Dr. Harry Swain  
Chairman, Site C Clean Energy Joint Review Panel  
160 Elgin Street, 22nd Floor, Place Bell Canada  
Ottawa, Ontario K1A 0H3  

By Email

Dear Dr. Swain:

Re: Site C Clean Energy Project – Environment Canada Written Submission

Thank you for your November 19, 2013 letter inviting Environment Canada to participate in the public hearing for the proposed Site C Clean Energy Project (the Project). In the coming days, Environment Canada will register for the public hearing in accordance with the direction offered by the Joint Review Panel (the Panel).

As requested, a technical review of the potential environmental effects of the Project has been conducted by EC based on the information provided by the Proponent before the Panel issued a Notice of Hearing on November 7th. The attached written submission includes a consideration of the fifteen specific subjects identified in your November 19th letter as those subjects relate to the EC mandate.

We look forward to participating in the upcoming public hearing during which EC experts will present the information and recommendations contained in the written submission.

Sincerely,

<original signed by>

Mike Beale  
Assistant Deputy Minister  
Environmental Stewardship Branch

Attach
BC HYDRO SITE C CLEAN ENERGY PROJECT

JOINT REVIEW PANEL

SUBMISSION OF THE DEPARTMENT OF THE ENVIRONMENT (ENVIRONMENT CANADA)

November 2013
Address for Communications:

Communications may be sent to Environment Canada at the address below

Attention: Steven Wright
Regional Director, EPOD Pacific-Yukon Region
201-401 Burrard Street
Vancouver, British Columbia
V6C 3S5

Signed on behalf of Environment Canada:

<original signed by>   25-11-13
Mike Beale
Assistant Deputy Minister
Environmental Stewardship Branch
Environment Canada

Date
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EXECUTIVE SUMMARY

On November 19, 2013, the Joint Review Panel (JRP) wrote to Environment Canada (EC) requesting the Department’s participation in the public panel hearings for the Site C Clean Energy Project (the Project). The JRP requested that EC provide a written submission on the potential effects of the Project based on the Department’s mandate and expertise.

EC has reviewed the Project, which includes the site preparation, construction, operation, decommissioning and restoration of a hydroelectric development, located 7 km southwest of Fort St. John, BC on the Peace River. The Project would be the third in a series of hydroelectric developments on the BC portion of the Peace River.

This submission summarizes EC’s technical review of information provided by the proponent, BC Hydro, and includes the Department’s observations and recommendations based on that review. The information considered by EC includes BC Hydro’s Environmental Impact Statement (EIS) and supporting documents, BC Hydro’s Amended Environmental Impact Statement and supporting documents, and BC Hydro’s responses to three sets of Additional Information Requests issued by the JRP. EC’s review of the Project was focused mainly on the environmental assessment boundaries defined by BC Hydro. EC has also considered the comments of Aboriginal peoples, the public and other stakeholders as tabled during the panel review process.

EC’s submission focuses on subject areas pertinent to the departmental mandate, such as the surface water regime, climate change, migratory birds and their habitat, aquatic environment and atmospheric environment.

The majority of EC’s recommendations relate to migratory birds and the steps that should be taken by BC Hydro to strengthen the impact of mitigation and monitoring measures. These steps include assessing migratory bird/species at risk and habitat in relation to the baseline conditions, addressing data gaps relating to migratory bird use of habitats during migration and winter, and minimizing migratory bird and species at risk mortality. A summary of EC’s recommendations can be found in Chapter 7. EC has also offered suggestions for the JRP to consider when assessing uncertainty related to potential environmental effects and appropriate mitigation and monitoring measures.
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>ARD/ML</td>
<td>Acid Rock Drainage/Metal Leaching</td>
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<td>AQMS</td>
<td>Air Quality Management System</td>
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<td>CEAA 2012</td>
<td>Canadian Environmental Assessment Act, 2012</td>
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<td>CEPA 1999</td>
<td>Canadian Environmental Protection Act, 1999</td>
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<td>EIS</td>
<td>Environmental Impact Statement</td>
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<td>Federal Authority</td>
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<td>Generalized Operations Model</td>
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<td>National Pollutant Release Inventory</td>
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<td>Northern Rivers Basin Study</td>
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<td>NREI</td>
<td>Northern Rivers Ecosystem Initiative</td>
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<td>TPR</td>
<td>Town of Peace River</td>
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<td>WMO</td>
<td>World Meteorological Organization</td>
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<td>WRF</td>
<td>Weather Research and Forecasting Model</td>
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<td>VEC</td>
<td>Valued Ecosystem Component</td>
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CHAPTER 1 – INTRODUCTION

EC has reviewed the Site C Clean Energy Project (the Project), which includes the site preparation, construction, operation, decommissioning and restoration of a hydroelectric development, located 7 km southwest of Fort St. John, BC on the Peace River.

The Project would be the third in a series of hydroelectric developments on the BC portion of the Peace River. The Project includes an earth fill dam 1,050 metres long and 60 metres high, an 1,100 megawatt generating station and associated structures, an 83 km long reservoir, realignment of four sections of Highway 29 and two 77 km transmission lines along an existing transmission line right-of-way connecting Site C to the existing provincial power grid.

EC is responsible for the implementation of the Government of Canada’s environmental agenda. EC’s mandate covers the preservation and enhancement of the quality of the natural environment, including water, air and soil, flora and fauna, including species at risk and migratory birds. Science plays a fundamental role in enabling EC to deliver on the Department’s mandate by informing environmental decision-making and regulations and by supporting the delivery of services to Canadians. EC, as a Federal Authority (FA), provides specialist or expert information or knowledge to Responsible Authorities (RAs), and review panels on environmental matters. Such information and knowledge is provided in accordance with the expertise that the Department has available as required under Section 20 of the Canadian Environmental Assessment Act, 2012 (CEAA 2012).

In delivering the departmental mandate, EC administers subsection 36(3) of the Fisheries Act which prohibits the deposit of a deleterious substance into fish-bearing waters. EC also participates in the regulation of toxic chemicals and the development and implementation of environmental quality guidelines pursuant to the Canadian Environmental Protection Act, 1999. EC is responsible for protecting and conserving migratory birds, as populations and individual birds, under the Migratory Birds Convention Act 1994. The Department also administers the Species at Risk Act (SARA), which has objectives to prevent wildlife species from becoming extirpated or extinct, to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity, and to manage species of special concern to prevent them from becoming endangered or threatened.

On November 19, 2013, the Joint Review Panel (JRP) requested EC’s participation in the public hearing process. The JRP requested that EC provide a written submission on the potential effects of the Project based on the Department’s mandate and expertise.

This submission summarizes EC’s technical review of information provided by the proponent, BC Hydro, and includes the Department’s observations and recommendations based on that review. The information considered by EC includes BC Hydro’s Environmental Impact Statement (EIS) and supporting documents, BC Hydro’s Amended Environmental Impact Statement and supporting documents, and BC Hydro’s responses to three sets of Additional Information Requests issued by the JRP. EC has also considered the comments of Aboriginal peoples, the public and other stakeholders as tabled during the panel review process. EC’s review of the Project was focused mainly on the environmental assessment boundaries defined by BC Hydro. This submission does not reflect a consideration of a 331 page report provided by BC Hydro on November 21, 2013 in response to Additional Information Request #4 from the JRP.
Information on the applicable legislation and policies administered by EC is provided in Chapter 2 with additional context provided in Appendices 1 and 2. Drawing on the applicable legislation and policies, EC’s submission is organised by the following topics or subject areas:

- Surface Water Regime and Climate Change (water hydrology, ice regime, climate change, downstream interests) - Chapter 3
- Wildlife and vegetation (migratory birds, habitat, wetlands, species at risk) - Chapter 4
- Aquatic environment (groundwater quality, geochemistry, environmental emergencies) – Chapter 5
- Atmospheric environment (air quality, GHG emissions, weather and climate) – Chapter 6

A summary of EC’s recommendations can be found in Chapter 7. EC has also provided suggestions intended to assist the JRP as it considers options for reducing uncertainty related to potential environmental effects and measures to address the effects.

The observations, recommendations and advice within this submission are provided for consideration by the JRP. However, this does not preclude BC Hydro from adopting them in advance of any final recommendations provided by the JRP.
CHAPTER 2 – ENVIRONMENT CANADA MANDATE, ROLES & RESPONSIBILITIES

2.1 Introduction

The mandate of EC is determined by the statutes and regulations assigned to it by Parliament through the Minister of the Environment. In delivering this mandate, EC is responsible for the development and implementation of policies, guidelines, codes of practice, inter-jurisdictional and international agreements, and related programs.

The scope of specialist or expert information or knowledge provided in this submission to the JRP is within EC’s mandate as defined by the Department of Environment Act and through other legislation assigned to the Minister of the Environment. Appendix 1 (Legislation and National Environmental Policies) describes in more detail these and other relevant legislation, national environmental policies and programs, and international agreements.

The summaries provided in this chapter of the submission describe relevant legislation and national environmental policies and programs administered or adhered to by EC and relevant to the Project. The information is up-to-date as of November 25, 2013. The summaries have been prepared for ease of reference and convenience only. For purposes of reliability and accuracy, and for interpreting and applying the legislation, regulation or policy, it is recommended that the reader review the original document itself, including any subsequent amendments.

EC observations, recommendations and advice in this submission are intended as expert support. The comments contained herein are in no way to be interpreted as any type of acknowledgement, compliance, permission, approval, authorization, or release of liability related to any requirements to comply with federal or provincial statutes and regulations. Responsibility for achieving regulatory compliance and cost effective risk and liability reduction lies solely with the proponent, BC Hydro.

2.2 Canadian Environmental Assessment Act, 2012 (CEAA 2012)– Section 20

Section 20 of CEAA 2012 sets out EC’s responsibility as a Federal Authority (FA) as follows:

Every federal authority that is in possession of specialist or expert information or knowledge with respect to a designated project that is subject to an environmental assessment must, on request, make that information or knowledge available, within the specified period, to
(a) the responsible authority;
(b) the review panel;
(c) a government, an agency or body, or a jurisdiction that conducts an assessment of the designated project under a substituted process authorized by section 32; and
(d) a jurisdiction that conducts an assessment, in the case of a designated project that is exempted under subsection 37(1).

2.3 Canadian Environmental Protection Act, 1999 (CEPA)

The Canadian Environmental Protection Act, 1999 (CEPA) provides the Government of Canada with tools to protect the environment and human health and establishes strict deadlines for controlling certain
toxic substances. CEPA also regulates environmental and human health effects from products of vehicle engine and equipment emissions, fuels, hazardous wastes, environmental emergencies, and other sources of pollution.

### 2.4 Fisheries Act

The responsibility for the administration (including the enforcement) of the pollution prevention provisions of the *Fisheries Act* (including subsection 36(3)) has been assigned to the Federal Minister of the Environment. This section of the Act prohibits the deposit of deleterious substances into waters frequented by fish, or deposit to any place where those deleterious substances may then report to fish-bearing waters. The overall objective of the department under Sub-section 36(3) is to protect and conserve fish by ensuring that water quality is not impaired.

### 2.5 Migratory Birds Convention Act, 1994 (MBCA)

EC’s mandate includes the protection, conservation and management of migratory birds and their habitat. The purpose of the *Migratory Birds Convention Act, 1994 (MBCA)* is to implement the Migratory Birds Convention between Canada and the United States by protecting and conserving migratory birds, as populations and as individual birds. Section 6 of the *Migratory Birds Regulation (MBC)* sets out the prohibitions including those related to the disturbance, destruction, or taking of a nest, egg or nest shelter of a migratory bird.

### 2.6 Species at Risk Act (SARA)

EC administers and enforces the federal *Species at Risk Act (SARA)* in partnership with the Department of Fisheries and Oceans and the Parks Canada Agency. The purpose of the SARA is to prevent wildlife species from becoming extirpated or becoming extinct, to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity, and to manage species of special concern to prevent them from becoming endangered or threatened.

### 2.7 The Federal Policy on Wetland Conservation

The Federal Policy on Wetland Conservation was adopted in 1991. The objective of this policy is to promote the conservation of Canada’s wetlands to sustain their ecological and socio-economic functions, now and in the future. The policy is a shared federal responsibility that directs all departments to sustain wetland functions in the delivery of their programs, services or expenditures. For more detail on the key wetland conservation policies and EC advice on mitigation measures please see Appendix 2.
3.1 Introduction

This chapter presents EC’s review of the surface water quantity sections of the BC Hydro Site C EIS, Amended EIS, Additional Information Requests and other supporting documents available on the Project, as they relate to EC’s mandates and interests. EC has a mandate to: preserve and enhance the quality of the natural environment, including water; conserve Canada’s renewable resources; conserve and protect Canada’s water resources; forecast daily weather conditions and warnings, and provide detailed meteorological information to all of Canada; enforce rules relating to boundary waters; and coordinate environmental policies and programs for the federal government.

EC is one of several government departments that have a mandate related to water quantity, and is the federal agency responsible for the collection, interpretation, and dissemination of standardized water quantity data and information in Canada. A number of areas of EC contribute to this mandate, including the Meteorological Service of Canada, the Water Survey of Canada hydrometric network, the Water Science and Technology Directorate. Through these programs, EC provides regional and long term water quantity and climate data, and supporting information which is used by government agencies, project proponents, and other stakeholders to evaluate baseline conditions and predict project impacts.

EC offers the analysis and advice in Chapter 3 in the context of Section 5 of CEAA, 2012. Water quantity falls under sections 5(1)(a) for its potential to impact fish, aquatic species and migratory birds; under 5(1)(b)(ii) for its potential to cause an environmental change outside the province of the Project; and under 5(1)(c) for its potential to affect Aboriginal uses and interests.

EC identified the following broad water-quantity-related issues as being of primary concern for review related to water quantity, and each is discussed in more detail below: Hydrology, River Ice, Climate Change and Considerations Related to Downstream Interests.

