surface Water Regime for a description of the surface water hydrology of the Peace River.

Floods on the Peace River at the dam site would consist of regulated discharges from Peace Canyon Dam combined with unregulated inflows from the catchment between Peace Canyon Dam and the proposed Site C dam site. The catchment between Peace Canyon Dam and the proposed Site C dam site is referred to as the Site C local catchment.
Flow data were collected from the Water Survey of Canada (WSC) gauges 07FA004 (Peace River above Pine River, referred to in this section as the Site C gauge) and 07EF001 (Peace River at Hudson’s Hope, referred to in this section as the Hudson’s Hope gauge).

Regional flow data were collected for the prediction of the probable maximum flood. This required the analysis of flow data in both the Williston and Site C local catchments.

37.1.2.3 Seismic Data

Refer to Volume 2 Section 11.2 Geology, Terrain, and Soils for descriptions of the regional and site-specific seismic data, and the regional and site-specific seismic hazard assessments.

37.1.3 Extreme Weather Events

Extreme weather conditions that were considered in the design and planning for the Project include:

- Wind
- Rain
- Snow
- Ice
- Lightning
- Low temperatures

These extreme weather events would be mitigated by the selection of appropriate return periods based on hazard assessments described in Section 37.1.1. The following subsections describe the potential effects of the extreme weather events listed above on the following Project components:

- Dam, generating station, and spillways
- Transmission line and substation
- Highway 29 realignment and other roads
- Hudson’s Hope shoreline protection

37.1.3.1 Dam, Generating Station, and Spillways

37.1.3.1.1 Wind

Wind can adversely affect the dam, generating station, and spillways by:

- Generating waves on the reservoir that:
  - Cause erosion
  - Combined with set-up, overtop the reservoir retaining structures
- Damaging buildings that house generating equipment and flow control equipment
Wind-generated waves and set-up can damage the earthfill dam by:

- Eroding the upstream face
- Overtopping and eroding the crest and downstream face

These potential adverse effects on the earthfill dam are mitigated by providing:

- Riprap on the upstream face to prevent erosion
- Sufficient freeboard to prevent the dam from being overtopped

The RCC buttress, power intakes, spillway headworks, and other concrete structures that retain the reservoir are:

- Not susceptible to erosion by waves
- Less susceptible to damage by overtopping

Therefore, the freeboard requirements for the earthfill dam govern.

The Canadian Dam Association Dam Safety Guidelines (CDA 2007a) recommend the following freeboard for earthfill dams to allow for wind effects:

- Normal freeboard:
  - With the reservoir at the maximum normal level, no overtopping by 95% of the waves caused by the wind with a return period of 1,000 years

- Minimum freeboard:
  - With the reservoir at the maximum flood level during passage of the inflow design flood, no overtopping by 95% of the waves caused by the wind ranging from return periods of two years to 100 years, depending on the consequences of overtopping

As described in Volume 2 Section 11.10 Microclimate, the North Peace Regional Airport, EC Climate ID: 1183000, is the only location close to the microclimate study area where long-term climate information is available. Meteorological stations were installed in the Peace River valley to support the evaluation of the microclimate. The first full year of climate data collection from the stations in the Peace River valley was completed in January 2012.

Wind data from the Fort St. John airport were used for the analysis of wind-generated waves and wind set-up on the reservoir, and for the assessment of the freeboard required for dikes, cofferdams, and the earthfill dam. This is because wind data have been recorded at the airport station over a much longer period, which is better suited to the frequency analysis required to estimate return periods.

A comparison between the wind data from the meteorological stations in the Peace River valley and the wind data from the Fort St. John airport station showed that wind speeds at the Fort St. John airport station up on the plateau are higher than in the valley. Therefore, using the wind data from the airport gives conservative results.

The weather station at the airport is located about 12 km northeast of the dam site, and the period of record analyzed was from 1971 through 2010.
The wind velocities recorded at the airport were increased by 20% to allow for the wind over water effect, which is the tendency for higher wind speeds over open water than over land. It was assumed that the wind would blow consistently from the direction that would produce the worst-case wind set-up and wind-wave effects.

Table 37.2 shows the required freeboard and the provided freeboard for the Stage 2 upstream cofferdam and the earthfill dam.

**Table 37.2 Freeboard Requirements for Wind Effects**

<table>
<thead>
<tr>
<th>Structure</th>
<th>Normal</th>
<th>Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Required a</td>
<td>Provided</td>
</tr>
<tr>
<td>Stage 2 upstream cofferdam c</td>
<td>1.0 m</td>
<td>13.6 m</td>
</tr>
<tr>
<td>Earthfill dam d</td>
<td>1.2 m</td>
<td>7.6 m</td>
</tr>
</tbody>
</table>

**NOTES:**

a Normal freeboard calculated with 1,000-year wind

b Minimum freeboard calculated with 100-year wind

For the Stage 2 upstream cofferdam:

- Normal freeboard calculated with the upstream water level for passage of 2,100 m³/s, equal to full discharge from Peace Canyon powerhouse plus 118 m³/s flow from the local catchment between Peace Canyon Dam and the Project
- Minimum freeboard calculated with the maximum flood level during passage of the June 2001 flood, which has an estimated return period of 60 years; see Section 37.1.8 for more information on floods used for the design of the Stage 2 diversion

For the earthfill dam:

- Normal freeboard calculated for the maximum normal reservoir level
- Minimum freeboard calculated for the maximum flood level during passage of the inflow design flood; see Section 37.1.9 for more information on the inflow design flood

The freeboard provided on the Stage 2 upstream cofferdam and the earthfill dam are greater than required for wind effects because other requirements govern:

- See Section 37.1.10.3 for Stage 2 upstream cofferdam for a description of the landslide-generated wave freeboard requirements
- See Section 37.1.3.1.4 for a description of frost protection of the impervious core of the earthfill dam and Section 37.1.10.3 for a description of the earthfill dam landslide-generated wave freeboard requirements

The riprap on the upstream face of the Stage 2 upstream cofferdam has been designed for the 100-year wind wave. The riprap on the upstream face of the earthfill dam cofferdam will be designed for the waves generated by the 1,000-year wind or a wind speed of 100 km/h, whichever is greater.

Structures such as the powerhouse superstructure and other buildings will be designed for wind in accordance with the National Building Code of Canada, using applicable importance factors. The provisions of the National Building Code of Canada are based on 50-year return period winds.

**37.1.3.1.2 Rain**

Drainage and erosion control measures such as ditches, culverts, detention ponds, and riprap are required to control runoff and prevent erosion or other damage to the dam, generating station and spillways, and associated roads and infrastructure.
Extreme rainfall as it relates to floods during operations is described in Section 37.1.9.

At the dam, generating station, and spillways, drainage and erosion control measures such as ditches, culverts, and riprap would be designed for:

- The 20-year rainfall for temporary works during construction
- The 200-year rainfall for the permanent works

### 37.1.3.1.3 Ice

Ice can adversely affect the dam, generating station, and spillways by:

- Raising water levels during construction, due to the ice front reaching the dam site area
- Loading from thermal expansion of ice on the reservoir

The current ice regime in the Peace River and the predicted ice regimes during construction and during operation are described in Volume 2 Section 11.7 Thermal and Ice Regime.

An ice front is predicted to reach the dam site area once every 15 years on average. As described in Volume 2 Section 11.7 Thermal and Ice Regime, as the ice front advances upstream, water levels typically rise by between 1 m and 5 m, due to the increased resistance and thickness of the ice cover.

Except for the Stage 2 upstream cofferdam, all temporary construction infrastructure, including roads and cofferdams, would be constructed to have at least 1 m freeboard above the maximum predicted ice level with the ice front at Site C. The freeboard for the Stage 2 upstream cofferdam with the water levels increased by 5 m due to the ice front reaching Site C would be 8.6 m with an inflow of 2,100 m$^3$/s.

The ice studies described in Volume 2 Appendix H Reservoir Water Temperature and Ice Regime Technical Data Report indicate that in the year with the thickest ice cover on the reservoir, the approach channel could be ice-free. Nevertheless, the dam, generating station, and spillways would be designed for the ice loads that could occur during operations due to thermal expansion of ice on the reservoir and in the approach channel.

### 37.1.3.1.4 Low Temperatures

Low temperatures could adversely affect the dam, generating station and spillways by:

- Frost penetration damaging the core of the earthfill dam
- Ice buildup preventing the operation of spillway gates
- Freezing preventing operation of other flow control equipment

Frost penetration can damage impervious cores constructed from frost-sensitive soils due to the formation of ice lenses during the winter and the subsequent thawing in the spring (Solymar and Nunn 1983).

Factors that mitigate such damage are surcharging the core with gravel to prevent frost penetration and to increase the confining pressure on the core material (Solymar and Nunn 1983; Paré et al. 1978).
In addition to the freeboard requirements for earthfill dams to allow for wind effects, the
Canadian Dam Association Dam Safety Guidelines recommend that the thickness of the
material covering the impervious core should be sufficient to prevent freezing of the core
in winter.

Based on the freezing index for North Peace Regional Airport, the maximum frost
penetration would be less than 3 m. Therefore, 3 m of gravel would be provided above
the top of the core to prevent frost penetration.

Operation of spillway gates would be required in the winter to maintain downstream
flows if the generating station went off-line for any reason. Operation of spillway gates in
the winter can be prevented by ice buildup on the body of the gates and on the seals
around the perimeters of the gates. The downstream face of the spillway gates would be
provided with an insulated enclosure, and heaters would be provided to prevent ice
buildup.

All other flow control equipment would be housed in heated enclosures or provided with
heaters to maintain required operability during the winter.

Heating and insulation design would be based on the extreme minimum temperature
measured at North Peace Regional Airport.

37.1.3.2 Transmission Line and Substation

The extreme weather events that could adversely affect the transmission infrastructure
are:

- Wind, ice, or combined wind and ice that can overload transmission lines or towers
- Snow pack and snow conditions, including snow creep that can overload towers
- Lightning strikes that can cause a power outage

The transmission line and substation would be designed to withstand, at a minimum,
1 in 200-year wind, ice, and snow loads.

Lightning arresters, overhead ground wires, and low station ground resistance would be
used to protect the transmission and substation equipment from potential damage by
lightning strikes.

37.1.3.3 Highway 29 Realignment and Other Roads

The extreme weather events that could adversely affect Highway 29 and other road
infrastructure are:

- Wind, which would:
  - Load bridges
  - Generate waves on the reservoir, which could erode embankments and
    causeways
- Rain, which would have to be drained from the road surface
- Snow, which would:
  - Add load to the bridges
Have to be drained when it melts

- Ice, which could jam between piers, adding a lateral load

The realigned segments of Highway 29, which would form part of the provincial highway system, and other permanent roads would be designed according to the B.C. Ministry of Transportation and Infrastructure (BCMoTI) standards for wind and snow loading on bridges and for road drainage.

Ice loads for design of the new bridges on the Highway 29 realignment segments would be in accordance with the Canadian Highway Bridge Design Code based on the worst predicted ice conditions on the reservoir during operation, described in Volume 2 Section 11.7 Thermal and ice Regime.

Wind-generated waves and wind set-up for the 200-year wind would be used for the design of the erosion protection of the portions of the Highway 29 realignment segments along the reservoir shoreline.

37.1.3.4 Hudson’s Hope Shoreline Protection

Wind-generated waves and wind set-up for the 200-year wind would be used for the design of the riprap for the Hudson’s Hope shoreline protection.

37.1.4 Drought

A potential effect of a drought on the Project would be financial, as low flows would result in reduced generation.

Williston reservoir has a multi-year storage capacity; consequently, it has the capability to store water in wet years for use in dry years. This storage capability partially mitigates the effect of a drought on the Project.

Volume 1 Section 7 Project Benefits describes the studies undertaken to determine the capacity and energy provided by the Project. The average annual energy of 5,100 GWh is based on historic inflows for a 60-year period. The firm energy of 4,700 GWh per year is based on the consecutive three-year sequence with the lowest inflows in that 60-year inflow series.

This shows that the upstream storage in the Williston Reservoir would allow the Project to generate approximately 92% of its average annual energy under drought conditions.

37.1.5 Sedimentation of the Reservoir

As discussed in Volume 2 Section 11.2 Geology, Terrain, and Soils, most of the proposed reservoir and tributary shorelines are surrounded by steep slopes, which are currently actively eroding and slumping. The terrain stability and post-reservoir erosion and stability impact lines are presented in Volume 2 Appendix B Geology, Terrain Stability, and Soil Reports, Part 1 Terrain Stability Mapping, and Part 2 Preliminary Reservoir Impact Lines, respectively.

Sediments would enter the reservoir from the following sources:

- Tributary bedload and suspended load
- Material from shoreline erosion
Material from potential landslides

The predicted behaviour of sediment and bedload in the proposed reservoir is described in Volume 2 Section 11.8 Fluvial Geomorphology and Sediment Transport Regime. It is predicted that coarser material from shoreline erosion would deposit adjacent to the shore and form a beach. Finer material would become suspended in the reservoir. Of the suspended reservoir sediments, all of the sand and the majority of the silt would settle in the reservoir. The remaining silt and clay would be suspended in the reservoir outflow and leave the reservoir. After 50 years of operation, it is predicted the thickness of reservoir sediment deposition would range from about 0.3 m to about 0.5 m in the main reservoir and from 3 m to 4 m near some shoreline sections. As described in Volume 2 Appendix I Fluvial Geomorphology and Sediment Transport Technical Data Report, the volume of the sediment deposited in the reservoir over 50 years would be 2.5% of the initial reservoir volume.

The actual mechanism for shoreline erosion is undercutting and over-steepening of the slopes by wave erosion, and shallow landslides from the over-steepened slopes. The shoreline erosion sediment volume estimate includes the contributions from both erosion and the associated landslides.

Considering only the slopes above the area of predicted erosion and the associated shallow landslides, it is estimated that there is about a 10% chance in 100 years of a landslide with sufficient mobility to put in the order of 2 million m³ of material into the reservoir. By comparison, the 1973 Attachie slide deposited approximately 7 million m³ on the valley bottom that would be occupied by the proposed reservoir, and it is estimated there is less than a 1% chance in 100 years of a similar-sized landslide with similar mobility.

The volume of sediment expected to enter the reservoir from landslides originating above the area of predicted erosion is small relative to the reservoir volume of 2,310 million m³. Further, the benefits of the Project do not depend on reservoir storage, as the generation results from flows entering the reservoir from upstream and not from storage in the Project reservoir. Therefore, sedimentation of the reservoir will not have an adverse effect on the Project.

37.1.6 Seismic Activity

37.1.6.1 Dam, Generating Station, and Spillways

37.1.6.1.1 Lessons Learned from Major Earthquakes

37.1.7 Concrete Dams

Nineteen concrete dams have been shaken by peak horizontal ground accelerations greater than 0.3g (Hansen and Nuss 2011). Based on the performance of these dams, Hansen and Nuss report:

- In general, concrete dams have performed very well when subjected to high-intensity accelerations
- The threshold of no damage is project specific, but is probably substantially higher than 0.3g for properly designed and constructed concrete dams
While a fault located directly below Shih Kang Dam in Taiwan caused a rupture and relative vertical displacement of 9 m, the remaining damaged concrete limited an immediate total and sudden release of the reservoir.

Peak horizontal ground accelerations are amplified from the base of the dam to the crest; in two cases, namely Pacoima arch dam in the USA (2.3g) and Kasho gravity dam in Japan (2.05g), this amplification produced measured peak accelerations at the crest in excess of 2.0g.

Peak accelerations at the crest, as expected, are greater with full reservoirs.

Several dams have been severely shaken on two occasions by separate major earthquakes with only minor damage, for example. Bear Valley Dam in the USA, with earthquakes one day apart, and Pacoima Dam in the USA, with earthquakes 23 years apart.

Many concrete dams have also been shaken by high-intensity aftershocks that occurred after the main earthquake without any additional damage.

Roller compacted concrete dams have performed no differently to date than a dam built of conventionally placed concrete.

Where damage has been identified, it has been cracking in the upper levels of the dam, and where additional features such as curbs, railings, gates, or guard or control houses are located.

Very little in the way of increased leakage has occurred in concrete dams subjected to major earthquakes, which can be attributed, in part, to the fact that any cracking caused by the earthquake has mainly been horizontal and located high in the dam, together with the reservoir not being full in many cases.

Some rock foundations have experienced a temporary increase in seepage following an earthquake.

There may be a number of reasons why concrete dams have performed well and invariably better than that predicted by design or analysis when shaken by an earthquake; the main reasons may be:

- The redundancy of the damaged structure to redistribute load
- The duration of strong shaking being too short to cause failure
- The increase in the tensile strength of the concrete during dynamic loading that increases resiliency
- An increase in the damping that reduces the seismic impact on the dam
- Reduced seismic impact because the natural frequency of the dam does not match the frequency of the earthquake
- Three-dimensional effects of canyon confinement or dam geometry (curvature) that help prevent failure.

A generally accepted potential failure mode for concrete dams during an earthquake is cracking of the concrete through the dam, forming removable blocks that slide during or after the earthquake. Hansen and Nuss report that severely shaken concrete dams to
date have cracked at locations of change in geometry (reentrant corners), but have not formed removable concrete blocks; thus, the entire potential seismic failure mode has not been fully achieved or experienced for concrete dams.

37.1.8 Earthfill Dams

Experience has shown that well-compacted earthfill dams perform well in earthquakes. However, dams constructed of hydraulic fill or founded on loose soil are susceptible to liquefaction.

Many dams have suffered deformation and damage resulting from earthquakes; for instance, the M8.0 Wenchuan earthquake of May 12, 2008 in China damaged over 1,500 dams, some seriously, but no dam failed (New South Wales Dams Safety Committee 2010).

Embankment dams can suffer two main types of damage, depending on the nature of foundation or fill materials, and the design and construction standards (New South Wales Dams Safety Committee 2010):

- Deformations, slumping, and cracking, which could lead to failure from loss of freeboard or piping along cracks
- Liquefaction of materials in either the foundation or the dam fill

Reports of the performance of dams under earthquake shaking have been provided by Seed (1980), Hinks and Gosschalk (1993), and USCOLD (1992). These sources show that there have been cases of damage, and some failures. In summary, there have been some 20 to 30 failures of earth dams, most less than 20 m high. Most, if not all, of the failures involved liquefaction of saturated, loose, fine-grained cohesionless soils.

Sherard (1967) listed the following as possible ways that an earthquake may cause failure of an earthfill dam:

- Disruption of the dam by movement on a major fault in the foundation
- Loss of freeboard due to differential tectonic ground movements
- Slope failures induced by ground motions
- Loss of freeboard due to slope failures or soil compaction
- Sliding of dam on weak foundation materials
- Piping through cracks induced by the ground motion
- Overtopping by seiches in the reservoir
- Overtopping due to slides into the reservoir
- Failure of spillway or outlet works

The lessons learned from the performance of dams during major earthquakes have been incorporated into the practices of modern dam engineering. The design of the dam, generating station, and spillways for the Project has been done in accordance with this practice.
37.1.8.1.1 Performance Requirements

As described in the regional and site-specific seismic hazard analysis for the Project in Volume 2 Section 11.2 Geology, Terrain, and Soils, seismic hazards are:

- The mean earthquake ground motions calculated on the basis of probability
- Described by peak spectral accelerations over a range of vibration periods
- Often characterized by the peak ground acceleration

Peak ground acceleration and peak spectral accelerations are given in terms of a percentage or decimal fraction of the acceleration due to gravity, e.g., 5.4%g or 0.054g.

As described in Volume 1 Section 4 Project Description, the earthquake design ground motions adopted for the dam, generating station, and spillways have an annual exceedance frequency of 1/10,000. In accordance with Canadian Dam Association Dam Safety Guidelines, the performance requirement is that the dam structures subjected to the earthquake design ground motions should perform without uncontrolled release of the reservoir, although severe damage or economic loss may be tolerated. Lower seismic design criteria are used for those parts of the dam, generating station, and spillways where damage or economic loss would be tolerated during the earthquake design ground motions.

The seismic performance requirements for the dam, generating station, and spillways are:

- Operating basis earthquake – the earthquake ground motions with a mean annual exceedance frequency of 1/475. All structures, components, and primary operational and control systems required for the safe operation of the dam, generating station, and spillways will be designed to be capable of operating immediately after the operating basis earthquake.

- Design basis earthquake – the earthquake ground motions with a mean annual exceedance frequency of 1/2,475. All structures, components, and primary operational and control systems required for the safe shutdown of the generating station and for the safe operation of the dam and spillway will be designed to be capable of operating immediately after the design basis earthquake. Any expected damage to structures, components, and primary operational and control systems required for the safe operation of the generating station will be designed to be repairable within 72 hours after the design basis earthquake.

- Earthquake design ground motion – the earthquake ground motions with a mean annual exceedance frequency of 1/10,000. All structures, components, and related mechanical operation and control devices that contribute to retaining the reservoir will be designed such that there is no uncontrolled release of water from the reservoir during or after the earthquake design ground motions, and such that flows past the dam can be safely managed after the earthquake. The earthquake design ground motion is sometimes referred to as the maximum design earthquake.
The computed peak horizontal ground accelerations for the above annual exceedance frequencies from the site-specific seismic hazard analysis described in Volume 2 Section 11.2 Geology, Terrain, and Soils are:

- 1/475: 0.022g
- 1/2,475: 0.087g
- 1/10,000: 0.250g

The National Building Code of Canada uses a probability level of 2% in 50 years to achieve uniform reliability for building design across the country. This probability level is numerically equivalent to an annual exceedance frequency of 1/2,475. The 2010 National Building Code gives peak horizontal ground acceleration for Fort St. John of 0.054g. This value is lower than the 1/2,475-year earthquake from the site-specific seismic hazard analysis mainly because mean hazards are used for dam design and median hazards are used for the National Building Code of Canada.

### 37.1.8.1.2 Earthfill Dam

There are no known active faults at the dam site; therefore, disruption of the dam by movement on a major fault in the foundation or the loss of freeboard due to differential tectonic ground movements are unlikely.

Site investigations were carried out to enable a liquefaction assessment to be undertaken in general accordance with Seed’s approach as recommended by Idriss and Boulanger (2008). The Idriss and Boulanger (2008) methodology is an update on the U.S. National Center for Earthquake Engineering Research guidelines for liquefaction assessment summarized in Youd et al. (2001).

The approach involves the evaluation of the cyclic stress ratio and the cyclic resistance ratio. The cyclic stress ratio is the ratio of earthquake-induced stresses to the effective overburden pressure, and is a function of depth and the earthquake peak ground acceleration. The cyclic resistance ratio is the soil’s ability to resist the earthquake-induced stresses. Idriss and Boulanger (2008) proposed an empirical correlation between cyclic resistance ratio and standard penetration test resistances based on case histories of sites that have or have not liquefied during earthquakes. The correlation is standardized based on an M7.5 earthquake, 1 atmosphere overburden pressure, and fines content less than 5%. As a result, corrections for actual fines content, overburden pressure, in situ stresses, and earthquake magnitude have to be applied to the cyclic resistance ratio correlation to make it comparable to cyclic stress ratio for the design earthquake. If the cyclic stress ratio is greater than the cyclic resistance ratio, liquefaction is predicted.

The liquefaction assessment identified some thin discontinuous zones in the riverbed alluvium that could be liquefiable at low confining pressures during the earthquake design ground motions. This means that the dam would not fail, but there could be some slumping at the upstream and downstream toe where the confining pressure is low.

The earthquake design ground motions would not cause any slope failures or failures on weak planes in the foundation but there would be some movements, both vertical settlement and laterally.
Considering the possible ways that an earthquake could damage or cause failure to an earthfill dam described by Sherard and listed in Section 37.1.6.1.1, the following defensive measures have been incorporated into the design of the earthfill dam based on recommendations by Seed (1982) to allow for potential movements:

- Provision of ample freeboard to allow for settlement or slumping
- Use of wide transition zones using material not vulnerable to cracking, (Zone 2A and Zone 2B in Figure 4.14 in Section 4 Project Description)
- Use of chimney drains near the central portion of the embankment, (Zone 2A and Zone 2B in Figure 4.14 in Section 4 Project Description)
- Provision of ample drainage zones to allow for possible flow of water through cracks, (Zone 2A, Zone 2B, and Zone 3 in Figure 4.14 in Section 4 Project Description)
- Use of a wide core zones of plastic materials not vulnerable to cracking, (Zone 1 in Figure 4.14 in Section 4 Project Description)
- Use of a well-graded filter zone upstream of the core to act as a crack stopper, (Zone 2A in Figure 4.14 in Section 4 Project Description)
- Use of fine, more plastic core material placed wet of optimum and compacted by special equipment in thin layers at the abutment contacts
- Widening the filters at the abutment contacts

The following methods were used to estimate the movements of the earthfill dam due to seismic events:

- Lateral displacement using the Newmark (1965) method and the Bray and Travasarou (2007) method

In the Newmark (1965) method, a mass of soil is assumed to behave as a rigid block sliding along a well-defined failure surface. A pseudo-static stability analysis is performed on the soil mass to calculate the yield acceleration. The yield acceleration is the acceleration applied to the soil mass that reduces the factor of safety against sliding to 1.0. A relationship is then applied to determine the earthquake-induced displacement from the calculated yield acceleration and the design earthquake parameters of peak ground acceleration and peak velocity. The relationship is based on case histories and model tests in the laboratory.

Bray and Travasarou (2007) is an update on the Newmark method. This method uses a semi-empirical relationship between the earthquake-induced displacements, the yield acceleration of the soil mass, and the peak ground acceleration of the design earthquake. Unlike the Newmark method, the relationship includes the input of the spectral acceleration of the design earthquake and the fundamental period of the soil mass. The relationship was validated through the re-examination of 16 case histories of earth dam and landfill performance.

Jansen (1990) developed an empirical equation for embankment settlement based on the earthquake magnitude, the earthquake acceleration at the crest of the embankment,
and the yield acceleration of the soil mass. The empirical equation was developed from 22 case histories where actual settlements were measured after an earthquake. Swaisgood (2003) proposed an empirical correlation to estimate the settlement of an embankment dam crest due to an earthquake. Based on the analysis of 70 case histories, Swaisgood determined that the most important factors that appear to affect embankment crest settlement during an earthquake include the peak ground acceleration and the earthquake magnitude. Using these parameters, a mathematical equation and chart were produced to estimate the crest settlements as a percentage of the dam height and alluvium thickness.

These methods are commonly used for the design of dams where no liquefaction is expected to occur.

The analyses using these methods indicated that:

- Little or no displacement of the earthfill dam would be expected for earthquakes up to the design basis earthquake
- For the earthquake design ground motions, deformations are expected to be:
  - A maximum lateral displacement in the order of 7 cm
  - A maximum crest settlement in the order of 5 cm

The above displacements are small, as the earthfill dam would be able to accommodate much greater deformations:

- According to the U.S. Federal Energy Regulatory Commission (FERC 2006), seismic displacements of earthfill dams should normally not exceed 60 cm and should never be greater than one-half the fine filter width (Zone 2A in Figure 4.14 in Section 4 Project Description, which would be 5 m wide)
- Also, the estimated settlement of the crest of the dam is about 1% of the earthfill dam freeboard of 7.6 m (see Table 37.2)

Cracking due to these small movements is unlikely, and the fine filters upstream and downstream of the core would be designed to protect against piping.

As described in Volume 2 Section 11.2 Geology, Terrain, and Soils, seismic seiche would be less than 0.45 m. If a seiche was caused by the earthquake design ground motions, the combined seiche and crest settlement would be 0.5 m compared to the freeboard of 7.6 m.

Landslide-generated waves are discussed under Section 37.1.10.3.

The earthfill dam would meet the performance requirements.

### 37.1.8.1.3 North Bank

Deep-seated movements of the north bank due to the existing unstable slopes could adversely affect the abutment of the earthfill dam. The existing unstable material above the earthfill dam would be excavated to flatten the slope and prevent deep-seated movements.

Potential movements of the north bank during earthquakes were determined using the Bray and Travasarou (2007) method.
No movements of the north bank slope above the earthfill dam are expected for peak ground accelerations up to 0.06g (annual exceedance frequency of approximately 1/750).

For the design basis earthquake, movements in the order of 1 cm to 3 cm are expected for surfaces up to 15 m deep in the north bank overburden slope using the Bray and Travasarou (2007) method. No movements are expected for deeper surfaces.

For the earthquake design ground motions, the expected maximum displacements are:

- About 30 cm for shallow localized surfaces within about 3 m of the surface of the slope
- About 10 to 20 cm for surfaces 10 to 15 m, below the surface of the slope
- About 1 cm for surfaces 30 to 50 m below the surface of the slope

The shallower movements “represent little more than superficial slippage” (Jansen 1990) and is only half of the 60 cm displacement considered permissible by the Federal Energy Regulatory Commission (FERC 2006) for embankment dam slopes.

The expected movements during the maximum design earthquake could cause some damage to drainage works on the slope, which would require subsequent repair and replacement.

Some damage to the access road on the north bank slope could occur, but it is expected that, following some minor repairs, the road would be usable by four-wheel drive vehicles.

Movements of the slope above the earthfill dam would have no dam safety implications; therefore, the north bank would meet the performance requirements.

### 37.1.8.1.4 RCC Buttress

Based on the performance of existing dams subjected to major earthquakes described in Section 36.1.6.1.1, major earthquakes could adversely affect the RCC buttress by causing:

- Cracking
- Increased foundation seepage
- Movements

Analysis of the buttress sections using the Fast Lagrangian Analysis of Continua (FLAC), which is an advanced two-dimensional computer program for geotechnical analysis of rock, soil, and structural support, indicated that there would be no permanent displacements for the design basis earthquake.

Due to the geometry of the buttress and the complex interaction of the structure and bedrock, time history seismic analyses were undertaken for the maximum design earthquake. In a time history analysis, earthquake records of ground acceleration versus time from actual earthquakes are scaled to the required peak ground acceleration and used to calculate the dynamic response of a structure or system.

To illustrate what an earthquake time history looks like, Figure 37.2 shows the horizontal components of the 1994 Northbridge earthquake scaled to 0.25 g. More details of this
earthquake scaled to 0.25g are given in Table 37.3. The Arias intensity shown in
Figure 37.2 and Table 37.3 is a measure of the strength of ground motion. Arias
intensity, which is determined by measuring the acceleration of transient seismic waves,
has been found to be a fairly reliable parameter to describe the earthquake shaking
necessary to trigger ground movements.

Based on the site-specific seismic hazard analyses described in Volume 2 Section 11.2
Geology, Terrain, and Soils, the parameters used for the selection and scaling of
recorded earthquake time histories included:

- Similarity between scaled response spectrum to the response spectrum of the
earthquake design ground motion for the range of vibration periods of the structures
- Earthquake magnitudes
- Epicentral distance
- Type of fault that caused the earthquake: reverse and strike slip faults
- Arias intensity 0.5 to 0.7
- Effective duration 10 to 14 seconds
- Peak ground accelerations, velocity, and displacement of the scaled time history

The largest earthquake recorded near the dam site is the Mw5.4 Dawson Creek
earthquake, which occurred at about 70 km to the southeast of the dam site on
April 14, 2001. The location of the Project, its tectonic setting, the presence of
embedded faults, the recorded seismicity around the Project, and the results of the
seismic studies suggest that the earthquakes contributing to the earthquake design
ground motion cannot be defined by a limited combination of magnitudes and distances.
The representative time histories needed to be selected from earthquakes with
wide-ranging magnitudes (from Mw5.5 to Mw7.0) and wide-ranging distances from the
recording seismograph (10 km to 150 km).

Table 37.3 summarizes the eight scaled earthquake records that were selected for the
dynamic analysis based on the parameters listed above.

Two-dimensional analyses of the dam, powerhouse, and spillway buttresses were
undertaken in Adina Structures, a finite element analysis program, to capture the
interaction between each RCC buttress, the rock, and reservoir. This enabled the
displacements and stresses in the RCC buttress sections and the rock to be examined
for the earthquake design ground motion.
Table 37.3  Scaled Earthquake Records

<table>
<thead>
<tr>
<th>Earthquake</th>
<th>Year</th>
<th>Magnitude</th>
<th>Distance (km)</th>
<th>Peak Ground Acceleration</th>
<th>Arias Intensity (m/s)</th>
<th>Effective Duration (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northridge</td>
<td>1994</td>
<td>6.7</td>
<td>23</td>
<td>0.25</td>
<td>0.40</td>
<td>10</td>
</tr>
<tr>
<td>San Fernando</td>
<td>1971</td>
<td>6.6</td>
<td>24</td>
<td>0.25</td>
<td>0.43</td>
<td>13</td>
</tr>
<tr>
<td>Coyote Lake</td>
<td>1979</td>
<td>5.7</td>
<td>13</td>
<td>0.24</td>
<td>0.26</td>
<td>6</td>
</tr>
<tr>
<td>Hector Mine</td>
<td>1999</td>
<td>7.1</td>
<td>69</td>
<td>0.23</td>
<td>0.69</td>
<td>17</td>
</tr>
<tr>
<td>Loma Prieta</td>
<td>1989</td>
<td>6.9</td>
<td>35</td>
<td>0.24</td>
<td>0.39</td>
<td>15</td>
</tr>
<tr>
<td>Nahanni</td>
<td>1985</td>
<td>6.8</td>
<td>22</td>
<td>0.24</td>
<td>0.58</td>
<td>8</td>
</tr>
<tr>
<td>Virginia</td>
<td>2011</td>
<td>5.8</td>
<td>122</td>
<td>0.23</td>
<td>0.38</td>
<td>10</td>
</tr>
<tr>
<td>Virginia</td>
<td>2011</td>
<td>5.8</td>
<td>54</td>
<td>0.23</td>
<td>0.69</td>
<td>12</td>
</tr>
</tbody>
</table>

The dynamic response to the earthquake design ground motion was analyzed by applying the horizontal and vertical accelerations of the eight time histories listed in Table 37.3. Based on these analyses, the earthquake design ground motion would cause:

- A permanent displacement of the RCC buttresses in the order of 1 cm
- Minor horizontal cracking
- The axis of the generating units to rotate about 0.5 mm over the height of the unit

The movements and cracking during the earthquake design ground motion would not impair the ability of the RCC buttress to retain the reservoir, and any damage to the generating units would be minor.

As described in Volume 1 Section 4 Project Description, seepage into the bedrock foundation of the buttress would be limited by the approach channel lining, and the drainage system would limit the groundwater pressure acting on the buttress. The approach channel lining and the drainage system would be designed to be functional after the deformations expected to occur under all loading conditions, including the earthquake design ground motion.

Nevertheless, the buttress has been designed to withstand the following severe loading condition, which represents a worst-case groundwater condition:

- Full reservoir hydrostatic pressure acting on a near vertical plane from the base of the approach channel to the foundation of the buttress
- Uplift from full hydrostatic at the base of the near vertical plane to tailwater level at the downstream limit of the buttress

This analysis demonstrated that the RCC buttress would retain the reservoir, whatever damage occurred to the approach channel lining and drainage system.

Therefore, it can be concluded that the buttress would meet the performance requirements.
37.1.8.1.5 Other Reservoir Retaining Structures

The other reservoir retaining structures (the power intakes, spillway headworks, auxiliary spillway, and associated training walls) would be founded on the buttress. These structures would be designed to meet the performance requirements given above, and would not move relative to the buttress.

While the reservoir retaining structures would safely retain the reservoir after the maximum design earthquake, it is possible that the generating units and spillway gates would not be operational for a period. With none of the generating units and spillway gates operational, the Project could pass a total flow of 4,000 m$^3$/s through the auxiliary spillway and by overtopping of the spillway gates with the reservoir at the maximum flood level. This total flow is equivalent to Peace Canyon with all four units operating at full capacity plus the 20 return period flood from the Site C local catchment.

Therefore, the performance of the other reservoir retaining structures would meet the performance requirements even if the generating units and spillway gates were not operational after the earthquake design ground motion.

37.1.8.1.6 Post-Earthquake Monitoring

In accordance with BC Hydro’s emergency planning guide if a seismic event occurs within a region, an inspection of the dam, structures, and generating facilities must be conducted.

Information regarding the intensity of shaking would be available from seismic instrumentation located at or near the dam site and from the Pacific Geoscience Centre. The response would depend on the intensity of the seismic shaking.