3.2 Hydrology

3.2.1 Historical Context


3.2.2 Current Regulated System

BC Hydro provided a narrative discussion on the hydrological changes on the Peace River and downstream PAD resulting from previous hydroelectric developments (Volume 2: Assessment Methodology and Environmental Effects Assessment, Section 11.1). However, the narrative provided did not incorporate several peer-reviewed studies that examined the separate effects of historical climatic variability and flow regulation to demonstrate how hydroelectric operations of the existing WAC Bennett Dam and Peace Canyon Dam have affected key components of the PAD hydrology. Overall, the narrative provided by BC Hydro in the EIS lacks important information about known effects of flow regulation on the hydrology of the PAD and Lake Athabasca.
The PAD evolved under a hydrological regime characterized by occasional extreme water level conditions that recharge perched basins (Peters et al., 2006a). The major rivers influencing the Lake Athabasca – PAD system are depicted in Figure 3.2.1. Key to this regime are spring ice jams on the Peace and Athabasca Rivers that cause flooding of near-by elevated perched basins, and summer high flows on the Peace River that restrict PAD-Lake Athabasca outflow (Peters and Buttle, 2010) and cause high lake levels that recharge (fill) near-by low elevation basins (Figure 3.2.2). Perched basins with little surface runoff are susceptible to drying out if not occasionally recharged by floodwaters (Peters et al. 2006b). The Peace Delta has not experienced a large scale flood event in 15 years.

Ice jamming is a key mechanism for recharging elevated perched basins in the PAD (Peters et al., 2006a). Under the current regulated flow regime associated with hydroelectric reservoir operations, the water level at which the ice cover forms in the fall or in the winter is higher than under natural conditions. Come spring, dislodgement and breakup of the ice prior to its melting and rotting in place requires larger flows than under natural conditions. In addition, sufficient flow is required once the ice breaks up, to cause flooding behind the ensuing ice jam. This, combined with less intense spring snow melt (a source of flow) in downstream tributaries because of generally declining snow depth since the 1970s, contribute to less frequent ice jam flooding (Beltaos, 2003; Beltaos et al., 2006; Romolo et al., 2006; Prowse and Conly, 1998). The most recent large ice jam flood events in the Peace Delta occurred in 1996 and 1997.

Drainage of the PAD-Lake Athabasca complex is normally northward via the Slave River; however, when the water levels of the Peace River are high enough, they prevent drainage of the large connected lakes and occasionally reverse the direction of flow in the outflow channels. The influence of Peace River water level on lake drainage is demonstrated in Figures 3.2.1 and 3.2.2. Blockage of water flowing out of Lake Athabasca and storage of inflows (i.e. Athabasca River) in Lake Athabasca are key to raising the lakes to flood levels. Peak summer flows on the Peace River are generally lower with regulation (Peters and Prowse, 2001). The combination of Peace River flow regulation and hydraulic effects of weirs on outflow channels (see mitigation measure below) has resulted in higher winter, similar average peak summer, and overall higher mean annual Lake Athabasca levels (Prowse et al., 1996). However, peak lake levels generated under a regulated regime are generally not as high as those estimated under natural conditions during wet years. The lake expansion mechanism is thus less effective in flooding and recharging near-by delta basins since 1968 (Peters et al., 2006a).

**Existing Mitigation Measures:** In September 1974, the Governments of Canada, Alberta and Saskatchewan entered into an agreement to conduct remedial work in the PAD with the intent of partially restoring water levels which had been affected by construction of WAC Bennett Dam in British Columbia (PAD-IC, 1987). Rock-fill weirs were constructed on Rivière des Rochers and Revillon Coupé in 1975-76, thus controlling outflow from two of the three main channel outflows from the PAD and Lake Athabasca to the Peace River (Prowse et al., 1996). The intent of the weirs was to compensate for the decline in lake levels due to the changed regime of the Peace River by restricting outflow and raising Lake Athabasca and connected PAD lake levels (PAD-PG, 1973). This mitigation measure was not designed to recharge the elevated perched basins in the PAD (Peters et al., 2006a; Prowse et al., 1996).

**Previous Adaptation Trial:** The studies and initiatives highlighted in section 3.2.1 Historical Context explored a number of adaptation strategies (i.e. artificial ice dam in a PAD channel, Prowse et al., 1996). In particular, the Northern River Basin Study (Prowse and Conly, 1996) recommended modification of the regulated flow regime to increase chances of creating ice jams in the PAD. In the spring of 1996, the hydroclimatic conditions were conducive to the potential formation of an ice jam on the lower Peace River. BC Hydro successfully modified the regulated flow regime for approximately 9 days during the spring of 1996 and contributed to increasing the maximum level of the floodwaters by 0.27 m, thereby
enhancing the flooding and recharging the PAD (Prowse et al., 2002). Extensive areas of highly perched basins in the Peace Delta were inundated during this event, many of which had not been recharged since the previous large ice jam flood event in 1974 (Peters et al., 2006a). The successful trial of this reservoir flow release in enhancing ice jam flooding in the downstream Peace Delta indicates that such water management options should be re-examined as a means to occasionally providing ecologically relevant flows for downstream areas and provide a strategy to adapt to unforeseen cumulative impacts of climate change and flow regulation.

3.2.3 Potential Effects of the Project

BC Hydro proposes to shift the point of flow regulation on the Peace River 85 km downstream with the construction of the Project. The construction and operation of the proposed Project will flood the river valley up to the Peace Canyon Dam and create a reservoir with a maximum depth of 55 m. Given the limited active storage volume of the Site C reservoir (about 1.5 days of active storage based on mean annual outflows from Peace Canyon Dam), the timing and quantity of water flowing through the Project will largely be governed by flow releases from the larger Williston Reservoir, as is currently the case with the Peace Canyon Dam. The current hydroelectric facilities control about 58% of the flow reaching the Peace River at the Peace Point hydrometric station – the percentage of controlled headwater flow will increase to about 63% with the addition of the Project (EIS Table 11.4.1).

The Project will potentially affect the hydrology of the Peace River during the construction, filling and operational phases. During these major phases of the Project, BC Hydro proposes to alter the river flows within existing water licenses to meet construction and power production needs. A state-of-the-art (Havno et al., 1995) one-dimensional numerical hydraulic model (MIKE11) of the Peace River between Peace Canyon Dam and Peace Point was set up and calibrated to existing conditions to simulate flow and associated water levels for several river cross sections along the river mainstem (Volume 2 Appendix D Surface Water Regime Technical Memos, Part 2 Downstream Flow Modelling (1D)).

Caveat No. 1

The MIKE11 hydraulic model simulations did not consider the effect of ice on flow and water levels. This modelling approach is acceptable as long as interested parties are made aware of the fact ice effects can modify MIKE11 results (e.g., changing flow rates, and ‘time of travel’ estimates) and did not consider the effects on flow of extreme ice formations such as ice jams (see Beltaos et al. 2006). The potential effects of the Project on river ice were evaluated in a separate modelling study reviewed below in Section 3.3.

On Page 11-72 of the EIS, BC Hydro states that Volume 1 Appendix B Reservoir Filling Plan includes a description of the expected changes to the surface water level regime of the Peace River during this phase of construction. The actual filling of the reservoir could take up to three months depending on the time of year, inflows to the Site C reservoir and the duration the reservoir will be held at a constant elevation. Figure 1 in this Appendix presents reservoir curves for various average inflows to provide estimated durations that Site C Dam outflows would be potentially lowered to about 390 cubic metres per second (cms) (minimum license outflow) to fill the reservoir. According to BC Hydro, this would preferably be done in late summer or fall to avoid the local basin spring freshet period to ensure controlled filling and maintain 1450 +/- 100 cms at the Town of Peace River (TPR) during the freeze-up period. Other than the reservoir filling curves, BC Hydro provides no scenarios of MIKE11 simulations to demonstrate potential effects of reservoir filling on flow and water levels at downstream locations of the Peace River, such as Peace Point near the PAD. The overview section of this Appendix provides an example based on average annual inflow of 1273 cms and a minimum outflow of 390 cms - it would take approximately 30 days to fill the 2310 million cubic metre volume of the reservoir. According to this
scenario using average conditions, flows reaching the Peace Point study boundary would be lowered by about 880 cms for one month. A decrease in flow of this magnitude and duration may have a noticeable impact on downstream flow and water level conditions. This information would be needed to assess potential effects of various reservoir filling options on downstream flow and water level conditions and to plan for the least impact scenario.

**Recommendation 3.1**

**EC requests that the JRP recommend that BC Hydro predict the impacts of filling the reservoir on downstream flow and water levels to the Peace Point study boundary with reference to average, best and worst case scenarios. This work should be undertaken before Project construction.**

To assess potential changes to the flow and water level regime as a result of the Project operations, a 60 year historical Williston Reservoir inflow sequence (1940-2000) and forecasted 2028-2029 electricity load/market price were used in a Generalized Operations Model (GOM) to simulate optimal future operations scenarios “Without” and “With Site C” Project (Section 11.4.1; Volume 2 Appendix D Surface Water Regime Technical Memos, Part 1 Operations Study). A subset of 10 years (1965-1974) was then selected for MIKE11 hydraulic scenario modelling (assumptions listed in Table 2 of the aforementioned Appendix). BC Hydro states that the selected 10-year average is 105% of the 60-year average flow, and contains years that are between 86% and 130% of the 60 year average. Although this time period may contain variability of flow magnitudes in the range projected for the near term future, the range of projected increases/decreases in flow magnitude and variability and the corresponding seasonal shifts in streamflow generation in the long-term are not considered via this approach – see Section 3.4 Climate Change below for a review of climate change information provided by BC Hydro. Consideration of projected climate impacts on flow would provide valuable information towards the cumulative effects assessment of the Project.

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**Caveat No. 2**

EC’s review of the EIS is based on the assumption that the GOM simulated data that were used to drive the MIKE11 hydraulic model simulations are representative of projected operations of the integrated BC Hydro system. Given that a scenario of “Site C with Climate Change” is not provided in the EIS, uncertainty exists as to the potential cumulative effects of the Project on the magnitude and timing of flow down the Peace River mainstem to the Peace Point boundary.

**The JRP is advised to consider the value of BC Hydro assessing – before Project construction - a third modelling scenario “Site C with Climate Change” that takes into account the range of projected impacts of climate change on the timing and magnitude (including extreme events) of streamflow generation.**

Compared to the large Williston Reservoir, the Project has a limited range of active water storage (1.8 metre equating to about 1.5 days of average WAC Bennett Dam outflows) and will be operated primarily as a run-of-river facility. Based on the GOM and future operating assumptions listed in Table 2 (Volume 2 Appendix D Surface Water Regime Technical Memos, Part 1 Operations Study), the Site C reservoir would be operated within the top 0.6 metre 99% of the time. Full drawdown and use of the 1.8 metre active reservoir range would occur less than 1% (equates to about 3.5 days per year on average) of the time to meet heavy loads and maintenance needs. A separate sensitivity assessment of an alternate future where Site C would be relied upon more heavily to meet BC system loads indicated that the reservoir would be operated within the top 0.6 metre about 83% of the time, and the daily fluctuation of the reservoir would exceed 1.0 metre for about 25% of the time (Volume 2 Appendix D Surface Water
Regime Technical Memos, Part 1 Operations Study). This alternate scenario was not input into the MIKE11 simulations and thus it is not possible to evaluate its potential effect on downstream Peace River flow and water levels.

The GOM hourly operational flows for the 10 year period were input into a commonly used and robust hydraulic model (MIKE11) to simulate flow and water levels “Without Site C” and “With Site C” along the Peace River main stem to the Peace Point hydrometric station (BC Hydro selected boundary conditions) about 70 km upstream of the PAD. MIKE11 modelling by BC Hydro suggests that the seasonal pattern of flows downstream of the Project will be similar to the current conditions (Figures 2 and 3 in Response to Working Group and Public Comments on the Site C Clean Energy Project Environment Impact Statement - Technical Memo Spatial Boundary Selection, April and May 2013). Seasonal flow divergences are seen in these figures at the Tailrace to Alces river mainstem points, while the result of operational differences with the addition of the Project are barely discernible (graphed lines overlie) by the TPR (see Caveat No. 1).

Visual estimates obtained from graphs presented in EIS Appendix C suggest that the amplitude of hourly flow changes will increase 50 to 100% on the Peace River at the point of the Tailrace. A much smaller increase in amplitude is predicted about 300 km downstream at the TPR, and fluctuations are almost completely attenuated by Peace Point, about 1000 km downstream of the Project. At Peace Point, the difference for scenarios “Without” and “With Site C” are visually mostly less than about 100 cms for the average water year (1969-70) and for the minimum and maximum flows over the 10-year simulated period (see Caveat No. 1). Noteworthy differences are seen during the period of freeze-up and breakup at Peace Point, which as outlined above in the Section 3.2.2 are key influences on the potential of ice jam formation and flooding of the downstream PAD environment. Additional graphs provided by BC Hydro (Figures 4 and 5 in Response to Working Group and Public Comments on the Site C Clean Energy Project Environment Impact Statement - Technical Memo Peace-Athabasca Delta, April 2013) indicate that flows occurring 75 to 100% of the time will be lower for the “With Site C Scenario” for the month of November (typical freeze-up month). Flow duration curves for the April 15 to May 15 period suggest that the operation of Site C under the GOM scenario will not affect flows that drive spring break-up backwaters associated with ice jam flood events near the PAD (i.e. flows greater than 4000 cms (Beltaos et al., 2006; Peters and Prowse, 2006)). Sustained flows that occasionally block outflow from and contribute reverse flow to Lake Athabasca and the PAD are also not expected to be affected by operation of the Project based on the information presented for the hourly flow graph at Peace Point (Volume 2 Appendix D Surface Water Regime Technical Memos, Part 2 Downstream Flow Modelling (1D), Appendix C and D).

Based on the simulation data presented in the EIS and Technical Memos (see Caveat No. 1 and 2), the largest potential effects of adding the Project on flows and water levels will be seen immediately downstream of the Site C Dam, with the effects diminishing in a downstream direction due to natural attenuation and the addition of water from several tributaries. Relative to the regulated baseline scenario, the simulations provided by BC Hydro suggest that the Project is not expected to modify the downstream flow hydrograph near the PAD beyond occasional short-term fluctuations. The downstream boundary of Peace River at Peace Point used in the EIS for assessing the direct impacts of the Project relative to the regulated flow baseline scenario is deemed reasonable by EC, in the context of the modelling scenarios chosen and provided in the EIS. (see Caveat No. 1 and 2).
Figure 3.2.1 Schematic of flow directions in the Lake Athabasca – Peace Athabasca Delta system (modified from PAD-IC, 1987)
Figure 3.2.2 a) Ice jam induced high water level on lower Peace River, b) diagram of flow direction in drainage channels of Lake Athabasca-PAD system and c) perched basins with water levels from open-water and ice jam extreme events: note only the latter is capable of flooding high-elevation zones (modified from Prowse and Conly, 2000; Peters and Buttle, 2010).
3.3 River Ice

3.3.1 Summary of BC Hydro’s Downstream Ice Regime Assessment

Volume 2 Appendix G discusses predicted changes to the ice regime of Peace River downstream of the proposed Project. Predictions were based on applications of a one dimensional river ice simulation model (CRISP), and included the cases of the Project alone and the Project plus the proposed Dunvegan Hydroelectric Project (also referred to herein as “Dunvegan”). Furthermore, the analysis was extended to two future climate scenarios. For the present climate, ice conditions during sixteen representative winters were simulated for the existing situation (no projects); the Project; and the Project plus Dunvegan, in order to quantify: the maximum extent of the ice cover; the timing of ice cover formation and breakup; associated water levels; changes to ice thickness; and changes to ice conditions as they relate to river transportation.

As the Project is not expected to modify the downstream flow hydrograph beyond occasional short-term fluctuations (but see Caveat No. 3 below), its main impact on the ice regime stems from its location, which is 85 km downstream of Peace Canyon Dam (present situation). This implies that the relatively warm water discharge that issues from a deep reservoir would be moved downstream by 85 km. The corresponding water temperature at the outlet of the Project was obtained from the results of a three-dimensional thermodynamic model of the Site C reservoir, as reported in Volume 2 Appendix H (“Technical Data Report: Reservoir Water Temperature and Ice Regime”).

With the Project in place, BC Hydro predicted that the maximum upstream extent of the ice cover will be reduced by about 30 to 50 km, but the ice cover would still advance upstream of TPR, as it does today, albeit a few days later. The ice front would not advance upstream of Taylor and would very rarely advance into British Columbia. With the Project plus Dunvegan, two ice fronts will form, one upstream and one downstream of the Dunvegan structure. The upstream ice front would still not advance upstream to Taylor for the range of winters examined in the study; the downstream front would still advance to TPR but about 10 days later than it does today.

Freeze-up water levels at TPR are not expected to change with the Project or the Project plus Dunvegan, while the risks of flooding and groundwater seepage may be slightly reduced. Freeze-up water levels in less populated areas such as upstream and downstream of Dunvegan would change by about plus or minus 1 metre. This is largely due to the difference in the timing of the flow controls as well as the slower advancing ice cover downstream of Dunvegan.

The timing of breakup at TPR is not expected to change as a result of the Project or the Project plus Dunvegan. Consequently breakup flood risk, which arises when Smoky River ice runs into a still-ice covered Peace River and forms major ice jams, will remain unchanged. The timing of breakup would not change at Sunny Valley or Dunvegan due to the Project, or the combination of the Project and the Dunvegan Project.

Impacts on ice bridge and ferry operations at the Shaftesbury Crossing (about 265 km downstream of the Project) were also examined in the EIS. Total combined durations are not expected to change as a result of the Project alone, but substantial decreases (~15 days) may be expected from the Project plus Dunvegan. Combined durations of ferry and ice bridge crossings at Tompkin’s landing would not change as a result of the Project or the Project plus Dunvegan. The modelling results further suggest that the average delay due to the Project in freeze-up at Sunny Valley (site of a private crossing, approximately 90 km downstream of the TPR) is two days. The combination of the Project and the Dunvegan Project leads to an average delay in freeze-up at Sunny Valley of three days. BC Hydro states that additional
crossings exist downstream of Tompkins Landing but their results suggested that they are located too far downstream to be influenced by the Project.

Simulations under a warmer future climate examined the “2050s” (2040-2069) and the “2080s” (2071-2098). BC Hydro predicted that ice cover initiation would occur later in the year (by 9 and 12 days, respectively, on the average) while the ice front will not advance as far upstream, by a considerable distance (see also Caveat No. 4 below). The probability of the ice front reaching the TPR would be reduced to between 80-90% from 100% under current conditions (no projects) and under current climate with the Project alone and the Project plus Dunvegan; with the Project alone and with climate change, the probability of the ice front advancing to TPR would be about 86% and 83% under the 2050s and 2080s scenarios respectively. With the Project plus Dunvegan and with climate change, the probability of an ice cover forming at TPR would be about 83% and 61% under the 2050s and 2080s scenarios. Similar information for other locations, such as Shaftesbury Crossing, BC-Alberta border, and District of Taylor, is also presented in Appendix G of Volume 2.

3.3.2 Assessment of BC Hydro’s Downstream Ice Regime Impacts

River ice processes are governed by complex interactions among climatic, hydrologic, hydraulic, and thermodynamic variables. The state of knowledge of river ice processes is not as advanced as in more traditional fields of engineering (e.g. structural engineering) and related scientific research is ongoing. Nevertheless, a number of numerical models have been a developed so far, which can simulate isolated, or different combinations of, river ice processes. One of the most comprehensive and advanced models that are available at present, the CRISSP1D model, has been utilized in the present EIS. Uncertainties arising from gaps in the state of knowledge are commonly addressed by carrying out comprehensive model calibration and validation. This was also done in the EIS, using relevant data obtained in several previous studies sponsored, or carried out, by BC Hydro. The extensive calibration procedures are described in detail in Appendix B and illustrated in Appendix C (both are within EIS Volume 2 Appendix G), and reveal a thorough understanding of river ice processes and the effects of related variables and coefficients. Note: Volume 2 Appendix G contains 3 appendices of its own, A, B, and C; these should not to be confused with similarly named appendices of the EIS volumes.

The downstream boundary that has been specified in the CRISSP1D model is Fort Vermilion. According to BC Hydro, this location is known from previous modelling studies to be well beyond the influence of the Project and of the Project plus Dunvegan; it is also the first location where the ice front is recorded by visual observations during each ice season. This selection was further corroborated by the results of CRISSP1D, which indicated that the influence on the ice regime of the two projects, which varies from one winter to the next, does not on the average extend beyond Carcajou (~ 280 km upstream of Fort Vermilion). Under future (warmer) climate scenarios, the model results indicated that the influence of the projects would be extended but still remain well above Fort Vermilion.

The temporal extent of the study was defined by the selection of 16 winters (1995-1996 through 2010-2011) to form the basis for the modelling. This selection reflects data availability and representativeness of winter severity. The minimum and maximum degree-days of freezing (TPR Airport; degrees C) over the 16 winter periods range from 69% to 144% of the historical mean value, while the historic range is only slightly greater (64% to 145% of the historic mean).

To assess the effects of the Project on operations during freeze-up and break up (described in Appendix A of Volume 2 Appendix G) and on the safety of ice crossings, it is necessary to know the thickness of the thermally grown ice sheet, which forms by freezing of interstitial water within the initial porous accumulations of frazil and pancake ice or by freezing of surface water in quiescent areas near the banks (border ice). Thermal ice growth was simulated outside of CRISSP1D using the model PRTIGM, which has
been developed in-house at BC Hydro, based on well-established thermodynamic equations. This model has already been calibrated and used operationally by BC Hydro for several years.

In addition to calibration, extensive model validation was carried out by BC Hydro. Several aspects of model output were checked against measured data with very good results. An exception occurs under the infrequent conditions of secondary consolidation of the newly formed ice cover. This process is not modeled by CRISSP1D and can lead to higher-than-predicted water levels. At present, there is not enough information to permit development of mathematical algorithms for simulating secondary consolidations. Improvements in this direction can only come from comprehensive monitoring and data collection in the future.

Future climatic conditions for the 2050s and 2080s were constructed by applying monthly average air temperature offsets to hourly historical data from the three climate stations used in the CRISSP model, which was then re-run for each of the 16 winters considered in the study. Monthly temperature offsets were calculated by taking the difference between projected future temperatures and observed values over the 1961-1990 climate normal period. Projections for the 2050s and 2080s periods were derived from eight global climate models forced with three emissions scenarios. Though there are considerable uncertainties in attempting to quantify the impacts of future climatic conditions on river ice regimes, the report provides a pragmatic analysis, which predicts climate impacts using the presently available knowledge.

EC concludes that state-of-the-art numerical tools and methods have been applied, along with good physical understanding and sound engineering judgment, to predict Project impacts on downstream river ice regimes.

It is beyond the scope of EC’s review to scrutinize the accuracy of the numerical results of the models used in the EIS. Nevertheless, the resulting findings and conclusions are all plausible in view of the stated boundary conditions and expected hydro-thermal effects of the proposed project.

Caveat No. 3
BC Hydro assumed that, although the maximum possible turbine flows at the Site C generating station would be on the order of 2,500 cms compared to 1,982 cms at Peace Canyon, the Peace Canyon flows would be representative of those at the Project. It is stated that:

“This is not an unreasonable assumption because the active storage in the Site C reservoir would be limited, and due to the lack of local inflows into the reservoir in the winter, higher turbine flows would not last for a long enough period to influence the overall ice regime. Flows at the Site C generating station that could be systematically higher than the maximum Peace Canyon turbine flows would also be limited by considerations of the downstream ice conditions that would require Site C generating station flows to be similar in magnitude to those at Peace Canyon (this relates to managing the risk of secondary consolidations downstream as discussed in Section 2.4). Sensitivity testing was performed to test this expectation, and results confirmed that the ice regime was not sensitive to the small changes in flows that could be attributed to the Project”. (Volume 2, Appendix G)

In view of potential impacts of freeze-up levels to the frequency of ice jam flooding and resulting replenishment of the PAD, it is important to ensure that fall and winter flows will not increase relative to present conditions, beyond the “small changes” envisaged in the above-cited paragraph.

Recommendation 3.2
EC requests that the JRP encourage BC Hydro to operate the Project in a manner that ensures fall and winter flows do not increase relative to present conditions so that ice jam flooding potential in the Peace-Athabasca Delta is not impacted.

_Caveat No. 4_

The technical data presented in Appendix T of Volume 2 indicate that fall and winter flows are likely to increase during the 21st century as a result of changes to air temperature and precipitation. However, the predictions of climate-related impacts on downstream ice regimes only consider changes in air temperatures; they do not consider any changes in flow discharge.

*If the JRP should wish to reduce uncertainty in the future climate-altered flow scenarios, the JRP is advised to consider the value of BC Hydro re-examining the climate-change modelling runs described in EIS Appendix G in light of predicted changes to flows. Such work should be undertaken before Project construction.*

For additional certainty around climate-related and ice regime impacts, see also boxed suggestions in Sections 3.2.3 and 3.4.1 of this submission.

### 3.4 Climate Change

#### 3.4.1 Review of BC Hydro’s Climate Change Assessment

EC has expertise in climate and climate change science. Climate change considerations are relevant to the Project because climate over the lifetime of the Project has been projected to be different from the current and past climate for the area. Implications of this change in climate on the Project should be considered.

EC has reviewed the climate change information presented in Volume 2, Appendix T (Technical Data Report: Climate Change Summary) of the EIS, as well as BC Hydro’s responses to EC’s Information Requests (IR’s) related to this Appendix. EC has also reviewed BC Hydro’s response to the JRP’s Additional Information Request #76.

In Appendix T, BC Hydro details past and present climate and hydrological trends in the region and provides projections of future flow for the Williston and Taylor local basin. BC Hydro describes the application of a statistical downscaling technique to coarse-resolution Global Climate Model (GCM) simulations to generate a set of climate and streamflow projections (based on hydrological modelling) for the project area. This work, conducted in collaboration with Pacific Climate Impacts Consortium (PCIC) staff, has been documented in a series of PCIC reports and EC accepts the findings. EC finds the techniques used appropriate and the results are consistent with other studies for similar regions.

However, EC noted that BC Hydro’s discussion of the projections is focused on the median values; this approach does not give adequate consideration to the inherent uncertainty in climate projection. BC Hydro provides a discussion of the temperature and precipitation projections emphasizing the range in the median projected values (from eight models) for three scenarios. The range of projected changes (i.e. the minimum and maximum for the 23 simulations) may be more informative for impacts and adaptation applications than the median or mean. For example, minimum projected summer
precipitation for the 2050s and 2080s is negative (i.e. a decrease) for all scenarios but the text lists positive values because the median of the projections are given. Similarly, the maximum temperature projections can be much higher than the median values. Although minimum and maximum temperature projections are provided in Tables 3 and 4 in the EIS, EC requested during the EIS review that the discussion in section 4.1.1 (and relevant sections of the executive summary and conclusion) be expanded to include attention to the potential magnitude of changes.

BC Hydro responded that the ensemble median is the “best estimate” and did not modify the discussion. In general, all projections from GCMs (across the range of models and emission scenarios) are considered equally plausible so there is no “best estimate”. Furthermore, the emission scenarios may not cover all possible future emissions scenarios and existing climate models do not represent all plausible models. As a result, the range of projected future change is very important for assessing possible impacts and their associated uncertainty. Although the range of projections is provided in the tables, it is requested that the discussion be expanded to clearly reflect uncertainty in the projected range of future climate changes, rather than rely on median values.

Given the inherent uncertainty in climate change projections, the JRP may wish to consider the value of BC Hydro taking the range of projected climate values into account (as opposed to only the median values) in project modelling, design and planning activities through the construction and operations stages of the Project.

EC also noted during the EIS review that BC Hydro did not provide a discussion of potential changes in future extremes in Volume 2, Appendix T. Given that flows in summer are projected to be lower, dry extremes may become more important. Similarly, since increased flows are projected for fall and winter, extreme wet events may have more of an impact. Other extremes could also impact important features such as infrastructure and processes such as sediment transport. EC requested that BC Hydro provide more information on the projected changes in weather and climate extremes of relevance to the project (e.g. heavy precipitation events, extreme cold and hot events, and prolonged dry periods).