A low-intensity earthquake is felt by only a few people in the local region, in which case an inspection, during daylight hours, would be required at the earliest opportunity (i.e., within 12 to 18 hours). A more thorough follow-up inspection may also be required by the Dam Safety Engineer.

A higher intensity earthquake, where the shaking is longer than a few seconds and is felt by nearly everyone in the region, would require an immediate inspection. A more thorough follow-up inspection, during daylight hours, would be required at the earliest opportunity (i.e., within 12 to 18 hours).

If, following these procedures, a dam safety hazard is identified, then response procedures would be implemented as outlined in the Emergency Preparedness Plan.

The Operation Maintenance and Surveillance Manual described in Volume 1 Section 4 Project Description would contain requirements for increased surveillance after any intense earthquake.

37.1.8.2 Transmission Line and Substation

Earthquake shaking could damage towers or lines, causing a power outage.

The towers and foundations would be designed for earthquake ground motions with annual exceedance frequency of 1/2,475.

Typically loads due to extreme weather, not seismic forces, govern the design of lines and structures.
37.1.8.3 Highway 29 Realignment and Other Roads
The realigned segments of Highway 29, which would form part of the provincial highway system, and other permanent roads, would be designed according to the BCMoTI seismic standards. In accordance with these standards, bridges would be designed to withstand earthquakes with a return period of 50 years.

37.1.8.4 Hudson’s Hope Shoreline Protection
In accordance with the Association of Professional Engineers and Geoscientists of B.C.’s guidelines for landslide assessments for proposed residential developments in B.C., the Hudson’s Hope shoreline protection would be designed for the earthquake with an annual exceedance frequency of 1/2,475 given in the National Building Code of Canada.

37.1.9 Wildfire
Wildfires can pose a hazard to Project components including the dam, generating, station and spillways, transmission line and substation, and roads.

Wildfires result either from anthropogenic causes such as campfires, or from natural causes such as lightning. Factors that influence the probability and magnitude of wildfires include: vegetation type, ignition sources, and weather conditions, including forest moisture, precipitation, wind speed, and direction, as well as the relative humidity and air temperatures. On average, approximately 9,100 forest fires occur annually in Canada. Of these, over 60% result from anthropogenic causes, most by accident, and up to 35% of these forest fires result from lightning (The Canadian Encyclopedia 2012).

The 2009 Natural Resources Canada fire danger rating at and surrounding the Project area, with the exception of the area around Hudson’s Hope, was classified as high. The area surrounding Hudson’s Hope was classified as very high (Figure 37.3). Historical fires greater than 200 hectares that occurred in the Project area from 1959 through 1999 typically resulted from anthropogenic activities (Figure 37.4).

The dam site would be cleared during construction and a vegetation-free buffer would be maintained around the dam, generating station, and spillways to provide firebreaks.

The transmission line right-of-way would be cleared during construction and maintained through a vegetation management plan, which would provide a firebreak. In addition, the towers would be constructed of steel and thus would be less susceptible to fire. A firebreak would also be maintained around the substation.

37.1.10 Floods During Construction
The following stages of construction of the dam, generating station, and spillways are described in Volume 1 Section 4 Project Description:

- Stage 1 – river channelization
- Stage 2 – river diversion

During river channelization, the river would be confined to its main channel by the north and south bank Stage 1 cofferdams.
During river diversion, the river would be diverted through two tunnels by the Stage 2 cofferdams to allow construction of the earthfill dam across the main river channel. Floods during construction would have an adverse effect on the Project if the cofferdams were overtopped during either of these stages. Studies to determine the magnitude of floods at the dam site during construction of the Project considered the inflows from the Site C local catchment and discharges from Peace Canyon Dam and separately. These are described in more detail below.

37.1.10.1 Site C Local Catchment Floods

Flood frequency analysis was performed using annual peak flows for the Site C local catchment, which were obtained by subtracting flows measured at the Hudson’s Hope gauge from flows measured at the Site C gauge. Refer to Section 37.1.2.2 and Volume 2 Section 11.4 Surface Water Regime for more information on these gauges. A 12-hour shift was applied to the records from the Hudson’s Hope gauge to allow for the travel time between the two gauges.

Flow data were available for the period 1980 to 2012. Flows for 1986 were excluded due to missing records. All flows were increased by 2.9% to account for inflows from the drainage area between the Hudson’s Hope gauge and Peace Canyon Dam, which is 2.9% of the Site C local catchment area.

The peak flows for each year were analyzed assuming a log-normal distribution. Table 37.4 presents the results of the analysis.

<table>
<thead>
<tr>
<th>Return Period (Years)</th>
<th>Mean Daily Flow (m³/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>887</td>
</tr>
<tr>
<td>5</td>
<td>1,453</td>
</tr>
<tr>
<td>10</td>
<td>1,905</td>
</tr>
<tr>
<td>20</td>
<td>2,382</td>
</tr>
<tr>
<td>50</td>
<td>3,062</td>
</tr>
<tr>
<td>100</td>
<td>3,620</td>
</tr>
</tbody>
</table>

The peak daily discharge of the largest flood from the Site C local catchment for the period 1980 to 2012 was 3,177 m³/s in June 2001. The return period of this flood is approximately 60 years.

Table 37.5 shows some recent precedents for the selection of floods used for the design of cofferdams and diversion works for the construction of large dams.

The June 2001 flood was initially selected for the design of the cofferdams and the diversion tunnels based on Canadian precedent and the two-year period before the elevation of the earthfill dam would be higher than the Stage 2 upstream cofferdam.
Table 37.5  Precedents (Current Canadian Practice) for the Selection of Floods for the Design of Diversion Works and Cofferdams

<table>
<thead>
<tr>
<th>Project</th>
<th>Design flood risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydro Quebec</td>
<td>5% overall risk – 40-year flood for two-year exposure period, e.g., SM3, Romaine 2, Eastmain 1 &amp; Peribonka</td>
</tr>
<tr>
<td>Manitoba Hydro</td>
<td>Conawapa 20-year flood &amp; Wuskwatim 50-year flood</td>
</tr>
<tr>
<td>SaskPower</td>
<td>5% overall risk – 40-year flood for two-year exposure period, Fort-a-la-Corne dam</td>
</tr>
<tr>
<td>Nalcor</td>
<td>5% overall risk – 40-year flood for two-year exposure at Muskrat Falls and Gull Island + 3 m cofferdam freeboard to reduce risk</td>
</tr>
</tbody>
</table>

Figure 37.5 shows the hydrograph shapes for the four largest annual floods in the period 1980 to 2012 normalized by the ratio of peak daily discharge to maximum daily discharge. The June 2001 flood hydrograph shape was selected as being representative of the large floods. The flood hazard period, i.e., the time of year when the largest floods occur, is late May to early July.

37.1.10.2  Stage 1 – River Channelization

The governing condition for the crest elevation of the Stage 1 cofferdams would be the maximum ice levels that would exist at the dam site if the ice front reached the dam site (see Section 37.1.3.1.3).

During the spring, one of the four generating units at Peace Canyon Dam is usually out of service for maintenance, which limits the maximum discharge to 1,487 m$^3$/s. However, due to low generation requirements in the spring, discharges are typically lower.

With the 100-year flood from the Site C local catchment combined with a discharge of 1,487 m$^3$/s from Peace Canyon Dam, the freeboard on the Stage 1 cofferdams would be 4 m. Based on 39 years of inflow data, the probability of the Peace Canyon Dam discharge exceeding 1,487 m$^3$/s would be 20%. Therefore, the annual probability of overtopping of the Stage 1 cofferdams is much less than 1/500.

37.1.10.3  Stage 2 – River Diversion

Williston reservoir has inter-year storage capability and the reservoir would be operated during construction to:

- Limit normal inflows to Site C to less than the diversion tunnel capacity
- Provide a storage reservation to allow discharges to be reduced during the passage of floods from the Site C local catchment

Daily operation of Williston Reservoir was modelled for the Stage 2 diversion period using operations models that incorporated 39 years of historic inflow sequences and provided daily output. The models were used to optimize Williston Reservoir operation with a fixed storage reservation with pre-generation and pre-spill as required to meet the downstream discharge constraints under all 39 inflow sequences.

The discharge constraints were:

- Releasing a total flow of 600 m$^3$/s at Site C during construction of the upstream closure section
Ramping up from 600 m³/s to the diversion tunnel capacity during completion of the Stage 2 upstream cofferdam See Section 4 Project Description for details of the river diversion activities. The initial design of the Stage 2 diversion works (tunnels and cofferdams) was based on the following assumptions:

- A repeat of the June 2001 Site C local catchment flood
- Peace Canyon Dam discharges:
  - 1,487 m³/s prior to flood arrival
  - Reduced to the minimum discharge of 283 m³/s when the flood arrives at the dam site
  - Restored to 1,487 m³/s after flood passage
- A storage reservation in the Williston Reservoir of 0.56 m would be adopted to enable the above reduction in discharges from Peace Canyon Dam.

Figure 37.6 shows routing of the June 2001 flood through the diversion tunnels. The figure shows:

- Inflow from the Site C local catchment
- Peace Canyon Dam discharges
- The headpond (pool level) upstream of the diversion tunnels
- The discharge from the diversion tunnels

Note that the discharge from the diversion tunnels would be less than the inflow because water would be stored in the headpond.

A risk assessment of a flood from the Site C local catchment exceeding the June 2001 flood, and damaging or overtopping the Stage 2 cofferdam was undertaken. Based on this risk assessment, BC Hydro decided to increase the capacity of the diversion works by increasing the diameter of the diversion tunnels and by constructing the Stage 2 cofferdam to the maximum practical height.

With these changes, the risk assessment demonstrated that, with the Peace Canyon Dam discharges as listed above, the annual exceedance frequency of a flood that would reduce the freeboard to less than the required 0.9 m and thus potentially damaging or overtopping the Stage 2 upstream cofferdam would be 1/120. The operations modelling using 39 years of inflow data indicated a 20% probability of the Peace Canyon Dam discharge exceeding 1,487 m³/s. Therefore, the annual exceedance frequency of a flood potentially damaging or overtopping the Stage 2 upstream cofferdam is approximately 1/600.

### 37.1.10.4 Highway 29 Realignment and Other Roads

In accordance with BCMoTI, the Highway 29 realignment bridges would be designed for the following floods:

- 20-year return period for the two-year construction period
37.1.11 Floods During Operation

As described in Volume 1 Section 4 Project Description, the Inflow Design Flood for the Project would be the probable maximum flood, which is defined as the most severe flood that may reasonably be expected to occur at a particular location (CDA 2007a). The probable maximum flood is evaluated by deterministic methods that maximize the various factors contributing to the generation of a flood. The probable maximum flood would be caused by hydrometeorological conditions (e.g., snowmelt and rainfall) that maximize soil moisture and thus maximize runoff.

The probable maximum flood at Site C would consist of regulated discharges from the W.A.C. Bennett Dam combined with unregulated inflows from the Site C local catchment. The studies to determine the probable maximum flood at Site C thus considered conditions in the Williston and Site C local catchments. In this section, the Site C local catchment refers to the catchment between the W.A.C. Bennett Dam and Site C, and the Site C catchment means the total catchment upstream of Site C, i.e., the Williston catchment plus the Site C local catchment.

The Williston and Site C local catchments are located in northeast British Columbia, approximately between latitudes 54° and 59° north and between longitudes 121° and 127° west. The catchments are described in Volume 2 Section 11.4 Surface Water Regime.

The prevailing west-east atmospheric circulation limits the arrival of moisture from the Atlantic or Gulf of Mexico, and moist air from the Pacific loses most of its moisture crossing the mountains. As a result, away from the mountains and foothills, the average annual precipitation ranges between 300 and 500 mm. However, this does not eliminate the risk of severe flooding. Most of the major river systems originate in areas where snow cover remains into May and June because of the high elevations and cool climate. The late spring snowmelt in the mountains corresponds with the June peak in monthly rainfall, creating the risk of combined snowmelt and rainfall flooding. Extensive heavy rainfall in the May through July period is usually the result of long-lived “cold lows” that persist in the foothills region for several days and draw moist Gulf of Mexico air into the area, causing prolonged heavy rainfall due to the presence of the low and upslope winds in the foothills and mountains. With or without contributions from snowmelt, these cold lows are the most common cause of flooding along the rivers flowing eastward. Away from major rivers in the eastern part of British Columbia, severe local thunderstorms are more likely to be the meteorological event associated with flooding.

The methods used to determine the probable maximum precipitation are described in Section 37.1.9.1. Determination of the probable maximum flood is described in Section 37.1.9.2.

37.1.11.1 Probable Maximum Precipitation

37.1.11.1.1 Methodology

Probable maximum precipitation is “theoretically the greatest depth of precipitation for a given duration that is physically possible over a given size storm area at a particular
geographic location at a given time of year”, as defined in Hydrometeorological Report No. 55A (Hansen et al. 1988), which is referred to in this section as HMR-55A.

The methodology for determining the probable maximum precipitation consisted of:

- Identification of historical storms
- Maximizing the storms based upon the maximum moisture likely to be available to them
- Transposing the storms to the Site C catchment

In mountainous terrain, rainfall amounts for historic storms have significant contributions from local orographic effects that are not directly transposable to other regions. Restricting storm samples to those occurring directly over the study basin would not provide a large enough sample of severe storms to ensure that a storm of maximum efficiency has been identified, leading to underestimation of the probable maximum precipitation. To overcome this deficiency, a technique referred to as storm separation was used as recommended in HMR-55A and by the Canadian Dam Association (CDA 2007b). In this method, the precipitation from a storm occurring over an orographic region is considered to consist of two components:

- A convergence component, which is the part of the precipitation not due to terrain features
- An orographic component, which is caused by relief

The storm separation method used to determine the probable maximum precipitation is described in Section 37.1.9.1.3.

37.1.11.1.2 Climate Data

Climate data were obtained for the catchment upstream of Site C and a large surrounding area. The larger area was needed to augment the database required for the analysis of the climate in the region. Climate data collected at the climate stations shown in Figure 37.1 were used for determining the probable maximum precipitation.

Canadian precipitation and temperature data were obtained from Environment Canada, Alberta Environment, and BC Hydro data collection platform (DCP) stations. Data for Montana and Idaho stations were obtained from the Western Regional Climate Center in Reno, Nevada. Daily precipitation records were obtained for all stations shown in Figure 37.1. Hourly data were obtained where available.

Dew point data were also obtained because there is a good relationship between dew point temperature and the amount of moisture in storms, particularly in the lowest layers of the atmosphere.

The good relationship between dew point measurement and moisture content is valid for summer and fall storms. However, direct precipitable water measurements collected from upper air balloons must be used for estimating storm moisture for spring storms. Upper air data were obtained from the National Climatic Data Center (NCDC 1997) for the period 1946 to 1997. More recent data were obtained from the U.S. National Oceanic and Atmospheric Administration Forecast Systems Lab.
The nearest radiosonde sites to the study area are Edmonton, Alberta and Glasgow, Montana in the U.S. Radiosonde data provide direct and more accurate measurements of atmospheric moisture at the measurement location. Assessment of spatial variation of maximum atmospheric moisture for spring months was aided by the use of a dew point analysis (Hopkinson 1999).

A total of 686 daily climate stations with a minimum of 20 years of records were examined, and 458 were included in the analysis. The reduction in the number of stations was due to several factors, including rejection of stations with obvious data problems such as apparent partial year records and the presence of outliers that could not be rationalized.

### 37.1.11.1.3 Storm Separation Method

The steps used in the storm separation method were:

1. Create a digital GIS coverage of 100-year 24-hour total precipitation for the study area using station estimates of 100-year rainfall and relying on spatial patterns of season rainfall developed using PRISM, a statistical model (Daly et al. 1994; Daly et al. 2002).

2. Create a digital GIS coverage of 100-year 24-hour convergence precipitation for the study area by assuming that rainfall in the flat plains area of Alberta was unaffected by orographic enhancement.

3. Create a GIS coverage of T/C (100-year total precipitation “T” divided by 100-year convergence-only precipitation “C”) to determine the orographic component of precipitation.

4. Identify relevant historical storms during summer months (the largest rain storms) and spring (lower rainfall amounts than in summer, but a higher potential for rain-on-snow events).

5. Determine the ratio of observed precipitation to 100-year precipitation for each storm and select the storms with the largest ratios to identify the most intense recorded storm rainfalls.

6. Determine the convergence component of each selected storm using the T/C coverage.

7. Determine the observed precipitable water content for each storm and create a GIS coverage of maximum precipitable water available over the whole study area.

8. Maximize storms by multiplying the observed convergence precipitation by the ratio of maximum to observed precipitable water.

9. Transpose the maximized storms from their storm centres to the basin area by multiplying the maximized convergence precipitation by the ratio of maximum precipitable water on the basin under study to that at the storm location.

10. Develop depth-area-duration curves for the transposed and maximized convergence storms.

11. Convert convergence-probable maximum precipitation to total probable maximum precipitation using T/C ratios.
12. Map total probable maximum precipitation (PMP).

### 37.1.11.1.4 100-Year 24-Hour Precipitation Map

A grid of T/C ratios (100-year total precipitation “T” divided by 100-year convergence precipitation “C”) is needed to account for the effect of orography on precipitation. The first step in deriving the T/C ratio is to create a GIS coverage of the 100-year 24-hour total precipitation.

The 100-year precipitation values were obtained by statistically analyzing hourly and daily rainfall data for all stations in the study area with more than 20 years of records. Considering the limited number of values in the samples and for homogeneity, a two-parameter distribution was assumed (Extreme value Type 1, also known as the Gumbel distribution, with parameters estimated by the method of moments). Daily values were adjusted by the 1.13 factor to convert once/day readings to estimates of 24-hour maxima (Hershfield 1961). Each station’s 100-year value was compared to gridded monthly values for June from precipitation “normals” coverages developed using the PRISM model (Daly et al. 1994; Daly et al. 2002). The inherent assumption is that precipitation patterns in extreme storms are similar to mean precipitation patterns and that the month of June was selected because of the more frequent occurrence of large storms in that month.

The ratios of 100-year 24-hour precipitation to monthly averages were distributed using inverse distance weighting with GIS software (ArcView), producing a gridded coverage of these ratios for the study area. This coverage was then multiplied by the monthly normals grid to obtain a gridded 100-year 24-hour rainfall coverage consistent with orographic precipitation enhancement, as identified by the PRISM mapping of monthly normal precipitation. The resulting map of 100-year 24-hour precipitation is shown in Figure 37.7.

### 37.1.11.1.5 100-Year 24-Hour Convergence Precipitation Map

The convergence component of probable maximum precipitation is often referred to as “free atmosphere forced precipitation” and is a key component of the Storm Separation Method. According to HMR-55A, the key to the convergence analysis is finding areas where the effects of topography are minimal or absent. This was done by estimating precipitation in “least orographic” areas (well east of the Rockies, for example) and by assuming that precipitation in those areas was 100% convergence related.

Areas in homogeneous terrain were selected first. The relationship between summer precipitation and maximum persisting dew point was found to be quite strong. By applying this relationship to estimated maximum dew points in areas with complex terrain, convergence values in those areas could be calculated. The latter step was carried out by manually, extending in the orographic areas the isocontour lines of the 100-year convergence precipitation along the lines of potential maximum dew point. This produced coverages with smooth contours that generally were aligned with lines of potential moisture (such as maximum persisting dew point). The resulting map of 100-year convergence-only precipitation is shown in Figure 37.8.
37.1.11.6 Development of T/C Map

The T/C coverage was obtained by dividing the 100-year 24-hour total precipitation grid (Figure 37.7) by the 100-year 24-hour convergence grid (Figure 37.8). The resulting T/C map is presented in the upper part of Figure 37.9. The lower part of the figure, which covers the state of Montana, was derived based on the 100-year 24-hour map from the U.S. National Oceanic and Atmospheric Administration Atlas No. 2 “Precipitation-Frequency Atlas of the Western United States” Volume 1 – Montana.

The magnitude of the convergence precipitation was estimated from the values on the open plains, decreasing gradually in a westerly direction following the procedure described in HMR-55A. The resulting contours were smoothed relative to the original 100-year map and the final T/C map was obtained by dividing the 100-year 24-hour map by the convergence coverage.

37.1.11.7 Historical Storm Analysis

Storm selection consisted of the following steps:

1. Begin with a list of the largest storms in British Columbia, Alberta, Saskatchewan, and Montana.
2. Collect all available daily precipitation data for those events.
3. Calculate the maximum 1-, 2-, and 3-day total precipitation for each storm for all available stations.
4. Multiply the 1-day values by 1.13 to convert daily values to 24-hour estimates.
5. Create spatial coverages of storm precipitation for the largest storms (based on ratios to 100-year values).
6. Select the most extreme storms according to the magnitude of normalized precipitation (observed divided by 100-year) and area of influence.

A few other important storms were identified by scanning rainfall data over a few consecutive days at several stations in the region defined in step 1 above.

A list comprising 39 storms was selected for the study. Two sets of storms were considered, namely summer (primarily June–July) and spring (April–May).

The largest storm was the Gibson Dam storm of June 7, 1964, where 17% of the 100-year precipitation was measured at the storm centre.

Knowledge of the approximate path of a storm assists in identifying the amount of moisture in the air mass that created the storm. Surface dew point data are obtainable from relatively few locations, but by choosing one upwind of the storm centre and relatively near the path of the storm, the dew point of the air mass can be estimated.

Three sources of data are available for information regarding the path of storms that occurred in recent decades:

1. Upper-air maps are available from a variety of sources. These display wind speed, wind direction, and other information. In general, these have been available since the mid-1940s.
2. The hysplit model (ARL 2007) and Canada’s CMC trajectory model (Côté et al. 1998) form complete systems for computing simple air parcel trajectories to complex dispersion and deposition simulations. Both models provide an estimate of the path that air parcels followed as they moved toward a particular location (in this case, a storm centre).

3. Balloon radiosonde data are available for selected locations, generally twice per day. These include reports of winds and other parameters at various levels in the atmosphere.

Prior to the 1940s, none of these types of data were available. For older storms, it was assumed that flow was from the southeast quadrant in summer. This is consistent with HMR-55A’s discussions of general flow patterns.

Dew point temperature data were used to determine the moisture content for summer storms. The storm path information was used to select a dew point observing station. For each station, the maximum persisting 12-hour dew point was determined using reported hourly data. The value considered most representative for the storm, based on the storm trajectory, was chosen as the “storm representative dew point”.

37.1.11.1.8 Storm Maximization

It is customary in calculating probable maximum precipitation to employ surface dew point observations to estimate atmospheric moisture. Typically, the maximum 12-hour persisting dew point is used as a surrogate for precipitable water, which represents total moisture available for precipitation. Precipitable water is calculated by assuming a saturated atmosphere from the surface upward. A saturated atmosphere is a situation in which the dew point equals the air temperature: that is, relative humidity is 100%.

However, the assumption of complete saturation over the whole air column is a very conservative one that tends to overstate precipitable water (Chen and Bradley 2006). Nonetheless, for consistency with other probable maximum precipitation studies (including all those published by the National Weather Service), dew point-based precipitable water calculations were performed.

Maximum 12-hour persisting 1,000 millibar (mb) dew points were obtained from a coverage based on Hopkinson (1999). These were compared to the “storm representative dew point” values, adjusted to 1,000 mb. Each dew point was converted to precipitable water using the approach from HMR-55A. The ratio of maximum to storm representative precipitable water was calculated (maximization ratio).

37.1.11.1.9 Storm Transposition

GIS was used to transpose maximum free atmosphere forced precipitation from each storm horizontally using variations in 100-year precipitable water. The free atmosphere forced precipitation value at any given transposed location was the original (storm centre) value multiplied by the ratio of the maximum precipitable water at the transposed location to the maximum precipitable water at the storm centre. Ideally, the transposed free atmosphere forced precipitation should actually be the ratio of precipitable water in the moist air inflow to the storm compared to the maximum precipitable water at an identical location in a relative sense for the transposed storm. The ratios will be the

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FOR GENERATIONS
same as those for storm centre ratios, provided the gradients of precipitable water are similar in both locations.

37.1.11.1.10 Dominant Storms

Depth-area-duration curves were developed for the convergence PMP using the maximized and transposed grids of all convergence summer/fall and spring storms. Convergence probable maximum precipitation depth-area-duration curves were then used to identify the storms most likely to generate the maximum precipitation over the Site C catchment. The dominant storms identified were those whose depth-area-duration curves are on or close to the envelope of the depth-area-duration curves.

37.1.11.1.11 Probable Maximum Precipitation

Transposition of the dominant storms provided the convergence precipitation. The effect of orography was taken into account by multiplying convergence precipitation by the T/C ratios.

As detailed in HMR-55A, an adjustment to T/C is normally used prior to the final conversion of convergence to total precipitation. The “storm intensification factor” is intended to account for the reduction in orographic effects when convective events dominate. The data required to evaluate the storm intensification factor with confidence were found to be insufficient at the latitude of Williston or Site C; therefore, it was not used, which is conservative because not including this factor yields higher total precipitation.

Since the total precipitation on a catchment will vary with the location of the storm centre and storm orientation, several potential storm centres and orientations were tested for each dominant storm. This was done by developing software that automatically computed the three-day rainfall over the catchments for a large number of storm centres and for changes in storm orientation up to 40°, either clockwise or counter-clockwise. The latter limit was set after looking at the orientation of all storms included in the study. It was found that the storms are generally orientated along a south-north line, with variations on each side by a maximum of about 40°.

Table 37.6 presents the catchment average precipitations for the dominant storms.

The probable maximum precipitations would be produced by the following storms, which are shown in bold in Table 37.6 below:

- In spring, by maximization and transposition of a storm that occurred in northeastern Alberta (52.17° N, 113.52° W) on May 1, 1964
- In summer, by maximization and transposition of the Gibson Dam storm that occurred in northern Montana (47.60° N, 112.75° W) on July 6, 1964
Table 37.6 Application of the Dominating Storms Over the Basins

<table>
<thead>
<tr>
<th>Tested Storms</th>
<th>Williston</th>
<th>Site C</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3 Day Total Precipitation (mm)</td>
<td>Orientation</td>
<td>3 Day Total Precipitation (mm)</td>
</tr>
<tr>
<td>Summer/Fall</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1944-06-13</td>
<td>152.2</td>
<td>Right 20°</td>
<td>186.7</td>
</tr>
<tr>
<td>1960-09-04</td>
<td>129.7</td>
<td>Left 40°</td>
<td>153.6</td>
</tr>
<tr>
<td>1962-06-03</td>
<td>147.6</td>
<td>Left 10°</td>
<td>178.2</td>
</tr>
<tr>
<td>1963-07-21</td>
<td>144.5</td>
<td>Right 10°</td>
<td>185.0</td>
</tr>
<tr>
<td>1964-06-07</td>
<td>155.0</td>
<td>Right 30°</td>
<td>232.7</td>
</tr>
<tr>
<td>1969-08-03</td>
<td>142.6</td>
<td>Left 40°</td>
<td>198.5</td>
</tr>
<tr>
<td>1970-06-27</td>
<td>140.3</td>
<td>Right 20°</td>
<td>184.3</td>
</tr>
<tr>
<td>1973-08-04</td>
<td>145.2</td>
<td>Left 30°</td>
<td>186.1</td>
</tr>
<tr>
<td>1990-06-11</td>
<td>144.7</td>
<td>Left 40°</td>
<td>190.4</td>
</tr>
<tr>
<td>1995-06-05</td>
<td>113.3</td>
<td>Right 30°</td>
<td>159.8</td>
</tr>
<tr>
<td>Spring</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1932-04-22</td>
<td>90.4</td>
<td>Left 20°</td>
<td>118.5</td>
</tr>
<tr>
<td>1964-05-01</td>
<td>109.1</td>
<td>Right 40°</td>
<td>143.5</td>
</tr>
<tr>
<td>1967-04-28</td>
<td>106.4</td>
<td>Right 40°</td>
<td>129.7</td>
</tr>
<tr>
<td>1974-04-26</td>
<td>105.9</td>
<td>Original</td>
<td>137.1</td>
</tr>
</tbody>
</table>

NOTE:

a  The Gibson Dam storm lasted 36 hours, and 88% of the rain fell during the first 24 hours.

Figure 37.10 and Figure 37.11 show the probable maximum precipitation over the Williston and Site C local catchments, respectively. These figures also show the boundaries of the sub-basins in the two catchments.

The summer probable maximum precipitation estimates apply primarily to mid-July. If snowmelt is delayed by unusual cold temperatures in April and May, the probable maximum flood could occur in June. Some reduction factors may then be required to adjust the summer probable maximum precipitation intensity to account for the generally lower temperatures in June.

The World Meteorological Office recommends including hydrometeorological factors such as the monthly distribution of maximum persisting dew point, the monthly distribution of 50-year return period 24-hour precipitation, or the monthly distribution of mean wind in the analysis of seasonal variation of probable maximum precipitation.

The hydrometeorological factors considered included:

- Wind, which often amplifies storm rainfall in mountainous regions, with higher winds resulting in higher precipitation. Data show that the mean wind speed over the Peace River basin decreases during the summer months.
- Maximum persisting dew point, which determines the moisture content of storms. Rainfall increases with increasing maximum persisting dew point, which normally
increases through the spring and is highest in the second half of July, and then decreases in the succeeding months.

For Site C, the distribution of the maximum persisting dew point and the distribution of maximum winds trend in opposite direction; therefore, it was decided not to apply a reduction factor to derive the June probable maximum precipitation from the mid-July probable maximum precipitation, which is conservative.

37.1.11.2 Probable Maximum Flood

37.1.11.2.1 Scenarios

The probable maximum flood results from the combination of a severe hydrometeorological event preceded by, or followed by, an extreme event.

As described in the CDA Guidelines (CDA 2007b), the severe event generally has a return period of about 100 years. The extreme event corresponds to the largest physically possible hydrometeorological event and is estimated by deterministic methods.

The CDA Guidelines recognize three probable maximum flood scenarios applicable to Canada:

1. Melting of the 100-year return period snowpack by a critical temperature sequence (severe event) followed by the spring probable maximum precipitation (extreme event).

2. Melting of the probable maximum snow accumulation by a critical temperature sequence (extreme event) followed by the 100-year return period spring rainfall (severe event).

3. The 100-year return period summer or fall rainfall (severe event) followed by the summer or fall probable maximum precipitation (extreme event).

A 15-day critical temperature sequence is normally sufficient to melt the entire snow cover in the boreal regions of Canada (i.e., most of the territory east of the Rocky Mountains) (Chow and Jones 1994).

Due to the large variations in altitude in the Site C catchment, it may take more than 15 days to melt the snowpack. With snowmelt starting in early May, a summer probable maximum precipitation occurring in June could be combined with melting of the 100-year snowpack. Therefore, the following scenario was included:

4. Melting of the 100-year return period snowpack by a critical temperature sequence longer than 15 days (severe event) followed by the summer probable maximum precipitation (extreme event) in early June.

Scenarios 1, 2, and 4 require the development of a critical temperature sequence for melting the snowpack. The same base sequence can be used for these three scenarios, with some variations to hasten or delay snowmelt depending on the timing of the probable maximum precipitation.
37.11.2.2 Snowpack

The probable maximum snow accumulation was determined by maximization of the snowstorms that occurred during particularly snowy winter seasons. The four snowiest winters were first identified and all snowstorms that occurred in these winters were identified based on snow depths recorded at all climate stations in the region. A snowfall was maximized if 5 cm or more snow was recorded at a minimum of three stations over the catchment. Each snowstorm was maximized and the total maximized accumulation for each winter season was computed.

The methodology used for estimating the probable maximum snow accumulation was that proposed by the World Meteorological Organization (WMO 1969), as amended by Chow and Jones (1994) for application in Canada’s boreal region.

Upper air data were used to estimate the moisture content in the air masses that produced the snow storms and to estimate the 100-year return period air moisture content. Maximization was done using upper air data because they provide more reliable estimates of moisture content than dew point temperature-derived estimates during the winter and spring. Air moisture from winter snow storms comes mostly from the Pacific Ocean. The upper air stations used for moisture content estimates were Prince George in central British Columbia, Fort Nelson in northern British Columbia, Port Hardy on the coast of southern British Columbia, and Annette Island in southern Alaska.

For Williston, the 2006 to 2007 winter season generated the probable maximum snow accumulation, and for the Site C local catchment, the governing winter season was 2004/05. Table 37.7 and Table 37.8 show the probable maximum snow accumulation for the Williston catchment and the Site C local catchment.

Table 37.7 Probable Maximum Snow Accumulation (cm) Over the Williston Catchment

<table>
<thead>
<tr>
<th>Sub-basin</th>
<th>Probable Maximum Snow Accumulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finlay</td>
<td>733</td>
</tr>
<tr>
<td>Natpak</td>
<td>656</td>
</tr>
<tr>
<td>Willoc</td>
<td>659</td>
</tr>
<tr>
<td>Parsnip</td>
<td>1142</td>
</tr>
</tbody>
</table>

Table 37.8 Probable Maximum Snow Accumulation (cm) Over the Site C Local Catchment

<table>
<thead>
<tr>
<th>Sub-basin</th>
<th>Probable Maximum Snow Accumulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Halfway</td>
<td>466</td>
</tr>
<tr>
<td>Graham</td>
<td>487</td>
</tr>
<tr>
<td>Lower Halfway</td>
<td>339</td>
</tr>
<tr>
<td>Moberly</td>
<td>268</td>
</tr>
<tr>
<td>Middle Peace</td>
<td>249</td>
</tr>
</tbody>
</table>

The 100-year return period snowpack was derived from data collected at snow course stations in and around the Williston and Site C catchments. In order to be conservative, the maximum snow water equivalent value in each year at each station was used in the analysis, whatever time during the winter season it was measured. The 100-year return
period snow water equivalent at each station was estimated using the Log-Pearson Type III distribution. Coverage of the snow water equivalent over the two catchments was prepared using ArcGIS. Table 37.9 and Table 37.10 show the snow water equivalent of the 100-year return period snowpack over each sub-basin for the Williston and Site C sub-basins.

Table 37.9 100-Year Snow Water Equivalent (mm) for Williston Sub-Basin

<table>
<thead>
<tr>
<th>Sub-basin</th>
<th>100-year Snow Water Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finlay</td>
<td>603</td>
</tr>
<tr>
<td>Natpak</td>
<td>533</td>
</tr>
<tr>
<td>Willoc</td>
<td>539</td>
</tr>
<tr>
<td>Parsnip</td>
<td>944</td>
</tr>
</tbody>
</table>

Table 37.10 100-Year Snow Water Equivalent (mm) for Site C Sub-Basin

<table>
<thead>
<tr>
<th>Sub-basin</th>
<th>100-year Snow Water Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Halfway</td>
<td>341</td>
</tr>
<tr>
<td>Graham</td>
<td>469</td>
</tr>
<tr>
<td>Lower Halfway</td>
<td>183</td>
</tr>
<tr>
<td>Moberly</td>
<td>253</td>
</tr>
<tr>
<td>Middle Peace</td>
<td>208</td>
</tr>
</tbody>
</table>

37.1.11.2.3 Rainfall

Figure 37.10 and Figure 37.11 show the probable maximum precipitation over the Williston and Site C catchments, respectively.

As described above, 100-year rainfalls are used in Scenarios 2 and 3 in addition to the probable maximum precipitation.

The 100-year return period summer/fall rainfall over three days was first estimated at several meteorological stations in the Site C local catchment. The 100-year estimates were obtained with the Generalized Extreme Value distribution, based on visualization of the curve fits. Table 37.11 shows the distribution of the 100-year three-day summer rainfall over the sub-basins.

Table 37.11 100-Year Three-Day Summer Rainfall Distribution on Site C Local Catchment

<table>
<thead>
<tr>
<th>Sub-basin</th>
<th>Three-Day Summer Precipitation (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Halfway</td>
<td>190.9</td>
</tr>
<tr>
<td>Graham</td>
<td>225.4</td>
</tr>
<tr>
<td>Lower Halfway</td>
<td>139.3</td>
</tr>
<tr>
<td>Moberly</td>
<td>117.0</td>
</tr>
<tr>
<td>Middle Peace</td>
<td>114.8</td>
</tr>
<tr>
<td>Catchment average</td>
<td>156.9</td>
</tr>
</tbody>
</table>

The 100-year return period spring rainfall was estimated based on a statistical analysis of the maximum three-day rainfall totals recorded between March 1 and May 31 on each
year at the climate stations. The 100-year estimates were obtained with the Log-Pearson Type III distribution, based on visualization of the curve fits. Table 37.12 shows the distribution of the 100-year three-day spring rainfall over the sub-basins.