BC Hydro did not provide more information on potential changes in extremes citing a lack of scientific consensus on treatment of extremes as well as limitations related to the method used for downscaling. EC acknowledges that understanding the nature of possible future changes in climate extremes is an area of active research, particularly at the regional scale. However, given that future changes in climate extremes are likely to occur (e.g., IPCC, 2012; IPCC, 2013), neither argument is sufficient to warrant exclusion of consideration of potential changes in weather and climate extremes.

The JRP may wish to consider the value of BC Hydro giving further attention to how possible future changes in project-relevant climate extremes for the area may affect the Project.

3.4.2 Comments on JRP Additional Information Request #76

EC agrees with BC Hydro that the latest Intergovernmental Panel on Climate Change (IPCC) report does not change their conclusions about the future hydrology of the Peace River Basin. The IPCC Annual Report AR5 does not present new research (i.e. BC Hydro should have already seen all relevant publications) and the references cited therein support their findings regarding shifts in seasonal distribution/timing of flow and a moderate increase in annual flow volume.

BC Hydro states in their response to JRP Additional Information Request #76 (p.20 of September 13, Evidentiary Update):
“The predictions do not say that this likely modest increase will be there in the next 10 years”. And
“From a resource planning perspective, resource reliance is based upon observable inflow data and not what may happen in the future between 2041 and 2070”.

In the JRP Context section of JRP #76 it is noted that BC Hydro projects water availability to be the same as the 1940-2000 average. BC Hydro indicates that the projected changes they present will not affect the preferred date for bringing Site C into service. Over the next 20 years or so (the period when the Project will come into service) it is appropriate to plan based on observable inflow (i.e. the 1940-2000 period). However, the seasonality of flow has been changing over this period and should be considered.

In the near-term (the next ~20 years), the anthropogenic climate changes anticipated for this region are likely to be small relative to the natural regional climate variability. As time progresses (out to mid-21st century), the anthropogenic influence will become larger relative to climate conditions over the recent past, and more pronounced temperature and precipitation differences beyond the range of observed natural climate variability are likely to emerge (i.e. stationarity cannot be assumed).

3.5 Considerations Related to Effects of Existing Flow Regulation on Downstream Interests

The preceding sections of Chapter 3 of this submission set out EC’s conclusions and recommendations concerning the potential effects of the Project on surface water hydrology and ice in the Peace River downstream of the proposed dam.

Beyond the Project, EC acknowledges the broader interests in understanding and managing the effects of existing hydro dams on the Peace River on downstream interests and values, including in the Peace Athabasca Delta. For the Government of Canada, those downstream interests include, but are not limited to, protection of wetland and riparian habitats that support migratory birds and species at risk, maintenance of the ecological integrity of Wood Buffalo National Park, and consideration of Aboriginal rights and related Crown obligations to downstream Aboriginal groups.

EC recognized those downstream interests in its June 2012 comments on the draft EIS Guidelines for Site C. In a letter to the Canadian Environmental Assessment Agency dated June 11, 2012 (www.ckea.gc.ca/050/documents/57120/57120E.pdf), the Department noted that the Peace River is already subject to flow regulation as a result of the construction and operation of the WAC Bennett Dam and the Peace Canyon Dam, and that operation of Site C in combination with the existing hydroelectric generating stations had the potential to result in cumulative impacts on the PAD. EC went on to recommend that the EIS for the Project include a discussion of existing hydro developments on the Peace River, the environmental effects that have occurred as a result and the effectiveness of measures taken to manage them.

In response to direction offered in the final EIS Guidelines, BC Hydro provided a narrative discussion of the hydrological changes resulting from previous hydroelectric developments (Volume 2: Assessment Methodology and Environmental Effects Assessment, Section 11.1). EC has reviewed this section of the EIS and offers detailed comments in Chapter 3. In its comments the Department notes that the EIS did not include important information from published scientific studies dating back to the 1970s that have documented the effects of flow regulation on the hydrology of the PAD.

Understanding and managing the health of the Peace River watershed, including the PAD and the entire Mackenzie River Basin, is a shared responsibility involving multiple jurisdictions and interests. It also
involves consideration of the effects of other stressors (e.g. oil sands development, water withdrawals, and climate change) that may act in combination with flow regulation to affect the watershed. As part of the Departmental mandate to conduct scientific research (e.g. as part of the Northern River Basins Study and Northern Rivers Ecosystem Initiative) and monitoring of surface water quantity and quality (e.g. as part of the Peace-Athabasca Delta Environmental Monitoring Program), EC generates scientific information that may be useful to other federal departments, provinces, industry, Aboriginal groups and others in fulfilling their own mandated responsibilities and objectives in relation to the PAD.

In addition to research and monitoring, EC participates in the Mackenzie River Basin Board, comprised of federal, provincial and territorial governments, as well as Aboriginal representatives, with a shared interest in the cooperative management of the water resources of the Mackenzie River Basin, including the PAD. The Board has no regulatory or licensing authorities of its own, but offers a series of guiding principles to support water management and planning in the Basin and produces State of the Aquatic Ecosystem Reports which provide scientific and traditional knowledge to decision makers.

In recognition of the known effects of flow regulation on the hydrology of the Peace-Athabasca Delta and the shared responsibility for understanding and managing them, a constructive next step could involve convening a multi-stakeholder technical committee to define the ecological flow needs that would be required to achieve specific environmental and/or traditional use objectives in the Peace-Athabasca Delta. The work of such a committee could be undertaken following the environmental assessment process for the Site C project.
4.1 Introduction

EC's mandate includes the protection, conservation and management of migratory birds and their habitat. The purpose of the *Migratory Birds Convention Act, 1994* (MBCA) is to implement the Migratory Birds Convention between Canada and the United States by protecting and conserving migratory birds, as populations and as individual birds. Regulations made under the MBCA provide, *inter alia*, for the conservation of migratory birds and the protection of their nests and eggs. Section 6 of the *Migratory Birds Regulations (MBR)* sets out prohibitions including those related to the disturbance, destruction, or taking of a nest, egg or nest shelter of a migratory bird. Prohibitions under section 6 also include the possession of a migratory bird, nest or egg, except under the authority of a permit for that purpose. Subsection 5.1 of the MBCA sets out prohibitions that include the deposition by a person or vessel of substances harmful to migratory birds in waters or areas frequented by migratory birds or in a place from which the substance may enter such waters or such an area.

EC provides information on migratory bird nesting periods as guidance to support the planning of activities in order to reduce the risk of illegal detrimental effects to migratory birds, their nests and eggs. To help with determining regionally relevant nesting periods, EC anticipates that it will in the relatively near future be able to provide estimated dates of regional nesting periods for broad habitat types within large geographical area within BC referred as ‘nesting zones’. These nesting dates are the result of a predictive model, referred to as ‘Rnest’. This model is based mainly on regional mean annual temperature, and the predicted ‘outcome’ dates are considered reasonably accurate to within a week. The regional nesting period dates are planned to be presented in a set of calendars that show the variation in nesting periods. These calendars would provide an estimate of the proportion of species that are predicted to be actively nesting on a given date during the general nesting period.

The guidance provided through Rnest would be general information, and constitute advice only. This advice would not be an authorization for the harming or killing of migratory birds or for the disturbance, destruction or taking of nests or eggs as prohibited under the *Migratory Birds Regulations*. The information would not guarantee that activities would avoid contravening the MBR or other laws and regulations. As a reminder, it is the responsibility of individuals and companies to assess their risk with regards to migratory birds, and design relevant avoidance and mitigation measures. Since the *Timing of Nesting Migratory Birds in Canada* applies to regional geographic areas, it is possible that local nesting periods could have a different starting date and/or duration than the dates published due to micro-climatic conditions in specific areas (e.g. high elevation sites or coastal sites), as well as inter-annual variation due to factors such as early spring or cold, wet summer.

In some cases, such as for migratory birds listed under the SARA, more specific information on nesting periods may be available and should be considered. At all times, the onus remains with the individual or company to comply with all applicable legislation.

Canada is also responsible, along with the Department of Fisheries and Ocean and the Parks Canada Agency, for administering the *Species at Risk Act*. The purposes of the SARA are to prevent wildlife species from becoming extinct or extirpated, to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity, and to manage species of special concern to prevent them from becoming endangered or threatened.

Section 79 of SARA pertains to situations where a person is required by a federal Act to ensure that an assessment of the environmental effects of a project is conducted. Subsection 79(1) requires every such
person to notify the competent Minister(s) without delay if the project is likely to affect a listed wildlife species or its critical habitat. Subsection 79(2) of SARA requires that the person identify the adverse effects of the project on the listed wildlife species and its critical habitat; and, if the project is carried out, to ensure that measures are taken to avoid or lessen those adverse effects and to monitor them, and to ensure that such measures are taken in a way that is consistent with all applicable recovery strategies and action plans. Subsection 79(3) defines ‘person’ as including an association or organization, and an authority as defined in subsection 2(1) of CEAA 2012, and anybody that is set out in Schedule 3 to that Act.

The Federal Policy on Wetland Conservation (the Wetland Policy) is a government-wide policy that was approved by federal Cabinet and adopted in 1991. It was developed as a federal response to wetland decline in Canada and is driven by interdepartmental, intergovernmental and widespread public support for, and interest in, the conservation of Canadian wetlands. The ecological importance and economic value of wetlands stem from their ability to perform key ecological (hydrological, biochemical, habitat and climate) functions. EC has a lead role in providing technical advice to other federal entities responsible for implementing the Wetland Policy. Refer to Appendix 2 for further EC advice regarding the Wetland Policy.

“Environment Canada’s Operational Framework for Use of Conservation Allowances” (Environment Canada 2012b) provides guidance in the use of conservation allowances. Conservation allowances are the third step of the mitigation hierarchy, a three-step approach that first examines options to avoid and minimize environmental impacts. The framework applies where Environment Canada has a role related to the review or approval of proposed land-use or resource-use activities, including those that occur on federal lands or waters, projects, or activities that are subject to federal legislation, actions that would affect Aboriginal and/or treaty rights, or when Environment Canada has environmental protection or conservation objectives that would be affected by the proposed activity. (Environment Canada, 2012, “Environment Canada’s Operational Framework for the Use of Conservation Allowances”, first page, not numbered.)

4.1.1 Introduction to the Wildlife Issues

The Project is located in Canada’s boreal region, a mosaic of forests and diverse wetlands including bogs, tufa seeps, muskeg, fens, and rivers (BAM 2013). The boreal forest is considered North America’s bird nursery, providing breeding habitat for over 300 species of birds, totaling 3 billion individuals, and producing about a third of all of Canada’s and the U.S.’s birds (Blancher and Wells 2005, BAM 2013).

These birds play a vital ecosystem role both locally - and regionally during migration - by consuming insects, rodents, carrion and other pests, pollinating flowers and dispersing seeds. It is through their abundant and healthy populations and landscape connectivity that boreal landbirds provide an estimated $5.4 billion annually in pest control services (Berlanga et al. 2010). Birds also excavate cavities and burrows essential for other wildlife, provide food and feathers, facilitate decomposition and nutrient cycling, represent culture and support recreation for people. About one third of Canadians spent time and money (approximately C$1.3 billion) viewing wildlife in 1996. As well, birds are important in many Aboriginal communities for economic, spiritual, and other purposes.

While some bird species are increasing, many, like aerial insectivores, shorebirds, forest and grassland birds, have been in steady decline for many years, as are the ecological services they provide to nature and people (NABCI 2012). Habitat destruction is the major cause of declines in bird populations, but mortality from human-related factors including collisions with vehicles and transmission lines also kill a large number of birds (Calvert el at 2013).
In general, the relationship between birds and their habitats is highly linked. As such, many species have limited flexibility in their range of nesting habitats, nesting only in or on particular substrates or species, relying on particular food resources, and breeding only at specific elevations or heights during specific periods of time. How birds use their environment is species-specific and region-specific.

High quality habitat for birds during migration is often limited. The reason is that migration is a critical period for the conservation of migratory bird populations: food is scarce, weather more unpredictable, and mortality risks from predation, collision and other such factors potentially higher (Sillet and Holmes 2002, Baker et al. 2004, Calvert et al. 2013). Adult birds, like many other wildlife species, generally follow predictable migratory routes, often returning to breed in the same area and even the same small territory in subsequent years. During spring migration, when suitable habitat is typically more limited, migration often occurs on different routes than those used during fall migration.

The Peace River flows through a unique west to east pass of the Rocky Mountains, connecting the boreal forests of the Prairies’ rolling Interior Plain to the valleys of the steeper Northern Boreal Mountains of British Columbia, Yukon and Alaska (Austin and Eriksson 2009, Environment Canada 2012). The river crosses the main hydrological divide of the Americas, which often functions as a biological/migratory divide (Newton 2003, Toews and Irwin 2008). While most of BC is above 1000 metres in elevation, the Peace River Valley is below 1000 metres and is warmer than the adjacent mountains and Taiga Plains to the north of Fort St. John (Austin and Eriksson 2009). The less severe climatic conditions of the Peace River Valley support higher productivity, more diverse habitats, and higher species richness (Austin and Eriksson 2009). Along the valley, habitats on the north and south-facing slopes are significantly different, with more coniferous trees on steep, cooler north-facing slopes and drier, more open and deciduous forests on warmer south-facing slopes (Wendy Easton, personal observation). Habitats differ and the topography is significantly steeper and narrower along the canyon within the proposed reservoir footprint relative to the wider, more open floodplain and grassland habitats east of the proposed dam (Wendy Easton, personal observation). It is important to note that grasslands make up only 1% of the province and while naturally rare, are of high conservation concern provincially due to increased development pressure (Austin and Eriksson 2009). In the context of the diversity of wetlands found in the Peace River Valley, it is also important to note that more than 30% of BC’s species of conservation concern depend on wetlands, many of which are small in size (Austin and Eriksson 2009).

4.1.2. Analysis Based on Best Available Information

The assessment of environmental effects requires a thorough understanding of the likely changes resulting from the Project on the components of the environment within federal jurisdiction (EIS Guidelines 8.5.2), including for migratory birds (Section 5(1)(a) of CEAA), changes in resources for Aboriginal traditional purposes (Section 5(1)(c) of CEAA), and SARA listed wildlife species (Section 79 of SARA). The EIS must provide an assessment of the potential cumulative adverse effects (EIS Guidelines 23.3); describe the renewable resources that would be significantly adversely affected (EIS Guidelines 23.4); and, detail a likely and achievable follow-up program that confirms the accuracy of assumptions made and of mitigation effectiveness (EIS Guidelines 23.5).