### Table 37.12 100-Year Three-Day Spring Rainfall Distribution on Site C Local Catchment

<table>
<thead>
<tr>
<th>Sub-basin</th>
<th>Three-Day Spring Precipitation (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Halfway</td>
<td>92.0</td>
</tr>
<tr>
<td>Graham</td>
<td>89.1</td>
</tr>
<tr>
<td>Lower Halfway</td>
<td>71.6</td>
</tr>
<tr>
<td>Moberly</td>
<td>65.2</td>
</tr>
<tr>
<td>Middle Peace</td>
<td>65.0</td>
</tr>
<tr>
<td>Catchment average</td>
<td>80.0</td>
</tr>
</tbody>
</table>

ArcGIS was used to prepare coverage of the 100-year return period daily rainfall. The three-day storm distribution was assumed to be similar to the distribution of the spring or summer/fall probable maximum precipitation, as applicable. The three-day rainfall was assumed to start seven days before the beginning of the probable maximum precipitation, which means that there were four days without rainfall between the 100-year rainfall and the probable maximum precipitation.

### 37.1.11.2.4 Critical Temperature Sequences

Critical temperature sequences were constructed to obtain severe sequences of high temperatures to accelerate melting of the snowpack. The methodology used for deriving the sequences was developed by Chow and Jones (1994).

The sequences were constructed by extracting for each year and at each meteorological station the maximum annual cumulated temperatures over 1, 2, 3, 4, 5, 10, 15, 30, and 45 consecutive days starting from the beginning of snowmelt. A statistical analysis for each series of cumulative temperatures was then carried out to obtain the 100-year return period estimate.

Progressively increasing sequences were constructed, culminating with the maximum temperature four or five days before the probable maximum precipitation, or any other intense rainfall, occurred. In all cases, the maximum daily temperature for any single day was limited to 24°C (Chow and Jones 1994). A slight drop in temperature is expected just before the probable maximum precipitation to reflect the passage of a cold front preceding the probable maximum precipitation (SNC-Shawinigan 1992). The probable maximum precipitation should last three days after the passage of the cold front and the temperature during the probable maximum precipitation should be close to the maximum dew point temperature at that location and time (Chow and Jones 1994).

The total duration of the temperature sequences depends on the snow water equivalent of the snowpack at the start of the melting period and on the snowmelt rate. As the duration of the melting period depends on the temperature sequence, temperature sequences of 15, 30, and 45 days’ durations were constructed and tested successively to determine which sequence is critical, i.e., which sequence results in the greatest runoff. The time taken by the melt water to pass through the snowpack is taken into account by the calibrated hydrological model (see Section 37.1.9.2.5). In all cases,
snowmelt is assumed to start on May 1, based on an analysis of snow on ground at selected meteorological stations.

Figure 37.12 and Figure 37.13 present the 30-day and 45-day, respectively, temperature sequences derived for all meteorological stations used in the calibrated hydrological model for Site C. In some scenarios, these sequences were modified to make sure that the snowpack had not melted completely before the arrival of the probable maximum precipitation. The basic criterion, whether developing and modifying the sequences, is to make sure that the rain event occurs about the same day as the maximum runoff due to snowmelt. When modifications to the sequences were needed, they generally consisted of subjectively decreasing the temperatures in the first segment of the sequence. The highest temperatures in the last segment of the sequences were kept untouched because these generate higher melt rates and therefore maximize snowmelt runoff when the probable maximum precipitation occurs.

37.1.11.2.5 Watershed Model

Determination of the probable maximum flood requires modelling of the physical processes that convert precipitation into streamflow. The physical processes producing floods are simulated using a watershed model that converts precipitation input into runoff from a watershed. The ability of the watershed model to provide an accurate representation of watershed hydrology is checked by comparing measured streamflow to streamflow simulated by model.

The UBC Watershed Model was used to determine the probable maximum flood for Site C because it:

- Is used by BC Hydro to forecast daily inflow to almost every BC Hydro reservoir and has proven ability to represent watershed hydrology
- Has been used to determine the probable maximum flood for many of BC Hydro’s projects (Micovic 2005), as well as for numerous international projects

The UBC Watershed Model was originally developed for daily streamflow forecasting on the Fraser River system (Quick and Pipes 1977). The model calculates watershed outflow using point measurements of precipitation and temperature data combined with physical watershed characteristics as input. The model was designed primarily for the calculation of streamflow from mountainous watersheds where streamflow consists of snowmelt, rain, and glacier outflow. Since the hydrological behaviour of the mountainous watershed is a function of elevation, the model uses the area-elevation bands concept. This concept accounts for orographic gradients of precipitation and temperature, which are assumed to behave similarly for each storm and are dominant gradients of behaviour in mountainous areas. The physical description of a watershed is input for each elevation band separately in the form of different variables such as area of the band, forested fraction and forest density, glaciated fraction, band orientation, and fraction of impermeable area.

The UBC Watershed Model is a continuous hydrologic model, which means that it provides continuous streamflow output for the duration of the meteorological input.

In addition to the UBC Watershed Model, a flood routing model based on the Muskingum-Cunge method (Cunge 1969) was used to convey flood hydrograph estimates along the main tributaries through the sub-basins of the Site C local catchment.
to the points of interest (i.e., hydrometric stations). The flood routing model computes attenuation effects and delays in peak arrival times.

Figure 37.14 shows the location of the pertinent meteorological stations and their respective areas of influence over the sub-basins in the Site C local catchment. The areas of influence of each station were established by application of the Thiessen Method (Thiessen 1911) and used to determine the weighting of their respective meteorological stations data over the modelled sub-basins.

Morphological characteristics, such as aereal extent, elevation bands, channel length and slope, and watershed boundaries in the Site C local catchment, were derived from a Digital Elevation Model with a resolution of 0.75 arc seconds, acquired from Natural Resources Canada. A GIS database of soil types and land cover was set up for each of the sub-basins, and percentages of impermeable and forested areas were calculated for each elevation band. Land cover and soil type information were collected from GIS databases available through Natural Resources Canada.

All sub-basin models in the Site C local catchment were calibrated and verified within the period ranging from September 1983 through September 2004. No verification was performed to the Upper Halfway sub-basin model due to the lack of streamflow data. The calibration of the hydrological model was aimed mainly at obtaining a satisfactory fit between computed and observed peak flows and volumes. For an ongoing evaluation of the calibration performance, statistical scores were used all along the process to assess the goodness-of-fit between computed results and observed data. Figure 37.15 compares simulated and observed hydrographs for the Middle Peace, Lower Halfway, and Moberly sub-basins for the 2000 to 2001 water year, which includes the flood of record at Site C.

The UBC Watershed Model gives daily streamflows. An analysis of hourly discharge at the gauging stations located in the Site C catchment revealed that the average ratio of peak instantaneous to maximum daily discharge ranged from 1.01 (Moberly River near Fort St. John) to 1.10 (Halfway River above Graham River). Therefore, daily discharges from the UBC Watershed Model were multiplied by 1.10 to give peak instantaneous discharges.

37.11.2.6 Probable Maximum Flood

The four scenarios listed in Section 37.1.9.2.1 were run in the watershed model to determine the scenario that governed the probable maximum flood. In running these scenarios, the inputs that maximized runoff (e.g., storm centering and orientation and temperature sequence) were used. The following paragraphs describe the results.

For Scenario 1, melting of the 100-year return period snowpack was assumed to start on May 1, with the temperature increasing until it reached a maximum in late May following the sequence shown in Figure 37.12. The spring probable maximum precipitation was then assumed to occur with the timing of the rainfall set to maximize both the snowmelt runoff and the rainfall runoff on the same day. Figure 37.16 presents the results of the application of this scenario for the Site C local catchment. The maximum daily flow is 5,200 m³/s, which, when multiplied by the 1.10 conversion factor, translates to a peak instantaneous flow of 5,720 m³/s.
For Scenario 2, melting of the probable maximum snow accumulation was assumed to start on May 1, with the temperature increasing until it reached a maximum in late May following the sequence shown in Figure 37.12. The 100-year return period spring rainfall was then assumed to occur with the timing of the rainfall set to maximize both the snowmelt runoff and the rainfall runoff on the same day. The daily distribution of the 100-year return period spring rainfall was prorated as for the spring probable maximum precipitation. Figure 37.17 presents the results of this scenario for the Site C local catchment. The maximum daily flow is 4,410 m³/s which, when multiplied by the 1.10 conversion factor, translates to a peak instantaneous flow of 4,850 m³/s.

For Scenario 3, the 100-year return period summer rainfall was assumed to occur in late July, followed by the summer probable maximum precipitation at the beginning of August. Based on an analysis of storms carried out for the Site C basin, the average time period between successive storms was found to be seven days. As a storm generally lasts three days, it was assumed that there would be four days without rain between the two successive storms. Figure 37.18 presents the results of this scenario for the Site C local catchment. The maximum daily flow is 9,920 m³/s, which, when multiplied by the 1.10 conversion factor, translates to a peak instantaneous flow of 10,900 m³/s.

For Scenario 4, a period with relatively cool temperatures in the first three weeks of May was considered in order to delay the maximum runoff due to snowmelt until the summer probable maximum precipitation, which is more intense than the spring probable maximum precipitation. Such a cool three-week period was observed over the Site C local catchment in May 1996. The scenario assumed melting of the 100-year return period snowpack starting on May 1, with the temperature sequence consisting of the low temperatures measured in the first three weeks of May 1996 followed by the fourth week of the critical temperature sequence shown in Figure 37.12. The resulting temperature sequence is shown in Figure 37.19. The summer probable maximum precipitation was then assumed to occur with the timing of the rainfall set to maximize both the snowmelt runoff and the rainfall runoff on the same day. Figure 37.20 presents the results of the application of this scenario for the Site C local catchment. The maximum daily flow is 11,500 m³/s, which, when multiplied by the 1.10 conversion factor, translates to a peak instantaneous flow of 12,560 m³/s.

The preceding discussion presents the results for the Site C local catchment, which indicates that Scenarios 3 and 4 give the highest flow from that catchment. However, outflows from W.A.C. Bennett Dam influence the ranking of the scenarios and are required to give the total probable maximum flood inflow to Site C.

The various components involved in a probable maximum flood scenario have to be consistent for both the Williston and the Site C basins. For example, the storm generating the probable maximum precipitation is so large that it can only be centred at one location (i.e., worst location over the Site C local catchment or worst location over the Williston catchment). When the probable maximum precipitation is centred on one catchment, the other catchment receives associated rainfall (see Figure 37.11, which shows the summer probable maximum precipitation centred on the Site C local catchment). On the other hand, it is reasonable to assume that the probable maximum snowfall accumulation can occur in the same year in both basins. This is because snow accumulates over several months during the winter and shows some consistency over a very large area. For the same reason, the 100-year return period snowpack can also be
assumed to occur in the same year in both basins. Critical temperature sequences must also be consistent for both basins.

The results of several simulations conducted for both Williston and Site C showed that four scenarios generate the largest total inflows at Site C. Table 37.13 presents the results of these four scenarios. The corresponding outflows from W.A.C. Bennett Dam are dependent on Williston reservoir levels and operating rules. Releases from Peace Canyon Dam occur simultaneously with releases from W.A.C. Bennett Dam and flow changes are expected to occur at the Halfway River within an hour. Therefore, no delay was assumed between flow leaving W.A.C. Bennett Dam and arriving at Site C.

In the governing case shown in Table 37.13, the Williston Reservoir would fill prior to the probable maximum precipitation and spill. As shown in Figure 37.20, the peak discharge from the W.A.C. Bennett Dam would coincide with the peak flow from the Site C local catchment.

Table 37.13 Site C Probable Maximum Flood Scenarios

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Maximum Daily Flow (m³/s)</th>
<th>Maximum Instantaneous Flow (m³/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenario 3 with summer probable maximum precipitation centred over Site C local catchment</td>
<td>18,000</td>
<td>19,300</td>
</tr>
<tr>
<td>Scenario 3 with summer probable maximum precipitation centred over Williston catchment</td>
<td>10,130</td>
<td>10,350</td>
</tr>
<tr>
<td>Scenario 4 with June probable maximum precipitation centred over Site C local catchment</td>
<td>12,800</td>
<td>14,200</td>
</tr>
<tr>
<td>Scenario 4 with June probable maximum precipitation centred over Williston catchment</td>
<td>9,690</td>
<td>9,810</td>
</tr>
</tbody>
</table>

37.1.11.3 Likelihood

The determination of the probable maximum precipitation followed accepted guidelines and standard practice. Reasonable but conservative assumptions (i.e., assumptions that would result in higher runoff estimates) were made. Key assumptions are:

- Precipitation patterns for extreme storms would be similar to mean patterns for June. This was considered reasonable because large storms occur most frequently in June.
- Precipitation in areas without orographic features is assumed to be 100% convergence related.
- Precipitable water was calculated assuming a completely saturated air column. This is a conservative assumption and is consistent with other PMP studies, but could overestimate the precipitable water (Chen and Bradley 2006).
- The moisture supply in a storm can be increased without altering the dynamic structure of the storm, but if too much moisture is added, the storm can be altered. The moisture maximization ratio was limited to 1.50, which is consistent with HMR-55A.
• The storm intensity factor was not considered, which is conservative, as it yields high total precipitation.

• It was assumed that the probable maximum precipitation in June would be the same as July.

In addition, GIS was used to centre and orientate the probable maximum precipitation on the catchments. Software was developed that automatically computed the three-day rainfall over the catchments for a large number of possible storm centres and storm orientation. This identified the worst possible combination of storm location and orientation, and gave the largest possible estimates of total precipitation.

Derivation of the probable maximum flood also followed accepted guidelines and standard practice. As described above, the probable maximum flood is evaluated by deterministic methods that maximize the various factors contributing to the generation of the flood and, therefore, the methodology does not define an annual exceedance probability.

The governing condition was Scenario 3 with a storm producing the 100-year return period rainfall over the entire Site C catchment (severe event), followed by the probable maximum precipitation (extreme event) centred over the Site C local catchment starting four days after the end of the first storm. For the Site C local catchment, the probable maximum precipitation is 1.5 times the average 100-year return period rainfall. The precipitation from the two storms is equivalent to 84% of the mean annual rainfall at Fort St. John.

The likelihood of these two events occurring four days apart is less than 1/10,000. The occurrence of the probable maximum flood is therefore considered to be extremely unlikely.

37.1.12 Slope Stability and Mass Wasting Events

Slope instability and mass wasting could adversely affect the Project by:

• Landslides damaging the dam, generating station, and spillways

• Landslides on the reservoir shoreline damaging property, including Highway 29

• Failure of a landslide dam, releasing high flows that overtop the Stage 2 upstream cofferdam

• Landslide-generated waves damaging the Stage 2 upstream cofferdam

• Landslide-generated waves on the reservoir damaging the earthfill dam

Volume 2 Section 11.2 Geology, Terrain, and Soils, and Volume 2 Appendix B Geology, Terrain Stability, and Soil Reports, Part 1 Terrain Stability Mapping describe:

• The terrain mapping techniques that were used to delineate areas with distinct surficial geology and terrain stability

• The terrain stability assessment (the potential for landslide initiation following disturbance by road construction or removal of forest cover) in the Project activity zone, including the dam site, reservoir, transmission line, and Highway 29 realignment segments
37.1.12.1 Dam Site Slope Stability

There are active slumps and small slides on the north bank of the Peace River at the dam site. The terrain stability mapping showed that the north bank is expected to contain areas with moderate likelihood (Class IV) to high likelihood (Class V) of landslide initiation following disturbance. As described in Volume 1 Section 4 Project Description, the north bank above the earthfill dam would be excavated to remove unstable material and flatten the slope. The slope would be designed so that there would not be any slides with the potential to cause an adverse effect on the Project. Refer to Section 37.1.2.3 for the performance of the north bank during earthquakes.

On the south bank at the dam site, the slopes between the Peace River and the terrace were assessed as having a low likelihood of landslide initiation following disturbance, with minor slumping expected along road cuts, especially for one or two years following construction (Class III). The majority of this slope is comprised of colluvium and weathered shale overlying shale bedrock. Colluvium and weathered shale would be excavated for construction of the dam. Disposal area R5b, the earthfill dam, the RCC buttress, and disposal area R6 would support the slope after construction. As a result, no slides from this slope are expected that could adversely affect the Project.

On the south bank downstream of the dam site, the slopes between the river and the terrace were assessed as having areas with a high likelihood of landslide initiation after disturbance (Class V). No disturbance of these slopes is currently planned. However, if any disturbance is required during construction, drainage and other slope stabilization methods would be utilized so that there would not be any potential slides that would have the potential to cause an adverse effect on the Project.

Above the terrace on the south bank of the Peace River at the dam site, the lower parts of the slopes were assessed as having very low likelihood of landslides following road construction, with minor slumping expected along road cuts, especially for one or two years following construction (Class II) and the upper parts of the slopes were assessed as containing areas with a moderate likelihood of landslide initiation following disturbance (Class IV). The approach channel has been located so that the excavations for this part of the Project would not disturb the slope. However, it is possible that some disturbance may occur during construction, in which case drainage and other slope
stabilization methods would be utilized so that there would not be any potential slides that would have the potential to cause an adverse effect on the Project.

### 37.1.12.2 Reservoir Shoreline Stability

Reservoir shoreline stability is described in Volume 2 Appendix B Geology, Terrain Stability, and Soil Reports, Part 2 Preliminary Reservoir Impact Lines.

As described, shoreline protection beneath the community of Hudson’s Hope would be constructed prior to filling the reservoir. The shoreline protection would extend from a location where the proposed reservoir shoreline transitions from bedrock to interbedded sand, silt, and clay materials at the upstream end, downstream to beyond the current location of the municipal sewage treatment facility, for a total length of about 2,650 m. As the proposed shoreline protection offsets the potential effects of the reservoir on erosion and slope stability, the potential for effects of slope stability on the Project in the area of Hudson’s Hope is very unlikely.

The proposed realigned segments of Highway 29 have been located outside of the preliminary impact lines where practical. Some existing segments of Highway 29 are currently situated on marginally stable slopes and are located within the Stability Impact Line. Each of these segments has been reviewed by BC Hydro and the BCMoTI. It has been determined by BC Hydro that the potential effects of the proposed reservoir on the stability of these highway segments are low, and an approach to ongoing highway monitoring and maintenance has been established in collaboration with the BCMoTI.

Therefore, through design and monitoring, adverse effects on the Project due to slope instability in this area are very unlikely.

The 1973 Attachie slide is described in Volume 2 Appendix B Geology, Terrain Stability, and Soil Reports, Part 2 Preliminary Reservoir Impact Lines. Since the 1973 slide blocked the Peace River, the potential occurrence of a similar slide at Attachie during the Stage 2 diversion was considered. For the purpose of determining the required capacity of the diversion tunnels, it was assumed that another similar size slide could occur at Attachie and form a landslide dam across the Peace River upstream of the Halfway River. The size of the landslide dam was based on LiDAR mapping of the remnants of the 1973 slide. A dam break analysis was performed to provide an estimate of the outflow from overtopping and washing out of the landslide dam. The Peace Canyon discharges recorded on May 23, 1973, the date of the Attachie slide, were used as the inflow.

The analysis showed that the diversion tunnels have sufficient capacity to pass the flood wave resulting from the breach of a landslide dam caused by a similar slide at Attachie, even if the peak of the landslide breach outflow coincided with the peak of a 50-year flood, because:

- Inflow from Peace Canyon Dam to the headpond at the cofferdam would be cut off by the landslide and the headpond level would drop
- The volume of water stored behind the landslide dam and released when the landslide dam breached would be about 41 million m³, which is a small proportion of the storage volume of the headpond, which would be about 401 million m³ at the crest level of the Stage 2 upstream cofferdam
As described in Volume 2 Appendix B Geology, Terrain Stability, and Soil Reports, Part 2 Preliminary Reservoir Impact Lines, the 1973 Attachie landslide was a very unusual event in terms of the volume of the slide and the high velocity, which combined to block the Peace River. The capacity of the diversion works would be sufficient to accommodate a similar event without overtopping of the Stage 2 upstream cofferdam.

### 37.1.12.3 Landslide-Generated Waves

Potential landslide-generated waves are described in Volume 2 Appendix B Geology, Terrain Stability, and Soil Reports, Part 2 Preliminary Reservoir Impact Lines. This section discusses the potential effects of landslide-generated waves on the Project during construction and operations.

During Stage 2 diversion, there would be no water impounded opposite Attachie or Bear Flat, so landslide waves could not be generated.

Physical hydraulic model studies of Attachie and Bear Flat undertaken in 1983 indicated that landslide-generated waves at either of these locations would travel down the reservoir and attenuate before reaching the dam and, therefore, potential landslides at these locations would not have an adverse effect on the dam.

Based on the terrain stability mapping, potential sources of extremely rapid landslides (landslides originating in over-consolidated glaciolacustrine deposits) were considered along the Peace River and Moberly River within approximately 5 km of the proposed dam site. Three key potential sources (due to their potential large volume, proximity to the dam, and orientation relative to the dam) were identified for detailed analysis. The governing source area of these three sources is located at the crest of the ridge on the left bank of the Moberly River at its confluence with Peace River. The estimated maximum landslide volume from the governing source area is 2 million m³.

The techniques for estimating potential landslide-generated waves described in Volume 2 Appendix B Geology, Terrain Stability, and Soil Reports, Part 2 Preliminary Reservoir Impact Lines were used to estimate the waves that could be generated by a landslide from the governing source area. Two parameters are required to estimate the potential landslide generated wave due to a landslide from this source area:

- Landslide volume that could enter the reservoir or headpond
- The velocity of the landslide entering the reservoir or headpond

These parameters were estimated from historic landslides.

Considering the typical deposit distribution of large overburden landslides in the reservoir area, it is expected that 50% of the potential landslide volume could reach the reservoir or headpond surface, with the remainder being deposited in the source area and on the slope between the source area and the reservoir or headpond. As a result, potential landslides that could impact the reservoir or headpond with volumes ranging between 0.5 million m³ and 1 million m³ were analyzed, in increments of 0.25 million m³. Corresponding estimated impact velocities ranged between 20 m/s and 25 m/s. These velocity estimates were based on a set of peak landslide velocities that were back-calculated using energy grade line methods at sites in the reservoir area where overburden landslide deposits are well preserved, in addition to velocities simulated during back-analyses of the 1973 Attachie slide using a numerical model. Note that not
all (and most likely only a small proportion) of previous overburden landslides in the reservoir area reached such extremely rapid velocities. The conservative assumption of extremely rapid behaviour was made for the purposes of determining the largest possible wave-generating event.

The analyses indicate that that the normal freeboards provided listed in Table 37.2 are sufficient to prevent a landslide-generated wave from overtopping:

- The Stage 2 cofferdam during diversion
- The earthfill dam during operation

The proposed highway realignment at the Halfway River crossing is situated inside the Wave Impact Line described in Volume 2 Appendix B Geology, Terrain Stability, and Soil Reports, Part 2 Preliminary Reservoir Impact Lines. The potential for landslide-generated waves has been considered in determining the highway embankment elevation, bridge elevation, and bridge design parameters. The proposed highway and bridge design at Halfway River has been reviewed by the BCMoTI and satisfies provincial design codes and safety guidelines.

### 37.1.12.4 Transmission Line

The transmission lines cross a gentle plateau area underlain by glaciolacustrine silts and clays or glacial till, with bogs scattered throughout the area. Much of the plateau area is very gently sloping, and no landslides are present. As described in Volume 2 Appendix B, Geology, Terrain Stability, and Soil Reports, Part 1 Terrain Stability Mapping, these areas are mapped as stable (Class I). Steeper slopes exist where streams cross the plateau.

The location of transmission towers will be selected to avoid unstable areas. This may require the adjustment of span lengths near stream crossings and other areas with steep slopes.

The risk of landslides adversely affecting the transmission line will be reduced by locating towers away from unstable areas and steep slopes.

### 37.1.13 Climate Change

The potential for climate change to affect the Project is described in this section. The potential effects of climate change on the Project are:

- Changes to the generation of electricity
- Changes to the magnitudes of extreme floods

Climate change in the Peace Region is discussed in Volume 2 Appendix T Climate Change Summary Report. As discussed in that report, as a result of climate change:

- Annual streamflow in the Peace River will likely increase through the 21st century
- Temperatures will increase into the 21st century
- Warming will be greatest in winter and will fall outside the range of historical variability
• Median projected precipitation changes range from 11% to 14% by 2050 and from 14.5% to 19% by 2080, depending on emission scenario
• Winter and spring will see the highest increases in flow
• Summer and spring precipitation will show less spatial variation
• Precipitation increases will not fall outside the range of historical variability

37.1.13.1 Electricity Generation

Increases in Peace River streamflow would increase the generation of electricity from the Project.

Thus, potential effects of climate change on electricity generation would be beneficial.

37.1.13.2 Floods

Given the anticipated schedule for construction of the Project, climate change is unlikely to affect the floods used for the design of the diversion works.

As described in Section 37.1.9, the Project would be designed to pass the probable maximum flood which is an extreme event determined by analysis of historical climate data. With climate change it is possible that estimates of the probable maximum flood may increase (due to higher precipitation) or decrease (due to lower snowpack or lower summer precipitation).

BC Hydro’s dam safety program and the B.C. Dam Safety Regulation require periodic dam safety reviews (currently every seven years for a dam in Site C’s category). As part of these reviews, it would be normal practice to review any changes to design standards and whether there is any evidence of changes to climatic conditions or floods that would affect the estimate of Inflow Design Flood. If there was any evidence to suggest that the Inflow Design Flood for the Project may have increased, studies would be undertaken to determine the new Inflow Design Flood.

The peak instantaneous inflow to Site C during the probable maximum flood is estimated to be 19,300 m$^3$/s (Section 37.1.9.2.6). As described in Section 4 Project Description, the spillways would have a capacity of 17,300 m$^3$/s at the maximum flood level because routing the probable maximum flood through the reservoir attenuates the flood, resulting in a peak instantaneous spillway discharge of 17,300 m$^3$/s. Spillway discharge would be less than inflow due to storage of flood water between the maximum normal reservoir level and the maximum flood level.

Should future estimates of the Inflow Design Flood be greater than the current estimate of the probable maximum flood, there would be a number of measures that could be undertaken in the future to enable Site C to pass the larger flood as described below:

1. A gate could be added to the auxiliary spillway to increase spillway capacity by about 1,000 m$^3$/s, which would also provide addition spillway capacity prior to reservoir surcharging.
2. The auxiliary spillway could be widened and rebuilt to increase spillway capacity by 20% or more.
3. The current probable maximum flood routing at Williston is conservative, in that all reservoir inflow is assumed to pass straight through the reservoir so that outflow equals inflow. Any temporary Williston reservoir storage would decrease flood peaks at Site C. For example, a slower ramp-up of Williston spillway discharge resulting in a 24-hour delay in reaching peak Williston discharge could result in reducing the current Site C probable maximum flood peak inflows by up to 3,700 m$^3$/s.

4. The earthfill dam could be raised to allow a higher maximum flood level, which would provide additional attenuation due to larger flood storage and additional spillway discharge capacity.

5. Use improved forecasting to pre-spill or pre-generate to provide more flood storage capacity to attenuate floods.

Based on the above measures it is considered that the Project would be able to accommodate changes to extreme floods due to climate change.

### 37.2 Potential Accidents and Malfunctions

#### 37.2.1 Introduction

This section:

- Identifies the parts of the Project that have the potential, through accident or malfunction, to adversely affect the environment
- Discusses the likelihood and circumstances under which those accidents or malfunctions could occur
- Provides an overview of the measures that would be implemented to reduce the likelihood and those that could be implemented to mitigate the potential occurrence of an accident or malfunction
- Identifies the potential effects of accidents and malfunctions

Dam breach analyses that have been undertaken for the Project are described in Section 37.2.2:

- Section 37.2.2.1 describes the data and methodology
- Section 37.2.2.2 presents the results for the Stage 2 upstream cofferdam
- Section 37.2.2.3 presents the results for the earthfill dam

Accidents and malfunctions that could occur during construction are discussed in Section 37.2.3.

Accidents and malfunctions that could occur during operation are discussed in Section 37.2.4.

Section 37.2.5 identifies the potential effects of accidents and malfunctions on valued components.
37.2.2 Dam Breach Analyses

As described in Volume 1 Section 4 Project Description, an understanding of the consequences of dam failure underlies several principles in the Canadian Dam Association Dam Safety Guidelines (CDA 2007c). Dam breach analyses are used to assess the consequences of dam failure by the characterization of a hypothetical dam breach and routing the resulting flood wave. The consequence classification of a dam is based on the consequences of a dam failure and determines not only the design standards but also the requirements for dam operation, maintenance and surveillance, and emergency preparedness planning. As described in Volume 1 Section 4 Project Description, BC Hydro has adopted the highest classification for the Project.

The requirements for operation, maintenance, and surveillance for dam safety, and for emergency preparedness plans, are described in Volume 1 Section 4 Project Description.

Failure of the Stage 2 upstream cofferdam or failure of the earthfill dam would have an adverse effect on the environment. As described in Section 37.1.8.3, the annual exceedance frequency of a flood potentially damaging or overtopping the Stage 2 upstream cofferdam is approximately 1/600.

As described in Volume 1 Section 4 Project Description, the dam would be designed to the highest standard for the inflow design flood and earthquake design ground motion contained in the Canadian Dam Association Dam Safety Guidelines, namely earthquake ground motions with an annual exceedance frequency of 1/10,000 and the probable maximum flood. As described in Section 37.1.9.3, the probable maximum flood is derived deterministically and the methods do not directly provide an annual exceedance frequency. However, the likelihood of the two consecutive storms occurring four days apart used in the determination of the probable maximum flood is less than 1/10,000.

Failure of the dam is very unlikely, given the extreme flood and earthquake for which it would be designed and given the rigorous operation, maintenance and surveillance requirements that would be implemented for the Project.

Despite the unlikely failure of the Stage 2 upstream cofferdam and the very unlikely failure of the earthfill dam, these possibilities are considered for assessing the potential effects of accidents and malfunctions and for preparing emergency preparedness plans.

37.2.2.1 Data and Methodology

This section describes the data and methodology used for the dam breach analyses that were undertaken to assess the potential effects of hypothetical failures of the Stage 2 upstream cofferdam and the earthfill dam. The methodology is well understood and in accordance with the state of practice for dam breach assessments.

The method consists of:

- Estimating dam breach parameters and the resulting flood wave
- Routing the flood waves from hypothetical dam breaches down the river

The MIKE 11 model, which is a one-dimensional hydrodynamic model that was used for routing the flood waves from hypothetical dam breaches down the Peace River from the
dam site to Peace Point, Alberta. The MIKE 11 model is described in Volume 2 Appendix D Surface Water Regime Technical Memos.

The MIKE 11 program has been used extensively for dam break analysis by BC Hydro and others, and is accepted by the U.S. Federal Emergency Management Agency for use in the National Flood Insurance Program (FEMA 2012). To gain acceptance by the Federal Emergency Management Agency, a model must be reviewed and tested. A model is certified by another U.S. government agency that is familiar with the model. The certifying agency reviews and tests the model to determine whether the model is scientifically correct and technically sound, and whether the model can provide adequate information to support National Flood Insurance Program studies and mapping (FEMA 2004).

As described below, the MIKE 11 model was modified for the dam breach study to improve accuracy for higher discharge scenarios.

### 37.2.2.1.1 Bathymetric and Topographic Data

The bathymetric data at cross-sections across the Peace River used to set up the MIKE 11 model are described in Volume 2 Appendix D Surface Water Regime Technical Memos. Approximately 50 sections were added in the Peace River reach in Alberta, mainly near the developed areas. Most of these sections have interpolated bathymetry.

Since the flood waves from hypothetical dam breaches would flood areas outside the normal river channel, topographic data were required to extend the river cross-sections in the MIKE 11 model to higher elevations. The areas above the normal river banks are referred to as overbank areas.

Topographic data along the Peace River in B.C. consist of a LiDAR digital elevation model collected in 2006 and 2007 (vertical accuracy approximately +/- 0.3 m). A provincial TRIM (Terrain Resource Inventory Mapping) digital elevation model was used in B.C. to fill gaps at higher elevations (vertical accuracy of approximately +/- 5 m).

The LiDAR digital elevation model collected between 2005 and 2009 (vertical accuracy approximately +/- 0.3 m) was acquired for over 50% of the 970 km length of the Peace River corridor in Alberta. This LiDAR digital elevation model covers the entire Peace River reach between the B.C.–Alberta border to 25 km downstream of the Town of Peace River and the main developed areas further downstream such as near Carcajou and Fort Vermilion. For study areas in Alberta not covered by LiDAR data (i.e., undeveloped areas downstream of the Town of Peace River), the Canadian Digital Elevation Data, which is available online, were used (vertical accuracy of approximately +/- 5 m).

LiDAR data were not readily available for a few small developed areas along the Peace River downstream of Fort Vermilion. Local surveys were performed in these areas to provide elevations along roads and near buildings.

Flood protection dikes for the Town of Peace River were represented in the model based on as-built drawings prepared by Bekevich Engineering Ltd. in 1999.

### 37.2.2.1.2 Hydrometric Data

Hydrometric data were required for hydrodynamic model calibration.
Volume 2 Section 11.4 Surface Water Regime describes the surface water regime of the Peace River and lists the Water Survey of Canada gauges along the Peace River between Peace Canyon Dam and Peace Point. Calibration of the MIKE 11 model relative to the Water Survey of Canada gauge rating curves is described in Volume 2 Appendix D Surface Water Regime Technical Memos.

Hourly flow data for Water Survey of Canada gauged tributaries and stations along the Peace River were obtained for the July 2002 and June 1990 periods for additional hydraulic model calibration for flood wave routing. A spill at Peace Canyon Dam in July 2002 had a maximum total outflow of about 3,200 m³/s, while June 1990 represents the flood of record for the Peace River at Peace Point.

37.2.2.1.3 Hydrodynamic Model Development and Calibration

The Project reservoir and the downstream Peace River channel and overbank areas were represented in the model with a series of cross-sections. Cross-sections were developed using the bathymetric and topographic data sources described above. The Peace River corridor was represented in the MIKE 11 model by more than 400 sections.

The boundary conditions for the MIKE 11 model consisted of an inflow to the Project reservoir (i.e., Peace Canyon Dam outflow plus local inflows) and an assumed constant water level more than 100 km downstream of Peace Point. As described in Volume 2 Appendix D Surface Water Regime Technical Memos, the downstream boundary was set far enough downstream to not influence simulated flows and levels at Peace Point. Gauged tributary flow estimates were added to the model as lateral inflows.

Manning’s coefficients for channel roughness were set in the model through the calibration process described below. Manning’s roughness is an empirically derived coefficient that is dependent on many factors, including the surface roughness and sinuosity of a river channel. It is used in hydraulic calculations for open channel flow. The velocity of flow in an open channel is inversely proportional to the roughness. The channel roughness used was approximately 0.03 in the reach between Site C and the B.C.–Alberta border and decreased to about 0.02 at Peace Point. Roughness coefficients in the 0.07 to 0.1 range were used to represent overbank areas with medium to dense vegetation.

The MIKE 11 model was calibrated and checked by:

• Comparing the model representation of the Site C Reservoir with the storage curve
• Matching the Water Survey of Canada rating curves along the Peace River downstream of Site C Dam
• Running hourly Peace Canyon discharges from July 2002 and June 1990 with corresponding lateral inflows from gauged tributaries (i.e., with no dam at Site C)

The calibration at Peace Point was extended up to the maximum discharge in the Water Survey of Canada rating curve, approximately 16,000 m³/s. The MIKE 11 representation of the Site C Reservoir was compared to the storage curve by computing the modelled dam breach outflow hydrograph volume immediately downstream of Site C dam. The modelled volume was found to be within 1% of the storage curve volume, which is shown in Figure 4.24 in Volume 1 Section 4 Project.
Description. The storage volume curve was calculated from the LiDAR digital elevation model for the reservoir area.

For the rating curve comparisons simulations, modelled results were generally within about 0.2 m of the full range of the Water Survey of Canada rating curves along the Peace River.