In undertaking the effects assessment, the EIS Guidelines direct BC Hydro to use best available information and methods and to assess baseline conditions, including with the use of predictive studies. The EIS Guidelines indicate that baseline conditions should include information on existing habitat, species presence, relative abundance, distribution and temporal use within the Local Assessment Area (LAA) for avian resources. In addition, the EIS Guidelines direct BC Hydro to assess the broad range of avian resources identified early by First Nations, including the loss of habitat for feeding, breeding, or overwintering for nesting birds including raptors, birds on migration and game birds (EIS Guidelines...
These points were echoed by the public and other stakeholders. The EIS Guidelines direct BC Hydro to describe the potential adverse effects of permanent and temporary habitat alteration and fragmentation; disturbance and/or displacement; and, the potential for direct and indirect mortality to individuals. The EIS Guidelines direct that the interactions of these aforesaid components must relate to the entire ecosystem and the communities of which they are part (EIS Guidelines 8.5.2.1, 12.2.4). All conclusions must be substantiated including statements of the assumptions that underlie the quantitative models and predictions, the quality of data and the degree of certainty of the predictions obtained.

An assessment of the potential environmental effects of the Project and the development of measures to avoid or mitigate adverse effects on migratory birds and Aboriginal resources (Section 5(1)(a) and 5(1)(c) of CEAA) as well as on species at risk (Section 79 of SARA) necessitates an understanding of where and how the Peace River floodplain contributes to the protection and conservation of birds and habitats, and of its capacity to produce ecological goods and services relevant to ecosystem function, First Nations and local communities. These should be the foundation for the assessment of effects and for decision-making with respect to mitigation and compensation, in order to ensure that the Project is delivered in a way that maintains ecosystem processes and ecosystem health.

4.2 Migratory Birds

4.2.1 Overview of Bird Values

An estimated 247 bird species, about ¾ of BC’s bird species, regularly breed, migrate and/or winter in BC’s Peace Region: 27 species of waterfowl, 34 species of waterbirds, 20 species of shorebirds and 166 species of landbirds (Canadian Wildlife Service unpublished data compiled from Environment Canada 2012, BC Bird Atlas, BC Species and Ecosystems Explorer database, E-bird, Partners in Flight database). Of these, 209 are protected by the MBCA. Thirty-two (32) of these bird species are considered at risk by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (10), federally, and/or provincially as blue or red-listed species.

Some bird species are only present during migration while others only occur in the winter. BC Hydro detected 169 species in the LAA during breeding bird surveys (Volume 2 Appendix R Part 4 Section 1.1.3.1), which constitutes approximately ¾ of the priority species identified in the Boreal Taiga Plains Bird Conservation Plan (Environment Canada 2012). This number is likely an underestimate, however, of the total number of bird species likely occurring in the LAA. This opinion is based on EC’s observation that BC Hydro’s survey program to date has not accounted for wintering birds and has not fully accounted for birds in migration.

In addition to information on the number of bird species recorded, the importance of the area for birds is also supported by previous surveys of the Peace River Valley which indicate abundant wildlife use, including that by migratory birds. For some species and groups, use of the Valley occurs during short but significant seasonally-based periods. Previous survey work has documented estimates of 17,000-30,000 songbirds and woodpeckers breeding in the reservoir impact zone (Blood 1979). During spring migration, observations have been made of large numbers of waterfowl moving along the Peace River (Thurber 1976), and of early migrating swans making use of the open river when the surrounding lakes were frozen (Blood 1979). Similarly, 11,000 shorebirds have been observed in a single month during migration (Thurber 1976) with reports (Siddle 2005) of observations of rarer species, including the White-rumped (Calidris fuscicollis); Pectoral (Calidris melanotos) and Stilt sandpipers (Calidris...
himantopus); the red-listed and species of Aboriginal interest Upland Sandpiper (*Bartramia longicauda*); and, the red-listed Hudsonian Godwit (*Limosa haemastica*).

It is also important to note that more birds, in species and in number of individuals, were observed in the Peace River Valley than on the plateau of the LAA. BC Hydro tallied close to 19,092 observations of 93 bird species in the Valley, including at least 31 migratory bird species found only along the river (Volume 2 Section 14.2.3. and Appendix R Part 4 Section 1.1.3.2.), and 6,574 observations of 74 species during similar surveys on the plateau (Volume 2 Appendix R Part 4 Section 1.1.3.2.). Historical surveys also found that the grasslands, wetlands, shrublands, broad floodplain forest, and small amounts of upland forest of the valley bottom support greater species diversity and productivity than the more extensive uplands (Blood 1979).

### 4.2.2 Effect: Habitat

#### 4.2.2.1 Baseline Condition - Birds and Habitats

Establishing an accurate baseline is important for predicting potential impacts of a project. It is also required, however, to be able to mitigate and monitor project effects (as part of a mitigation and monitoring strategy), to manage potential cumulative impacts, and to apply lessons to future proposals. EC has indicated deficiencies in the EIS, in relation to bird-habitat associations and species occurrence, and the assessment of the relative importance of habitats to birds, in the following areas:

- Habitat reporting is inconsistent, non-standard, and bird data are not specifically associated with validated habitat units;
- Reporting is expressed primarily as species diversity;
- Bird abundance is not represented;
- Bird occurrence is not expressed or calculated consistently by ecosystem or habitat types;
- Bird occurrence and habitat use information is limited during spring migration, fall migration, and winter;
- The EIS did not generate migratory bird population estimates such that the effects of the Project at the population level, either within the LAA or at a broader (regional) scale, could not be quantified (this is particularly important for at-risk species);
- Identification or discussion of the habitat features critical and limiting to migratory birds across the year is lacking;
- Habitat suitability models have significant deficiencies (e.g. broad habitat type approach, quality and suitability of the model input data, interpretation and professional opinion on habitat rankings, absence of error estimates and faulty validation process) and are of limited use to inform habitat features required by at risk species; and,
- Spatial and ecological scope of the factors and processes that would be affected by the Project (e.g. sources of direct and indirect mortality, changes to habitat quality and/or carrying capacity within the reservoir footprint and in adjacent areas) is narrow.

These deficiencies in the EIS, which present challenges in determining the potential impact of the Project on migratory birds, also present challenges in developing a baseline that can be used for mitigation and monitoring should the Project be approved.

#### Recommendation 4.1

EC requests that the JRP recommend that BC Hydro undertake the following steps, for the purpose of updating and informing its mitigation (including compensation) strategy/plans:
a) Report on migratory bird use and impacts using the habitat terminology described in Volume 13 Vegetation and Ecological Communities (and supporting technical reports). Habitat units should be standardized for all wildlife resources, be verifiable by real data, and follow provincial standards and classification systems to support a comprehensive ecosystem assessment and complementary mitigation measures for multiple valued components; and

b) Complete the assessment, including providing estimates of abundance, of the baseline condition for migratory bird species (including species at risk and species of Aboriginal interest), their associated habitats, and across seasons, including differentiating and providing LAA statistics of where habitat would be permanently lost or fragmented, (e.g. by roads or transmission lines) and where habitat would be expected to remain intact.

In relation to (b) above, the assessment should include the loss of rare ecosystems in terms of migratory bird species and abundance, species at risk (including migratory birds), and species of Aboriginal interest. Notable rare forested ecosystems unique to floodplains include spruce-currant-horsetail (07/SH) and black cottonwood-red osier dogwood (09/Fm02), which are suitable for rare warbler species. The assessment should also characterize and quantify fine-scale river habitat features associated with, and responsible for, aquatic bird distribution and abundance.

**Technical Rationale**

To assess the effects of habitat changes on migratory birds, information is needed on how species and populations use and distribute themselves across habitats, spatially and temporally. This assessment requires data on habitat, species, relative abundance, distribution and temporal use within the LAA (EIS Guidelines 12.2.3.3).

BC Hydro narrowed the focus of baseline data, assessment of effects, and corresponding mitigation to a small number of species at risk. As a consequence of this approach the assessment, in EC’s opinion, fails to capture or represent the life requisites and effects pathways for migratory birds, including birds of Aboriginal interest (EIS guidelines 8.3, 8.5). Baseline data, assessment of effects and mitigation measures are notably deficient or lacking for birds entirely dependent upon the Peace River and adjacent lowland habitats (IR #34). This includes migratory waterfowl, shorebirds, waterbirds, and landbirds associated with freshwater habitats, including rivers, streams, lakes, ponds, and wetlands; and also includes terrestrial habitats, including grasslands, riparian shrub habitat, and mature and climax floodplain forest. Bird use of these habitats occurs during the breeding and non-breeding, i.e. spring migration, fall migration and winter seasons.

BC Hydro did not present bird abundance data in the EIS in relation to the LAA, Regional Assessment Area (RAA), or by habitat type in either of those study areas. The absence of site-specific abundance data reduces EC’s ability to properly assess the scope of the populations that would be impacted, and also the specific areas and habitats where these impacts would occur. The absence of a quantitative effects assessment puts into question the mitigation proposed by BC Hydro to effectively target the full suite of potentially impacted species and their associated habitats. Nevertheless, noting EC’s concerns raised to date regarding survey coverage, breeding songbird surveys tallied 39,635 observations over four years in the LAA (Volume 2 Appendix R Part 4 Section 1.1.3.1). It is worth noting, for comparison, the historical record of 11,000 shorebirds observed during migration in relation to the threshold of 20,000 shorebirds for a site to be designated internationally as a Site of Regional Importance under the Western Hemispheric Shorebird Reserve Network program (www.whsrn.org). Given that the 11,000 figure is based on a single study, and given typical year to year variation in shorebird numbers at other sites in the province, further consideration of the local and concentrated importance of the area for migrating shorebirds seems warranted.
EC has also advised that the assessment’s focus on a small number of species at risk (almost entirely terrestrial) is not representative of the larger suite of federally protected migratory birds and birds of Aboriginal interest (IR#34).

In EC’s opinion, and for the purposes of environmental assessment for a project of the scale and complexity of the Project, an understanding of bird associations with their habitat, based on species distribution, abundance and density, among and between habitat types and habitat features is appropriate. It is evident that the choice of criteria and methods used to determine and measure bird use of habitats is relevant to the quality of habitat association information. The use of quantitative metrics – including relative abundance and density – removes some uncertainty in assessing bird use and the functional values of the habitats impacted, which in turn provides the objective criteria needed in support of mitigation (including compensation) strategies and plans.

The EIS makes reference to three habitat classification systems to describe the LAA; two are presented in the vegetation assessment (for terrestrial and rare and sensitive plant communities), and a third is introduced in the bird assessment to discuss effects. The goal and intent of the vegetation mapping effort is described as follows:

“Terrestrial ecosystem mapping of the Peace River Corridor was requested by BC Hydro and Power Authority as base mapping for strategic planning. Terrestrial ecosystem mapping (TEM) can be used as the basis for a number of types of interpretive maps including wildlife habitat…”


Given the EIS’s focus on strategic planning and interpretive reporting, EC is of the opinion that the terminology used to characterize terrestrial ecosystems in the migratory bird assessment needs to be consistent with the ecosystem types and habitat classes presented in the vegetation assessment. However, the habitat descriptors used in the bird assessment differ from, or are not directly comparable to, those used in the vegetation assessment. The new habitat terms are of different spatial scales, from the very broad and large (e.g. forested upland, a composite of various forest and cover types that cover the bulk of the LAA) to the very narrow and fine (e.g. non-vegetated anthropogenic) and, in some cases, are not mutually exclusive.

In relation to the above, and by way of example, the habitat types used to report for waterfowl occurrence are ‘backchannel’, ‘lake’, ‘river’, and ‘wetland’. They are referred to in Table 1.3.3. as ‘broader habitat categories’. These terms are not independent spatially or temporally. The contrasting of ‘river’ and ‘backchannel’ habitat is, in EC’s view, insufficient to capture the breadth of the Peace River habitat features important to migratory birds, to identify river habitats available and used by migratory birds, and to determine what might be limiting to particular species. An understanding of these habitat features is needed to properly develop mitigation and compensation programs. Backchannels are an attribute (finer-scale feature) of the river and they do not exist independently from the river, like the other two categories. The Peace River supports a wide floodplain shaped by flood waters overtopping the river’s main channel. Floodplains can be very wide relative to the size of the main river channel, and the size of the floodplain will vary depending on the range of water levels observed on the river. The distinction between main river channel, side channels and floodplain wetlands can be blurred. Because water levels and flow vary widely throughout the year (e.g. because of spring runoff and summer droughts), the number and size of backchannels will change constantly (e.g. they will gradually disappear as water levels rise and gradually reappear as water levels go down). Other river features important to migratory birds are presence of meanders, oxbow lakes, woody debris, islands, aquatic vegetation, substrate type, streams, bedform configuration (running water, pool, etc.) etc. Mapping and measuring the area covered by river channels at one point in time does not capture the dynamic nature...
of river channels. Ecologically, back-channels are rarely referred to as ecological units and are considered separately from the river itself. A backchannel is a feature and subset of the river itself, and in EC’s opinion, does not constitute a ‘general habitat type’ that is independent from the other habitat types presented in the report.

Another example of the difficulty of determining correspondence between the migratory bird habitat assessment and the vegetation assessment is with respect to the general aquatic habitat types. The terms ‘river’ and ‘backchannel’ fall short of the four types of ‘water’ and six types of ‘wetland’ identified in the vegetation assessment (‘backchannel’ is not one of them and it is not synonymous with ‘riparian wetland’) (page 13-9 and 13-18 of the Vegetation Assessment). In Volume 2, Section 13, subsection 13.2.1.1 - Terrestrial Habitats, Table 13.4 reports 3,965 ha of wetlands in the LAA, whereas Section 13.2.1.2 in the Rare and Sensitive Ecological Communities reports 4,074 ha (line 23). In IR Gov_0018-005, BC Hydro advised that this difference arose from adding up Open Water and Pond to the wetland area. To EC, this appears to create a second definition of ‘wetlands’, one that is different from that presented in Table 1.1.9 of the Vegetation Assessment (page 26 of 455), where ‘wetland’ did not include Open Water and Ponds. The definition of wetland and water provided by BC Hydro in response to IR#93 on 28 October 2013 presents a third definition of the terms, with the addition of “lakes” to “water” (p. 5). In Volume 2, Appendix R, Part 4, Migratory Birds, landbird habitat features are described variously as:

- ‘Habitat class’ (e.g. Table 1.1.8, revision 1, July 19, 2013, p. 19 of 266) that refer to ‘valley’ and ‘plateau’;
- Habitat ‘type’ (e.g. Table 1.1.11 and 1.1.12, p. 22 and 23 of 266);
- ‘Transect’ or ‘transect label’ (e.g. Tables 1.2.1 and 1.2.2, p. 29 of 266); and,
- For waterfowl, habitat features are presented by ‘broader habitat categories’ and ‘stratum’ (p. e.g. Table 1.3.2, revision 1, July 19, 2013, p. 43 of 266).

The above terms are not presented or described in Volume 2, Appendix R, Part 1, Vegetation and Ecological Communities. It is unclear to EC how cross-referencing of habitat types described in the vegetation assessment with those in the wildlife assessment, including those associated with migratory birds, is to be achieved. Along these lines, the Vegetation and Ecological Community report describes the term ‘plateau’ as a broad landscape feature that is not mapped or described. For the migratory bird assessment, ‘plateau’ and ‘valley’ are defined on a physical basis (see Map 1.7.2, which does not include or refer to habitat units but uses geographic boundaries to define the habitat types). The explanation for the definition of the Peace River Valley is that it ‘was a standard area provided as a shapefile by BC Hydro’ (Volume 2, Appendix R, Terrestrial Vegetation and Wildlife Report, Part 4, Migratory Birds, Section 1.1.2.3.2, p. 9 of 266). The terms ‘Valley’ and ‘Plateau’ do not appear to have been applied consistently in the assessment (e.g. Watson Slough, which appears in Map 1.7.2 as ‘valley’ habitat but is described in Section 1.2.2.3.1 as plateau given the statement that ‘some portions of the slough have been affected by human activity, namely the upper portions at margins of cultivated fields on the plateau’ (p. 55 of 455). Watson Slough and its associated farmland are relatively low in elevation compared to the Peace River such that there is a lack of clarity as to which set of landscape features they belong to. The translation of these two types of landscape features as habitat types is further limited by the recognition by BC Hydro that ‘the Plateau does contain some river valley habitats associated with tributaries’ (Volume 2, Appendix R, Terrestrial Vegetation and Wildlife Report, Part 4, Migratory Birds, Revision 1 – July 19, 2013, page 9 of 266).

EC previously requested that BC Hydro clarify the bird habitat types the survey transects were associated with, how transect locations were stratified by habitat type, and habitat-species associations.
4.2.3 Seasonal Assessment (non-breeding season)

Lowland river, wetland, riparian and grassland habitats, especially east-west through the Rocky Mountains, are limited in BC (Austin and Eriksson 2009) and are important for maintaining migratory and population connectivity for wildlife throughout the northwestern boreal, including the Northwestern Interior Forest Bird Conservation Region of northern BC, the Yukon and Alaska (Fraser 2000, Berlanga et al. 2010, http://www.nabc.net/International/English/bcr4.html)

The Peace River Valley is an example of the importance of low elevation habitats and their use for wildlife movements; indeed, historical surveys, plus surveys summarized in the EIS, report diverse and abundant migration of migratory birds along the Peace River (Thurber 1976, Blood 1979, Robertson 1999). It appears, however, that in the EIS, BC Hydro assumes that the plateau along the proposed reservoir would serve the same ecological functions for birds in migration as the future lost valley habitat (IR# S30, 31). Noting concerns stated earlier regarding the scope of migration surveys, EC is of the opinion that the data do not support this assumption. EC has advised BC Hydro in the review process to date, and continues to advise that the effects assessment take into account impacts to birds and associated staging and stopover habitats during spring and fall migration. EC has also advised that the effects of changes on the amount and quality of habitat and its ability to support migratory birds stemming from the Project’s activities across all LAA habitats be assessed.

Recommendation 4.2

EC requests that the JRP recommend that BC Hydro undertake an assessment of the habitat values of the LAA in support of the development of its mitigation (including compensation) strategy/plans so as to address the habitat needs of migrating and wintering migratory birds. This work should include the following:

a) An undertaking to quantify migrant and wintering bird abundance in the LAA (i.e. generate abundance estimates, by species and groups of species); identify and characterize important migration and wintering habitats; and determine habitat-species associations at the habitat type and habitat feature levels; and

b) An assessment of the impacts resulting from the loss of habitat due to the reservoir, transmission line, roads and ancillary sites at the regional level.

In relation to (b) above, consideration should be given to alternative migration routes which have suitable habitat, orientation and elevation within the region to support fully functional migration routes between the Peace Region and BC’s Northwestern Interior Forest Bird Conservation Region

Technical Rationale

Riparian habitats are considered critical as routes for migratory movement and as stopover habitats for many migrants in BC (Mackenzie Nature Observatory, unpublished reports) and throughout North America (Carlisle et al. 2009). Habitats of the Peace River canyon are expected to be particularly important to birds in migration, especially in spring, as these habitats are warmer, more sheltered, and therefore subject to less wind and cooling than the adjacent upland areas. They also have earlier plant growth and likely more insect availability than adjacent areas in late winter and early spring. Given these attributes, canyon habitats of the Peace River are likely disproportionately important relative to nearby upland habitats, in particular for birds that need to manage their energy reserves during migration.
However, EC thinks the most important role of the Peace River to migrant waterfowl occurs in March when the river is open but nearby wetlands and streams are still frozen. It is the first and most significant open water habitat available to migratory birds. Waterfowl use of the river during that period was documented by EC in the course of aerial surveys conducted in late March 2012 and 2013. The importance of the river during early spring migration (i.e. before the peak migration occurs, which happens when all wetlands are ice-free and available to waterfowl) was also captured by Blood (1979), who noted that ‘early migrating swans made considerable use of the river in spring when the surrounding lakes were still frozen’, and by Siddle (2005) who concluded that Fort St. John and the Peace River are ‘important stopover sites since they are the only suitable habitat in BC for the Central Flyway’ (page 34 of 266).

The literature cited and field work BC Hydro and EC have conducted to date indicate that the Peace River floodplain and adjacent areas support significant landbird, shorebird and waterfowl/waterbird migrant populations. The EIS and subsequent information offered from BC Hydro do not, however, provide an assessment of the magnitude of spring migration, of the key habitats or of areas used during migration, nor of the significance of the various habitats or habitat features found in the LAA. There is, in EC’s opinion, insufficient information to properly quantify and gauge the importance and significance of the LAA to migrating or wintering birds and, therefore, to assess the level of risk the Project presents to them.

In addition, winter habitats support a different suite (Volume 2, Appendix R, Part 4, Section 1.1.3.4) and number of migratory terrestrial and aquatic species (Robertson 1999). There is no evidence of winter surveys, beyond an aquatic survey in February 1996 (Robertson 1999), for any migratory birds, species at risk, or birds of Aboriginal interest. Information on the size of the wintering populations, locations, or specific habitat features significant for wintering birds are not provided. An assessment of the magnitude and relative habitat use of wintering landbird species has not been completed.

4.2.4 Linking Birds with Habitat to Assess Effects

Developing mitigation measures that are effective and science-based requires more than an understanding of diversity of species; it requires an understanding of the productivity and carrying capacity of habitats to support bird populations. This is necessary in order to distinguish between highly productive habitats with abundant resources and poorer quality habitats.

EC has identified methodological concerns related to the assessment of habitat productivity and use by birds. Standardized counts will improve the ability to describe and validate relative patterns of habitat suitability. As well, estimates of population sizes (e.g. Blancher et al. 2007, Bayne and Hobson 2002) support comparisons between the effects of different activities over different habitats and scales (Cumming et al. 2010), with implications for mitigation and compensation. This is important where the EIS (Volume 2 Appendix R Part 4 Section 1.1.3.2) and others (Blood 1979) demonstrate that species diversity and productivity is much greater on the valley bottom than on the more extensive uplands.

The EIS focuses on a limited number of migratory birds that are at risk. However, common, widespread species are also of conservation concern. These species shape the environment by forming and driving much of the ecosystem structure, function and services. Even relatively small, proportional declines in their abundance can result in larger absolute losses of individuals and biomass (Gaston and Fuller 2008). The decline of a species can result in ecosystem level changes that are difficult to predict; for example, the disappearance of a common cavity-excavating species due to food loss can drive the loss of many other species dependent upon new cavities.
Finally, EC is concerned with how the migratory bird assessment linked bird use and habitat type and has identified methodological issues.

Recommendation 4.3

For the purposes of updating and informing its mitigation (including compensation) strategy/plans, EC requests that the JRP recommend that BC Hydro provide a summary of the field surveys conducted in all the habitat types identified in EIS Tables 13.4, 13.5 and 13.6, indicating the data collection efforts by habitat, at both coarse and broad scales.

Recommendation 4.4

EC requests that the JRP recommend that BC Hydro identify, in table form and maps, the individual locations of all surveyed species together with the associated mapped ecosystem unit for each Project component, differentiating in the LAA: where habitat would be permanently lost; where habitat would be fragmented (e.g. by roads or transmission lines); and, where habitat would remain intact. BC Hydro should also provide the same for each species where associated mapped ecosystem units were not surveyed for the LAA.

In relation to recommendations 4.3 and 4.4 above, it would be important that, in support of the mitigation and compensation strategy/plan, wildlife survey data and ecosystem mapping be provided for proposed measures in relation to habitats located outside of the LAA (IR #S43).

Technical Rationale

In the EIS, migratory bird survey data have not been analyzed to generate population estimates over the Project reservoir footprint, the LAA or RAA. An estimate of the density and relative abundance of migratory birds across the LAA and habitats is critical for the assessment of the magnitude of the effects, the evaluation of the value and productivity of the habitats, the adjustment of activities to avoid or mitigate effects, and the evaluation of progress and performance against the mitigation programs.

The understanding of baseline conditions that drives the assessment of effects and development of mitigation measures is further impaired by the limited scope of the data reports and summaries provided in the EIS. EC has consistently noted and advised on the use of established scientific and reporting principles when reporting on survey types, survey designs, data summaries and data analyses of both the bird and habitat data. Information on study design, sample size, summary counts (especially repeated counts within season or between years), estimates of variability, validation of habitat/ecosystem units, and links between bird and habitat surveys is not comprehensive, nor are these parameters described in enough detail to assess validity of assumptions and soundness of conclusions. Further, it is EC’s opinion that the calculation of diversity estimates does not provide any meaningful information to direct and evaluate mitigation for the protection and conservation of migratory birds, including species at risk, nor do the EIS bird models (IR #39, #40, #S41, see also comments under Section 4.3 of this submission, Species at Risk). Models and their predictions need to include and assess error and be validated with suitable datasets (e.g. standardized data collected within a well-considered statistically designed framework to produce reliable predictions (Cumming et al. 2010, Matsuoka et al. 2011, Matsuoka et al. 2012).

EC has further concerns related to how habitat types were linked to bird use in the migratory bird assessment. In Volume 2, Appendix R, Part 4, Revision 1, 19 July 2013, page 12 of 266, BC Hydro states that, “...bird observations were related to general habitat types created from specific ecosystem habitats occurring within the mapped area.”. BC Hydro then advises that, “...these general types were used
because specific locations were not available for all the observations [therefore] nine general habitat types were described...”. EC interprets the aforesaid as follows:

- That a proportion of bird observations could not be related to specific ecosystem habitats (which is inferred to be the ‘ecosystem types’ as presented in Table 13.4); and,
- That a proportion of bird sightings were not point-based or habitat-based or both and could therefore not be associated with either a specific location or a specific habitat.

From the above, this suggests that

- Data were possibly not collected exhaustively across all ecosystem types (as identified in Tables 13.4, 13.5 and 13.6);
- Field survey designs were not meant to sample the habitats presented and defined in Tables 13.4, 13.5 and 13.6; and,
- The magnitude of the non-match with the habitat types used in the Vegetation Report was such that habitat-specific assessments and analyses were not possible or useful, so they were not conducted or presented in the EIS.

For EC to determine if the bird survey programs conducted to date fully inform bird habitat use across the suite of habitats of the LAA - at coarse or fine spatial scales - information is needed regarding habitats and associated bird survey coverage, including, for example:

- The extent to which the migratory bird assessment used the Terrestrial Ecosystem Mapping (TEM) habitat classification system (which in turn was used to guide the effects assessment) (this could be done in a summary table showing the extent to which the bird assessment data sources and field studies used the TEM habitat classification system);
- If, and by how much, the full suite of habitats present in the LAA were covered by the field surveys (this could be done in a summary table showing all the LAA habitat types, and, for each habitat, total area, survey name/type, spatial coverage (as % of total habitat area) covered by each survey); and,
- The extent to which information from each individual survey could be related to the habitat classification presented in the vegetation assessment, in order to provide information on the strength of the habitat inference that can be gained from each survey

### 4.2.5 Predicting Suitable Habitat for Birds and Assessing Effects

Statistical habitat modelling can effectively interpolate sparse data over large, under-sampled regions (Gottschalk et al. 2005). However, models and their predictions must be verified by real, standardized data collected within a well-considered statistically designed framework to produce reliable predictions (Cumming et al. 2010, Matsuoka et al. 2011). In EC’s opinion the habitat suitability models used in the EIS do not reflect the ecological needs of at-risk migratory birds and species of Aboriginal interest; nor do the models infer the future suitability of habitat in the LAA and RAA for the majority of migratory bird species.