For the July 2002 flow routing tests, modelled flows at Water Survey of Canada stations followed the observed flow patterns very well to the Town of Peace River. Modelled flows at Peace Point were within 200 m$^3$/s of measured values. The Water Survey of Canada gauge at Fort Vermilion was out of operation in 2002, so no comparison could be made between model and observed data at this location.

Modelled flows for June 1990 generally followed the observed flow patterns at Water Survey of Canada stations to the Alces River. Modelled maximum flows at Dunvegan and the Town of Peace River were approximately 1,400 m$^3$/s and 3,700 m$^3$/s less than the observed maximum flows, likely due to local inflows from ungauged tributaries downstream of the Alces River during the very large storm event that occurred in this reach during the June 12–14, 1990 period that resulted in the flood of record for the Smoky River. Ungauged flow contributions are typically relatively low in this reach.

The Water Survey of Canada measured discharges for the Peace River at the Town of Peace River for June 1990 were input into the MIKE 11 model to route the flows further downstream. There was very good agreement between modelled and measured flows at Peace Point. Daily measured flow data for June 1990 were used for comparison with modelled results at Fort Vermilion since the hourly measured data are unreliable.

Modelled peak water levels through the developed areas at Fort Vermilion for the June 1990 event were within 0.5 m of high water marks reported in Alberta Environment (2000).

### 37.2.2.1.4 Dam Breach Parameters

Breach parameters (breach width and breach formation time) for the cofferdam and earthfill dam were estimated using USBR (1988) to represent the hypothetical failures.

### 37.2.2.2 Failure of the Stage 2 Upstream Cofferdam

#### 37.2.2.2.1 Scenarios

The following analyses are for the Stage 2 River Diversion shown on the construction schedule in Figure 4.40 in Volume 1 Section 4 Project Description.

As described in Section 37.1.8, part of the strategy for managing floods during Stage 2 diversion is to reduce discharges from Peace Canyon Dam on the arrival of a flood from the Site C local catchment. The following assumptions were made to assess the potential effects of a hypothetical failure of the Stage 2 upstream cofferdam:

- 50-year flood routed through the headpond and tunnels
- Three units at Peace Canyon Dam at full discharge without any reduction in discharges on flood arrival at Site C leading to overtopping of the upstream cofferdam, i.e., the flow management measures to reduce Peace Canyon discharges on flood arrival at the dam site are not implemented
Two sets of downstream tributary inflows were considered:

- 50-year floods with the peaks coinciding with the dam breach flood wave arrival at the confluence of the tributary and the Peace River from all gauged tributaries downstream to the Town of Peace River, Alberta, and coincident historical maximum flows from the tributaries downstream from the Town of Peace River
- Constant average June flows

The dam breach parameters were based on the first year of diversion, when construction of the portion of the earthfill dam across the main river channel would commence. In subsequent years, partial construction of the main earthfill dam downstream of the cofferdam would lead to a multi-stage failure and likely lower downstream peak flows and water levels.

For comparative purposes, flow routings were also completed for:

- The natural river conditions, which give the water levels and flows for the 50-year flood that would naturally occur without the Project
- The expected conditions, which give the water levels and flows for the 50-year flood with the river diverted through the tunnels and the flow management measures implemented as planned

### 37.2.2.2.2 Results

Table 37.14 shows the maximum water levels and peak flows for the 50-year flood scenario with 50-year tributary inflows as listed above for the natural river conditions, i.e., with no cofferdam. These are the water levels and flows that would naturally occur without the Project.

<table>
<thead>
<tr>
<th>Location</th>
<th>Distance from Site C (km)</th>
<th>Max. Water Level (m)</th>
<th>Peak Flood Flow (m$^3$/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site C</td>
<td>0</td>
<td>414.7</td>
<td>4,850</td>
</tr>
<tr>
<td>Old Fort</td>
<td>7</td>
<td>411.0</td>
<td>4,840</td>
</tr>
<tr>
<td>Taylor</td>
<td>18</td>
<td>406.8</td>
<td>7,980</td>
</tr>
<tr>
<td>B.C.–Alberta border</td>
<td>62</td>
<td>387.4</td>
<td>10,050</td>
</tr>
<tr>
<td>Dunvegan</td>
<td>191</td>
<td>348.4</td>
<td>10,540</td>
</tr>
<tr>
<td>Town of Peace River</td>
<td>291</td>
<td>318.1</td>
<td>17,330</td>
</tr>
<tr>
<td>Carcajou</td>
<td>546</td>
<td>267.1</td>
<td>17,010</td>
</tr>
<tr>
<td>Fort Vermilion</td>
<td>726</td>
<td>254.5</td>
<td>15,640</td>
</tr>
<tr>
<td>Peace Point</td>
<td>1,031</td>
<td>219.6</td>
<td>16,060</td>
</tr>
</tbody>
</table>

Table 37.15 shows the maximum water levels and peak flows for the 50-year flood scenario with 50-year tributary inflows as listed above with the cofferdam. These are the water levels and flows that would occur with the flow management measures implemented as planned.
Table 37.15  Inundation Modelling Results for 50-Year Flood with Cofferdam and 50-Year Tributary Inflows

<table>
<thead>
<tr>
<th>Location</th>
<th>Distance from Site C (km)</th>
<th>Max. Water Level (m)</th>
<th>Peak Flood Flow (m³/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site C</td>
<td>0</td>
<td>430.5</td>
<td>2,440</td>
</tr>
<tr>
<td>Old Fort</td>
<td>7</td>
<td>408.9</td>
<td>2,440</td>
</tr>
<tr>
<td>Taylor</td>
<td>18</td>
<td>406.0</td>
<td>5,850</td>
</tr>
<tr>
<td>B.C.–Alberta border</td>
<td>62</td>
<td>386.2</td>
<td>7,980</td>
</tr>
<tr>
<td>Dunvegan</td>
<td>191</td>
<td>347.3</td>
<td>8,480</td>
</tr>
<tr>
<td>Town of Peace River</td>
<td>291</td>
<td>317.3</td>
<td>14,900</td>
</tr>
<tr>
<td>Carcajou</td>
<td>546</td>
<td>266.3</td>
<td>14,790</td>
</tr>
<tr>
<td>Fort Vermilion</td>
<td>726</td>
<td>253.9</td>
<td>13,630</td>
</tr>
<tr>
<td>Peace Point</td>
<td>1,031</td>
<td>218.7</td>
<td>13,330</td>
</tr>
</tbody>
</table>

Table 37.16 and Table 37.17 present the results of the analyses for the 50-year flood overtopping scenario listed above with the two tributary inflow scenarios described above.
Table 37.16  Inundation Modelling Results for the Stage 2 Upstream Cofferdam
Overtopping with 50-Year Tributary Inflows

<table>
<thead>
<tr>
<th>Location</th>
<th>Distance from Site C (km)</th>
<th>Initial Water Level a (m)</th>
<th>Max. Water Level (m)</th>
<th>Water Level Increase (m)</th>
<th>Flood Arrival Time b (hr.)</th>
<th>Time to Flood Peak b (hr.)</th>
<th>Peak Flood Flow (m³/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site C</td>
<td>0</td>
<td>--</td>
<td>433.9</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>22,840</td>
</tr>
<tr>
<td>Old Fort</td>
<td>7</td>
<td>409.2</td>
<td>417.4</td>
<td>8.2</td>
<td>0.5</td>
<td>2.3</td>
<td>18,950</td>
</tr>
<tr>
<td>Taylor</td>
<td>18</td>
<td>405.9</td>
<td>410.3</td>
<td>4.4</td>
<td>1.0</td>
<td>3.9</td>
<td>18,770</td>
</tr>
<tr>
<td>B.C.–Alberta border</td>
<td>62</td>
<td>386.0</td>
<td>391.1</td>
<td>5.1</td>
<td>2.2</td>
<td>9.5</td>
<td>17,830</td>
</tr>
<tr>
<td>Dunvegan</td>
<td>191</td>
<td>346.4</td>
<td>349.4</td>
<td>3.0</td>
<td>8.2</td>
<td>19.1</td>
<td>15,580</td>
</tr>
<tr>
<td>Town of Peace River</td>
<td>291</td>
<td>316.8</td>
<td>319.6</td>
<td>2.8</td>
<td>13.0</td>
<td>26.2</td>
<td>21,390</td>
</tr>
<tr>
<td>Carcajou</td>
<td>546</td>
<td>262.6</td>
<td>267.8</td>
<td>5.2</td>
<td>27.0</td>
<td>43.2</td>
<td>19,670</td>
</tr>
<tr>
<td>Fort Vermilion</td>
<td>726</td>
<td>250.3</td>
<td>254.9</td>
<td>4.6</td>
<td>48.0</td>
<td>67.8</td>
<td>16,960</td>
</tr>
<tr>
<td>Peace Point</td>
<td>1,031</td>
<td>215.5</td>
<td>219.7</td>
<td>4.2</td>
<td>77.7</td>
<td>124.5</td>
<td>16,370</td>
</tr>
</tbody>
</table>

NOTES:

a  Prior to cofferdam breach
b  From start of cofferdam breach

Table 37.17  Inundation Modelling Results for the Stage 2 Upstream Cofferdam
Overtopping with Average June Tributary Inflows

<table>
<thead>
<tr>
<th>Location</th>
<th>Distance from Site C (km)</th>
<th>Initial Water Level a (m)</th>
<th>Max. Water Level (m)</th>
<th>Water Level Increase (m)</th>
<th>Flood Arrival Time b (hr.)</th>
<th>Time to Flood Peak b (hr.)</th>
<th>Peak Flood Flow (m³/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site C</td>
<td>0</td>
<td>--</td>
<td>433.9</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>22,840</td>
</tr>
<tr>
<td>Old Fort</td>
<td>7</td>
<td>409.1</td>
<td>417.3</td>
<td>8.2</td>
<td>0.5</td>
<td>2.4</td>
<td>18,950</td>
</tr>
<tr>
<td>Taylor</td>
<td>18</td>
<td>404.6</td>
<td>409.6</td>
<td>5.0</td>
<td>1.1</td>
<td>3.7</td>
<td>17,020</td>
</tr>
<tr>
<td>B.C.–Alberta border</td>
<td>62</td>
<td>382.1</td>
<td>389.4</td>
<td>7.3</td>
<td>3.0</td>
<td>9.7</td>
<td>14,620</td>
</tr>
<tr>
<td>Dunvegan</td>
<td>191</td>
<td>342.2</td>
<td>347.8</td>
<td>5.6</td>
<td>11.0</td>
<td>20.3</td>
<td>11,790</td>
</tr>
<tr>
<td>TPR</td>
<td>292</td>
<td>313.2</td>
<td>316.3</td>
<td>3.1</td>
<td>18.0</td>
<td>26.3</td>
<td>10,800</td>
</tr>
<tr>
<td>Carcajou</td>
<td>546</td>
<td>259.5</td>
<td>263.0</td>
<td>3.5</td>
<td>37.0</td>
<td>51.8</td>
<td>9,000</td>
</tr>
<tr>
<td>Fort Vermilion</td>
<td>726</td>
<td>249.2</td>
<td>251.2</td>
<td>2.0</td>
<td>50.0</td>
<td>81.2</td>
<td>7,250</td>
</tr>
<tr>
<td>Peace Point</td>
<td>1,031</td>
<td>214.1</td>
<td>216.0</td>
<td>1.9</td>
<td>80.0</td>
<td>123.9</td>
<td>6,990</td>
</tr>
</tbody>
</table>

NOTES:

a  Prior to cofferdam breach
b  From start of cofferdam breach

37.2.2.3  Failure of the Earthfill Dam

37.2.2.3.1  Scenarios

The following dam breach scenarios for Site C were assessed:

- Sunny day failure (for example, after an earthquake or piping through the earthfill dam or its foundation)
- Overtopping failure during the probable maximum flood
Mean annual flows in the Peace River system were assumed for the sunny day failure scenario, since it could occur at any time of the year. The Site C reservoir was assumed to be at the maximum normal reservoir level of elevation 461.8 m prior to dam failure. These initial conditions are consistent with the Canadian Dam Association Guidelines (CDA 2007c).

For the purposes of assessing the overtopping failure scenario during the probable maximum flood, malfunction or debris blockage of all spillway gates and the auxiliary spillway overflow was assumed. This is a very conservative assumption to trigger the hypothetical dam breach during the probable maximum flood.

Peace River gauged tributaries between Site C and the Town of Peace River (i.e., as far downstream as the Heart River) were assumed to be coincidentally at 200-year flood conditions. The 200-year maximum daily flood estimates for the Peace River tributaries between Site C and the Town of Peace River are listed below:

- Pine: 4,720 m$^3$/s
- Beatton: 2,110 m$^3$/s
- Kiskatinaw: 720 m$^3$/s
- Pouce Coupe: 460 m$^3$/s
- Clear: 530 m$^3$/s
- Smoky: 10,380 m$^3$/s
- Heart: 200 m$^3$/s

The locations of the above tributaries are listed in Volume 2 Section 11.4 Surface Water Regime.

Gauged tributaries downstream of the Town of Peace River were considered too far from Site C to assume 200-year flood conditions concurrent with the probable maximum flood, since the storm providing the probable maximum precipitation would not extend that far. Therefore, the historical maximum daily flows were used for these tributaries. The timing of the peak flows for all gauged tributaries was set to coincide with the Site C dam breach flood arrival at the corresponding tributary confluence locations. The shapes of the tributary hydrographs were derived from analysis of large historical events.

For comparative purposes, dynamic flow routings of the probable maximum flood were also performed to provide baseline inundation levels for:

- The natural river conditions that give the water levels and flows for the probable maximum flood that would naturally occur without the Project
- The expected conditions that give the water levels and flows for the probable maximum flood with operation of the spillway as designed

According to the Canadian Dam Association Dam Safety Guidelines (2007b), powerhouse discharge can be included for flood passage, subject to limitations of power system operations and demand. The spillway capacity for the Project was selected based on the conservative assumption that the powerhouse would be out of operation during the probable maximum flood due to the severe weather conditions that cause the
flood. For the dam breach analysis, it was also assumed that there would be no powerhouse discharges for the probable maximum flood scenarios.

### 37.2.2.3.2 Results

#### Sunny Day

Model results at key locations for the sunny day failure are presented in Table 37.18.

**Table 37.18: Inundation Modelling Results for the Sunny Day Failure Scenario**

<table>
<thead>
<tr>
<th>Location</th>
<th>Distance from Site C (km)</th>
<th>Initial Water Level a (m)</th>
<th>Max. Water Level (m)</th>
<th>Water Level Increase (m)</th>
<th>Flood Arrival Time b (hrs.)</th>
<th>Time to Flood Peak b (hrs.)</th>
<th>Peak Flood Flow (m³/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site C Dam</td>
<td>0</td>
<td>–</td>
<td>461.8</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>77,090</td>
</tr>
<tr>
<td>Old Fort</td>
<td>7</td>
<td>407.7</td>
<td>425.8</td>
<td>18.1</td>
<td>0.9</td>
<td>2.8</td>
<td>72,590</td>
</tr>
<tr>
<td>Taylor</td>
<td>18</td>
<td>403.3</td>
<td>418.2</td>
<td>14.9</td>
<td>1.5</td>
<td>3.9</td>
<td>64,500</td>
</tr>
<tr>
<td>B.C.–Alberta border</td>
<td>62</td>
<td>380.0</td>
<td>402.3</td>
<td>22.3</td>
<td>3.8</td>
<td>9.0</td>
<td>46,370</td>
</tr>
<tr>
<td>Dunvegan</td>
<td>191</td>
<td>340.2</td>
<td>356.8</td>
<td>16.6</td>
<td>9.5</td>
<td>17.7</td>
<td>34,800</td>
</tr>
<tr>
<td>Town of Peace River</td>
<td>291</td>
<td>311.9</td>
<td>322.2</td>
<td>10.3</td>
<td>15.7</td>
<td>25.8</td>
<td>31,510</td>
</tr>
<tr>
<td>Carcajou</td>
<td>546</td>
<td>256.9</td>
<td>267.8</td>
<td>10.9</td>
<td>30.8</td>
<td>46.6</td>
<td>23,190</td>
</tr>
<tr>
<td>Fort Vermilion</td>
<td>726</td>
<td>247.4</td>
<td>254.0</td>
<td>6.6</td>
<td>42.2</td>
<td>73.9</td>
<td>14,300</td>
</tr>
<tr>
<td>Peace Point</td>
<td>1,031</td>
<td>212.3</td>
<td>218.1</td>
<td>5.8</td>
<td>73.5</td>
<td>111.1</td>
<td>11,730</td>
</tr>
</tbody>
</table>

**NOTES:**
- a Prior to dam breach
- b From start of Site C Dam breach

The peak outflow for the Site C sunny day failure scenario would be about 77,090 m³/s at Site C and would attenuate to 46,370 m³/s at the B.C.–Alberta border, 31,510 m³/s at the Town of Peace River, and 11,730 m³/s at Peace Point, which is less than the peak discharge for the June 1990 flood of record at Peace Point.

Peak water levels would be 15 m to 22 m above the initial water levels within B.C. and 6 m to 17 m above the initial water levels near the populated areas in Alberta, and the dikes at the Town of Peace River would be overtopped by 1.7 m.

#### Probable Maximum Flood

Model results at key locations for the probable maximum flood are given in Table 37.19, Table 37.20 and Table 37.21.
Table 37.19  Inundation Modelling Results for the Probable Maximum Flood without the Project

<table>
<thead>
<tr>
<th>Location</th>
<th>Distance from Site C (km)</th>
<th>Maximum Water Level (m)</th>
<th>Peak Flood Flow (m³/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site C Dam</td>
<td>0</td>
<td>420.5</td>
<td>18,730</td>
</tr>
<tr>
<td>Old Fort</td>
<td>7</td>
<td>417.7</td>
<td>18,710</td>
</tr>
<tr>
<td>Taylor</td>
<td>18</td>
<td>412.1</td>
<td>23,210</td>
</tr>
<tr>
<td>B.C.–Alberta border</td>
<td>62</td>
<td>396.0</td>
<td>25,350</td>
</tr>
<tr>
<td>Dunvegan</td>
<td>191</td>
<td>354.5</td>
<td>25,380</td>
</tr>
<tr>
<td>Town of Peace River</td>
<td>291</td>
<td>322.9</td>
<td>33,900</td>
</tr>
<tr>
<td>Carcajou</td>
<td>546</td>
<td>271.1</td>
<td>32,200</td>
</tr>
<tr>
<td>Fort Vermilion</td>
<td>726</td>
<td>257.5</td>
<td>29,390</td>
</tr>
<tr>
<td>Peace Point</td>
<td>1,031</td>
<td>222.1</td>
<td>25,280</td>
</tr>
</tbody>
</table>

The results in Table 37.19 show that, under natural conditions, the probable maximum flood would cause extensive flooding at all communities downstream. The dikes at the Town of Peace River would be overtopped by 2.4 m.

Table 37.20  Inundation Modelling Results for the Probable Maximum Flood with the Project

<table>
<thead>
<tr>
<th>Location</th>
<th>Distance from Site C (km)</th>
<th>Maximum Water Level (m)</th>
<th>Peak Flood Flow (m³/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site C Dam</td>
<td>0</td>
<td>466.3</td>
<td>17,100</td>
</tr>
<tr>
<td>Old Fort</td>
<td>7</td>
<td>417.2</td>
<td>16,970</td>
</tr>
<tr>
<td>Taylor</td>
<td>18</td>
<td>411.6</td>
<td>21,440</td>
</tr>
<tr>
<td>B.C.–Alberta border</td>
<td>62</td>
<td>395.1</td>
<td>23,350</td>
</tr>
<tr>
<td>Dunvegan</td>
<td>191</td>
<td>352.3</td>
<td>23,400</td>
</tr>
<tr>
<td>Town of Peace River</td>
<td>291</td>
<td>322.5</td>
<td>32,480</td>
</tr>
<tr>
<td>Carcajou</td>
<td>546</td>
<td>270.9</td>
<td>31,190</td>
</tr>
<tr>
<td>Fort Vermilion</td>
<td>726</td>
<td>257.4</td>
<td>28,920</td>
</tr>
<tr>
<td>Peace Point</td>
<td>1,031</td>
<td>222.1</td>
<td>25,210</td>
</tr>
</tbody>
</table>

The results in Table 37.20 show that with the Project operating as designed, flooding would be attenuated to some extent relative to natural conditions; therefore, flooding would be less extensive. The maximum spillway discharge would be 17,100 m³/s. Peak flows in the Peace River would increase downstream to the Town of Peace River due to the assumed coincident lateral peak inflows from the tributaries. Lateral inflows downstream of the Town of Peace River would be relatively less and hence the peak flows would gradually attenuate. The modelled peak flows at the Town of Peace River and Peace Point are 32,480 m³/s and 25,210 m³/s, respectively. The dikes at the Town of Peace River would be overtopped by about 2 m.
### Table 37.21 Inundation Modelling Results for the Overtopping of the Earthfill Dam

<table>
<thead>
<tr>
<th>Location</th>
<th>Distance from Site C (km)</th>
<th>Initial Water Level a (m)</th>
<th>Max. Water Level (m)</th>
<th>Water Level Increase (m)</th>
<th>Flood Arrival Time b (hrs.)</th>
<th>Time to Flood Peak b (hrs.)</th>
<th>Peak Flood Flow (m³/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site C Dam</td>
<td>0</td>
<td>–</td>
<td>469.8</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>111,160</td>
</tr>
<tr>
<td>Old Fort</td>
<td>7</td>
<td>406.5</td>
<td>429.4</td>
<td>22.9</td>
<td>0.6</td>
<td>2.8</td>
<td>106,610</td>
</tr>
<tr>
<td>Taylor</td>
<td>18</td>
<td>405.6</td>
<td>422.3</td>
<td>16.7</td>
<td>1.0</td>
<td>3.8</td>
<td>97,760</td>
</tr>
<tr>
<td>B.C.–Alberta border</td>
<td>62</td>
<td>387.2</td>
<td>409.6</td>
<td>22.4</td>
<td>3.6</td>
<td>8.6</td>
<td>75,020</td>
</tr>
<tr>
<td>Dunvegan</td>
<td>191</td>
<td>348.3</td>
<td>364.1</td>
<td>15.8</td>
<td>8.2</td>
<td>16.3</td>
<td>61,920</td>
</tr>
<tr>
<td>Town of Peace River</td>
<td>291</td>
<td>317.8</td>
<td>328.5</td>
<td>10.7</td>
<td>12.7</td>
<td>23.7</td>
<td>67,000</td>
</tr>
<tr>
<td>Carcajou</td>
<td>546</td>
<td>262.3</td>
<td>274.2</td>
<td>11.9</td>
<td>24.6</td>
<td>38.6</td>
<td>51,680</td>
</tr>
<tr>
<td>Fort Vermilion</td>
<td>726</td>
<td>250.8</td>
<td>259.5</td>
<td>8.7</td>
<td>37.0</td>
<td>60.5</td>
<td>42,520</td>
</tr>
<tr>
<td>Peace Point</td>
<td>1,031</td>
<td>216.2</td>
<td>223.1</td>
<td>6.9</td>
<td>74.4</td>
<td>122.5</td>
<td>29,830</td>
</tr>
</tbody>
</table>

**NOTES:**

a  Prior to dam breach
b  Start of Site C Dam breach

The peak outflow for the Site C probable maximum flood failure scenario would be 111,160 m³/s and would attenuate to 75,020 m³/s at the B.C.–Alberta border and 67,000 m³/s at the Town of Peace River.

Peak water levels would be 17 m to 23 m above initial water levels within B.C. and 7 m to 16 m above initial water levels near the populated areas in Alberta, and the dikes at the Town of Peace River would be overtopped by 8 m.

### Sensitivity Analysis and Uncertainty Assessment

#### Dam Breach Parameters

The sensitivity of the results of the analyses to the dam breach parameters was assessed.

A 50% increase in the breach width for the probable maximum flood overtopping failure scenario resulted in a 40% higher peak dam breach discharge, from 111,160 m³/s to 156,460 m³/s. However, the peak discharge would be attenuated to 69,980 m³/s at the Town of Peace River (approximately 4% higher than shown in Table 37.21). Peak water levels at key downstream locations within B.C. would be approximately 2.6 m to 3.3 m higher with the increased breach width. Peak water levels would be 1.1 m and 0.4 m higher at Dunvegan and the Town of Peace River, respectively, with no increased flooding below the Town of Peace River.

A piping failure scenario was evaluated to test the sensitivity of the probable maximum flood failure assumptions. Piping is internal erosion of an earthfill dam leading to the formation of a “pipe” through the dam that eventually leads to a progressive failure.

Piping failure was assumed to initiate on the day of peak probable maximum flood inflow with no blockage of the spillway. Similar tributary flow assumptions were made as the probable maximum flood overtopping failure scenario. Since the maximum reservoir
level for a piping failure scenario would be less than the overtopping case, peak
downstream water levels would either be slightly lower or very similar to peak water
levels presented in Table 37.21.

The Site C sunny day failure scenario was re-evaluated with breach parameters
obtained from the Von Thun and Gillette equation (Von Thun and Gillette 1990). A
breach width of 189 m (17% larger than the USBR estimate) and a breach formation
time of 0.9 hours (twice as fast as the USBR estimate) were assessed. The peak dam
breach outflow was increased by about 15%. However, at the Town of Peace River the
peak discharge would be increased by only 4% due to attenuation along the Peace
River.

**Tributary Discharges**

The sensitivity of assumed tributary flows on downstream inundation was tested for the
sunny day and probable maximum flood failure scenarios. The sunny day failure
scenario was re-evaluated by using twice the annual average tributary flows. The higher
tributary flows resulted in an increase in peak water levels at key locations along the
Peace River by about 0.1 m, with no minimal in the extent of inundation.

The probable maximum flood failure scenario was re-evaluated with 25% lower tributary
discharges than the assumed 200-year or historical maximum daily flows. Reduced
tributary discharges resulted in 0.15 m to 0.4 m reduction in peak water levels in B.C.
and 0.5 m to 0.8 m reduction in peak water levels at key locations in Alberta. There were
nominal reductions in the maximum discharge at key locations for the probable
maximum flood failure scenario; for example, from 75,020 m³/s to 73,340 m³/s at the
B.C.–Alberta border, and from 67,000 m³/s to 62,040 m³/s at the Town of Peace River.

**Roughness Coefficients**

As stated above, the MIKE 11 model was calibrated for the Peace River system using
Manning’s roughness coefficients in the range of 0.02 to 0.03 in the river, and 0.07 to 0.1
for overbank areas. For sensitivity testing, the MIKE 11 model was rerun with 20%
higher roughness coefficients for the Site C probable maximum flood (no failure)
scenario. The modelled results indicate that the peak flood levels at key locations in the
Peace River would be approximately 1 m higher within B.C. and 0.6 m to 1.4 m higher in
Alberta.

**37.2.2.3.3 Downstream Extent of Studies**

The EIS Guidelines require a description of the effects of a dam break at Site C by	abulating the expected flood arrival time and water surface elevation at downstream
communities along the Peace River to Peace Point, Alberta until the estimated water
surface is within the estimated 200 year flood level (the level used in British Columbia to
delineate natural flood hazard areas).

The peak flow at Peace Point from the sunny day dam break shown in Table 37.18
would be less than:

- The flood of record at Peace Point, which was 12,600 m³/s mean daily flow on
  June 17, 1990, measured at Water Survey of Canada gauge 07KC001
The 200-year flood, which is estimated to be 14,000 m$^3$/s based on a flood frequency analysis using the log normal method for the daily flows from Water Survey of Canada gauge 07KC001 for the period 1968 to 2012.

For the PMF, it is not pertinent to extend the analysis beyond Peace Point to a 200-year flood level, since the initiating event itself has an annual exceedance frequency of less than 1/10,000, and the tributary inflows are 200-year inflows from Site C to the Town of Peace River with the historical maximum daily flows for the tributaries between the Town of Peace River and Peace Point.

### 37.2.2.4 Measures to Reduce Likelihood or Mitigate Potential Occurrence of a Dam Breach

#### 37.2.2.4.1 Inflow Flood Forecasting and Flood Warning

BC Hydro operates a hydrometric data collection system in the Williston and Site C local catchments. Three additional data collection platforms were installed in the Site C local catchment in 2012 and three more will be installed in 2013 to provide more data for streamflow forecasting from the Site C local catchment. The data from the hydrometric data collection system would be used to improve the calibration of the watershed models and improve flood forecasting in the Site C local catchments.

As described in Section 37.1.9.2.5, the UBC Watershed Model is a continuous hydrologic model that provides continuous streamflow output for the duration of the meteorological input. BC Hydro runs the UBC Watershed Model to predict streamflow into Williston Reservoir. Calibrated UBC Watershed Models would be used to predict streamflow into Site C after it came into operation.

These calibrated models are capable of predicting flood flows from hydrometeorological data and would be used to predict inflows to the Project. After each flood these models would be updated with meteorological and streamflow data as a continuous process of improving the reliability of the models to predict floods.

Extensive heavy rainfall in the May through July period is usually the result of long-lived “cold lows” that persist in the foothills region for several days and draw moist Gulf of Mexico air into the area, causing prolonged heavy rainfall due to the presence of the low and upslope winds in the foothills and mountains. With or without contributions from snowmelt, these “cold lows” are the most common cause of flooding along the rivers flowing eastward (Section 37.1.9).

With modern weather system tracking, the development of such severe weather conditions would be monitored on a real time basis. The River Forecast Centre of the B.C. Ministry of Forests, Lands and Natural Resource Operations collects and interprets snow, meteorological and streamflow data to provide warnings and forecasts of stream and lake runoff conditions around the province. The River Forecast Centre issues flood advisories and warnings.

During construction flood forecasts would be used so that operating personnel at Peace Canyon Dam are on alert and ready to reduce discharges prior to flood arrival at the dam site. Reducing the Peace Canyon discharges earlier than described in Section 37.1.8.3 would result in lower headpond levels when the flood arrives, which would reduce the peak water levels and reduce the risk of overtopping. As shown in
Figure 37.1, it would take approximately four days for the headpond levels to peak after the start of the flood from the Site C local catchment. In the event that a larger flood than the capacity of the diversion works was forecast, there would be sufficient time to implement the emergency preparedness plans and evacuate potentially flooded areas downstream.

The governing condition for the probable maximum flood would be a storm producing the 100-year return period rainfall over the entire Site C catchment (severe event), followed by the probable maximum precipitation (an extreme event with 1.5 times the average 100-year return period rainfall) centred over the Site C local catchment starting four days after the end of the first storm (Section 37.1.9.2). Due to the severity of the weather conditions leading to a probable maximum flood, there would be sufficient time to implement the emergency preparedness plans and evacuate potentially flooded areas downstream.

37.2.2.4.2 Spillway Gate Reliability

The probable maximum flood failure scenario is based on a very conservative assumption of malfunction or debris blockage of all spillway gates so that there would be no spillway discharge, even over the auxiliary spillway, and the entire flood would flow over the top of the earthfill dam. This assumption is reasonable to define worst-case flooding for emergency preparedness planning purposes, but is not realistic.

BC Hydro has adopted reliability principles for the design, operation, maintenance, inspection, and testing of flood discharge gate systems to attain and maintain reliability. The reliability target for the spillway gate systems at the Project would be a probability of failure on demand during a severe flood in the order of 1/1,000 to 1/10,000.

The measures used to obtain this level of reliability include:

- Equipment and defence in depth:
  - Use of well-proven equipment with proven track records
  - Any single random failure of gate operating equipment, control, or instrumentation should not prevent gate operation
  - Redundancy incorporated in the design of gate systems
  - Segregation and diversity as appropriate to protect against common cause failure
  - Gate equipment designed to avoid potential hazards and failures and maintain reliable operation through inherent features without reliance on control action or personnel intervention
  - Conservatively designed gate equipment with significant margins allowed for both predicted duty and abnormal situations
  - In a multiple gates system, the essential services and controls for individual gates segregated and protected from common cause failure
  - Local control of the flood discharge gate systems available, separate from buildings housing the main controls, such that the occurrence of hazards should not prejudice adequate means of control
• Hazards:
  o Design of gate equipment accounts for all external and internal hazards
  o Layout of system equipment and related services to minimize the effects of hazards
  o Gate operating and control equipment should be protected against natural and human hazards
• Control, monitoring, and instrumentation:
  o Equipment failure, gate movements, and other actions on the gate system communicated to the appropriate personnel when, or shortly after, they occur
  o Flood discharge gate systems to be operated by the standard controls and according to the established procedures
• Maintenance, inspection, and testing:
  o Management of equipment maintenance emphasizes the safety critical nature of the systems and adopts a proactive approach to achieving and maintaining a highly reliable performance
  o Preventive (time-based) maintenance carried out on critical items, plus regular functional checks to detect degradation of components
  o Abnormal conditions of equipment investigated promptly, and urgent action taken where necessary, to restore the system to a fully reliable state
  o The design of equipment and control interfaces incorporates good ergonomics practice to facilitate reliable operation, fault recovery, and ease of maintenance
  o Critical tasks performed under the guidance of written procedures
  o Flood discharge gate systems regularly inspected and tested
• Training:
  o Staff required to perform tasks to be trained and certified competent
  o Staff have regular hands-on experience in performing the tasks or receive periodic refresher training
  o Regular emergency exercises performed to practice the use of procedures and provide more realistic opportunities for staff training

High gate reliability would materially reduce the risk of overtopping of the earthfill dam during a large flood.

Further, in the event that a spillway gate was inoperable during a flood, a spillway undersluice in that bay could be operated to offset the loss of capacity from the spillway gate.

37.2.2.4.3 Debris management

Volume 1 Appendix A Vegetation, Clearing, and Debris Management Plan describes the waterborne debris clearing strategy that would be implemented during construction and the first five to 10 years of reservoir operations.
The primary debris management strategy for Site C during operation would be debris containment on the reservoir and regular removal rather than debris passage through the spillway. This is consistent with BC Hydro’s approach on other reservoirs.

Debris containment would consist of a primary cable-reinforced debris boom for debris collection and containment just upstream of the approach channel. Where possible, the boom would be a shear boom directing debris to the upstream face of the earthfill dam, where a dedicated debris removal facility would be located.

The primary debris boom design would follow BC Hydro practice for a cable reinforced double stick log boom. The debris boom, while a key component of the debris management strategy, would be combined with a number of secondary components to effectively manage debris. The secondary components would include:

- Development of comprehensive proactive debris management strategy to address the following:
  - Debris inventory (estimates of current and potential future debris quantities)
  - Debris management approaches, e.g., limiting debris inflow, debris control and collection, debris disposal, and discharge facility requirements
- Inventorying and managing debris before it reaches the main boom, which could include a second upstream shear boom for debris collection and debris removal

Debris that bypasses the debris boom would require removal in the approach channel or passage by the spillway. To facilitate debris removal in the approach channel, the gantry used for the installation of intake and spillway stoplogs would be equipped with a jib arm outfitted for debris removal.

Spillway features that facilitate debris passage or mitigate potential blockage are:

- Wide spillway gates
- Wide overflow auxiliary spillway
- Pier noses that extend upstream from the gates to retain debris before it can reach and potentially block the gates

Debris testing in the physical hydraulic model of the approach channel and spillway indicates that the above features would be successful in preventing blockage by debris.

Successful debris management would materially reduce the risk of overtopping of the earthfill dam during a large flood.

### 37.2.2.4.4 Powerhouse Operation

As discussed in Section 37.2.2.3.1, for sizing the spillway capacity, it was assumed that the powerhouse would not operate during the probable maximum flood. However, to the extent possible, the powerhouse would be operated during large flood to provide additional discharge capacity and possibly draw the reservoir down prior to flood arrival. Powerhouse operation during the probable maximum flood would reduce the risk of overtopping.
### 37.2.2.4.5 Increasing Cofferdam Freeboard

Measures that could be implemented to reduce the likelihood of damage or overtopping of the Stage 2 upstream cofferdam during construction include adding temporary walls using concrete lock blocks or similar materials to reduce wave overtopping.

### 37.2.2.4.6 Earthquake Design

As shown in Table 37.18, 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, 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.

As described in Section 37.1.6.1, the deformations of the reservoir retaining structures during the earthquake design ground motion would be small. The earthfill dam and RCC buttress could withstand much larger movements without releasing the reservoir.

As part of the design, larger ground motions than the 1/10,000 annual exceedance frequency earthquake design ground motion are being considered to provide robust structures that can withstand larger ground motions than recommended by the Canadian Dam Association Dam Safety Guidelines.

The robustness of the seismic design reduces the risk of a sunny day failure due to earthquake.

### 37.2.2.4.7 Sunny Day Failure Due to Piping

The design of the earthfill dam and the materials used to construct it are described in Volume 1 Section 4 Project Description. The dam has been designed to reduce the risk of piping as follows:

- Based on testing in a large permeameter at hydraulic gradients several times greater than expected in the core of the dam, the glacial till in the impervious core would be internally stable and resistant to piping
- The wide filter zones on the downstream side of the impervious core that are widened at the abutments
- Foundation treatment including dental excavation and concrete, and grouting would mitigate piping in the foundation

Failures due to piping rarely occur without warning. Dam surveillance and monitoring pursuant to the operation, maintenance, and surveillance manual would likely see evidence of distress well in advance of a potential failure.

Measures to mitigate potential piping would include drawing down the reservoir using the spillway underslunes. Lowering the reservoir level would mitigate in two ways:

- Reducing the gradients through the dam and foundation, reducing piping potential, which is a function of gradient
- The dam breach flood wave and inundation levels downstream would be reduced due to lower volumes in the reservoir
Given the likely warning of potential piping problems, there would be time to implement the emergency preparedness plan and evacuate areas that could be flooded downstream.

37.2.3 Potential Accidents and Malfunctions During Construction

The following accidents and malfunctions that could occur during construction are discussed in this section:

- Release or spills of chemicals and hazardous materials
- Containment of pond leakage or failure
- Sediment control failure
- Fire and explosion

Volume 5 Section 35 Summary of Environmental Management Plans discusses the environmental management framework for the Project. The construction environmental management plans would be designed and implemented to reduce the likelihood or mitigate the potential occurrence of the above accidents or malfunctions. The emergency response plan would provide the framework for managing accidents and malfunctions that may occur during construction.

The following descriptions of accidents and malfunctions should be read in the context of the environmental management plans discussed above.

The following sections describe the measures to reduce the likelihood or mitigate the potential occurrence of the above accidents or malfunctions.

37.2.3.1 Release or Spills of Chemicals or Hazardous Materials

Large quantities of chemicals and hazardous materials would not be stored on the construction sites; rather, they would be brought to site in quantities similar to the rate at which they are consumed. Chemicals would be transported to site either by rail or by truck and stored in appropriate containers according to applicable standards and regulations. Temporary construction infrastructure that would store chemicals and hazardous materials include:

- Vehicle maintenance facilities – chemicals stored would include lubricants, antifreeze, petroleum products, and other materials required to maintain construction equipment
- Tank farm where diesel, gasoline, and other liquid fuels required for construction would be stored. Proper secondary containment such as double-wall tanks or lined containment areas would be installed to minimize fuel seepage into the environment.
- Explosive magazines for secure storage of ammonium nitrate and stick explosives
- Storage facilities for cement, fly-ash, and other concrete additives
- Waste treatment facilities – for camp, truck washing, and cement wastewater, as well as antifreeze, lubricants, and other liquid and solid wastes generated on-site
Secondary containment of hazardous substances would be provided as recommended in the Canadian Council of Ministers of the Environment (CCME) Environmental Codes of Practice (CCME 1993; CCME 1994).

Spills most likely to occur would be from activities such as refuelling. Fuel trucks would transport diesel from the tank farm to the various heavy equipment on-site. Pickup trucks and other more mobile equipment would refuel at the tank farm directly.

Other likely spill events would result from breaks in hydraulic lines of excavators or other large construction equipment. To minimize the effect of hazardous material spills, with the exception of the initial construction of the construction berms, all construction areas would be contained behind a dike or other confinement structure, and therefore the spill would not be exposed to the environment outside of the construction site.

All vehicles would be equipped with an appropriately sized spill kit, and personnel operating would have applicable training. Spills would be cleaned up as soon as possible.

37.2.3.2 Containment Pond Leakage or Failure

Containment ponds would be constructed to manage storm water runoff and wastewater collected on-site. A potential source of wastewater collected on-site would be from the cement plants. Both the storm water and cement plant wastewater containment ponds would be settlement ponds.

The water surface level and containment structure would be monitored on an ongoing basis for both its geotechnical stability and chemical properties. Should a containment pond leak or fail, the Project emergency response plan would be followed.

37.2.3.3 Sediment Control Failure

Management structures to control sediment from entering the Peace River and other watercourses would be installed, monitored, and maintained at various locations throughout the Project.

The magnitude and impact as a result of a failure to a sediment control structure would depend on the location and purpose of the structure. The impact to the environment in the event of a sediment control device failure may be the release of a pulse of sediment into the water.

37.2.3.4 Fire and Explosion

Fire control measures for the construction of the Project would be designed and implemented.

Fire controls at the dam site would include strategically positioned heat and smoke detectors and alarms, as well as automatic sprinklers and suitable extinguishers.

Planning for work areas would ensure that personnel could easily evacuate in the event of an emergency.

Debris from clearing activities would be managed to minimize risk of fire and magnitude of fires should one occur. Construction sites would be cleared with adequate buffers to minimize wildfire spreading at the construction sites.
Explosives would be used at the dam site, and West Pine, Wuthridge, and Portage Mountain quarries. Although the majority of the rock that would be excavated at the dam site would be ripped with heavy equipment, drilling and blasting would be required for unweathered rock that is too hard to rip on the north and south bank rock excavations as well as in the diversion tunnels.

To minimize the risk of explosion, dynamite and detonators would be stored on-site in explosives magazines and, when required, would be loaded and transported to the blasting sites. Explosive magazines would be stored a safe distance from other facilities. Ammonium nitrate and fuel oil would be delivered by truck and only mixed during delivery down the blast hole.

### 37.2.4 Potential Accidents and Malfunctions During Operation

The following accidents and malfunctions that could occur during operation are discussed in this section:

- Release or spill of chemicals or hazardous materials
- Fire and explosion
- Transmission line or generating station outage

Dam Safety Incidents are defined as abnormal conditions or performance of the dam (including mis-operation or component failure) with the potential to jeopardize the safety of the dam but that, at this time, is not expected to lead to a breach of the dam. The Operations, Maintenance and Surveillance Manual described in Volume 1 Section 4 Project Description would contain requirements for increased surveillance after any Dam Safety Incidents and for the preparation of responses applicable to the incident to mitigate dam failure. The dam breach analyses described in Section 37.2.2 indicate the consequences if the responses are insufficient to prevent dam breach.

Volume 5 Section 35 Summary of Environmental Management Plans discusses the environmental management framework for the Project. The operation environmental management plans would be designed and implemented to reduce the likelihood or mitigate the potential occurrence of the above accidents or malfunctions. The emergency response plan would provide the framework for managing accidents and malfunctions that may occur during operation.

The following descriptions of accidents and malfunctions should be read in the context of the environmental management plans discussed above.

The following sections describe the measures to reduce the likelihood or mitigate the potential occurrence of the above accidents or malfunctions.

#### 37.2.4.1 Release or Spills of Chemicals or Hazardous Materials

##### 37.2.4.1.1 Overview

Large quantities of chemicals and hazardous materials would not be stored at the dam, generating station, and spillways but would be delivered to the site in the quantities required for operations and maintenance.

Hazardous materials that would have limited on-site storage are expected to include:
- Oils and lubricants
- Miscellaneous paints
- Solvents
- Varsol
- Lead-acid storage batteries
- Compressed gases including SF₆ for the gas-insulated switchgear
- Fuels, including diesel for backup power generation

Lubricants and hydraulic oils are used in governors, intake, and undersluice gates, and would be present in equipment bearing and gearbox oil reserves. Transformer insulating oils are typically Voltesso (used in each station service transformer and in the system power transformers). Equipment containing polychlorinated biphenyl (PCB), asbestos, and mercury, which were commonly used in electrical equipment in the past, would not be used by the Project.

Hazardous substances associated with transmission line operation include herbicides for vegetation management. Herbicides would be stored and used in accordance with manufacturer’s written recommendations and BC Hydro management standards and practices.

Transportation, handling, storage, and disposal of hazardous substances, including hazardous wastes, would be done in accordance with BC Hydro management standards and practices.

Hazardous materials would be stored in a secure location in accordance with the manufacturer’s instructions. In addition, all hazardous materials management would comply with the WCB Occupational Health and Safety Regulation.

Secondary containment of hazardous substances would be provided as recommended in the Canadian Council of Ministers of the Environment (CCME) Environmental Codes of Practice (CCME 1993; CCME 1994), and as required by applicable Fire Codes.

The dam, generating station, and spillways would have drainage and sump systems for all structures, including provisions for emptying the intakes, penstocks, and the spiral cases and draft tubes in the powerhouse. Sources of water with the potential for oil contamination would be directed to oil-water separator systems. Transformers would be equipped with spill containment systems that would drain fluids into oil-water separators. The oil-water separator systems would be regularly inspected and maintained. Oil would be collected from separators for recycling or off-site disposal at an approved disposal facility.

Oil would be used in major mechanical and electrical components of the generating station and spillways. The power transformers would be filled with electrical insulating oil as a heat transfer/cooling medium. The governors that would control and regulate the operation of the turbines would have self-contained hydraulic systems that include accumulators for storing pressurized hydraulic oil. The turbine and generator bearings for each unit would have their own lubricating systems. The intake gates would probably be hydraulically operated, but could be mechanical hoist operated. Each of these oil systems would have piping, the majority of which would be oil-filled at all times.
In addition to the oil in major components of the generating station, there would be small quantities of oil in crane gearboxes, spillway gate gearboxes, and in air compressors; oil would also be present in varying amounts in other mobile equipment and vehicles periodically brought onto the site for maintenance and general service purposes.

Measures incorporated into the design and construction of the generating station would include oil control and containment systems sized appropriately to address potential oil spill scenarios. Oil containment basins and oil-water separators having individual capacities to contain all of the oil used in the systems they serve would either be built as part of the powerplant structures or provided by commercially available tank systems. Under normal operating conditions, these systems would function to contain and separate all oil flowing into them. Any oil leaking from the hydraulic hoist for the intake gates would float on the surface of the gate well where it could be cleaned up with sorbent materials.

37.2.4.1.2 Worst Case Oil Spill

Depending on their design, the generator step-up transformers on the draft tube deck of the powerhouse would contain up to 90,000 L of oil and would be located close to the river. The transformers would be situated over sumps filled with gravel and provided with a deluge system. Each step-up transformer would be provided with a drainage system that would have a dedicated oil-water separator with the capacity to simultaneously:

- Contain the total volume of oil from one step-up transformer
- Simultaneously process the step-up transformer oil together with the deluge flow from the step-up transformer fire protection system
- The combined maximum expected rain and snowmelt inflow

In considering the operation of the powerplant, all potential oil leaks and spills would be securely contained during all reasonably foreseeable conditions, with the possible exception of a loss of transformer insulating oil under the following scenarios:

- Spill onto the draft tube deck of the powerhouse during a transformer oil change
- Spill onto a road or parking area from a tanker truck
- Spill resulting from a transformer explosion

Transformer oil changes are likely to occur once every 40 to 50 years, with intermediate oil processing once every 7 to 10 years.

In the first scenario, a spill could result from an improperly connected hose, or a hose or hose connection failure. Spilled transformer oil would flow to the transformer oil containment system and oil-water separator, or to powerhouse drains and their oil-water separator. Given the supervision that would be provided during a transformer oil change, an oil spill with a volume greater than the capacity of the oil-water separators, resulting in a spill to the river, is considered to be extremely unlikely.

In the second scenario, a spill could result from a ruptured tank or broken or leaky valve on a tanker truck travelling to the powerhouse or parked adjacent to the powerhouse. Spilled oil would have the potential to flow or seep to the Peace River. Large tanker trucks are compartmentalized, with individual tanks usually containing about 10,000 L. Tanker transfer systems include valves on each compartment and valves would be
37.2.4.1.3 Release of SF₆ Gas

Sulphur hexafluoride (SF₆) is an inorganic, colorless, odorless, and non-flammable greenhouse gas that is a dielectric material in gaseous state. SF₆ would be used as an electrical insulator in the high voltage circuit breakers and switchgear connecting the unit transformers on the draft tube deck to the transmission lines.
The circuit breakers and switchgear would be designed in a compartmentalized manner to limit the amount of $\text{SF}_6$ that could escape in the event of a leak from the equipment.

BC Hydro has established practices for the handling and management of $\text{SF}_6$ in an environmentally sound and responsible manner.

In summary, the main principles for managing $\text{SF}_6$ are:

- Purchasing of $\text{SF}_6$ is centralized, so that it is captured by BC Hydro's $\text{SF}_6$ tracking system
- Using $\text{SF}_6$ in a manner that minimizes risks to human health and the environment
- Developing a loss reduction strategy that identifies $\text{SF}_6$ loss reduction objectives and targets
- Training employees in all procedures related to the way they have to handle or use $\text{SF}_6$ in the course of their duties
- Minimizing the intentional venting of $\text{SF}_6$, except for small amounts needed to do gas sampling or to protect human life in an emergency
- Handling and using $\text{SF}_6$ to minimize contamination with air, moisture, oil, or other unwanted substances
- Recovering for reuse or reclaiming as much $\text{SF}_6$ as possible when equipment is maintained or decommissioned
- Tracking use of $\text{SF}_6$
- Storing contaminated $\text{SF}_6$ until there is a way to separate the $\text{SF}_6$ from the contaminants
- Treating $\text{SF}_6$ that cannot be separated from contaminants in a way that destroys the $\text{SF}_6$ and removes environmental concerns associated with it

37.2.4.2 Fire and Explosion

Fire control measures for operation of the Project would be designed and implemented in compliance with BC Hydro management standards and practices.

Fire controls at the dam, generating station, and spillways would include:

- Strategically positioned heat and smoke detectors
- Alarms to trigger fire warning and response
- Automatic water deluge system on each generator and power transformer
- Sprinklers over areas containing combustible materials
- Readily available and fully functional dry chemical hand-held fire extinguishers, pressurized water extinguishers where appropriate, and retardants located throughout the facility, particularly in areas used for storing paints, lubricants, oil, diesel, and gasoline or other combustible materials
- Pressurized fire hydrant connections at strategic locations throughout the facility
Effective response protocols would be developed to respond to fire according to BC Hydro management standards and practices. Response would provide for:

- Shut down of part or all of the facility, depending on the severity of a fire
- Call out for external emergency assistance
- Evacuation of personnel

Operating personnel would receive effective fire response training.

Transmission system fire could potentially originate from such sources as lightning, arcing, a downed line, or other inadvertent contact between the energized line and surrounding vegetation (e.g., as a result of a danger tree falling onto the line).

Preventive measures include vegetation management (e.g., to maintain a safe distance between energized lines and surrounding trees) and periodic inspection of poles and other transmission system elements. Fires would most likely be reported by observers to local departments, or to the provincial fire centre, who would coordinate the response.

The effects of a fire at the powerplant or along the transmission line corridor would mostly be contained locally, at the scene. A major fire at the powerplant would result in smoke in the local atmospheric environment and it is possible that oil and other products and materials in the powerplant would burn and release airborne contaminants. However, deluge systems and other fire controls would be in place to quench starting fires, and it is considered unlikely that an initial fire would develop into a major fire. A major fire at the powerplant would be no worse than a major fire at any industrial facility, and area fire departments and firefighters are equipped to deal with such occurrences. A major fire at the powerplant and a fire along the transmission line corridor that affected transmission would probably result in a station shutdown.

37.2.4.3 Transmission Line or Generating Station Outage

As described in Section 11.4 Surface Water Regime, the proposed minimum flow downstream from the Project is 390 m³/s.

The Project would be capable of maintaining this minimum flow under any foreseeable equipment malfunctions:

- The minimum flow is less than the discharge capacity of one of the six generating units. Hydroelectric generating units are very reliable. The generating station would be capable of passing the minimum flow after a sudden outage of up to four units, with one unit out of service for an annual inspection and maintenance.
- There are two 500 kV transmission lines, so an equipment malfunction on one line would not lead to a total generating station outage
- The spillway gate controls would open spillway gates as required to pass the minimum flow in the event of a total generating station outage
- Backup power, e.g., a diesel generator, would be provided for the spillway gates
37.2.5  Effects of Accidents and Malfunctions on Valued Components

The results of the potential effects of accidents and malfunctions on valued components are summarized in Figure 37.22. The effects were categorized as follows:

- 0 – No interaction is predicted
- 1 – An adverse effect may result from an interaction, but standard measures to avoid or minimize the potential effect are available and are well understood to be effective, and residual effects are negligible
- 2 – Interactions may result in an adverse effect and mitigation measures are not well understood to be effective

For the interactions categorized as “2”, the following subsections describe the reasons for those categorizations.

37.2.5.1  Construction Phase

37.2.5.1.1  Breach of Stage 2 Upstream Cofferdam

A breach of the Stage 2 upstream cofferdam would result in a flood wave that would cause temporary incremental flooding of areas between the maximum water levels presented in Table 37.14, which would naturally occur, and the maximum water levels presented in Table 37.16, which would result from a breach. In addition to temporary flooding, the flood wave from a breach would cause erosion in overbank areas and changes to the river channel due to erosion as well as the deposition of alluvial materials and debris. Erosion of the toe of steep banks could trigger landslides.

Fish and fish habitat would be adversely affected:

- By changes to the river channel
- By a pulse of sedimentation due to overbank erosion and landslides
- Because fish in the flooded areas would be displaced, injured, or killed by the force of the flood wave or by impingement on obstacles, or stranded when the flood waters recede as the wave moves downstream

Fish stocks would gradually recover as fish move in from tributaries and from unaffected areas upstream and downstream.

Vegetation and ecological communities would be adversely affected, as flooding and erosion of overbank areas would damage and potentially destroy vegetation and ecological communities. In the flooded areas, some vegetation such as grasses and shrubs would regrow fairly quickly, but damaged or uprooted trees would take longer to re-establish. Some ecological communities might not re-establish.

Wildlife within the flooded area could be killed or injured by the force of the flood wave or impingement against obstacles, or could be drowned. Wildlife would move back into the area after the flood had receded and vegetation re-established.

Current use of lands and resources for traditional purposes would be adversely affected by the adverse effects on fish, wildlife, and vegetation described above. The adverse effects would diminish with time as the fish, wildlife, and vegetation recovered.
Agriculture in the flooded areas would be adversely affected by:

- Erosion of agricultural land
- Crop damage
- Cattle killed or injured by the force of the flood wave or impingement against obstacles, or drowning

Depending on the amount of erosion, effects on agricultural land or crops may last one or more seasons.

Oil and gas infrastructure located downstream within the flooded area would be damaged, but could be repaired and back in operation within a relatively short period of time.

The harvest of fish and wildlife resources would be adversely affected by the adverse effects on fish and wildlife described above. The adverse effects would diminish with time as the fish and wildlife resources recovered.

Outdoor recreation and tourism would be adversely affected due to the effects on wildlife, fisheries, navigation, visual aesthetics, and damage to downstream recreation sites. Damaged recreation sites would be repaired, and outdoor recreation and tourism would recover as the affected valued components recovered.

Navigation on the river downstream would be temporarily impaired as a result of debris deposition and changes to the river channel.

The visual and aesthetic resources of the river valley downstream would be adversely affected by erosion, deposition of debris, and damage to vegetation and infrastructure in the flooded areas, which would alter the landscape. The adverse effects would diminish with time as the vegetation recovered and damages were repaired.

It is likely that some downstream heritage sites would be adversely affected by erosion and deposition of debris.

Human health would be adversely affected because residences and recreational areas are located within the flooded area. The emergency preparedness plan would be implemented, and people within the potentially flooded areas would be evacuated. Nevertheless, some loss of life or injury is possible and some evacuees may be affected by post-traumatic stress.

37.2.5.1.2 Fire of Explosion

During the construction phase, fires caused by the Project would most likely start within a cleared construction site and, therefore, would only have an adverse effect on a valued component if the fire spread outside of the cleared area.

If an accidental explosion occurred, it would not cause an adverse effect on valued components unless the explosion caused a fire that spread from the construction area.

Vegetation and ecological communities would be adversely affected by fires that spread from a construction site. The adverse effects would diminish with time as the vegetation recovered.
Wildlife would be adversely affected if an extensive fire spread from a construction site. The adverse effects would diminish with time as the wildlife returned to the area.

The current use of lands and resources by Aboriginal persons for traditional purposes may be adversely affected by the adverse effects on vegetation and ecological communities and wildlife. The adverse effects would diminish with time as wildlife move back into the area and as vegetation recovered, although some ecological communities could be lost.

Visual and aesthetic resources may be adversely affected by the burnt vegetation. The adverse effects would diminish with time as the vegetation recovered.

37.2.5.2 Operations Phase

37.2.5.2.1 Breach of Earthfill Dam

A breach of the earthfill dam would result in flood wave that would cause:

- Temporary flooding of the areas between the initial water levels and the maximum water levels presented in Table 37.18 for a sunny day failure
- Temporary incremental flooding of the areas between the maximum water levels presented in Table 37.19, which would occur during the probable maximum flood under natural conditions, and the maximum water levels presented in Table 37.21, which would result from a breach due to overtopping of the earthfill dam during the probable maximum flood

Breach of the earthfill dam would rapidly drain the reservoir, exposing un-vegetated areas to erosion by wind and precipitation. The rapid drawdown of the reservoir would likely cause landslides in areas where colluvium and glaciolacustrine deposits had been saturated by the reservoir. Some of the material deposited in reservoir arms would erode, adding to the sediment load in the water outflowing from the breach.

The physical effects of the temporary flooding downstream (i.e., erosion, the deposition of alluvial materials, and debris) would be as described for the breach of the Stage 2 upstream cofferdam; however, the extent of these effects would be much greater.

The effects of a breach of the earthfill dam on the valued components where the interaction is categorized as “2” in Figure 37.22 would be similar to the effects described for a breach of the Stage 2 upstream cofferdam, except that the extent would be much greater. Effects additional to those described for the Stage 2 upstream cofferdam are described below.

Greenhouse gases would be emitted during reconstruction of the dam and damaged infrastructure, and during restoration of aquatic and terrestrial habitat. There would also be a short-term increase in greenhouse gases due to the exposure or previously submerged vegetation, which would decompose and release greenhouse gases at a greater rate. After reconstruction and refilling of the reservoir, the greenhouse gas emissions from the reservoir would return to the levels prior to the breach.

There would be additional adverse effects on oil, gas, and energy because a breach of the earthfill dam would likely damage or destroy the Spectra pipeline that crosses the Peace River at Taylor. The pipeline crossing could be repaired or replaced shortly after the breach, so that the effect would be short term.
Navigation upstream would be adversely affected by draining of the reservoir, which would leave navigation infrastructure on the former shoreline unusable. As well, the bathymetry of the river and the stability of the banks would be unknown and would present hazards to navigation.

There would be additional adverse effects on visual and aesthetic resources upstream of the dam due to draining of the reservoir leaving the formerly inundated zone exposed, un-vegetated, and susceptible to erosion. After reconstruction and refilling of the reservoir, the upstream visual and aesthetic resources would return to the levels prior to the breach.

There would be an adverse effect on community infrastructure because the flood wave from a breach of the earthfill dam would overtop the dikes at the Town of Peace River, which would damage or destroy infrastructure in the flooded area.

There would be an adverse effect on transportation, as the CN rail bridge across the Peace River southeast of Fort St. John and the Highway 29 bridge across the Peace River at Taylor would be damaged or destroyed.

**37.2.5.2.2 Release or spills of chemical and hazardous materials**

As described in Section 37.2.4.1, the worst-case oil spill would be 9,000 L into the river from the explosion of a generator step-up transformer on the draft tube deck of the powerhouse. Due to the light nature of the oil, any adverse effects on the valued components will be of short duration, as any oil that is not collected will disperse and break down fairly rapidly.

Fish and fish habitat could be adversely affected by oil.

Riparian vegetation and ecological communities that come into contact with the oil could be adversely affected.

Current use of lands and resources for traditional purposes could be adversely affected to the extent that oil adversely affects fish and riparian vegetation.

**37.2.5.2.3 Fire or Explosion**

A fire or explosion during operation of the Project would only have adverse effects on the valued components if an extensive fire spread from the source.

Adverse effects would be similar to those described for the construction phase.

**37.3 Cumulative Environmental Effects**

**37.3.1 Approach to Assessment of Cumulative Effects of the Project**

Section 19(1) of the *Canadian Environmental Assessment Act* (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”. In accordance with this statutory requirement, Section 8.5.3 of the EIS Guidelines requires “… an assessment of 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 …” In order to meet this requirement, and to predict the cumulative effects of
the Project on each VC where the Project is likely to result in a residual adverse effect, a
Regional Assessment Area (RAA) and three “Cases” were developed. These are
described below.

37.3.1.1 The Boundaries of the RAA for Each VC

The spatial boundaries of the RAA for each VC (see Table 37.22) have been developed
based on consideration of:

- Where possible interactions with other projects or activities overlap spatially or
temporally
- Ecologically defensible boundaries (e.g., wildlife range boundaries)

### Table 37.22 Regional Assessment Areas

<table>
<thead>
<tr>
<th>Valued Component</th>
<th>Regional Assessment Area</th>
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</thead>
<tbody>
<tr>
<td>Fish and Fish Habitat</td>
<td>Peace River from Peace Canyon Dam, B.C. to Vermilion Chutes, Alberta, which is a distance of approximately 865 km</td>
</tr>
<tr>
<td>Vegetation and Ecological Communities</td>
<td>The proposed dam, reservoir, transmission line, Highway 29 realignment, temporary access roads, and quarries occur within five Wildlife Management Units – designated 7-31, 7-32, 7-33, 7-34, and 7-35, which includes most of the Peace Lowlands ecoserction</td>
</tr>
<tr>
<td>Wildlife Resources</td>
<td>Vegetation and Ecological Communities RAA, as described above</td>
</tr>
<tr>
<td>Greenhouse Gases</td>
<td>National</td>
</tr>
<tr>
<td>Local Government Revenue</td>
<td>City of Fort St. John, District of Taylor, District of Hudson’s Hope, District of Chetwynd, City of Dawson Creek, and Peace River Regional District</td>
</tr>
<tr>
<td>Labour Market</td>
<td>Peace River Regional District, Northern Rockies Regional Municipality, and Fraser-Fort George Regional District</td>
</tr>
<tr>
<td>Regional Economic Development</td>
<td>Peace River Regional District, Northern Rockies Regional Municipality, and Fraser-Fort George Regional District</td>
</tr>
<tr>
<td>Current Use of Lands and Resources for Traditional Purposes</td>
<td>Fish and Fish Habitat RAA and Wildlife Resources RAA, as described above</td>
</tr>
<tr>
<td>Agriculture</td>
<td>Peace River Regional District, the Northern Rockies Regional District, and the Peace River Agricultural Region (Statistics Canada Agricultural Region 8)</td>
</tr>
<tr>
<td>Forestry</td>
<td>Dawson Creek Timber Supply Area, Fort St. John Timber Supply Area, and Peace River supply block of Timber Forest Licence 48</td>
</tr>
<tr>
<td>Oil, Gas, and Energy</td>
<td>Project activity zone, area within Five-Year Beach Line, and Spectra Energy’s Taylor water intake</td>
</tr>
<tr>
<td>Minerals and Aggregates</td>
<td>Fort St. John, District of Hudson’s Hope, District of Taylor, Peace River Regional District, Area “C”</td>
</tr>
<tr>
<td>Harvest of Fish and Wildlife Resources</td>
<td>Peace River Regional District</td>
</tr>
<tr>
<td>Outdoor Recreation and Tourism</td>
<td>Peace River Regional District</td>
</tr>
<tr>
<td>Navigation</td>
<td>Navigation – Project activity zone, downstream to Peace Island Park, and the Shaftesbury and Tompkins Landing ice bridges Aviation – Area from the North Peace Regional Airport (Fort St. John airport) to the crest of the potential Project construction site</td>
</tr>
</tbody>
</table>
37.3.1.2 The Three Cases

**Baseline Case**: The Baseline Case demonstrates the current status of the VC, which necessarily ensures that the effects of all projects and activities that “…have been … carried out …” are accounted for in the assessment of the cumulative effects of the Project.

September 5, 2012 was chosen to demarcate the Baseline Case from the future cases described below, because 1) this was the date that the EIS Guidelines were issued by the federal Minister of Environment and the Executive Director of the BCEAO, and 2) by this date, BC Hydro had already substantially developed the assessment of potential effects and cumulative effects of the Project.

**Future Case without the Project**: In order to predict the status of the VC, taking into account the residual effects of projects and activities that “have been” and “will be” carried out, the Future case without the Project was developed.

Projects and activities that “will” be carried out are necessarily more certain than the Project itself. Consequently, available information about the residual effects of projects and activities that are at least as foreseeable as the Project was gathered. The list of those projects and activities was developed in accordance with the requirements of Section 8.5.3.2 of the EIS Guidelines.

For each VC:

- The projects and activities on the Project Inclusion List found within the RAA for that VC were identified
- Using the information available, the potential residual effects of those projects that may overlap in time and space with the potential residual effects of the Project were identified
- The status of the VC, taking into account the effects of projects and activities that have been and will be carried out, was predicted by considering the impact of those residual effects on the Baseline Case for the VC
Project Case: To demonstrate the cumulative effects that are likely to result from the Project, the Project Case for each VC was developed. In this case, the potential cumulative effects of the Project on each VC have been predicted by taking into account the potential residual effects of the Project that are likely to combine in time and space with those identified in the Future Case without the Project.

37.3.1.3 The Project Inclusion List
Screening criteria were used to identify other projects and activities for consideration in the cumulative effects assessment (Table 37.23).

Effects from potentially overlapping projects or activities that are recently operational may not be fully reflected in baseline conditions. For each VC, those projects and activities have been evaluated to determine whether they should be included in Baseline Case or the Future Case without the Project and the Project Case.

Table 37.23 Screening Criteria Used to Identify Other Projects and Activities For Consideration in the Cumulative Effects Assessment

<table>
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<tr>
<th>Type of Overlap</th>
<th>Excluded</th>
<th>Included</th>
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<tbody>
<tr>
<td>Spatial</td>
<td>• Project or activity is outside the largest RAA. By using a conservatively large RAA, all potential cumulative effects for VCs will be captured. &lt;br&gt; • Project or activity is located in Alberta beyond 100 m of the Peace River high water mark or further downstream than Fort Vermilion (i.e., downstream of the RAA boundary of the Fish and Fish Habitat VC).</td>
<td>• Project or activity is within the largest RAA. &lt;br&gt; • Project or activity is located in Alberta within 100 m of Peace River high water mark and as far downstream as Fort Vermilion.</td>
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<tr>
<td>Temporal</td>
<td>• Project was in operation or activity was occurring prior to September 5, 2012; therefore, associated residual effects may be reflected in baseline case conditions.² &lt;br&gt; • Project or activity is not reasonably foreseeable (i.e., not as likely to proceed as Site C Clean Energy Project).</td>
<td>• Active projects in federal or provincial environmental assessment or other regulatory process. &lt;br&gt; • Approved projects and activities that are: &lt;br&gt;   o not constructed &lt;br&gt;   o under construction or &lt;br&gt;   o constructed, but not operational &lt;br&gt; • Project or activity is reasonably foreseeable (i.e., at least as likely to proceed as the Site C Clean Energy Project).</td>
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NOTES:
² Effects from potentially overlapping projects or activities that are recently operational may or may not be fully reflected in baseline conditions. Those projects and activities have been evaluated in the VC cumulative effects sections to determine whether they should be included in Baseline Case or the Future Case without the Project and the Project Case.
projects and activities located within the largest RAA to be taken into account in the Future Case without the Project and in the Project Case:

- Registered active projects listed on the BCEAO and CEA Agency websites, including hydroelectric projects such as the Dunvegan Hydroelectric Project (Volume 2 Sections 10.5.2.2 and 10.5.2.10)
- Registered oil and gas applications listed on the British Columbia Oil and Gas Commission or National Energy Board websites (Volume 2 Section 10.5.2.4)
- Registered water licence applications listed on the Ministry of Environment’s Water Stewardship Division website (Volume 2 Section 10.5.2.5)
- Projects or activities associated with existing or “accepted” applications for land tenure under the B.C. Land Act or the B.C. Range Act (e.g., range tenures, grazing licenses, wind, gravel) as provided by GeoBC (2012) (Volume 2 Section 10.5.2.6)
- Current harvest plans associated with tenured forest operations and timber sales (Volume 2 Section 10.5.2.7)
- Official Community Plans, and parks and recreation plans (Volume 2 Section 10.5.2.8)
- Large waste discharges into the Peace River from Peace Canyon Dam to Vermilion Chutes, Alberta (Volume 2 Section 10.5.2.9)

A list of all other future foreseeable projects and activities considered in the assessment of the potential residual effects of the Project is provided in Volume 2 Section 10.5.3 Cumulative Effects Assessment, Table 10.7. The locations of these other projects and activities are shown in Figure 10.3, Figure 10.4, Figure 10.5, and Figure 10.6.

37.3.2 Description of Potential Cumulative Effects

For those VCs for which residual adverse effects are predicted, the potential cumulative effects of the Project have been assessed and are discussed in the respective VC-specific chapters of this EIS.

37.3.3 Identification of Mitigation Measures

With respect to certain VCs, BC Hydro has recommended possible regional approaches to mitigation. These mitigation measures may involve government departments and/or third parties in independent or collaborative initiatives. The potential possible regional approaches to mitigation are discussed in the respective VC-specific chapters of this EIS.

37.3.4 Characterization of Cumulative Residual Effects

Residual cumulative effects have been characterized using the criteria described in Volume 2 Section 10.4.2.2 and in Table 10.3. The potential residual adverse cumulative effects are discussed in the respective VC-specific chapters of this EIS.
37.3.5 Determination of Significance of Cumulative Residual Effects

BC Hydro provides a determination of the significance of the potential residual adverse cumulative effects that may result from the Project, and its rationale for the determination, in the respective VC-specific chapters of this EIS.

37.3.6 Summary of the Potential Cumulative Effects of the Project

A summary of the assessment of potential cumulative adverse effects that are likely to result from the Project in combination with other projects or activities that have been or will be carried out for relevant Project VCs is presented in Table 37.24.

<table>
<thead>
<tr>
<th>Valued Component</th>
<th>Residual Effect of the Project</th>
<th>Cumulative Effect of the Project</th>
<th>Significant Cumulative Effect (Y/N)</th>
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<td>Section 13</td>
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<td>Y</td>
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<td>Vegetation and</td>
<td>Alteration and fragmentation</td>
<td>The anticipated residual effects</td>
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<td>Ecological</td>
<td>of habitat for the terrestrial</td>
<td>to Vegetation and Ecological</td>
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<td>Section 14</td>
<td>Habitat alteration and</td>
<td>The anticipated residual effects</td>
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<td>butterflies and dragonflies,</td>
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<td>amphibians and reptiles,</td>
<td>Project. The footprints of other</td>
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<td>migratory birds, non-migratory</td>
<td>projects and activities</td>
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<td>game birds, raptors, bats,</td>
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<td>large carnivores.</td>
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<td>effect with the Project is also</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>considered significant.</td>
<td></td>
</tr>
</tbody>
</table>
## 37.4 Capacity of Renewable Resources

This section summarizes the results of the assessment of the potential effects of the Project on the capacity of renewable resources to meet the needs of present and future generations. Renewable resources are natural resources, living (e.g., fish, wildlife, and forest) and non-living (agricultural soils, scenic landscapes), that are replenished on an ongoing basis, either naturally or by human action. Renewable resources are used by people either consumptively (e.g., fishing, hunting, or forestry) or non-consumptively (recreational and visual resources).

This section also summarizes the Project’s beneficial use of a renewable resource for present and future generations.

The potential effects of the Project were assessed, taking into account predicted changes to the physical environment as described in Volume 2 Section 11 Environmental Background.