EC does not support the approach that a habitat suitability model can be developed for SARA-listed species based on general habitat features. In some cases, for example, habitat suitability maps identify large areas as suitable (30-50% of total area) that, in EC’s opinion, likely are not representative of the actual habitat use by the listed species (e.g. Figures 1.7.7, 1.7.8, 1.7.13 and 1.7.14). These model outcomes may be reflective of the large initial habitat classes inputted into the model or the ranks assigned to different habitat types and subtypes. Model outcomes may also be due to the model assumptions or as a result of the true limiting factors responsible for the distribution and abundance of the species not being sufficiently understood nor captured by the habitat classification used in the model.
EC notes the reliance of the EIS on habitat suitability models and that for the species not modelled, the
EIS offers no analysis, either through mapping or other evaluations of these potential effects.

Given the reliance on habitat suitability models to assess impacts to migratory bird habitat, and by
extension migratory birds, EC makes the following recommendation to the JRP in support of refining the
assessment of impacts to migratory birds and in support of updating its mitigation (including
compensation) strategy/plans:

Recommendation 4.5

EC requests that the JRP recommend that BC Hydro produce an effects pathway that demonstrates
the rationale and how the indicator species represent the ecological needs of the larger suite of
migratory birds and species of Aboriginal interest. This should include individual models of
representative migratory waterfowl and landbirds associated with each of the freshwater habitats
(river habitat and fish-waterfowl) and terrestrial habitats (including grasslands, riparian shrub habitat,
and mature and climax floodplain forest).

Recommendation 4.6

EC requests that the JRP recommend that BC Hydro produce a scientifically defensible and
statistically-based sampling framework to support predictive models for use in a comparative
assessment at multiple scales. This should use standardized surveys and counts to produce estimates
of population size (as noted prior in this submission), by which to improve the ability to describe and
validate relative patterns of habitat suitability to support comparisons between the effects of
different activities over different habitats and scales that in turn support mitigation (including
compensation) strategy/plans.

In relation to 4.5 and 4.6 above, EC offers the following considerations that would assist with this
undertaking:

• Describe and submit to peer-review the mathematical model showing how the input habitat
data and the suitability rankings were processed to generate the overall habitat suitability maps;
• Provide quantitative (i.e. not descriptive) statistical information on the error(s) associated with
each model.
• Validate model assumptions and predictions using a field study that would be developed on a
habitat and sampling based approach and that would provide statistical inference (i.e.
statistically sound estimate accompanied by a measure of error).
• Generate a new set of models, at a spatial scale finer than ‘general habitat types’. This would
require the identification of habitat types and features responsible for bird distribution and
supporting field studies, including in relation to at-risk species. In the new models, model
reliability qualifiers (currently based on literature review, field data and professional opinion)
would be replaced with a statistical sensitivity analysis of the model. The results of the
sensitivity analysis would inform:
  o The robustness of the model
  o The model inputs that cause significant uncertainty in the output
  o How to correct inputs that cause significant uncertainty
  o A search for errors in the model (e.g. search for unexpected relationships between input
    and output, e.g. prediction that over 50% of the entire area is suitable habitat for a
    listed species)
  o Model simplification (e.g. fixing model inputs that have no effects on the output or
    identification and removal of redundant parts of the model
**Technical Rationale**

The primary source of information used to develop the warbler habitat suitability models was a literature review weighted by professional opinion. Some models, like the one for the Bay-breasted Warbler, had over two dozen model assumptions with missing or incomplete data. For Trumpeter Swan, one of the assumptions listed is that ‘Reservoir’ is one of the two High-rated habitats. Subsequent assignments of ‘moderate suitability’ rather than ‘low suitability’ or ‘nil’ have significant ramifications on the outcome of the final habitat suitability map. In EC’s opinion, the use of the literature cited to predict or estimate use across a broad suite of habitats and on the weight given to professional opinion in the final model prediction must be treated and interpreted with caution.

Model validation appears to be subjective, using literature review, some field data and professional opinion without using novel data to test model assumptions. How, and the extent to which, field surveys were used to validate the model remains unclear. It appears to EC that field surveys were not habitat-based or habitat-stratified, or designed to assess bird use across the entire suite of habitats identified in the vegetation assessment. Field surveys were primarily presented as (cumulative) occurrences, and not adjusted by survey effort or type or habitat type; further, they are not discussed with respect to abundance, habitat use or habitat density. Given that distribution and apportioning of populations across modeled habitats was not assessed, it is unclear to EC how field surveys were used to validate habitat suitability models.

In the majority of cases, (see examples in this submission Section 4.3 Species at Risk), there appears to EC to be discrepancies between field occurrences of birds and suitable habitat as defined by the habitat model. In EC’s opinion, statements regarding model confidence should be amended where mismatches in bird presence and suitable habitat occur such that, ‘the predicted definition of suitable habitat for species ‘X’ does not match the field occurrence of the species’, and that the confidence given to the model should be ‘low’. To EC, the aforesaid is indicative that the issue is with the model itself, not with how the listed species selects habitat (i.e. choose to distribute largely in areas with unsuitable habitat, for other reasons).

**4.2.6 Physical Changes to Aquatic Habitats**

Downstream of Peace Canyon Dam, flow regulation has altered the physical structure and vegetation communities of floodplain habitats and, as a result, the quality and quantity of habitat conditions for wildlife resources. These changes also have a temporal aspect, i.e. the timing, extent, and frequency of floodplain inundation has been altered.

The creation of the Site C reservoir would have various effects on the physical and ecological environment of the Peace River. For example, there would be an immediate and permanent loss of island habitats and reduction in shallow water areas within the reservoir. Sedimentation rates are anticipated to change, as the proposed reservoir would trap a portion of the sediments delivered from tributaries, while the remainder (mostly clay) would be transported out of the reservoir to downstream the Peace River. The loss of shallow water areas would be important to waterfowl and shorebirds that feed in shallow water and to all migratory birds that depend on aquatic invertebrates found in shallow water.

In the context of these relatively major changes, further information is needed to be able to adequately characterize the changes and the implications for migratory bird populations.

**Recommendation 4.7**
EC requests that the JRP recommend that BC Hydro develop mitigation measures specific to migratory birds and bird species of Aboriginal interest that address the changes in aquatic and riparian-related food resources associated with the change from a fluvial to a reservoir system. This could include:

a) designing and implementing a long-term tracking program for fish-eating and insectivorous birds by which to assess the ecological changes associated with the reservoir and downstream of the dam; and

b) taking into account Peace River floodplain features and habitats that are of importance to individual species (as defined in the literature, analyses of available data and/or from future surveys), including for example limiting factors (other than nest sites) and future recreational use of existing features.

**Technical Rationale**

Briefly, the EIS states that the major physical changes to aquatic habitats would be:

- Increased habitat volume;
- Reduction in diversity of the types of habitat available for fish and aquatic organisms;
- Alteration of hydraulic conditions (e.g. depth, velocity) and seasonal patterns of water level;
- Changes to the thermal and ice regimes; and,
- Changes to water quality.

The report titled ‘Baseline aquatic productivity in the Peace River 2012 Report’ identified water depth, water velocity, temperature, flow and distance from the dam (p. ii) as the most important habitat attributes that determine the composition and biomass of benthic invertebrates. Changes in depth, velocity and flow associated with construction and operations of the Site C reservoir would therefore cause changes in composition and biomass of benthic invertebrates. Migratory birds that either directly forage on benthic invertebrates (e.g. some waterfowl, shorebirds, and aerial insectivorous birds) or prey on fish that feed on benthic invertebrates (e.g. mergansers) would therefore be affected by changes in food abundance, food type and food availability. Physical changes would also affect riparian habitats and food availability for herbivorous species (e.g. Canada Goose, Trumpeter Swan).

The Executive Summary of the Downstream Ice Regime Technical Data Report starts with the statement that ‘with the project in place, the model predicts that the maximum upstream extent of the ice cover would be on average about 30 to 50 km further downstream than under existing conditions’ (Volume 2, Appendix G, page i of ix). With the filling of the reservoir, ice formation is predicted to occur on an annual basis where it has not readily occurred in the past (Volume 2 Appendix H Reservoir Water Temperature and Ice Regime Technical Data Report). The Report states that, “…based on the 2013 spring data and ice modelling, ice break-up will occur most often in April at a time when many waterfowl species start arriving to the area. The presence of ice where it has not occurred in the past and the timing of the ice break up will have negative effects on aquatic bird species.” (Vol. 2, Section 14, Revision 1 – July 19, 2013, p. 14-33).

EC conducted aerial surveys of spring migrant waterfowl in March 2013 and noted that both the Dinosaur Reservoir and the main stem of the Peace River were ice-free in late March and that, as per the March 2012 surveys conducted by EC, spring migrant waterfowl had arrived in late March. EC would like clarifications on how the BC Hydro 2013 spring bird data were used to support the conclusion that ice-breakup would primarily occur in April given that EC observed the river and reservoir to be ice-free in late March. The Downstream Ice Regime Technical Data Report states that,”…with the onset of warming temperatures, longer days and increased solar radiation in March, the ice front starts its recession downstream. The ice front passes through the Town of Peace River anywhere from late March to late
April.” (p. 6 of 107). Given that the prediction for April ice-free conditions are for the Town of Peace River (and not for the Site C reservoir site), the ice front would presumably pass at an earlier date than in the Town of Peace River, where it is predicted to occur from late March to late April. EC comments earlier in the review process identified the uniqueness and critical value of the Peace River to early spring migrant waterfowl, when all nearby wetlands are frozen.

Water quality is expected to change as a consequence of the Project. The pH and Total and Dissolved Oxygen contents are predicted to have low increases (with some uncertainty) (Volume 2, Section 10, page 11-64); these increases have the potential to translate to changes in existing assemblages of aquatic invertebrates, which in turn has the potential to impact the migratory bird food web.

In EC’s opinion, the Project effects would be broader and longer-term than hitherto identified and, for some species more detrimental.

Further to the above, EC disagrees with the assumption made in the EIS that nest site availability is the most important limiting factor. Specifically, for a mitigation and compensation program to be successful, it is critical that the underlying mechanism(s) that limit populations be identified and understood. In EC’s opinion, changes in food supply or availability of food (water chemistry, fish, invertebrate, changes in water depth) will be more likely to be limiting to waterfowl and shorebird species than is nest site availability. Limiting factors also need to be considered seasonally as, for example, open water availability is likely limiting in late March but not in late August. Given the aforesaid, EC does not agree with the implicit assumption that nest boxes and the gradual re-establishment of vegetation would be sufficient to reverse Project effects. In Volume 2, Section 14, page 14-71a, BC Hydro states that waterfowl “…are considered to have high resilience to the effects of habitat alteration and fragmentation, providing there is suitable forage and nesting available.” The fisheries, invertebrate and physical feature assessments all suggest that food supply and food availability to migratory birds would both change under this project (e.g. changes in fish community, increases fish biomass, removal of shallow water areas, removal of islands, changes in invertebrate species etc.). For migratory birds, the effects on food supply are unlikely to be fully (or possibly even partially) reversible and it is therefore important to recognize that installation of nest boxes or re-establishment of shoreline vegetation can at best only be partially effective to address all the residual effects.

In EC’s view, factors that affect the potential for a species to recover from habitat losses include the size of the affected and regional populations, the degree to which the species is a habitat specialist, how the species respond to habitat losses, ecological factors (e.g. reproductive rate and success, habitat growth rate) and the particular need that the habitat fills for the species at any particular time. In EC’s opinion, some bird populations affected by the Project would be expected to recover; others would be impacted but would not show effects at the regional population level; and, for some species with very specific and narrow habitat requirements (e.g. fish eaters and/or river specialists and listed species), populations would not be expected to return to pre-Project levels.

In EC’s opinion, the analysis of literature cited provided in response to JRP IR#S30 is insufficient to support BC Hydro’s statement that recovery would take place for all species. A first limitation of the literature review assessment is that BC Hydro did not estimate the waterfowl and shorebird populations present or affected by the Project or the regional population, such that the magnitude of the populations affected remains unclear. For example, with respect to shorebirds, Blood (1979) estimated that 400 pairs of sandpipers and 40 pairs of Killdeer nested in the Impact Area, and that nesting habitat would be reduced by 50 to 75% due to reservoir construction.

Siddle (2005) concluded that Fort St. John and the Peace River are ‘important stopover sites since they are the only suitable habitat in BC for the Central Flyway’ (page 34 of 266). Volume 2, Appendix 4, Table
1.1.3 (Revision 1- July 19, 2013, page 13 of 266) refers to 40 waterfowl and shorebird species while the literature cited refer to a much smaller number of species associated with general habitat features. In EC’s opinion, the general definitions as described by the aforesaid do not capture the full range of habitat use by all waterfowl and shorebird species. The reports cited primarily describe species diversity and occurrence rather than population effects and regional population levels. None of the literature cited reports indicates that: one, waterfowl and shorebird populations returned to Pre-Project population levels in reservoir areas after habitat conversion; and two, that seasonal habitat use in the reservoir (for nesting, brood rearing etc.) was similar to pre-reservoir conditions.

4.2.7 Wetland Habitat of Migratory Birds and Species at Risk

Construction related activities would result in the loss of 675 ha of wetlands. This evaluation assumes all proposed mitigation (Volume 2 Vegetation and Ecological Communities, Table 13.5 Mitigation Measures to Reduce Habitat Alteration and Fragmentation) would be fully effective. BC Hydro advises that an additional 121 ha of wetlands could be potentially impacted during Project operations, associated primarily with the transmission line; this area of impact could be less on the basis of footprint micro-adjustments of the transmission line made to avoid wetland features (Volume 2 Vegetation and Ecological Communities, Section 13.3.1.1 Terrestrial Ecosystems).

In Section 13.4.3 Determination of Significance of Residual Effects, BC Hydro has identified that the Project would result in significant adverse effects to certain ecological communities and rare plants. Hydro does not extend this determination to wetlands, for the following reasons:

- Impact magnitude is not ‘High’. Area loss of wetland would be between 16.6% (construction only) and potentially up to 19.6% (construction and operations), which is less than the 20% threshold used by which to assign as impact as ‘High’; and,
- The availability of wetland complex occurrences in upland areas.

However, the EIS identifies significant cumulative adverse effects to vegetation and ecosystem communities, including therefore to wetlands as well (Volume 2 13.5.5 Determination of Significance of Residual Cumulative Effects). The EIS also states that significant cumulative effects would occur in the event the Project was not built. This would be due to the expected effects of other future projects and activities that are likely to occur (Volume 2 Section 13.5.5 Characterization of Residual Cumulative Effects).