### 37.4.1 Effects of the Project on VCs that Contain, or Pertain to, Renewable Resources

Table 37.25 lists the VCs that are considered in this EIS and that contain, or pertain to, renewable resources. In the table, for each renewable resource, the use of the resource is described, whether the uses are consumptive or non-consumptive is indicated, and

<table>
<thead>
<tr>
<th>Valued Component</th>
<th>Residual Effect of the Project</th>
<th>Cumulative Effect of the Project</th>
<th>Significant Cumulative Effect (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Section 15</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Greenhouse</td>
<td>The residual quantities of</td>
<td>Increasing GHG emissions from</td>
<td>Y</td>
</tr>
<tr>
<td>Gases</td>
<td>GHGs released to the</td>
<td>the many sources globally and</td>
<td></td>
</tr>
<tr>
<td></td>
<td>atmosphere are low, and are</td>
<td>the resulting increase in GHG</td>
<td></td>
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<tr>
<td></td>
<td>a small fraction of</td>
<td>concentrations in the</td>
<td></td>
</tr>
<tr>
<td></td>
<td>provincial, national, and</td>
<td>atmosphere, and the consequent</td>
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</tr>
<tr>
<td></td>
<td>global emissions.</td>
<td>changes to the global climate,</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>are currently believed to be a</td>
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<tr>
<td></td>
<td></td>
<td>significant cumulative</td>
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</tr>
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<td></td>
<td></td>
<td>environmental effect, even</td>
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<tr>
<td></td>
<td></td>
<td>without the Project. While the</td>
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<td></td>
<td></td>
<td>Project's contribution to a net</td>
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<td></td>
<td></td>
<td>change in global GHG emissions</td>
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<td></td>
<td></td>
<td>is relatively small, and the</td>
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<tr>
<td></td>
<td></td>
<td>environmental effect of the</td>
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<td></td>
<td></td>
<td>Project related GHG emissions on</td>
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<tr>
<td></td>
<td></td>
<td>global climate is not</td>
<td></td>
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<td></td>
<td></td>
<td>measurable, the cumulative effect</td>
<td></td>
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<td></td>
<td></td>
<td>with the Project is also</td>
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<tr>
<td></td>
<td></td>
<td>considered significant.</td>
<td></td>
</tr>
<tr>
<td><strong>Section 24</strong></td>
<td></td>
<td>Decrease in access to hunting</td>
<td>N</td>
</tr>
<tr>
<td>Harvest of Fish</td>
<td></td>
<td>areas (0.8% of Limited Entry</td>
<td></td>
</tr>
<tr>
<td>and Wildlife</td>
<td></td>
<td>Hunting area 7-20a is in the LAA),</td>
<td></td>
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<tr>
<td>Resources</td>
<td></td>
<td>and displacement of hunting</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>activities and wildlife away from</td>
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<tr>
<td></td>
<td></td>
<td>the Project activity zone outside</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>the LAA.</td>
<td></td>
</tr>
<tr>
<td><strong>Section 27</strong></td>
<td></td>
<td>Increase in the amount of visible</td>
<td>N</td>
</tr>
<tr>
<td>Visual</td>
<td></td>
<td>anthropogenic disturbances in the</td>
<td></td>
</tr>
<tr>
<td>Resources</td>
<td></td>
<td>short term.</td>
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<tr>
<td></td>
<td></td>
<td>Increase in the amount of visible</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>anthropogenic disturbances in the</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>long term.</td>
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</tr>
</tbody>
</table>
the results of the assessment of the potential effects on the Project on the VC are summarized.

**Table 37.25 Summary of Consideration of Renewable Resources Within the EIS**

<table>
<thead>
<tr>
<th>Valued Component</th>
<th>EIS Section</th>
<th>Resource Use, Consumptive (C), Non-Consumptive (NC)</th>
<th>Potential Significant Adverse Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish and Fish Habitat</td>
<td>Volume 2 Section 12</td>
<td>Fishing (C, NC)</td>
<td>Construction:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Loss of habitat due to construction headpond and reservoir filling</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Reduced fish health and survival due to sediment inputs from construction headpond and reservoir filling</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Hindered fish movement due to obstruction to fish passage</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Operations:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Hindered fish movement due to obstruction to fish passage</td>
</tr>
<tr>
<td>Vegetation and Ecological Communities</td>
<td>Volume 2 Section 13</td>
<td>Landscape viewing, plant gathering (C)</td>
<td>• Habitat alteration and fragmentation to certain ecological communities and rare plants</td>
</tr>
<tr>
<td>Wildlife Resources</td>
<td>Volume 2 Section 14</td>
<td>Wildlife viewing, hunting, trapping (C)</td>
<td>Construction and Operations</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• 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).</td>
</tr>
<tr>
<td>Current Use of Lands and Resources for</td>
<td>Volume 3 Section 19</td>
<td>Fishing, hunting, trapping, plant gathering for</td>
<td>Changes to other cultural and traditional uses of the land during construction and operations</td>
</tr>
<tr>
<td>Traditional Purposes</td>
<td></td>
<td>Aboriginal purposes (C)</td>
<td></td>
</tr>
<tr>
<td>Agriculture</td>
<td>Volume 3 Section 20</td>
<td>Cultivation for agricultural purposes (C, NC)</td>
<td>No significant adverse residual effects</td>
</tr>
<tr>
<td>Forestry</td>
<td>Volume 3 Section 21</td>
<td>Timber harvesting for industrial purposes (C)</td>
<td>No significant adverse residual effects</td>
</tr>
<tr>
<td>Harvest of Fish and Wildlife Resources</td>
<td>Volume 3 Section 24</td>
<td>Fishing, hunting for recreation, hunting for</td>
<td>No significant adverse residual effects</td>
</tr>
<tr>
<td></td>
<td></td>
<td>commercial guiding purposes, trapping for</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>commercial purposes (C)</td>
<td></td>
</tr>
<tr>
<td>Outdoor Recreation and Tourism</td>
<td>Volume 3 Section 25</td>
<td>Landscape and wildlife viewing, fishing, hunting, outdoor recreation/tourism activities in the outdoor environment (C, NC)</td>
<td>No significant adverse residual effects</td>
</tr>
</tbody>
</table>
### Project Beneficial Use of Renewable Resources

The Peace River provides a reliable, long-term, and renewable source of water. Since 1968, surface water resources on the Peace River have been used non-consumptively to produce renewable electricity for past and present generations, and will continue to produce electricity for future generations. The Project would allow BC Hydro to reuse the same water used at two upstream hydroelectric stations to produce hydroelectric energy, in a non-consumptive manner, to provide substantial renewable electricity benefits to both present and future generations.

BC Hydro commissioned a climate study to understand potential future changes to the climate in key watersheds, including the Peace River, and related potential changes to the annual cycle and volume of inflows. This study confirmed that, with predicted global climate change, reliable inflows will continue on the Peace River (Volume 2 Appendix T Climate Change Summary Report).

### Requirements of Any Follow-Up Programs

A follow-up program is designed 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, as described in Section 23.5 of the EIS Guidelines. The rationale for recommending a follow-up program for a particular VC is provided in Volume 2 Section 10 Effects Assessment Methodology. Follow-up programs for relevant VCs are provided in the EIS in Volume 2 Sections 12–15, Volume 3 Sections 16–27, Volume 4 Sections 28–33, and in Volume 5 Section 39 Complete List of Mitigation and Follow-Up Measures.
References

Literature Cited


38 SUMMARY OF POTENTIAL RESIDUAL EFFECTS OF THE PROJECT

This section summarizes the potential adverse residual effects of the Project. Residual adverse effects are the effects of the Project that may remain after taking into account the implementation of mitigation measures.

Table 38.1 below identifies anticipated residual effects based on the assessment of potential environmental effects (Volume 2 Sections 12 to 15), economic and land and resource use effects (Volume 3 Sections 16 through 27), and social, heritage and human health effects (Volume 4 Sections 28 through 33).

Table 38.1 identifies the Project phase(s) in which the effect is expected to occur, the contributing Project activities or physical works, the proposed mitigation measures that are to be used to avoid or reduce the potential effect, the residual effects and its determination of significance.

As per the EIS Guidelines Section 8.5.2 Analysis of Effects and Section 23 Requirements for the Federal Environmental Assessment, Table 38.2 describes how the following federal considerations are addressed in the EIS:

- Changes to the environment
- Changes to components of the environment within federal jurisdiction
- Changes to the environment that would occur on federal or transboundary lands
- Changes to the environment that are directly linked or necessarily incidental to federal decisions
- Effects of changes to the environment on Aboriginal peoples
- Effects of changes to the environment that are directly linked or necessarily incidental to federal decisions
### Table 38.1 Summary of Potential Residual Effects of the Project

Note: The purpose of this table is to track RESIDUAL EFFECTS rather than all potential effects. Therefore, table entries are restricted to those potential effects that cannot be mitigated, in whole or in part, resulting in a potential adverse residual effect.

<table>
<thead>
<tr>
<th>Potential Residual Effect</th>
<th>Project Phase</th>
<th>Contributing Project Activity or Physical Works</th>
<th>Proposed Mitigation</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss of fish habitat</td>
<td>Construction</td>
<td>Construction of the dam and generating station, Highway 29, and Hudson's Hope shoreline</td>
<td>Implement the Fish and Aquatic Habitat Management Plan. Place material relocation sites 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. Compensate for fish habitats affected by Highway 29 realignment ‘like for like’ in the vicinity of the habitat loss. 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 berm. Retain non-merchantable trees and vegetation in riparian areas within a 15 m buffer zone from the high water mark. Merchantable trees, and vegetation that could interfere with navigation, will be removed</td>
<td>Not significant</td>
</tr>
<tr>
<td>Potential Residual Effect</td>
<td>Project Phase</td>
<td>Contributing Project Activity or Physical Works</td>
<td>Proposed Mitigation</td>
<td>Significance</td>
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<td>---------------------------</td>
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<td>-------------</td>
</tr>
<tr>
<td>Loss of fish habitat</td>
<td>Construction</td>
<td>Construction headpond and reservoir filling</td>
<td>Contour Highway 29 materials sites prior to decommissioning to provide littoral fish habitat in the reservoir. Cap with gravel and cobbles material repositioning areas, 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.</td>
<td>Significant</td>
</tr>
<tr>
<td>Altered fish habitat due to transformation of reservoir habitat</td>
<td>Operations</td>
<td>Operation of the reservoir</td>
<td>Manage reservoir fluctuation within a 1.8 m maximum normal operating range to reduce effects to the shoreline fish habitat.</td>
<td>Not significant</td>
</tr>
<tr>
<td>Altered fish habitat downstream of Site C Dam</td>
<td>Operations</td>
<td>Operation of the reservoir</td>
<td>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.</td>
<td>Not significant</td>
</tr>
</tbody>
</table>

Site C Clean Energy Project Environmental Impact Statement
Section 38: Summary of Potential Residual Effects of the Project
<table>
<thead>
<tr>
<th>Potential Residual Effect</th>
<th>Project Phase</th>
<th>Contributing Project Activity or Physical Works</th>
<th>Proposed Mitigation</th>
<th>Significance</th>
</tr>
</thead>
</table>
| Reduced fish health and survival due to sediment inputs | Construction  | Construction of the dam and generating station  | 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 sediments that are introduced into the aquatic environment. Reduce equipment production rates to reduce the amount of sediments generated by equipment when needed. | Not significant |
<p>| Reduced fish health and survival due to sediment inputs | Construction  | Construction headpond and reservoir filling    | 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 in winter, where feasible, to reduce soil disturbance | Significant |
| Reduced fish health and survival due to fish entrainment | Construction  | Construction headpond and reservoir filling    | 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. | Not significant |</p>
<table>
<thead>
<tr>
<th>Potential Residual Effect</th>
<th>Project Phase</th>
<th>Contributing Project Activity or Physical Works</th>
<th>Proposed Mitigation</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced fish health and survival due to increased total dissolved gas supersaturation</td>
<td>Construction</td>
<td>Construction headpond and reservoir filling</td>
<td>The spillway design has been modified to reduce total dissolved gas generation. 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.</td>
<td>Not significant</td>
</tr>
<tr>
<td>Reduced fish health and survival due to fish entrainment</td>
<td>Operations</td>
<td>Operation of the dam and generating station</td>
<td>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 spillway and tailrace areas.</td>
<td>Not significant</td>
</tr>
<tr>
<td>Reduced fish health and survival due to increased total dissolved gas supersaturation</td>
<td>Operations</td>
<td>Operation of the dam and generating station</td>
<td>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. Develop and implement an operational procedure to reduce total dissolved gas concentration in tailwater.</td>
<td>Not significant</td>
</tr>
</tbody>
</table>
### Potential Residual Effect

<table>
<thead>
<tr>
<th>Potential Residual Effect</th>
<th>Project Phase</th>
<th>Contributing Project Activity or Physical Works</th>
<th>Proposed Mitigation</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hindered fish movement due to obstruction to fish passage</td>
<td>Construction</td>
<td>Operation of the dam and generating station</td>
<td>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.</td>
<td>Significant</td>
</tr>
<tr>
<td>Hindered fish movement due to obstruction to fish passage</td>
<td>Operations</td>
<td>Operation of the dam and generating station</td>
<td>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.</td>
<td>Significant</td>
</tr>
</tbody>
</table>

### Section 13 – Vegetation and Ecological Communities

| Habitat Alteration and Fragmentation | Construction | Clearing, grubbing, site preparation, diversion and reservoir filling | Implement the following Environmental Management Plans:  
1. Air Quality Management Plan  
2. Erosion Prevention and Sediment Control Plan  
3. Fisheries and Aquatic habitat Management Plan  
4. Fuel Handling and Storage Management Plan  
5. Soil Management, Site Restoration and Revegetation Plan  
6. Vegetation and Invasive Plant Management Plan  
Maintain a spatial database of rare plant occurrences within the Local Assessment Area  
Place transmission towers and temporary roads away from wetlands and known rare plant occurrences where feasible. Establish Environmental Protection zones to protect known rare plant occurrences located adjacent to construction. | Significant |
## Proposed Mitigation

<table>
<thead>
<tr>
<th>Potential Residual Effect</th>
<th>Project Phase</th>
<th>Contributing Project Activity or Physical Works</th>
<th>Significance</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>areas where feasible.</td>
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<tr>
<td></td>
<td></td>
<td>Plan and implement construction activities in a manner that seeks to maintain the hydrology of adjacent wetlands, particularly where known rare plant occurrences are present.</td>
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<td></td>
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<td>Implement measures to maintain existing hydrological patterns as much as possible if roads cannot avoid wetlands.</td>
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<td></td>
<td></td>
<td>Install culverts under access roads to maintain hydrological balance.</td>
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<td></td>
<td></td>
<td>Install sedimentation barriers as needed.</td>
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<td></td>
<td></td>
<td>Retain vegetation on steep, unstable slopes that would be highly susceptible to landslides if the vegetation was removed.</td>
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<tr>
<td></td>
<td></td>
<td>Retain non-merchantable trees and vegetation in riparian areas within a 15 m buffer zone from the high water mark.</td>
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<tr>
<td></td>
<td></td>
<td>Merchantable trees and vegetation that could interfere with navigation will be removed using clearing practices to maintain a 15 m machine-free zone.</td>
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<td></td>
<td>BC Hydro will fund a compensation program that will include:</td>
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<td>• A survey of habitat enhancement projects in the regional assessment area 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.</td>
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<tr>
<td></td>
<td></td>
<td>• Identification of areas that are under threat from development or in need of habitat enhancement. Where opportunities exist, BC Hydro</td>
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</tbody>
</table>
### Section 38: Summary of Potential Residual Effects of the Project

<table>
<thead>
<tr>
<th>Potential Residual Effect</th>
<th>Project Phase</th>
<th>Contributing Project Activity or Physical Works</th>
<th>Proposed Mitigation</th>
<th>Significance</th>
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<tbody>
<tr>
<td></td>
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<td>will consider direct purchase – if offered for sale – and/or 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. Undertake targeted surveys in the regional assessment area to locate additional occurrences directly affected rare plant species that the Conservation Framework identifies as requiring additional inventories. Undertake a study that attempts to clarify the taxonomy of ochroleucus bladderwort. The study plan, which will be developed in consultation with the B.C. Conservation Data Centre, may include field, herbaria, and genetic work.</td>
<td></td>
</tr>
</tbody>
</table>

### Section 14 – Wildlife Resources

| Habitat Alteration and Fragmentation | Construction and operations | Construction of the dam and generating station, Highway 29, access roads, transmission line Reservoir filling Quarrying and excavation of construction materials | Implement the following Environmental Management Plans:  
- Erosion Prevention and Sediment Control Plan  
- Fisheries and Aquatic habitat Management Plan  
- Fuel Handling and Storage Management Plan  
- Soil Management, Site Restoration and Revegetation  
- Surface Water Quality Management Plan  
- Vegetation and Invasive Plant Management Plan  
- Wildlife Management Plan  
Provide as inputs to the final design phase 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 | Significant |
<table>
<thead>
<tr>
<th>Potential Residual Effect</th>
<th>Project Phase</th>
<th>Contributing Project Activity or Physical Works</th>
<th>Proposed Mitigation</th>
<th>Significance</th>
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<tbody>
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<td></td>
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<td>locations so further reductions and avoidances can be considered. Establish appropriate barriers and Environmental Protection Zones to avoid direct disturbance to wetland sites. Create new wetland habitat areas for migratory birds and a range of other species. Create areas that are “fish-free”, where appropriate, to reduce the effects of fish predation on invertebrates, amphibian eggs and larvae, and young birds. Maintain existing hydraulic patterns if roads cannot avoid wetlands. Ditches, culverts, and other structures will be placed to maintain the natural drainage patterns and allow the movement of flows. Retain vegetation on steep, unstable slopes that would be highly susceptible to landslides if the vegetation was removed. Retain non-merchantable trees and vegetation within riparian areas around existing water bodies within a 15 m buffer zone from the high water mark. Merchantable trees may still be removed using clearing practices in order to maintain a 15 m machine-free zone. Locate artificial snake dens on warm aspect slopes in open areas away from major roads. Incorporate nest boxes for cavity-nesting waterfowl into wetland mitigation plans and within riparian vegetation zones, where feasible. Provide a portion of BC Hydro-owned land for breeding habitat for Northern Harrier and Short-eared Owl. Wetland compensation will also be made available to address some habitat losses for these two species. Incorporate bat roosting habitat.</td>
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</tbody>
</table>
### Section 38: Summary of Potential Residual Effects of the Project

<table>
<thead>
<tr>
<th>Potential Residual Effect</th>
<th>Project Phase</th>
<th>Contributing Project Activity or Physical Works</th>
<th>Proposed Mitigation</th>
<th>Significance</th>
</tr>
</thead>
</table>
| Disturbance and Displacement | Construction and operations | Filling of the construction headpond and reservoir | Implement the following Environment Management Plans:  
  - Soil Management, Site Restoration and Revegetation Plan  
  - Wildlife Management Plan  
  
  Clear during winter months where feasible. If clearing work during the critical bird breeding season cannot be avoided, develop and implement a nest and lek search prior to clearing. Reduce, where feasible, light pollution at work sites  
  
  Restrict access on roads used by work crews during construction  
  
  Incorporate the location of rare species along the transmission line right-of-way or adjacent to generation facilities into BC Hydro’s GIS-based mapping system  
  
  Provide all known grouse lek | Not significant |
### Potential Residual Effect

<table>
<thead>
<tr>
<th>Potential Residual Effect</th>
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<th>Proposed Mitigation</th>
<th>Significance</th>
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<tbody>
<tr>
<td></td>
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<td>locations during the final construction design phase</td>
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<td>Use appropriate flagging if work is required immediately adjacent to any leks, and instruct personnel to avoid these sites.</td>
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<td></td>
<td>Update the baseline data on Bald Eagle nest sites from 2011 prior to commencement of construction</td>
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<td></td>
<td>Erect Bald Eagle nesting platforms along the reservoir shoreline. If an active nest is lost due to the Project, new nesting structures will be provided.</td>
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<td></td>
<td>Retain Bald Eagle nests outside the dam construction area that are confirmed active the year that clearing is started within the reservoir through the entire construction phase until reservoir filling is initiated.</td>
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<td></td>
<td>Remove nests that could be lost during seasonal flooding associated with dam construction. For active nests retained through the construction period, a &quot;no-clearing buffer&quot; around each active nest will be implemented.</td>
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<td></td>
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<td></td>
<td>Develop a Human-Bear Conflict Management Plan for the Project.</td>
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</tbody>
</table>
## Section 38: Summary of Potential Residual Effects of the Project

<table>
<thead>
<tr>
<th>Potential Residual Effect</th>
<th>Project Phase</th>
<th>Contributing Project Activity or Physical Works</th>
<th>Proposed Mitigation</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct and Indirect Mortality</td>
<td>Construction and operations</td>
<td>Filling of the construction headpond and reservoir&lt;br&gt;Quarrying and excavation of construction materials at Portage Mountain&lt;br&gt;Clearing&lt;br&gt;Equipment and materials movement by road or train</td>
<td>Implement the following Environment Management:&lt;br&gt; Erosion Prevention and Sediment Control Plan&lt;br&gt; Fuel Handling and Storage Management Plan&lt;br&gt; Vegetation and Invasive Plant Management Plan&lt;br&gt; Wildlife Management Plan&lt;br&gt;Design a portion of the wetlands created to compensate for habitat loss to remain fish-free to eliminate predation to invertebrates (dragonfly larva), amphibians, and reptiles.&lt;br&gt;Include amphibian passage structures in road design where roads are adjacent to wetlands or amphibian migrations&lt;br&gt;Clear forested habitat – potential roosting and cover sites for bats and fisher – before inundation begins. Clearing will take place during late fall and winter, before the birthing season, and when bats are not present or are in hibernacula, where feasible.&lt;br&gt;Schedule construction activities following guidance from Peace Region Selected Terrestrial and Aquatic Wildlife Least Risk Windows&lt;br&gt;Develop a Human-Bear Conflict Management Plan for the Project.</td>
<td>Not significant</td>
</tr>
</tbody>
</table>

### Section 15 – Greenhouse Gases

<table>
<thead>
<tr>
<th>Emission of Greenhouse Gases</th>
<th>Construction</th>
<th>The burning of diesel and gasoline in vehicles and heavy equipment&lt;br&gt;Emissions associated with construction materials</th>
<th>Implement fleet management measures to reduce fuel consumption and increase fuel efficiency.</th>
<th>Not significant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Release of Greenhouse Gases</td>
<td>Operations</td>
<td>Clearing, filling and operation of the reservoir</td>
<td>Reduce the long-term conversion of land while still achieving the purpose of the Project.</td>
<td>Not significant</td>
</tr>
</tbody>
</table>
### Potential Residual Effect

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<thead>
<tr>
<th>Potential Residual Effect</th>
<th>Project Phase</th>
<th>Contributing Project Activity or Physical Works</th>
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</thead>
<tbody>
<tr>
<td><strong>Section 18 – Regional Economic Development</strong>&lt;br&gt;Due to Project expenditures:&lt;br&gt;Change in business opportunities during construction&lt;br&gt;Change in business and contracting profile, capabilities and capacity during construction</td>
<td>Construction</td>
<td>Construction of the Project</td>
<td>Continue the Project business liaison program&lt;br&gt;• Work with local Economic Development Commissions and business organizations&lt;br&gt;• Continue to deliver business information sessions&lt;br&gt;• Broadly communicate contracting opportunities&lt;br&gt;• Encourage use of, and participation in, the Project business directory&lt;br&gt;Apply BC Hydro Aboriginal procurement policy to increase Aboriginal participation in Project business opportunities.&lt;br&gt;Seek information on Aboriginal businesses and capabilities.</td>
<td>Project benefits on Regional Economic Development</td>
</tr>
</tbody>
</table>

| **Section 19 – Current Use of Land and Resources for Traditional Purposes**<br>Changes in fishing opportunities and practices | Construction and operations | Construction and operation of the Project | Consult Aboriginal groups respecting the development of fish habitat compensation projects that align with BC Hydro compensation programs.<br>Seek input from Aboriginal groups respecting mitigation strategies.<br>Continue to consult with Aboriginal groups on clearing plans and protocols.<br>Develop a communications program to inform harvesters of planned or unplanned events related to construction activities that may affect fishing opportunities or access.<br>Develop a communications program to inform harvesters of longer-term changes in fish community composition.<br>Implement mitigation measures set out in Volume 2 Section 12 Fish and Fish Habitat and Volume 3 Section 24 Harvest of Fish and Wildlife Resources. | Not significant |
### Section 38: Summary of Potential Residual Effects of the Project

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<th>Contributing Project Activity or Physical Works</th>
<th>Proposed Mitigation</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Changes in hunting and trapping opportunities and practices</td>
<td>Construction and operations</td>
<td>Construction and operation of the Project</td>
<td>Consult with Aboriginal groups respecting the development of wildlife habitat compensation projects that align with BC Hydro compensation programs. Seek input from Aboriginal groups respecting mitigation strategies, such as mitigation measures related to trap lines in the Project activity zone. Continue to consult with Aboriginal groups on clearing plans and protocols. 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 and Volume 3 Section 24 Harvest of Fish and Wildlife Resources pertaining to trapping.</td>
<td>Not significant</td>
</tr>
<tr>
<td>Changes to other cultural and traditional uses of land</td>
<td>Construction and operations</td>
<td>Construction and operation of the Project</td>
<td>Work with Aboriginal groups to ground truth traditional land use information for specific areas within the Project activity zone prior to commencing construction, e.g., when determining the exact location of an access road. Continue to consult with Aboriginal groups regarding clearing plans and protocols. Develop a communications program to inform harvesters of planned or unplanned events that may affect opportunities to harvest plants, berries, and other resources. Continue to consult with Aboriginal groups respecting the development of habitat compensation projects that align with BC Hydro compensation programs. Work with Aboriginal groups to identify permanent habitation structures used in the current</td>
<td>Significant</td>
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<tr>
<td>Potential Residual Effect</td>
<td>Project Phase</td>
<td>Contributing Project Activity or Physical Works</td>
<td>Proposed Mitigation</td>
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<td>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. 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:</td>
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</table>
## Section 38: Summary of Potential Residual Effects of the Project

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<th>Potential Residual Effect</th>
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<th>Significance</th>
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<tbody>
<tr>
<td></td>
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<td>▪ identification and naming of key cultural sites and the potential to integrate Aboriginal names into Project operations and sites</td>
<td>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 Outdoor Recreation and Tourism</td>
</tr>
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<td></td>
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<td>▪ recording of stories and history associated with key cultural sites that may be affected by the Project</td>
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<td>▪ protecting and documenting, including mapping, of important Aboriginal trails and sites</td>
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<td>▪ contribute funding to sponsor a youth culture camp that includes transfer of knowledge around medicinal and food plants</td>
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<td>▪ engage with Aboriginal groups to commemorate lost and/or inundated places</td>
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<td></td>
<td>▪ engage with Aboriginal groups around potential plans to undertake ceremonies prior to the commencement of construction on key elements of the Project</td>
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<td></td>
<td>▪ develop and implement an education program respecting Aboriginal culture, history and use of lands and resources in the Project Area to be offered to all workers on the Project</td>
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<tr>
<td>Potential Residual Effect</td>
<td>Project Phase</td>
<td>Contributing Project Activity or Physical Works</td>
<td>Proposed Mitigation</td>
<td>Significance</td>
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</tbody>
</table>
| Permanent loss of agricultural land | Construction and operations | Filling and operation of the reservoir | Implement mitigation measures including:  
  - Irrigation improvements  
  - Drainage improvements  
  - Relocation of suitable quality soil in selected locations  
  - Inclusion of land in the Agricultural Land Reserve  
  - Agricultural compensation fund | Not significant |

**Section 20 – Agriculture**

| Changes in fishing opportunities | Construction | Clearing and filling of the reservoir | Implement Outdoor Recreation and Tourism mitigation measures that support recreational shoreline use, boating access, and water-based navigation, to also mitigate construction effects on fishing opportunities  
Implement Fish and Fish Habitat mitigation measures that support fish and wildlife populations, to also mitigate construction effects on fishing opportunities | Not significant |

| Changes in fishing opportunities | Operations | Operation of the reservoir | Benefit to fishing opportunities during operations. No mitigation required. | Project benefits to fishing opportunities |

| Changes in hunting opportunities | Construction | Construction of the dam and generating station, Highway 29 and access roads  
Quarrying and excavation of construction materials  
Clearing | Implement Outdoor Recreation and Tourism mitigation measures that support recreational shoreline use, boating access, and water-based navigation, to also mitigate construction effects on hunting opportunities  
Implement Wildlife Resources mitigation measures that support wildlife populations, to also mitigate construction effects on hunting opportunities | Not significant |

| Changes in use of harvesting areas | Construction | Construction of the Project | Benefit to the use of harvesting areas during construction. No mitigation required. | Project benefits to the use of harvesting areas |
### Summary of Potential Residual Effects of the Project

<table>
<thead>
<tr>
<th>Potential Residual Effect</th>
<th>Project Phase</th>
<th>Contributing Project Activity or Physical Works</th>
<th>Proposed Mitigation</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Changes in outdoor recreation and tourism infrastructure</td>
<td>Construction</td>
<td>Clearing and filling of the reservoir</td>
<td>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. Identify public communications procedures for public safety hazards, and access restrictions and closures during construction of the Site C dam using a Public Safety Management Plan. Provide funds to the District of Hudson’s Hope for enhancement of Alwin Holland Municipal Park or other community shoreline recreation areas. Provide a Community Recreation Site Fund to support development of new shoreline recreation sites on the Site C reservoir and on the Peace River and tributaries between Site C and the Alberta border. 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. Establish a permanent north bank Site C dam site public viewpoint.</td>
<td>Not significant</td>
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</table>
### Potential Residual Effect

<table>
<thead>
<tr>
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<th>Proposed Mitigation</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Changes to water-based navigability</td>
<td>Construction</td>
<td>Construction of the dam, generating station and Highway 29</td>
<td>Provide recreational boaters with information about restricted navigation zones at the dam site, 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, as part of the Public Safety Management Plan. Build three boat launches along the Site C reservoir accessible via Highway 29 to support navigability and navigational use. BC Hydro will fund community groups to support re-establishment of recreational sites on the Site C reservoir and downstream, and to re-establish and create new use patterns and access. BC Hydro will 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. BC Hydro will fund the development of a Navigation and Recreation Opportunities Plan, intended to enable the local communities to plan for boating and recreation opportunities created by the Site C reservoir.</td>
<td>Not significant</td>
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</table>
## Section 38: Summary of Potential Residual Effects of the Project

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<tr>
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<tr>
<td><strong>Section 27 – Visual Resources</strong></td>
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<tr>
<td>Changes to visual resources</td>
<td>Construction</td>
<td>Clearing Construction of the dam and generating station, Hudson’s Hope shoreline protection, transmission line, Highway 29 and access roads Quarrying and excavation of construction materials Reservoir filling</td>
<td>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. 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.</td>
<td>Not significant</td>
</tr>
<tr>
<td>Changes to visual resources</td>
<td>Operations</td>
<td>Operation of the dam and generating station and reservoir</td>
<td>No mitigation proposed.</td>
<td>Not significant</td>
</tr>
<tr>
<td><strong>Section 28 – Population and Demographics</strong></td>
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<tr>
<td>Increases to PRRD and City of Fort St John population</td>
<td>Construction</td>
<td>Construction of the Project</td>
<td>Implement mitigation measures proposed for the Labour Market and Housing VCs, including the provision of camp accommodation, to moderate growth of the local population Implement mitigation measures proposed for the Community Infrastructure and Services VC to mitigate the effects of an increased local population</td>
<td>Not significant</td>
</tr>
<tr>
<td>Changes to in and out migration from Aboriginal communities</td>
<td>Construction</td>
<td>Construction of the Project</td>
<td>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.</td>
<td>Not significant</td>
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</table>

BC Hydro will work with local
### Section 38: Summary of Potential Residual Effects of the Project

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<td></td>
<td>area First Nations to develop and deliver the cross-cultural awareness training. Procurement of local Aboriginal businesses for Project construction contracts where feasible.</td>
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</table>

#### Section 29 – Housing

| Housing demand of increased population may create shortages in the apartment rental market | Construction | Construction of the Project | Scale camp capacity up or down as required to accommodate direct workers. Provide logistical assistance to the Project workforce seeking local accommodation, through a community camp co-ordinator. Build approximately 40 new permanent housing units to be used by the construction workforce in the Fort St. John area, to expand the supply of rental housing. Transition the units to permanent affordable housing use after construction. 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). | Not significant |
### Section 30 – Community Infrastructure and Services

<table>
<thead>
<tr>
<th>Potential Residual Effect</th>
<th>Project Phase</th>
<th>Contributing Project Activity or Physical Works</th>
<th>Proposed Mitigation</th>
<th>Significance</th>
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</thead>
<tbody>
<tr>
<td>The Project would create incremental demand on local health and social services driven by increased in-community population and camp workforce associated with the Project</td>
<td>Construction</td>
<td>Construction of the Project</td>
<td>Provide health care services (doctor, nurse) for Project workforce. Provide Northern Health with actual workforce and camp population statistics to help plan for service levels. Provide new families with local information package about health, education, and social services. Fund daycare spaces in the City of Fort St. John area.</td>
<td>Not significant</td>
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</tbody>
</table>

### Section 31 – Transportation

<p>| 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 Lower collision frequency due to permanent road upgrades on some routes | Construction | Construction traffic associated with construction of the Project. Commuter traffic associated with construction of the Project. | <strong>Highway 29 North</strong> Implement Traffic Management Plan to include Traffic Control Plans, Public Information Plans, Incident Plans, and Implementation Plans. Realign Highway 29 incorporating geometric and cross-section improvements for sections of highway that would be inundated by the reservoir between Hudson’s Hope and Bear Flat 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 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. | Not significant |
| | | | <strong>Highway 29 South</strong> 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. | | |</p>
<table>
<thead>
<tr>
<th>Potential Residual Effect</th>
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<th>Contributing Project Activity or Physical Works</th>
<th>Proposed Mitigation</th>
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</thead>
<tbody>
<tr>
<td><strong>Jackfish Lake Road</strong></td>
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<td></td>
<td></td>
<td><a href="#">Provide a shuttle service between Chetwynd and the Project site, based on demand</a></td>
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<td><a href="#">Equip Project vehicles travelling on Project access road with radios.</a></td>
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<td><a href="#">Control access to Project access road at north end of Jackfish Lake Road.</a></td>
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<td><a href="#">Strengthen road base and hard-surface 31 km of Jackfish Lake Road, widening where required.</a></td>
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<td><a href="#">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.</a></td>
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<tr>
<td><strong>North Bank Minor Roads</strong></td>
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<td><a href="#">Implement carpool program.</a></td>
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<td><a href="#">Use conveyor belt for transport of materials from 85th Avenue Industrial Lands to dam site.</a></td>
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<td><a href="#">Hard-surface 240 Road and the portion of 269 Road south of the intersection with 240 Road.</a></td>
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<td></td>
<td><a href="#">Realign a portion of Old Fort Road south of 240 Road.</a></td>
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<td></td>
<td></td>
<td><a href="#">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.</a></td>
<td></td>
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<td></td>
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<td><a href="#">Widen shoulders or add a path on 271 Road between the Wuthrich Quarry and Highway 97.</a></td>
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<td><a href="#">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.</a></td>
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*(# denotes extracted text from the image)*
### Potential Residual Effect

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</thead>
<tbody>
<tr>
<td>Road safety</td>
<td>Operations</td>
<td>Operation of the reservoir and change to microclimate and fog conditions Permanent road upgrades</td>
<td>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</td>
<td>Not significant Project benefit to road safety due to permanent road upgrades</td>
</tr>
</tbody>
</table>

### Section 32 – Heritage Resources

<table>
<thead>
<tr>
<th>Changes to resource integrity:</th>
<th>Construction</th>
<th>Construction of the Project</th>
<th>Implement the following:</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface disturbance</td>
<td></td>
<td></td>
<td>Heritage Resources Management Plan</td>
<td>Not significant</td>
</tr>
<tr>
<td>Disturbance of structures</td>
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<td></td>
<td>Chance find procedure</td>
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<tr>
<td>Subsurface disturbance</td>
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<td>Construction monitoring</td>
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<tr>
<td>Compaction</td>
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<td>Depending on the nature and importance of identified heritage resources, various mitigation measures will be used:</td>
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<tr>
<td>Erosion</td>
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<td></td>
<td>▪ Avoid sites and reduce resource damage where possible</td>
<td></td>
</tr>
<tr>
<td>Changes to resource accessibility:</td>
<td></td>
<td></td>
<td>▪ Manage any found burials following provincial guidelines</td>
<td></td>
</tr>
<tr>
<td>Increased access</td>
<td></td>
<td></td>
<td>▪ Conduct additional reconnaissance and field surveys as warranted</td>
<td></td>
</tr>
<tr>
<td>Unauthorized collection</td>
<td></td>
<td></td>
<td>▪ Document historical sites and relocate important structures, if found</td>
<td></td>
</tr>
<tr>
<td>Lack of access</td>
<td></td>
<td></td>
<td>▪ Class I Staged Scientific Excavation</td>
<td></td>
</tr>
<tr>
<td>Other relevant considerations raised by Aboriginal groups</td>
<td></td>
<td></td>
<td>▪ Class II Stratified Sample Excavation</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>▪ Systematic surface collection</td>
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<td></td>
<td></td>
<td></td>
<td>▪ Resource capping</td>
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<td></td>
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<td></td>
<td>▪ Commemorate heritage resources as appropriate</td>
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<td></td>
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<td></td>
<td>▪ Provide funds to local museums to support heritage</td>
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</tr>
</tbody>
</table>
### Potential Residual Effect

<table>
<thead>
<tr>
<th>Potential Residual Effect</th>
<th>Project Phase</th>
<th>Contributing Project Activity or Physical Works</th>
<th>Proposed Mitigation</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Operations</td>
<td>Operation of the reservoir</td>
<td></td>
<td>Not significant</td>
</tr>
</tbody>
</table>

**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*

**Programming**
Through implementation of Heritage Resources Management Plan any specific issues raised by Aboriginal groups can be addressed.

**Operation**
Implement the following:
- Heritage Resources Management Plan
- Chance Find Procedure
- Systematic surface collection
- Reservoir erosion monitoring
- Conduct reconnaissance and systematic surface collection of exposed resources or installation of protective measures

**NOTE:** N/A – not applicable
### Table 38.2 Summary of Effects on Federal Considerations

<table>
<thead>
<tr>
<th>Federal considerations</th>
<th>How Addressed in the EIS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Changes to the Environment</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>An understanding of the changes the Project may cause to the environment is presented in Volume 2 Section 11 Environmental Background, including:</td>
</tr>
<tr>
<td></td>
<td>▪ Geology, terrain and soils</td>
</tr>
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<td></td>
<td>▪ Surface water regime</td>
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<td></td>
<td>▪ Water quality</td>
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<tr>
<td></td>
<td>▪ Groundwater regime</td>
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<tr>
<td></td>
<td>▪ Thermal and ice regime</td>
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<tr>
<td></td>
<td>▪ Fluvial geomorphology and sediment transport</td>
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<tr>
<td></td>
<td>▪ Methylmercury</td>
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<td></td>
<td>▪ Microclimate</td>
</tr>
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<td></td>
<td>▪ Air quality</td>
</tr>
<tr>
<td></td>
<td>▪ Noise and vibration</td>
</tr>
<tr>
<td></td>
<td>▪ Electric and magnetic fields</td>
</tr>
<tr>
<td></td>
<td>Changes to the environment as a result of the Project are used to assess the potential environmental effects of the Project on Fish and Fish Habitat (Volume 2 Section 12), Vegetation and Ecological Communities (Volume 2 Section 13), and Wildlife Resources (Volume 2 Section 14)</td>
</tr>
<tr>
<td><strong>Changes to components of the environment within federal jurisdiction</strong></td>
<td></td>
</tr>
<tr>
<td>Fish and Fish Habitat</td>
<td>The assessment of Project effects on fish and fish habitat and aquatic species was undertaken in consideration of the federal <em>Fisheries Act</em>, and the federal <em>Species at Risk Act</em>. The results of the assessment are presented in Volume 2 Section 12 Fish and Fish Habitat, and are summarised in Volume 1 Executive Summary.</td>
</tr>
<tr>
<td>Wildlife</td>
<td>The assessment of Project effects on wildlife resources was undertaken in consideration of the federal <em>Migratory Birds Convention Act</em> and the federal <em>Species at Risk Act</em>. The results of the assessment are presented in Volume 2 Section 13 Vegetation and Ecological Communities and Section 14 Wildlife Resources, and are summarised in Volume 1 Executive Summary.</td>
</tr>
<tr>
<td><strong>Changes to the environment that would occur on federal or transboundary land</strong></td>
<td></td>
</tr>
<tr>
<td>Federal land</td>
<td>There are no aspects of the Project directly on federal land, and there are no changes to the environment predicted on federal land including Indian Reserves. (see Volume 1 Section 4.1 Project Location)</td>
</tr>
</tbody>
</table>
Site C Clean Energy Project Environmental Impact Statement
Section 38: Summary of Potential Residual Effects of the Project

<table>
<thead>
<tr>
<th>Federal considerations</th>
<th>How Addressed in the EIS</th>
</tr>
</thead>
</table>
| Transboundary land: the Project is approximately 62 river km upstream of the BC-Alberta border 1,300 river km upstream of the Alberta – Northwest Territory border (Slave River) | The Project changes to environmental conditions on the Peace River downstream of the Project are described in Volume 2 Section 11 Environmental Background. The technical study areas extend into Alberta for:  
  - Surface water regime (Section 11.4), the downstream study boundary extends to Peace Point, Alberta  
  - Thermal and ice regime (Section 11.7), downstream study boundary for ice study extends to Fort Vermilion, Alberta  
  - Fluvial geomorphology and sediment transport (Section 11.8), the downstream study boundary extends to Peace Point, Alberta  
  No technical study areas extended into Northwest Territory.  
  The Local Assessment Areas for the following Valued Components extended into Alberta:  
  - Fish and Fish Habitat (Volume 2 Section 12 Fish and Fish Habitat), the downstream assessment boundary extends to Many Islands, Alberta  
  - Current Use of Lands and Resources for Traditional Purposes (Volume 3 Section 19) extends downstream to Many Islands, Alberta (based on the LAA for fish and fish habitat)  
  - Navigation (ice bridges at Shaftesbury and Tomkins Landing) (Volume 3 Section 26 Navigation), the downstream assessment boundary includes the locations of ice bridges in Alberta at Shaftesbury and Tomkins Landing  
  No Local Assessment Areas extended into Northwest Territory.                                                                                                                                 |

<table>
<thead>
<tr>
<th>Changes to the environment that are directly linked or necessarily incidental to federal decisions</th>
</tr>
</thead>
</table>
| **Fisheries Act**                                                                            | The assessment of Project effects on fish and fish habitat and aquatic species was undertaken in consideration of potential federal decisions under the federal *Fisheries Act*, and the federal *Species at Risk Act*.  
  The results of the assessment are presented in Volume 2 Section 12 Fish and Fish Habitat, and are summarised in Volume 1 Executive Summary. |

| Navigable Waters Protection Act                                                                 | The assessment of the Project effects on navigation was undertaken in consideration of potential federal decisions under the *Navigable Waters Protection Act*.  
  The results of the assessment are presented in Volume 3 Section 26 Navigation, and are summarised in Volume 1 Executive Summary. |

| Explosives Act                                                                               | Project activities that include the manufacture, storage and use of explosives would require federal decisions under the federal *Explosives Act*.  
  Detailed planning and permitting for the manufacture, storage, handling and use of explosives would be undertaken, including development of detailed environmental and safety management plans, prior to the associated Project construction activities. |

| Radiocommunication Act                                                                        | Project activities that include the installation and operation of radio communication equipment would require federal decisions under the federal *Radiocommunication Act*.  
  Detailed planning and licensing for installation and operation of radiocommunication equipment would be undertaken, including development of detailed environmental and safety management plans, prior to the associated Project construction activities. |
### Federal considerations | How Addressed in the EIS

<table>
<thead>
<tr>
<th>Effects of changes to the environment on Aboriginal peoples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Where Aboriginal groups identified interests in any valued component, additional baseline information was incorporated into the assessment as made available.</td>
</tr>
<tr>
<td>Traditional land use studies and community baseline studies were requested for First Nations near the Project area to provide baseline information and information about aboriginal interests in any valued component.</td>
</tr>
<tr>
<td>The following sections of the EIS address potential changes to the environment that may affect Aboriginal people:</td>
</tr>
<tr>
<td>- Volume 3 Section 19 Current Use of Lands and Resources for Traditional Purposes (using in particular information drawn from Volume 2 Section 11 Environmental Background, Section 12 Fish and Fish Habitat, Section 13 Vegetation and Ecological Resources, Section 14 Wildlife Resources and Volume 3 Section 24 Harvest of Fish and Wildlife Resources)</td>
</tr>
<tr>
<td>- Volume 3 Section 24 Harvest of Fish and Wildlife Resources (where information was provided aboriginal interests in commercial guide-outfitting and trapping were specifically considered)</td>
</tr>
<tr>
<td>- Volume 4 Section 32 Heritage Resources (aboriginal interests and traditional use studies, where provided, were considered in the assessment of effects on archaeological and historic resources)</td>
</tr>
<tr>
<td>- Volume 4 Section 33 Human Health (aboriginal receptors were specifically considered in the human health assessment)</td>
</tr>
<tr>
<td>- Volume 5 Section 34 Asserted or Established Aboriginal Rights and Treaty Rights, Aboriginal Interests and Information</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Effects of changes to the environment that are directly linked or necessarily incidental to federal decisions</th>
</tr>
</thead>
<tbody>
<tr>
<td>The assessment of Project effects on fish and fish habitat and aquatic species was undertaken in consideration of potential federal decisions under the federal <em>Fisheries Act</em>, and the federal <em>Species at Risk Act</em>.</td>
</tr>
<tr>
<td>The results of the assessment are presented in Volume 2 Section 12 Fish and Fish Habitat, and are summarised in Volume 1 Executive Summary.</td>
</tr>
<tr>
<td>The assessment of the Project effects on navigation was undertaken in consideration of potential federal decisions under the <em>Navigable Waters Protection Act</em>.</td>
</tr>
<tr>
<td>The results of the assessment are presented in Volume 3 Section 26 Navigation, and are summarised in Volume 1 Executive Summary.</td>
</tr>
</tbody>
</table>
39 COMPLETE LISTS OF MITIGATION AND FOLLOW-UP MEASURES

Two main categories of mitigation measures are described in the EIS: 1) those measures that will be implemented as standard practice during Project construction and operation in compliance with federal and provincial regulatory requirements, in compliance with existing BC Hydro policy and procedures, and in accordance with the technically feasible, cost-effective, and environmentally sound management of large-scale hydroelectric and infrastructure projects; and 2) those measures that have been developed specifically to avoid or reduce the potential adverse effects of the Project on the VCs.

Mitigation measures that fall within the first category are described in Volume 5 Section 35 Summary of Environmental Management Plans in the context of the Project’s proposed Environmental Management Program. Section 35 also lists relevant provincial and federal legislation, BC Hydro policies and procedures, and regulatory guidance documents to be followed during Project implementation.

Table 39.1 provides a complete list of the mitigation and compensation measures that fall within the second category – that is, the Project-specific measures identified in the EIS that are to be implemented during construction and operation to mitigate potential adverse effects on VCs, such that they are either unlikely to occur or are unlikely to be significant. Table 39.1 describes the potential effect on the VC, provides a reference to the relevant Environmental Management Plan where appropriate, indicates whether a potential residual effect is expected to occur despite the implementation of mitigation, and lists the anticipated significance, if any, of this effect.

Table 39.2 provides a complete list of the follow-up measures identified in the EIS. As described in Volume 5 Section 37.5 Requirements of any Follow-up Programs such measures will be implemented as necessary to address uncertainty regarding the nature or extent of predicted adverse residual effects on a VC and/or uncertainty about the potential for such an effect to become significant. Follow-up measures will also be used to evaluate the effectiveness of recommended mitigation measures to avoid or reduce adverse residual effects. Table 39.2 identifies the objectives of each follow-up program and briefly describes follow-up methods (e.g., type of information to be collected, monitoring frequency and duration, reporting requirements).

The Project-specific mitigation measures and the follow-up measures listed in Table 39.1 and Table 39.2, respectively, are described in the EIS with respect to potential environmental effects (Volume 2 Sections 12 to 15), economic, and land and resource use effects (Volume 3 Sections 16 through 27), and social, heritage, and human health effects (Volume 4 Sections 28 through 33).
### Table 39.1 Complete List of Mitigation Measures

<table>
<thead>
<tr>
<th>Potential Effect</th>
<th>Proposed Mitigation</th>
<th>Potential Residual Effect (Y/N)</th>
<th>Significant (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Section 12 – Fish and Fish Habitat</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loss of habitat due to construction of the dam and generating station, Highway 29, and Hudson’s Hope shoreline protection during construction</td>
<td>Implement the Fish and Aquatic Habitat Management Plan. Place material relocation sites 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. Compensate for fish habitats affected by Highway 29 realignment ‘like for like’ in the vicinity of the habitat loss. 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 berm. Retain non-merchantable trees and vegetation in riparian areas within a 15 m buffer zone from the high water mark. 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.</td>
<td>Y – Potential loss of fish habitat</td>
<td>N</td>
</tr>
<tr>
<td>Potential Effect</td>
<td>Proposed Mitigation</td>
<td>Potential Residual Effect (Y/N)</td>
<td>Significant (Y/N)</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>---------------------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Loss of habitat due to construction headpond and reservoir filling during construction</td>
<td>Contour Highway 29 materials sites prior to decommissioning to provide littoral fish habitat in the reservoir. Cap with gravel and cobbles material repositioning areas, 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.</td>
<td>Y – There would be a loss of habitat</td>
<td>Y</td>
</tr>
<tr>
<td>Altered fish habitat due to transformation of reservoir habitat during reservoir operations</td>
<td>Manage reservoir fluctuation within a 1.8 m maximum normal operating range to reduce effects to the shoreline fish habitat.</td>
<td>Y – There would be a change in habitat</td>
<td>N</td>
</tr>
<tr>
<td>Altered fish habitat downstream of Site C Dam during operations</td>
<td>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.</td>
<td>Y – There would be a change in habitat</td>
<td>N</td>
</tr>
</tbody>
</table>
| 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 sediments that are introduced into the aquatic environment. Reduce equipment production rates to reduce the amount of sediments generated by equipment when needed. | Y – Sediment inputs affecting fish health and survival | N                 |
<p>| 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 in winter, where feasible, to reduce soil disturbance | Y – Sediment inputs affecting fish health and survival | Y                 |</p>
<table>
<thead>
<tr>
<th>Potential Effect</th>
<th>Proposed Mitigation</th>
<th>Potential Residual Effect (Y/N)</th>
<th>Significant (Y/N)</th>
</tr>
</thead>
</table>
| 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. | Y                                                                          | N/A                          |
| Reduced fish health and survival due to stranding during construction             | Monitor fish habitat areas where periodic dewatering occurs to determine primary stranding locations  
Implement a fish collection and relocation program for stranded fish  
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  
Contour mainstem bars, where practical, to reduce potential for fish stranding | Y                                                                          | N/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. | Y – Fish would be harmed due to entrainment | N                             |
| Reduced fish health and survival due to increased total dissolved gas during construction | The spillway design has been modified to reduce total dissolved gas generation  
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 | Y – Fish would be exposed to total dissolved gas during spills | N                             |
<table>
<thead>
<tr>
<th>Potential Effect</th>
<th>Proposed Mitigation</th>
<th>Potential Residual Effect (Y/N)</th>
<th>Significant (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced fish health and survival due to stranding during operations</td>
<td>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.</td>
<td>N</td>
<td>N/A</td>
</tr>
<tr>
<td>Reduced fish health and survival due to fish entrainment during operations</td>
<td>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 spillway and tailrace areas.</td>
<td>Y – Fish would be harmed due to entrainment</td>
<td>N</td>
</tr>
<tr>
<td>Reduced fish health and survival due to increased total dissolved gas supersaturation during operations</td>
<td>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 Develop and implement an operational procedure to reduce total dissolved gas concentration in tailwater</td>
<td>Y – fish would be exposed to total dissolved gas during spills</td>
<td>N</td>
</tr>
<tr>
<td>Hindered fish movement due to obstruction to fish passage during construction</td>
<td>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.</td>
<td>Y – Hindered fish movement would occur</td>
<td>Y</td>
</tr>
<tr>
<td>Hindered fish movement due to obstruction to fish passage during operations</td>
<td>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.</td>
<td>Y – Hindered fish movement would occur</td>
<td>Y</td>
</tr>
</tbody>
</table>
### Section 13 – Vegetation and Ecological Communities

<table>
<thead>
<tr>
<th>Potential Effect</th>
<th>Proposed Mitigation</th>
<th>Potential Residual Effect (Y/N)</th>
<th>Significant (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Habitat alteration and fragmentation:</td>
<td>Implement the following Environmental Management Plans:</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>▪ Air Quality Management Plan</td>
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<td></td>
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<tr>
<td></td>
<td>▪ Erosion Prevention and Sediment Control Plan</td>
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<tr>
<td></td>
<td>▪ Fisheries and Aquatic habitat Management Plan</td>
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<td></td>
<td>▪ Fuel Handling and Storage Management Plan</td>
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<td></td>
<td>▪ Soil Management, Site Restoration and Revegetation Plan</td>
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<tr>
<td></td>
<td>▪ Vegetation and Invasive Plant Management Plan</td>
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<tr>
<td></td>
<td>Maintain a spatial database of rare plant occurrences within the Local Assessment Area</td>
<td></td>
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<tr>
<td></td>
<td>Place transmission towers and temporary roads away from wetlands and known rare plant occurrences where feasible.</td>
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<tr>
<td></td>
<td>Establish Environmental Protection zones to protect known rare plant occurrences located adjacent to construction areas where feasible.</td>
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<tr>
<td></td>
<td>Plan and implement construction activities in a manner that seeks to maintain the hydrology of adjacent wetlands, particularly where known rare plant occurrences are present.</td>
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<tr>
<td></td>
<td>Implement measures to maintain existing hydrological patterns as much as possible if roads cannot avoid wetlands.</td>
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<td></td>
<td>Install culverts under access roads to maintain hydrological balance</td>
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<td></td>
<td>Install sedimentation barriers as needed.</td>
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<td></td>
<td>Retain vegetation on steep, unstable slopes that would be highly susceptible to landslides if the vegetation was removed</td>
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<tr>
<td></td>
<td>Retain non-merchantable trees and vegetation in riparian areas within a 15 m buffer zone from the high water mark. Merchantable trees and vegetation that could interfere with navigation will be removed using clearing practices to maintain a 15 m machine-free zone.</td>
<td></td>
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<tr>
<td></td>
<td>BC Hydro will fund a compensation program that will include:</td>
<td></td>
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<tr>
<td></td>
<td>▪ A survey of habitat enhancement projects in the regional assessment area 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</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>▪ Identification of areas that are under threat from</td>
<td></td>
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</tr>
</tbody>
</table>
### Section 14 – Wildlife Resources

<table>
<thead>
<tr>
<th>Potential Effect</th>
<th>Proposed Mitigation</th>
<th>Potential Residual Effect (Y/N)</th>
<th>Significant (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development or in need of habitat enhancement. Where opportunities exist, BC Hydro will consider direct purchase – if offered for sale – and/or 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.</td>
<td>development or in need of habitat enhancement. Where opportunities exist, BC Hydro will consider direct purchase – if offered for sale – and/or 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.</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Undertake targeted surveys in the regional assessment area to locate additional occurrences of the 18 directly affected rare plant species that the Conservation Framework identifies as requiring additional inventories.</td>
<td>Undertake targeted surveys in the regional assessment area to locate additional occurrences of the 18 directly affected rare plant species that the Conservation Framework identifies as requiring additional inventories.</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Undertake a study that attempts to clarify the taxonomy of ochroleucus bladderwort. The study plan, which will be developed in consultation with the B.C. Conservation Data Centre, may include field, herbaria, and genetic work.</td>
<td>Undertake a study that attempts to clarify the taxonomy of ochroleucus bladderwort. The study plan, which will be developed in consultation with the B.C. Conservation Data Centre, may include field, herbaria, and genetic work.</td>
<td>Y</td>
<td>Y</td>
</tr>
</tbody>
</table>

#### Habitat Alteration and Fragmentation during construction and operations

Implement the following Environmental Management Plans:

- Erosion Prevention and Sediment Control Plan
- Fisheries and Aquatic habitat Management Plan
- Fuel Handling and Storage Management Plan
- Soil Management, Site Restoration and Revegetation
- Surface Water Quality Management Plan
- Vegetation and Invasive Plant Management Plan
- Wildlife Management Plan

Provide as inputs to the final design phase 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 so further reductions and avoidances can be considered.

Establish appropriate barriers and Environmental Protection Zones to avoid direct disturbance to wetland sites.

Create new wetland habitat areas for migratory birds and a range of other species.

Create areas that are “fish-free”, where appropriate, to reduce the effects of fish predation on invertebrates, amphibian eggs and larvae, and young birds.

Maintain existing hydraulic patterns if roads cannot avoid wetlands. Ditches, culverts, and other structures will be placed to maintain the natural drainage patterns.
<table>
<thead>
<tr>
<th>Potential Effect</th>
<th>Proposed Mitigation</th>
<th>Potential Residual Effect (Y/N)</th>
<th>Significant (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>and allow the movement of flows</td>
<td>Retain vegetation on steep, unstable slopes that would be highly susceptible to landslides if the vegetation was removed</td>
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<tr>
<td></td>
<td>Retain non-merchantable trees and vegetation within riparian areas around existing water bodies within a 15 m buffer zone from the high water mark. Merchantable trees may still be removed using clearing practices in order to maintain a 15 m machine-free zone. Locate artificial snake dens on warm aspect slopes in open areas away from major roads. Incorporate nest boxes for cavity-nesting waterfowl into wetland mitigation plans and within riparian vegetation zones, where feasible. Provide a portion of BC Hydro-owned land for breeding habitat for Northern Harrier and Short-eared Owl. Wetland compensation will also be made available to address some habitat losses for these two species. Incorporate bat roosting habitat features into new bridge designs, where feasible Install bat boxes on free-standing poles or on facility walls where their presence will not interfere with facility operations and maintenance. Create and disperse natural or artificial piles of coarse woody debris to maintain fisher foraging areas and cold-weather rest sites. Create arboreal resting sites for fisher Provide artificial fisher den boxes within forested stands that have limited den trees. Manage BC Hydro-owned lands at the Halfway River and Wilder Creek to provide ungulate winter range on the north bank of the Peace River. Consider the use of supplemental ungulate feeding programs during severe winters</td>
<td>Y</td>
<td>N</td>
</tr>
</tbody>
</table>

Disturbance and Displacement during construction and operations

Implement the following Environment Management Plans:
- Soil Management, Site Restoration and Revegetation Plan
- Wildlife Management Plan
Clear during winter months where feasible. If clearing work during the critical bird breeding season cannot be avoided, develop and implement a nest and lek search prior to clearing. Reduce, where feasible, light pollution at work sites Restrict access on roads used by work crews during construction
<table>
<thead>
<tr>
<th>Potential Effect</th>
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<th>Potential Residual Effect (Y/N)</th>
<th>Significant (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incorporate the location of rare species along the</td>
<td>Incorporate the location of rare species along the transmission line right-of-way or adjacent to generation facilities into BC Hydro’s GIS-based mapping system. Provide all known grouse lek locations during the final construction design phase. Use appropriate flagging if work is required immediately adjacent to any leks, and instruct personnel to avoid these sites. Update the baseline data on Bald Eagle nest sites from 2011 prior to commencement of construction. Erect Bald Eagle nesting platforms along the reservoir shoreline. If an active nest is lost due to the Project, new nesting structures will be provided. Retain Bald Eagle nests outside the dam construction area that are confirmed active the year that clearing is started within the reservoir through the entire construction phase until reservoir filling is initiated. Remove nests that could be lost during seasonal flooding associated with dam construction. For active nests retained through the construction period, a “no-clearing buffer” around each active nest will be implemented. Update baseline data on Bald Eagle nest sites from 2011 prior to commencement of construction. Erect Bald Eagle nesting platforms along the reservoir shoreline. If an active nest is lost due to the Project, new nesting structures will be provided. Retain Bald Eagle nests outside the dam construction area that are confirmed active the year that clearing is started within the reservoir through the entire construction phase until reservoir filling is initiated. Remove nests that could be lost during seasonal flooding associated with dam construction. For active nests retained through the construction period, a “no-clearing buffer” around each active nest will be implemented. Develop a Human-Bear Conflict Management Plan for the Project.</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Mortality during construction and operations</td>
<td>Implement the following Environment Management: Erosion Prevention and Sediment Control Plan. Fuel Handling and Storage Management Plan. Vegetation and Invasive Plant Management Plan. Wildlife Management Plan. Design a portion of the wetlands created to compensate for habitat loss to remain fish-free to eliminate predation to invertebrates (dragonfly larva), amphibians, and reptiles. Include amphibian passage structures in road design where roads are adjacent to wetlands or amphibian migrations. Clear forested habitat – potential roosting and cover sites for bats and fisher – before inundation begins. Clearing will take place during late fall and winter, before the birthing season, and when bats are not present or are in hibernacula, where feasible. Schedule construction activities following guidance from Peace Region Selected Terrestrial and Aquatic Wildlife Least Risk Windows. Develop a Human-Bear Conflict Management Plan for the Project.</td>
<td>Y</td>
<td>N</td>
</tr>
</tbody>
</table>
### Section 15 – Greenhouse Gases

<table>
<thead>
<tr>
<th>Potential Effect</th>
<th>Proposed Mitigation</th>
<th>Potential Residual Effect (Y/N)</th>
<th>Significant (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emission of GHGs from construction activities</td>
<td>Implement fleet management measures to reduce fuel consumption and increase fuel efficiency.</td>
<td>Y – Emission of GHGs</td>
<td>N</td>
</tr>
<tr>
<td>Release of GHGs during operation</td>
<td>Reduce the long-term conversion of land while still achieving the purpose of the Project.</td>
<td>Y – Emission of GHGs</td>
<td>N</td>
</tr>
</tbody>
</table>

### Section 16 – Local Government Revenue

| Change in local government revenue: 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. | Implement measures to address potential effects on demand for services and infrastructure, as described under Community Infrastructure and Services Provide Project workforce camps that will be self-sufficient and not dependent upon local government services Provide a one-time payment to the District of Hudson’s Hope to address private land no longer available for development Provide annual grants-in-lieu payments estimated at $1.3 million annually to local governments as directed by provincial Order-In-Council, throughout operations | N | N/A |

### Section 17 – Labour Market

| Change in demand for direct and indirect construction phase labour – Project demand for labour during construction is greater than local labour availability | Use local labour supply as available Augment and enhance the local labour supply:  - Provide support for training and skill development, focused on increasing the local labour market participation rate and skill level of Local Assessment Area population  - Fund student bursaries for trades training  - Support Aboriginal training initiatives and capacity building  - Recruit, including accessing labour pools outside of the region, and attract new entrants to the local labour force  - Fund additional daycare spaces in the Fort St. John area to support spousal participation in the labour market  - Encourage Aboriginal participation in the workforce | N | N/A |
### Section 18 – Regional Economic Development

<table>
<thead>
<tr>
<th>Potential Effect</th>
<th>Proposed Mitigation</th>
<th>Potential Residual Effect (Y/N)</th>
<th>Significant (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Due to Project expenditures: Change in business opportunities during construction Change in business and contracting profile, capabilities and capacity during construction</td>
<td>Continue the Project business liaison program  - Work with local Economic Development Commissions and business organizations  - Continue to deliver business information sessions  - Encourage use of, and participation in, the Project business directory  Apply BC Hydro Aboriginal procurement policy to increase Aboriginal participation in Project business opportunities. Seek information on Aboriginal businesses and capabilities.</td>
<td>Y – Positive effect on Regional Economic Development</td>
<td>N</td>
</tr>
</tbody>
</table>

### Section 19 – Current Use of Land and Resources for Traditional Purposes

<table>
<thead>
<tr>
<th>Potential Effect</th>
<th>Proposed Mitigation</th>
<th>Potential Residual Effect (Y/N)</th>
<th>Significant (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Changes in fishing opportunities and practices during construction and operations</td>
<td>Consult Aboriginal groups respecting the development of fish habitat compensation projects that align with BC Hydro compensation programs.  Seek input from Aboriginal groups respecting mitigation strategies.  Continue to consult with Aboriginal groups on clearing plans and protocols.  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.  Implement mitigation measures set out in Volume 2 Section 12 Fish and Fish Habitat and Volume 3 Section 24 Harvest of Fish and Wildlife Resources.</td>
<td>Y – Reduced access to fishing areas and potentially reduced success in harvest of targeted species</td>
<td>N</td>
</tr>
<tr>
<td>Changes in hunting and trapping opportunities and practices during construction and operations</td>
<td>Consult with Aboriginal groups respecting the development of wildlife habitat compensation projects that align with BC Hydro compensation programs.  Seek input from Aboriginal groups respecting mitigation strategies, such as mitigation measures related to trap lines in the Project activity zone.  Continue to consult with Aboriginal groups on clearing plans and protocols.  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.</td>
<td>Y – Temporary reductions in availability of targeted species and temporarily reduced access to hunting areas during construction.</td>
<td>N</td>
</tr>
<tr>
<td>Potential Effect</td>
<td>Proposed Mitigation</td>
<td>Potential Residual Effect (Y/N)</td>
<td>Significant (Y/N)</td>
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</table>
| Changes to other cultural and traditional uses of land during construction and operations | - Work with Aboriginal groups to ground truth traditional land use information for specific areas within the Project activity zone prior to commencing construction, e.g., when determining the exact location of an access road.  
- Continue to consult with Aboriginal groups regarding clearing plans and protocols.  
- Develop a communications program to inform harvesters of planned or unplanned events that may affect opportunities to harvest plants, berries, and other resources.  
- Continue to consult with Aboriginal groups respecting the development of 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.  
- 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, measures to address effects on cabins associated with tenured trap lines. Where untenured cabins may be impacted by the Project, BC Hydro will work with Aboriginal individuals to determine appropriate measures that could be implemented.  | Y – Permanent loss of use of and access to certain culturally important places and valued landscapes within the LAA | Y                             |
### Section 20 – Agriculture

<table>
<thead>
<tr>
<th>Potential Effect</th>
<th>Proposed Mitigation</th>
<th>Potential Residual Effect (Y/N)</th>
<th>Significant (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temporary loss of agricultural land during construction and operations</td>
<td>Implement the following Environmental Management Plans:</td>
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<tr>
<td></td>
<td>• Soil Management, Site Restoration and Revegetation Plan</td>
<td></td>
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<td></td>
<td>• Borrow and Quarry Site Reclamation Plan</td>
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<td></td>
<td>• Vegetation and Invasive Plant Management Plan</td>
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<td></td>
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<td>N</td>
<td>N/A</td>
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<tr>
<td>Permanent loss of agricultural land during construction and operations</td>
<td>Implement mitigation measures including:</td>
<td>Y – Permanent loss of agricultural land</td>
<td>N</td>
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<tr>
<td></td>
<td>• Irrigation improvements</td>
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<tr>
<td></td>
<td>• Drainage improvements</td>
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<td></td>
<td>• Relocation of suitable quality soil in selected locations</td>
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<td></td>
<td>• Inclusion of land in the Agricultural Land Reserve</td>
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<td></td>
<td>• Agricultural compensation fund</td>
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</tbody>
</table>
### Site C Clean Energy Project Environmental Impact Statement

**Volume 5: Asserted or Established Aboriginal Rights and Treaty Rights, Aboriginal Interests and Information, Environmental Management Plans, and Federal Information Requirements**

**Section 39: Complete Lists of Mitigation and Follow-up Measures**

<table>
<thead>
<tr>
<th>Potential Effect</th>
<th>Proposed Mitigation</th>
<th>Potential Residual Effect (Y/N)</th>
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</tr>
</thead>
</table>
| Effects on individual farm operations during construction                           | Acquire land required for the Project as outlined in Section 11.3 Land Status, Tenure and Project Requirements. Implement the following Environmental Management Plans:  
  - Soil Management, Site Restoration and Revegetation Plans  
  - Vegetation and Invasive Plant Management Plan, including biosecurity protocols if required  
  - Traffic Management Plans  
  - Public Safety Management Plan                                                                                                           | N                               | N/A               |
| 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                                                                                     | N                               | N/A               |
| Change to agricultural economic activity during construction and operations        | Implement an agricultural compensation fund.                                                                                                                          | N                               | N/A               |
| Change to regional food production and consumption                                | No change anticipated to regional food self-reliance. No mitigation required.                                                                                       | N                               | N/A               |

**Section 21 – Forestry**

| Change in land use, resource use, access, and activities related to industrial forestry use | No change anticipated to industrial forest use. No mitigation required.                                                                                                                                               | N                               | N/A               |
| 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.                                                                                             | N                               | N/A               |
### Section 22 – Oil, Gas and Energy

<table>
<thead>
<tr>
<th>Potential Effect</th>
<th>Proposed Mitigation</th>
<th>Potential Residual Effect (Y/N)</th>
<th>Significant (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in land and resource use, and oil and gas infrastructure during construction and operations</td>
<td>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.</td>
<td>N</td>
<td>N/A</td>
</tr>
<tr>
<td>Access to oil and gas resources and industry activity during construction</td>
<td>Access to resources would not be restricted. No mitigation required.</td>
<td>N</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Section 23 – Minerals and Aggregates

<table>
<thead>
<tr>
<th>Potential Effect</th>
<th>Proposed Mitigation</th>
<th>Potential Residual Effect (Y/N)</th>
<th>Significant (Y/N)</th>
</tr>
</thead>
</table>
| 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 sources  
- BC Hydro commitment to stockpile surplus rock material at the West Pine, Wuthrich, and Portage Mountain quarries | N                                                              | N/A               |

### Section 24 – Harvest of Fish and Wildlife Resources

<table>
<thead>
<tr>
<th>Potential Effect</th>
<th>Proposed Mitigation</th>
<th>Potential Residual Effect (Y/N)</th>
<th>Significant (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Changes in fishing opportunities during construction</td>
<td>Implement Outdoor Recreation and Tourism mitigation measures that support recreational shoreline use, boating access, and water-based navigation, to also mitigate construction effects on fishing opportunities. Implement Fish and Fish Habitat mitigation measures that support fish and wildlife populations, to also mitigate construction effects on fishing opportunities.</td>
<td>Y – Decrease in fishing opportunities</td>
<td>N</td>
</tr>
<tr>
<td>Changes in fishing opportunities during operations</td>
<td>Benefits on fishing opportunities during operations. No mitigation required.</td>
<td>Y – Positive effect on fishing opportunities</td>
<td>N</td>
</tr>
<tr>
<td>Changes in hunting opportunities during construction</td>
<td>Implement Outdoor Recreation and Tourism mitigation measures that support recreational shoreline use, boating access, and water-based navigation, to also mitigate construction effects on hunting opportunities. Implement Wildlife Resources mitigation measures that support wildlife populations, to also mitigate construction effects on hunting opportunities.</td>
<td>Y – Decrease in hunting opportunities</td>
<td>N</td>
</tr>
<tr>
<td>Potential Effect</td>
<td>Proposed Mitigation</td>
<td>Potential Residual Effect (Y/N)</td>
<td>Significant (Y/N)</td>
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</tr>
<tr>
<td>Changes in hunting opportunities during operations</td>
<td>No change anticipated in hunting opportunities during operations. No mitigation required.</td>
<td>N</td>
<td>N/A</td>
</tr>
<tr>
<td>Changes in use of harvesting areas during construction</td>
<td>Positive effect on use of harvesting areas during construction. No mitigation required.</td>
<td>Y – Positive effect on use of harvesting areas</td>
<td>N/A</td>
</tr>
<tr>
<td>Changes in use of harvesting areas during operations</td>
<td>No change anticipated in use of harvesting areas during operations. No mitigation required.</td>
<td>N</td>
<td>N/A</td>
</tr>
<tr>
<td>Changes in trapping opportunities during construction</td>
<td>Implement Wildlife Resources mitigation measures that support fur-bearing populations to also support the availability of harvestable species for trapping. Conclude agreements and implement any agreed to provisions, where appropriate, with third-party tenured trapline holders.</td>
<td>N</td>
<td>N/A</td>
</tr>
<tr>
<td>Changes in trapping opportunities during operations</td>
<td>Conclude agreements and implement any agreed-to provisions, where appropriate, with third-party tenured trapline holders</td>
<td>N</td>
<td>N/A</td>
</tr>
<tr>
<td>Changes in guide outfitter opportunities during construction</td>
<td>Provide communications regarding area or road closures, to help outfitters plan their guided activities to avoid conflict with the Project Implement Outdoor Recreation and Tourism mitigation measures that support recreational shoreline use, boating access, and water-based navigation, to also mitigate construction effects on guide-outfitting opportunities Implement Wildlife Resources mitigation measures that support game populations to also support the availability of harvestable species for guide outfitting activities. Conclude agreements and implement any agreed to provisions, where appropriate, with third-party tenured guide-outfitters.</td>
<td>N</td>
<td>N/A</td>
</tr>
<tr>
<td>Changes in guide outfitter opportunities during operations</td>
<td>Implement Wildlife Resources mitigation measures that support game populations to also support the availability of harvestable species for guide outfitting activities.</td>
<td>N</td>
<td>N/A</td>
</tr>
<tr>
<td>Potential Effect</td>
<td>Proposed Mitigation</td>
<td>Potential Residual Effect (Y/N)</td>
<td>Significant (Y/N)</td>
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</tr>
<tr>
<td><strong>Section 25 – Outdoor Recreation and Tourism</strong></td>
<td>Changes in outdoor recreation and tourism infrastructure during construction 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. Identify public communications procedures for public safety hazards, and access restrictions and closures during construction of the Site C dam using a Public Safety Management Plan Provide funds to the District of Hudson’s Hope for enhancement of Alwin Holland Municipal Park or other community shoreline recreation areas. Provide a Community Recreation Site Fund to support development of new shoreline recreation sites on the Site C reservoir and on the Peace River and tributaries between Site C and the Alberta border. 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. Establish a permanent north bank Site C dam site public viewpoint.</td>
<td>Y – Changes in outdoor recreation and tourism infrastructure</td>
<td>N</td>
</tr>
<tr>
<td>Changes in outdoor recreation and tourism infrastructure during operations</td>
<td>Develop a Public Safety Management Plan that will identify public communications procedures for public safety hazards, and access restrictions and closures during operation Identify public communications procedures for public safety hazards, and access restrictions and closures during operation of the Site C dam using a Public Safety Management Plan Fund the development of a B.C. Peace River/Site C Reservoir Navigation and Recreation Opportunities Plan.</td>
<td>N</td>
<td>N/A</td>
</tr>
</tbody>
</table>
| Change in outdoor recreation and tourism use levels during construction         | The Project is anticipated to increase recreation and tourism use levels during construction, and would not require specific mitigation measures. Implement these Housing measures that would also support recreation and tourism use:  
  • Work with the private sector and local government to develop new RV sites.  
  • Implement on-site workforce housing.                                                                                                                                                                                                                                                                                                                                                               | N                             | N/A               |
### Section 26 – Navigation

<table>
<thead>
<tr>
<th>Potential Effect</th>
<th>Proposed Mitigation</th>
<th>Potential Residual Effect (Y/N)</th>
<th>Significant (Y/N)</th>
</tr>
</thead>
</table>
| Changes to navigability, navigational use and access during construction          | Provide recreational boaters with information about restricted navigation zones at the dam site, 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, as part of the Public Safety Management Plan.  
  Build three boat launches along the Site C reservoir accessible via Highway 29 to support navigability and navigational use.  
  BC Hydro will fund community groups to support re-establishment of recreational sites on the Site C reservoir and downstream, and to re-establish and create new use patterns and access.  
  BC Hydro will 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.  
  BC Hydro will fund the development of a Navigation and Recreation Opportunities Plan, intended to enable the local communities to plan for boating and recreation opportunities created by the Site C reservoir. | Y – Changes to water-based navigability                                          | N                               |
| Changes to navigability, navigational use and access during operations            | Provide boater communications to enable trip planning and safety for boaters’ recreational boating activities in consideration of any temporary navigation restrictions or public safety concerns during the early years of the Site C reservoir operations | N                               | N/A               |
| Potential navigational hazards in waterways during construction                  | No mitigation required.                                                                                                                             | N/A                             | N/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. Signage, as required, will be provided in accordance with the Guidelines for Public Safety Around Dams. | N                               | N/A               |
### Potential Effect Proposed Mitigation Potential Residual Effect (Y/N) Significant (Y/N)

<table>
<thead>
<tr>
<th>Potential Effect</th>
<th>Proposed Mitigation</th>
<th>Potential Residual Effect (Y/N)</th>
<th>Significant (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Navigation use restrictions during construction</td>
<td>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, will address navigability and navigational use, and the identification of potential hazards and interferences in waterways. Provide public communication about areas that remain open to navigation and are accessible during construction (inclusive of boat launches and other public access)</td>
<td>N</td>
<td>N/A</td>
</tr>
<tr>
<td>Navigation use restrictions during operations</td>
<td>Provide boater communications to enable trip planning and safety for boaters’ recreational boating activities in consideration of any temporary navigation restrictions or public safety concerns during the early years of the Site C reservoir operations</td>
<td>N</td>
<td>N/A</td>
</tr>
<tr>
<td>Changes to microclimate during operations</td>
<td>No change anticipated. No mitigation required.</td>
<td>N</td>
<td>N/A</td>
</tr>
<tr>
<td>Changes to visibility of structures and overhead wiring during operations</td>
<td>No change anticipated. No mitigation required.</td>
<td>N</td>
<td>N/A</td>
</tr>
<tr>
<td>Changes to Shaftesbury and Tompkins Landing ferry and ice bridge operations during operations</td>
<td>No change anticipated. No mitigation required.</td>
<td>N</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Section 27 - 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. 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. | Y - Changes to visual resources | N                 |
| Changes to visual resources during operations                                   | No mitigation proposed.                                                                                                                                                                                                | Y - Changes to visual resources (shoreline erosion) | N                 |
### Section 28 – Population and Demographics

<table>
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<tr>
<th>Potential Effect</th>
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<th>Potential Residual Effect (Y/N)</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Changes to PRRD population, with specific reference to City of Fort St. John during construction</td>
<td>Implement mitigation measures proposed for the Labour Market and Housing VCs, including the provision of camp accommodation, to moderate growth of the local population. Implement mitigation measures proposed for the Community Infrastructure and Services VC to mitigate the effects of an increased local population.</td>
<td>Y - Increases to PRRD and City of Fort St. John population</td>
<td>N</td>
</tr>
<tr>
<td>Changes to Aboriginal community populations during construction</td>
<td>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 cross-cultural awareness training. Procurement of local Aboriginal businesses for Project construction contracts where feasible.</td>
<td>Y - Potential in and out migration from Aboriginal communities</td>
<td>N</td>
</tr>
</tbody>
</table>

### Section 29 – Housing

<table>
<thead>
<tr>
<th>Potential Effect</th>
<th>Proposed Mitigation</th>
<th>Potential Residual Effect (Y/N)</th>
<th>Significant (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in the demand for housing, with specific reference to the City of Fort St. John during construction</td>
<td>Scale camp capacity up or down as required to accommodate direct workers. Provide logistical assistance to the Project workforce seeking local accommodation, through a community camp co-ordinator. Build approximately 40 new permanent housing units to be used by the construction workforce in the Fort St. John area, to expand the supply of rental housing. Transition the units to permanent affordable housing use after construction. 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).</td>
<td>Y - Housing demand of increased population may create shortages in the apartment rental market. Demand for emergency housing may increase</td>
<td>N</td>
</tr>
<tr>
<td>Potential Effect</td>
<td>Proposed Mitigation</td>
<td>Potential Residual Effect (Y/N)</td>
<td>Significant (Y/N)</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td><strong>Section 30 – Community Infrastructure and Services</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Change in demand for, or provision of, services – health and social services during construction</td>
<td>Provide health care services (doctor, nurse) for Project workforce. Provide Northern Health with actual workforce and camp population statistics to help plan for service levels. Provide new families with local information package about health, education, and social services. Fund daycare spaces in the City of Fort St. John area.</td>
<td>Y - The Project would create incremental demand on local health and social services driven by increased in-community population and camp workforce associated with the Project.</td>
<td>N</td>
</tr>
<tr>
<td>Change in demand for, or provision of, services – emergency services during construction</td>
<td>Communicate project management plans and activities to emergency service providers. Provide security, firefighting, first aid, and medical transport services for all Project construction sites and activities. Implement policies on safe living and work environment. Implement Traffic Management Plan. Provide direct funding to the RCMP to increase policing in the region Provide on-site first aid and emergency transport. Provide on-site firefighting services. Develop and implement Project emergency plans, including integration with existing BC Hydro Peace River facilities.</td>
<td>N</td>
<td>N/A</td>
</tr>
<tr>
<td>Change in demand for, or provision of, services – education services during construction</td>
<td>Provide funding to Northern Opportunities to support their pre-apprenticeship program Provide early notice to education institutions for planning purposes Partner with education institutions on training</td>
<td>N</td>
<td>N/A</td>
</tr>
<tr>
<td>Change in demand for, or provision of, services – recreation and leisure services during construction</td>
<td>Provide recreation facilities and programming at the camps for workforce. Work with City of Fort St. John on potential workforce policies or agreements regarding use of community leisure and recreation facilities.</td>
<td>N</td>
<td>N/A</td>
</tr>
</tbody>
</table>
## Section 39: Complete Lists of Mitigation and Follow-up Measures

<table>
<thead>
<tr>
<th>Potential Effect</th>
<th>Proposed Mitigation</th>
<th>Potential Residual Effect (Y/N)</th>
<th>Significant (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in demand for, or provision of, services – solid waste during construction</td>
<td>Implement construction Waste Management Plan, including waste reduction and recycling policies, and management of industrial waste. Coordinate waste management planning with PRRD. Deliver and stockpile landfill cover material for Fort St. John landfill.</td>
<td>N</td>
<td>N/A</td>
</tr>
<tr>
<td>Change in demand for, or provision of, services – sewer and water</td>
<td>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.</td>
<td>N</td>
<td>N/A</td>
</tr>
<tr>
<td>Displacement of infrastructure during construction</td>
<td>Fund relocation of Hudson’s Hope water intake, pumping station, and treatment plant. 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), Taylor water supply (well site access), 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.</td>
<td>N</td>
<td>N/A</td>
</tr>
</tbody>
</table>

## Section 31 – Transportation

**Highway 29 North**
- Realign Highway 29 incorporating geometric and cross-section improvements for sections of highway that would be inundated by the reservoir between Hudson’s Hope and Bear Flat.
- 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 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.

<table>
<thead>
<tr>
<th>Potential Effect</th>
<th>Proposed Mitigation</th>
<th>Potential Residual Effect</th>
<th>Significant</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Y - Potential changes to traffic delays and road safety – all road segments</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Residual adverse effects anticipated on all road segments due to general increase in traffic</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Improved road safety on some routes due to permanent road upgrades on some routes</td>
<td></td>
</tr>
<tr>
<td>Potential Effect</td>
<td>Proposed Mitigation</td>
<td>Potential Residual Effect (Y/N)</td>
<td>Significant (Y/N)</td>
</tr>
<tr>
<td>------------------</td>
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<td>---------------------------------</td>
<td>------------------</td>
</tr>
</tbody>
</table>
| **Jackfish Lake Road**  
Potential Effect: Jackfish Lake Road
Proposed Mitigation: 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. | Y | Y |
| **North Bank Minor Roads**  
Potential Effect: North Bank Minor Roads
Proposed Mitigation: Implement carpool program. 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. | Y | Y |
| **Road safety during operations**  
Potential Effect: Road safety during operations
Proposed Mitigation: 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 | Y | N |

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39-23
### Section 32 – Heritage Resources

#### 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

#### Proposed Mitigation

- Implement the following:
  - Heritage Resources Management Plan
  - Chance find procedure
  - Construction 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
  - Manage any found burials following provincial guidelines
  - 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.

#### 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

#### Proposed Mitigation

- Implement the following:
  - Heritage Resources Management Plan
  - Chance Find Procedure Systematic surface collection
  - Reservoir erosion monitoring
  - Conduct reconnaissance and systematic surface collection of exposed resources) or installation of protective measures
### Section 33 – Human Health

<table>
<thead>
<tr>
<th>Potential Effect</th>
<th>Proposed Mitigation</th>
<th>Potential Residual Effect (Y/N)</th>
<th>Significant (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in ambient air quality during construction</td>
<td>Implement Air Quality Management Plan</td>
<td>N</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Utilize filters at concrete batch plants and crushers, and silos for fly ash cement and aggregate at concrete batch plants</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Retain vegetation barriers where practical</td>
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<tr>
<td></td>
<td>Reduce burning of wood waste and follow BC Ministry of Environment Open Burning Smoke Control Regulation</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Conduct detailed modelling once the exact locations of emission sources are better defined. Use modelling results to determine where to place PM$<em>{2.5}$ and PM$</em>{10}$ monitors on the north and south bank.</td>
<td></td>
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<tr>
<td></td>
<td>Locate work camps outside the area of potential air quality exceedance.</td>
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<tr>
<td></td>
<td>Monitor air quality associated with construction of Hudson’s Hope shoreline protection; implement mitigation measures as required</td>
<td></td>
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<tr>
<td></td>
<td>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</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in noise and vibration during construction</td>
<td>Provide temporary noise barriers between work sites and receptors, use portable enclosures/barriers implement notification of work program for residents Develop Noise and Vibration Management Plans for work site, monitor noise levels at work sites and adaptive management as required Construct perimeter fencing Retain or plant tree screens Build berms and acoustic barriers Enclose elements of conveyor belt system Develop and implement noise monitoring and adaptive management as required</td>
<td>N</td>
<td>N/A</td>
</tr>
<tr>
<td>Change in potable and recreational water quality during construction</td>
<td>Implement the following Environmental management Plans: • Spill Prevention and Emergency Response Plan • Erosion Prevention and Sediment Control Plan • Groundwater Protection Plan</td>
<td>N</td>
<td>N/A</td>
</tr>
</tbody>
</table>
### Complete Lists of Mitigation and Follow-up Measures

<table>
<thead>
<tr>
<th>Potential Effect</th>
<th>Proposed Mitigation</th>
<th>Potential Residual Effect (Y/N)</th>
<th>Significant (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in potable and recreational water quality during operations</td>
<td>Implement the following Environmental Management Plans:</td>
<td>N</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>• Spill Prevention and Emergency Response Plan</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Erosion Prevention and Sediment Control Plan</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Groundwater Protection Plan</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>N</td>
<td>N/A</td>
</tr>
<tr>
<td>Change in country foods</td>
<td>Monitor mercury concentrations in fish to identify changes</td>
<td>N</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Provide the public with information about safe fish consumption levels</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:**

N/A – not applicable
Table 39.2 is a complete list of recommended follow-up programs for Project VCs, as described in detail in each of the VC effects assessment in Volume 2 Sections 12 through 15, Volume 3 Sections 16 through 27, and Volume 4 Sections 28 through 33.

### Table 39.2 Complete List of Follow-Up Measures

<table>
<thead>
<tr>
<th>Follow-Up Program Objective(s)</th>
<th>Follow-Up Monitoring Description</th>
<th>Frequency</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Section 12 – Fish and Fish Habitat</strong></td>
<td>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.</td>
<td>Annual</td>
<td>15 years following reservoir filling</td>
</tr>
<tr>
<td><strong>Section 13 – Vegetation and Ecological Communities</strong></td>
<td>The selection of candidate species, identification of suitable sites, and further establishment of the study design will be discussed with specialists.</td>
<td>Annual</td>
<td>During construction and first 10 years of operations</td>
</tr>
<tr>
<td>To measure effectiveness of enhancement and compensation programs against compensation objectives</td>
<td>Measurement criteria will include vegetation growth, persistence of rare plants and success of invasive plant species.</td>
<td>Annual</td>
<td>During construction and first 10 years of operations</td>
</tr>
<tr>
<td><strong>Section 14 – Wildlife</strong></td>
<td>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</td>
<td>Annual</td>
<td>During construction and first 10 years of operations</td>
</tr>
</tbody>
</table>
### Section 15 – Greenhouse Gases

<table>
<thead>
<tr>
<th>Follow-Up Objective(s)</th>
<th>Follow-Up Monitoring Description</th>
<th>Frequency</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>To verify the accuracy of the GHG estimates and predictions presented in this EIS</td>
<td>Monitor changes in GHG emissions from Site C reservoir.</td>
<td>Annual</td>
<td>First 10 years of operations</td>
</tr>
<tr>
<td></td>
<td>Monitor and report GHG emissions during operation and maintenance activities.</td>
<td>In accordance with BC Hydro reporting requirements</td>
<td>In accordance with BC Hydro reporting requirements</td>
</tr>
</tbody>
</table>

### Section 19 – Current Use of Lands and Resources for Traditional Purposes

<table>
<thead>
<tr>
<th>Follow-Up Objective(s)</th>
<th>Follow-Up Monitoring Description</th>
<th>Frequency</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>To verify the accuracy of the predictions of potential effects and the effectiveness of mitigation measures on hunting and trapping opportunities</td>
<td>Monitor community-based programs, which may involve incorporation of local, community, or traditional knowledge provided a sound methodology with clear indicators and outcomes is delineated. Engage with Aboriginal groups to discuss potential community-based monitoring programs, such as programs intended to monitor the productivity and abundance of wildlife species</td>
<td>Annual</td>
<td>During construction and for the first five years of operations</td>
</tr>
</tbody>
</table>

### Section 20 – Agriculture

<table>
<thead>
<tr>
<th>Follow-Up Objective(s)</th>
<th>Follow-Up Monitoring Description</th>
<th>Frequency</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>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:</td>
<td>Monitor Project-induced changes in wildlife habitat utilization, 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 1 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.</td>
<td>Annual</td>
<td>Five years prior to reservoir filling and first five years of operations</td>
</tr>
<tr>
<td></td>
<td>- Crop and stored feed damage due to changes in wildlife habitat utilization</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Crop drying due to changes in climatic factors</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Crop production due to changes in groundwater elevation</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Livestock damage due to new access to the reservoir</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monitoring objectives would be to</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Confirm if a Project change has occurred, and</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2. Specify the adverse effect on agricultural operations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Determine appropriate mitigation measures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Follow-Up Program</td>
<td>Follow-Up Monitoring Description</td>
<td>Frequency</td>
<td>Duration</td>
</tr>
<tr>
<td>-------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
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<td>-----------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Objective(s)</td>
<td>Monitor climatic factors relevant to future irrigation improvement decisions that may be proposed under the agricultural compensation fund.</td>
<td>Annual</td>
<td>Five years prior to reservoir filling and first five years of operations</td>
</tr>
<tr>
<td></td>
<td>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.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Section 22 – Oil, Gas and Energy</td>
<td>Establish baseline and monitor change in thermal and sediment conditions on Spectra water intake in Taylor. To be determined in discussion with Spectra.</td>
<td>To be determined in discussion with Spectra</td>
<td>During construction and first 10 years of operations</td>
</tr>
<tr>
<td>Section 26 – Navigation</td>
<td>Geotechnical drilling and instrumentation to facilitate expanded baseline monitoring of groundwater conditions and slope movements. Priority would be given to locations where Highway 29 or other infrastructure is (or would be) located within the impact lines and to slopes where a potential landslide-generated wave hazard has been identified. Prior to diversion, installation and testing of the necessary instrumentation and telemetry at locations where real-time groundwater and slope movement data acquisition and transmission are required. Prior to diversion, determination of the instrumentation monitoring and visual inspection frequency, based on predictions of the degree of change caused by river diversion and the impoundment of the reservoir. The frequency of instrumentation monitoring and visual inspection would be adjusted based on the nature of the changes in collected data and shoreline conditions that are observed. The instrumentation monitoring and visual inspection program would be integrated into BC Hydro’s system-wide operation and dam safety programs.</td>
<td>Annual</td>
<td>During first five years of operation</td>
</tr>
</tbody>
</table>
### Section 29 – Housing

<table>
<thead>
<tr>
<th>Follow-Up Program Objective(s)</th>
<th>Follow-Up Monitoring Description</th>
<th>Frequency</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>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</td>
<td>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</td>
<td>Semi-annual</td>
<td>During construction</td>
</tr>
</tbody>
</table>

### Section 31 – Transportation

<table>
<thead>
<tr>
<th>Follow-Up Program Objective(s)</th>
<th>Follow-Up Monitoring Description</th>
<th>Frequency</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>To determine if Project related traffic volumes are adversely affecting traffic operations</td>
<td>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</td>
<td>Annually</td>
<td>During construction</td>
</tr>
<tr>
<td>To determine if fog mitigation measures are required on, and on the approaches to, Taylor Bridge to maintain overall road safety</td>
<td>Monitor the change in fog hours on, and on the approaches to, the Taylor Bridge.</td>
<td>Seasonally</td>
<td>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</td>
</tr>
</tbody>
</table>

### Section 32 – Heritage Resources

<table>
<thead>
<tr>
<th>Follow-Up Program Objective(s)</th>
<th>Follow-Up Monitoring Description</th>
<th>Frequency</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>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</td>
<td>Effects of shoreline erosion on heritage resources will be monitored.</td>
<td>Annual</td>
<td>First five years of operations</td>
</tr>
<tr>
<td>Follow-Up Program Objective(s)</td>
<td>Follow-Up Monitoring Description</td>
<td>Frequency</td>
<td>Duration</td>
</tr>
<tr>
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</tr>
<tr>
<td>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.</td>
<td>Follow-up work on archaeological sites will be prescribed by the methods put forth in B.C. <em>Heritage Conservation Act</em> 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.</td>
<td>TBD, in consultation with the B.C. Archaeology Branch</td>
<td>TBD, in consultation with the B.C. Archaeology Branch</td>
</tr>
</tbody>
</table>
40 CONCLUSION AND CONDITIONS

BC Hydro is proposing to construct and operate the Site C Clean Energy Project (the Project), a third dam and generating station on the Peace River in northeast B.C. The Project, which is described in Volume 1 Section 4 of the EIS, would provide up to 1,100 megawatts (MW) of capacity and about 5,100 gigawatt hours (GWh) of energy each year to the Province’s integrated electricity system. The Project would be a source of clean, reliable and cost-effective electricity for BC Hydro’s customers in B.C. for more than 100 years.

40.1 The Proponent, BC Hydro

BC Hydro is a Crown corporation owned by the Province of British Columbia. BC Hydro’s mandate is to generate, manufacture, conserve, purchase, and sell electricity to meet the needs of its customers. BC Hydro serves 95% of B.C.’s population, delivering electricity safely and reliably to approximately 1.9 million customers. BC Hydro operates an integrated system with 31 hydroelectric facilities and three thermal generating plants, totaling approximately 12,000 MW of installed generating capacity. BC Hydro’s own generation is complemented by additional electricity purchased from Independent Power Producers in the province to meet customers’ annual needs.

BC Hydro delivers electricity to its customers through a network of over 75,000 km of transmission and distribution lines, approximately 300 substations, 900,000 utility poles, and 325,000 individual transformers. The system is connected to other transmission systems in British Columbia, Alberta, and Washington State, which improves the overall reliability of the system and provides opportunities for trade.

BC Hydro carries out its mandate under the Hydro and Power Authority Act. The BC Hydro Public Power Legacy and Heritage Contract Act ensures public ownership of BC Hydro’s transmission and distribution systems, all of BC Hydro’s existing generation and storage assets, and any future increases to the capacity and energy capability of these facilities. The Clean Energy Act, S.B.C., 2010, c. 22, updated several elements included in the 2007 BC Energy Plan, and provides statutory guidance for how BC Hydro is to meet the Province’s energy objectives.

40.2 The Project Components and Activities

The components and activities of the Project are:

- 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

• Activities required to construct and operate the Project

40.3 The Assessment Process

The environmental assessment of the Project is being carried out in accordance with the B.C./Canada Agreement. This EIS contains the information required by the EIS Guidelines, which were issued by the Minister of Environment of Canada and the Executive Director of the Environmental Assessment Office of British Columbia after being developed in accordance with the process required by the B.C./Canada Agreement. In meeting the requirements of the EIS Guidelines, the objectives of the three guiding principles set out the EIS Guidelines have been met:

• **Environmental Assessment**: The EIS demonstrates that comprehensive process to identify and evaluate the potential effects of the Project and ways to avoid or mitigate adverse effects has been conducted.

• **Public Participation**: The EIS demonstrates that the public has been provided with information which provides a clear understanding of the Project as early as possible in the review process and that the public has been provided with opportunities to participate in the environmental assessment process.

• **Aboriginal Consultation**: BC Hydro has engaged, and will continue to engage, with Aboriginal groups that may be affected by the Project, and that have asserted or established Aboriginal rights or treaty rights in the Project area, as early as possible in the project planning process.

Accordingly this EIS is, in accordance with the Terms of Reference of the Joint Review Panel, sufficient for the purposes of providing notice of, and holding, public hearings.

40.4 Need for the Project

Forecasts show that customer demand for electricity is expected to increase by about 40% over the next 20 years and that the Project, which would provide energy and dependable capacity for more than 100 years, is required to meet this projected demand.

BC Hydro must plan in advance to meet its customers’ residential, business and industrial requirements and to ensure that the electricity resources required are available. The Project, like other large hydro projects, has a long lead time prior to the Project in-service date due to the lengthy construction period and the requirement for design work, stakeholder engagement, and regulatory review. As a result, BC Hydro considers its customers’ long-term requirements in evaluating the need for the Project.

Based on the load resource balance analysis, new resources are required to meet the energy and dependable capacity needs of BC Hydro customers within the next 10 to 15 years, even when taking into account BC Hydro’s Demand Side Management (DSM) Target and Revelstoke Unit 6, and excluding load from LNG facilities. The addition of non-compression LNG load served by BC Hydro, lower than expected DSM results, or higher than expected attrition of IPP contracts would accelerate the need for new resources.
40.5 Alternatives to the Project

In order to evaluate the Project compared to other resource options, BC Hydro developed several portfolios of resources, one of which includes the Project and was referred to in the analysis as the “Site C portfolio.” Each of the portfolios would provide comparable energy and capacity to the Site C portfolio and each took into account the relevant policy context, including the legislative requirements of the Clean Energy Act. A comparison of the financial, technical, environmental and economic development attributes of the portfolios demonstrates that the Project provides the best combination of financial, technical, environmental, and economic development attributes and is therefore the preferred option to meet the need for energy and capacity within BC Hydro’s planning horizon.

40.6 Purpose of the Project

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 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.

40.7 Alternative Means of Carrying out the Project

BC Hydro has conducted a number of evaluations of alternate means to develop the hydroelectric potential of the Site C Flood Reserve. This work is consolidated in a comprehensive study, Review of Alternate Sites on the Peace River, which reviews previously identified alternates and any new alternates and compares them to the Project using a consistent evaluation process. The evaluation framework considered multiple project attributes including technical, financial, environmental and social attributes for each alternative and compared them with the Project’s attributes. The conclusion of the alternates study is that the Project is the preferred means of cost-effectively maximizing the development of the hydroelectric potential of the Site C Flood Reserve.

40.8 Information Distribution and Consultation

BC Hydro began consulting with Aboriginal groups in late 2007, well before a decision was made to advance the Project to the environmental assessment process. While consultations are ongoing, BC Hydro has a comprehensive record of issues and interests raised by Aboriginal groups. These issues and interests have been taken into account in the assessment. BC Hydro also began consulting with communities in late 2007, and has led or participated in more than 500 public consultation meetings, presentations, local government meetings, community events and open houses. Input from these consultations informed project planning and design, as well as the proposed mitigation measures. The EIS also demonstrates the consultation with federal and provincial government agencies and includes a summary of issues, concerns and interests raised.
40.9 Technical Studies

BC Hydro conducted a comprehensive study of baseline conditions and background information to prepare for the effects assessment of the Project. Multi-year planning and technical studies were conducted. The findings are included in a large number of technical data reports that are appended to the EIS. This work was completed as a preliminary step in the effects assessment process. With this information, it was possible to identify and assess the potential effects of the Project on valued components (VCs).

The technical investigation of the potential changes to the physical environment, land, water and air, is described in the environmental background section of the EIS and supported by an extensive volume of technical data reports.

40.10 The Valued Components

Using the methodology set out in Section 8.3 of the EIS Guidelines, 22 VCs have been identified, and the potential residual effects of the Project on those VC have been assessed. The VCs are:

- Fish and Fish Habitat
- Vegetation and Ecological Communities
- Wildlife Resources
- Greenhouse Gases
- Local Government Revenue
- Labour Market
- Regional Economic Development
- Current Use of Lands and Resources for Traditional Purposes
- Agriculture
- Forestry
- Oil, Gas and Energy
- Minerals and Aggregate
- Harvest of Fish and Wildlife Resources
- Outdoor Recreation and Tourism
- Navigation
- Visual Resources
- Population and Demographics
- Housing
- Community Infrastructure and Services
- Transportation
40.11 Assessment of the Potential Effects and Cumulative Effects of the Project

Using the methodology set out in Sections 8.4 and 8.5 of the EIS Guidelines, the potential effects and potential cumulative effects of the Project on the VCs have been assessed. The results of the assessment are contained in Sections 12 through 33 in the EIS.

BC Hydro has made changes to the historic project design to avoid or reduce potential adverse effects. In addition, the assessment of the potential effects of the Project took into account a comprehensive set of technically and economically feasible mitigation measures proposed by BC Hydro to further avoid, reduce, or, in some cases, compensate for, potential adverse effects. A framework for environmental and safety management has been developed to protect the health and safety of the public and workers, and to ensure that measures recommended to mitigate the potential adverse effects of the Project are implemented.

While the Project is likely to result in some significant residual adverse effects, most would not be significant. However, some potential residual adverse effects of the Project on following VCs, as they are found today, would be significant:

- Fish and Fish Habitat
- Vegetation and Ecological Communities
- Wildlife Resources
- Current Use of Lands and Resources for Traditional Purposes

To conduct the cumulative effects assessment, a number of projects and activities that may not yet have commenced but are as likely as, or more likely than, the Project to proceed have been identified. Those projects and activities may also result in residual adverse effects that are not yet reflected in the baseline status of the VCs. The cumulative effects assessment has determined that some of the effects of those projects or activities would likely overlap in time and space with the residual effects of the Project and combine to produce a cumulative effect.

The residual effects of the Project on two of the VCs listed above, Vegetation and Ecological Communities and Wildlife Resources are expected to be significant and, accordingly, those effects are also significant when considered in combination with the effects of other projects or activities. However, the effects on those VCs resulting from other projects and activities that have been or will be carried out are considered significant, even without the Project.

The residual effects of the Project on Fish and Fish Habitat, on the Current Use of Lands and Resources for Traditional Purposes, and on other VCs are not predicted to combine with the residual effects of the other projects and activities.

Increasing GHG emissions from the many sources globally and the resulting increase in GHG concentrations in the atmosphere, and the consequent changes to the global...
climate, are currently believed to be a significant cumulative environmental effect, even without the Project. While the Project’s contribution to a net change in global GHG emissions is relatively small and the environmental effect of the Project related GHG emissions (on its own) on global climate is not measurable, the cumulative effect is considered significant.

40.12 Impact to the Exercise of Treaty Rights

BC Hydro’s understanding of the asserted or established Aboriginal rights and treaty rights of each Aboriginal group, and how the exercise of those rights may be impacted by the Project, is presented in the EIS. BC Hydro is continuing to consult with Aboriginal groups and to seek accommodations where appropriate.

40.13 Follow up Program

BC Hydro proposes to implement a follow up program with a number of measures. Specific measures have been identified to address specific 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. Volume 5 Section 39, Table 39.2, identifies the objectives of each follow-up measure and briefly describes follow-up methods (e.g., type of information to be collected, monitoring frequency and duration, reporting requirements).

40.14 Environmental, Economic, Social, and Sustainability Benefits

The Project would provide a wide range of benefits to British Columbians and Canada. Businesses and workers who are involved with the construction and with the operation of the Project would receive benefits through employment, and regional economic development. The Project would be a clean, renewable and reliable power resource that would provide cost-effective long-term energy and dependable capacity to BC Hydro customers with a low risk of future increases in the Project’s cost of energy. All British Columbians and Canadians would receive benefits through increased government revenues during the construction and the operation the Project. Finally, the Project would contribute to sustainable development through its optimization of existing BC Hydro hydroelectric facilities on the Peace River and through its delivery of electricity with low GHG emissions intensity.

BC Hydro is committed to continuing to negotiate benefits agreements with Peace region communities and impact benefits agreements with some Aboriginal groups.

40.15 Justification of the Potential Significant Adverse Effects

The assessment of the potential effects of the Project on 22 valued components indicates that the effects of the Project can largely be mitigated through careful project planning, comprehensive mitigation programs. However, the Project is likely to result in significant adverse effects on four VCs. In view of the following, those effects would be justified in the circumstances:
• BC Hydro serves more than 1.9 million residential, commercial, and industrial customers, which represent 95% of the electricity users in the Province. Over the next 10 to 15 years, demand for electricity is expected to grow by up to 40%, and BC Hydro has a legislated obligation to ensure a secure supply of power to meet this need. Based on BC Hydro’s long-term planning process and analysis of alternative resources to meet need, the Site C Project has been identified as the preferred resource option to meet both long-term energy and capacity requirements. As hydroelectric projects are complex, they require a long lead time to plan, design, and to complete the rigorous environmental assessment process. In addition, they take many years to construct. For these reasons, BC Hydro believes the Project should proceed to ensure that the energy and dependable capacity from the Project is available to meet forecasted customer demand.

• The Project would provide employment, economic development, ratepayer, taxpayer, and community benefits. The construction of the Project would create approximately 10,000 direct construction jobs and approximately 33,000 total jobs through all stages of development. It would also provide substantial economic benefits including a contribution of $3.2 billion to the provincial GDP during construction. BC Hydro is committed to providing lasting benefits and opportunities to Aboriginal groups and communities through the construction and operation of the Project. Examples of regional benefits would include employment and contracting opportunities, improvements to infrastructure, road upgrades, new outdoor recreation opportunities and additional affordable housing units.

• As a clean, renewable resource, the Project would deliver electricity with low GHG emissions per unit of energy produced. Emissions would be comparable to other renewable sources such as wind and run-of-river hydro. As such, the Project will support both provincial and federal GHG reduction strategies. In addition, the dependable capacity provided by the Project will facilitate the integration of additional renewables into BC Hydro’s system, supporting the Province’s clean energy strategy.

• The Project would take advantage of water already stored in the upstream reservoirs to generate over 35% of the energy generated by BC Hydro’s largest facility with only 5% of the reservoir area.

In summary, while the Project has the potential to result in some significant residual effects, they are justified by (1) the public interest served by delivering 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 and (4) because the Project would also take advantage of water already stored in the upstream reservoirs to generate over 35% of the energy generated by BC Hydro’s largest facility with only 5% of the reservoir area. Further, BC Hydro is continuing to consult with Aboriginal groups and to seek accommodations where appropriate.
40.16 Issuance of a Decision Statement and Environmental Assessment Certificate, with Conditions

The EIS demonstrates that under Sections 53 and 54 of CEAA 2012, a Decision Statement should be issued stating the Project is likely the result in significant adverse effects that can be justified in the circumstances and that BC Hydro must comply with the following conditions:

- Implement Environmental Management Plans which provide for measures to mitigate the environmental effects referred to in Sections 5(1) and 5(2) of CEAA 2012; those EMPs are:
  - Fisheries and Aquatic Habitat Management Plan
  - Air Quality Management Plan
  - Erosion Prevention and Sediment Control Plan
  - Surface Water Quality Management Plan
  - Blasting Management Plan
  - Fuel Handling and Storage Management Plan
  - Vegetation and Invasive Plant Management Plan
  - Soil Management, Site Restoration and Revegetation Plan
  - Wildlife Management Plan
  - Human-Bear Conflict Management Plan
  - Public Safety Management Plan (marine navigation provisions)
  - Heritage Resources Management Plan

- Implement the follow-up programs identified in Table 39.2 of Volume 5 Section 39, of the EIS.

The EIS also demonstrates that under Section 17(3)(c)(i) of BCEAA, an Environmental Assessment Certificate should be issued for the Project subject to the following conditions:

- Implement the Environmental Management Plans described in Volume 5 Section 35 of the EIS
- Implement the follow-up programs identified in Table 39.2 of Volume 5 Section 39, of the EIS.