Based on information submitted to the review process to date, EC refers BC Hydro to Appendix 2 for guidance on the application of the Federal Policy on Wetland Conservation Policy to the Project.

Recommendation 4.8

EC requests that the JRP recommend that BC Hydro, in conjunction with pre-construction and operations wetland monitoring (to assess potential impacts to structure and composition), conduct migratory bird and species at risk (plants, lichens, and animals) pre-construction and operations monitoring to assess potential changes in wetland functions. BC Hydro should consult with EC on the duration and frequency of monitoring in relation to migratory birds and species at risk.

Recommendation 4.9

Further to Recommendation 4.8, EC requests that the JRP recommend that BC Hydro complete a Wetland Compensation Plan that includes and addresses any temporary or permanent changes in
wetland structure and composition currently not predicted or unknown in relation to construction or operation of the reservoir, transmission line, or any other activities associated with the Project, and defined as extending over and beyond an ecologically relevant period (in the order of five years), that change or impair functions supporting migratory birds and/or species at risk. BC Hydro should:

a) incorporate consultation with EC and other interested and implicated agencies and Aboriginal groups in relation to migratory birds and species at risk
b) submit the final Wetland Compensation Plan no later than three months prior to construction, should the Project proceed; the submission and its timing should be made a commitment under the CEAA 2012.
c) ensure that the Wetland Compensation Plan achieve a full replacement of the wetlands lost in terms of area and functions

Technical Rationale

EC has raised concerns in the process to date regarding the wetlands assessment, which have largely covered all areas of the assessment: methodology, data analysis, impact assessment, mitigation and compensation, and monitoring. Early on, EC recommended, consistent with the EIS Guidelines, that a wetland functions assessment be completed in support of the EIS. With respect to the latter, the information BC Hydro has submitted since the EIS was submitted does not, in EC’s opinion, constitute a project-specific wetlands functions assessment. For example, the response to IR #S68 includes information from literature and guidance sources that are intended to provide a broad overview of the types of functions wetland classes can provide.

An evaluation of site-specific data is needed because of the heterogeneity that exists within and across wetland classes in terms of wildlife use (for example, see Hanson et al. (2008)). In particular, the absence of an evaluation of the ecological (habitat) functions that the wetlands of the LAA provide to wildlife, including for example, with respect to an understanding of species presence, relative abundance, density and seasonal (breeding, migration) and daily use (security, forage, nesting), reduces the robustness of the assessment. In BC Hydro adopting a generic-based approach, EC is unable to determine whether the mitigation proposed would be fully effective to address the likely impacts to the wetlands and associated wildlife (particularly for migratory birds). Further, in the absence of an a priori understanding of the specific range of functions currently provided, and acknowledging the limits of the extent to which these functions can be effectively replaced, project impacts could be larger than predicted in the EIS. While it is acknowledged that certain types of wetlands cannot be replaced (for example, Marl Fen wetlands), BC Hydro’s evaluation does not extend to the functions that such wetlands provide, including to wildlife.

EC is of the opinion that adverse effects to wetlands and associated functions should be addressed through a mitigation (including compensation) strategy/plan. EC also advises that the Wetland Policy applies to the Project, and that a Wetland Compensation Plan be developed where it does apply. EC anticipates that the Wetland Policy may not apply in all areas of the Project where impacts to wetlands and associated functions would be sustained. In those situations, EC recommends that the mitigation (including compensation) strategy/plan be developed to address significant cumulative adverse effects where that circumstance arises.

4.2.8 Methylmercury
In Volume 2, Appendix 4, part 4 of 7, part 4 of 4, page 120, BC Hydro advises that the Project would result in the release of a deleterious substance that could cause bird mortality. Fish mercury levels are anticipated to increase after the reservoir is filled. The Williston reservoir had mercury levels more than 3 times higher than the baseline state (Vol. 2, Section 10, page 11-164); mercury contamination is expected to take place at less than 3 times the baseline state after reservoir completion (Technical Memo Methylmercury, Revision 1 – July 19 2013, page 5). The EIS advises that methylmercury levels would peak 3 to 8 years after flooding and return to baseline conditions 10-15 years later (Section 4-33-1, pages 4-33-11; 4-33-15 and 4-33-16). Peak concentrations in fish in the Site C reservoir are expected to increase by a factor of 3 to 4 times baseline levels and return to baseline levels approximately 20 years thereafter (Technical Memo Methylmercury, Revision 1 – July 19, 2013, page 12). Bio-accumulation is predicted to occur in both fish and benthic invertebrates (Technical Memo on Methylmercury, Revision 1 – July 19, 2013, page 2) in the new reservoir scenario.

Exposure, contamination and bio-accumulation of methylmercury in food sources is a potential source a mortality risk to migratory birds that needs to be evaluated. The Technical Memo on Methylmercury, Revision 1 – July 19, 2013 reports, on page 2, advises that, “wildlife risk assessment was undertaken to assess the implications to wildlife of incrementally higher exposure to dietary methylmercury.” The Methylmercury model developed to provide insights on the expected scope and effects of mercury contamination in birds predicted a reduction in offspring production for 6 of the 7 bird species considered: Belted Kingfisher, Common Merganser, Mallard, Bank Swallow, Spotted Sandpiper and Bald Eagle, with no effects on Canada Goose, and an expected reduction in offspring ranging from 2.6% to 16.8% (Memo Methylmercury 8 May, 2013 Revision 1 – July 19, 2013, Section 2.3.1, page E-6). The model predicted that effects would occur within the reservoir area and return to baseline conditions after approximately 20 years and downstream of the reservoir with return to baseline conditions after four to six years) (Memo Methylmercury 8 May, 2013 Revision 1 – July 19, 2013, Section 2.3.1, page 12).

**Recommendation 4.10**

| EC requests that the JRP recommend that BC Hydro conduct follow-up monitoring of mercury trends in belted kingfisher and other fish-eating wildlife of importance to local stakeholders as a condition for the Project approval. Such follow-up would be the responsibility of BC Hydro, and designed and evaluated jointly by the BC Hydro, relevant government agencies, Aboriginal groups and local stakeholders. |

**Technical Rationale**

The wildlife risk assessment contained in the *Effects of Methylmercury on Wildlife* report is comprehensive and consistent with current scientific practice in Canada. The assumptions, baseline data and calculations are described in sufficient detail for review. If the predictions about future increases in fish mercury concentrations associated with reservoir construction are accurate, then the conclusions made about possible mercury impacts on the wildlife species considered in the risk assessment are reasonable, based on the evidence presented. The assessment identifies potential reductions in the reproductive success of belted kingfishers during the years of peak fish mercury concentrations. These reproductive impacts are not considered sufficient to have long-term impacts on kingfisher populations. Potential mercury impacts on other wildlife species are considered negligible.

However, given the uncertainty associated with accurately predicting the extent and duration of future increases of mercury concentrations in fish and fish-eating wildlife associated with the Project, follow-up monitoring of mercury trends in belted kingfisher and other fish-eating wildlife of importance to Aboriginal groups and local stakeholders would be a reasonable requirement for Project approval. Such follow-up monitoring would: i) confirm the accuracy of the conclusions above, which predict the risk of some degree of reproductive impairment in belted kingfisher, and ii) would serve to indicate if mercury
concentrations and impacts were greater than predicted, so that informed management decisions could be made to protect affected wildlife.

4.2.9 Effect: Mortality

The inadvertent harming, killing, disturbance or destruction of migratory birds, nests and eggs as a consequence of anthropogenic activities is known as ‘incidental take’, and is illegal. Additional guidance and information regarding the issue of incidental take, can be accessed at Environment Canada’s website at [http://www.ec.gc.ca/nature/default.asp?lang=En&n=2D16D723-1](http://www.ec.gc.ca/nature/default.asp?lang=En&n=2D16D723-1)

The Project has the potential to kill individuals or destroy active nests of migratory birds as a consequence of the following:

1. Vegetation clearing associated with the reservoir, transmission lines, dam, roads and other infrastructure;
2. Filling of the reservoir;
3. Operation of the reservoir;
4. Habitat maintenance associated with the transmission lines and roads;
5. Bird collisions associated with the transmission lines and vehicles.

Impacts to individuals and active nests of migratory birds would be direct and cumulative. Certain impacts would occur once, whereas others impacts would occur on an ongoing basis over the life of the Project.

EC has experience with active nest searches in complex habitats such as those referenced for this Project. It is EC’s view that searches in complex habitats for active migratory bird nests for the purpose of protecting those nests from the above Project activities are likely to be unreliable. Reliance on such searches carries an associated risk of harm to individuals and nests and is therefore generally discouraged.

4.2.9.1 Reservoir

The main impact of reservoirs is the loss of habitats through inundation, though fluctuating water levels associated with reservoirs may also flood nests. With respect to the latter, to which this section is dedicated, active nests of migratory birds would be lost or harmed where vegetation clearing associated with reservoir filling and operations overlapped with the breeding bird season. Vegetation clearing for construction and reservoir filling are considered one-time impacts (noting both of these activities could occur over several years), whereas maintenance vegetation management and reservoir operations would be an on-going impact (over the breeding season).

Savard and Rioux (in Calvert et al. 2013) advise that a detailed study of avian nest mortality in relation to water level fluctuations in reservoirs was made for the Kinbasket and Arrow Lakes reservoirs in the Columbia valley of British Columbia (BC Hydro unpublished data). Based on that study, the authors note the following:

- Most nest failures were due to predation (78.3%, n=258 nests, in the Arrow Lakes Reservoir and 77%, n= 353 nests, in the Kinbasket Reservoir);
- The failure of seven nests (5.8%) was directly caused by reservoir operations, all in the Arrow Lakes Reservoir; and,
- No nest losses could be attributed to reservoir operations in the Kinbasket Reservoir.
In light of the above, the authors conclude that avian mortality was low. Savard and Rioux (in Calvert et al. 2013) advise that a study of the drawdown zones of the Columbia River reservoir network documented several nest [sic] flooded by rising water levels and that impacts were negligible from a population perspective. They also indicate that impacts could be significant locally when locally rare species are affected (BC Hydro unpublished data).

Based on evaluation of reservoir impacts in Quebec, Savard and Rioux (in Calvert et al. 2013) advise that a reliable estimate of casualties caused by hydro-power reservoirs for Canada is not possible; for Quebec, they speculate that - for the province with the greatest number of reservoirs in terms of area - 152,162 nests are affected annually (equivalent to the loss of 35,770 breeding birds) due to reservoir flooding.

Savard and Rioux (in Calvert et al. 2013) conclude that:

• Nest mortality caused by hydro-power reservoirs is considered negligible, but that this is highly speculative, in large part because of the coarseness of the data available on reservoir size, the way they were filled, and the yearly water fluctuations and timing;
• Data on breeding bird densities could be refined; and,
• Detailed studies similar to those in British Columbia (BC Hydro unpublished data, in Calvert et al. 2013) or to Lehoux et al. (2003) in the St. Lawrence are greatly needed to derive more realistic and credible estimates for each reservoir.

BC Hydro has characterized mortality risk to migratory birds, which by extension includes reservoir impacts to active nests, as occurring during the construction period only, and that the risk would be negative in direction, low in magnitude, local in geographic extent, moderate term in duration, monthly in frequency, reversible, of high resilience, of low level of confidence, and of high probability.

BC Hydro has proposed the following mitigation:

• Avoid clearing activities during the breeding season, which BC Hydro has defined as May 01-July 31 for songbirds and April 01-July 31 Trumpeter Swan and raptors; and,
• Where avoidance of the breeding bird season is not feasible, develop an active nest search protocol in consultation with the BC Ministry of Forests, Lands and Natural Resource Operations and EC.

**Recommendation 4.11**

| EC requests that the JRP recommend that BC Hydro develop a monitoring-mitigation strategy to address the loss of active nests due to the reservoir and downstream of the dam. |

In relation to 4.11 above, EC advises that the strategy consider and incorporate such things as the following:

• Monitoring the potential direct effects of the operations of the Project both within the reservoir and downstream of the dam
• Monitor current levels of dam operations impacts on active nests to gauge and address cumulative effects
• Identify and implement mitigation
• Incorporate work described under the section above.
• Incorporate consultation with EC and other interested and implicated agencies and Aboriginal groups.

**Technical Rationale**
EC has, in the course of the review process, raised concerns regarding impacts of the reservoir to active nests. EC has advised that disturbance-related effects to ground-nesting and shrub-nesting birds would, depending on habitat availability, be local or regional in scope; and, depending on the species, that effects would more likely be moderate to high due to flooding of active nests. In this regard, if sensitive species are impacted, resilience might not be as high as BC Hydro suggests. EC is of the opinion, supported by findings of Calvert et al. 2013, that impacts would occur during the operations phases and, based on this, EC has requested BC Hydro expand its analysis to the operation phase of the Project. In characterizing the operations phase, impacts might not be reversible. The extent and duration of any such effects would be contingent on the implementation and effectiveness of a long-term, science-based monitoring-mitigation program.

EC has also offered the following recommendations to address concerns raised to date, including that BC Hydro:

- Undertake a technical review of relevant research and monitoring programs in support of developing mitigation strategies. This would include reporting on the findings of on-going nest mortality studies at its other reservoir operations (for example, the Columbia River system);
- Model the types of vegetation present along the shoreline for the reservoir scenario by which to develop a predictive tool to assess potential impacts to active nests of ground- and shrub-nesting birds;
- Review of (on-going) research and monitoring (for example, Dr. David Green of Simon Fraser University http://www.sfu.ca/biology/faculty/green) at reservoirs subject to the Columbia River Basin Water Use Plan (BC Hydro 2007) in support of any such modelling exercise as referenced above; and,

With respect to the last bullet above, EC has consistently advised that it does not support active nest searches in other than simple habitat types. Notwithstanding, and amongst other things, BC Hydro has proposed to address potential impacts to the active nests of migratory birds through the development of an active nest search protocol in consultation with the BC Ministry of Forests, Land and Natural Resource Operations and EC.

It is important to note that EC cannot permit the take of active nests under the MBCA, and therefore also cannot entertain compensation measures to address potential harm or loss to active nests.

Impacts from the Site C reservoir – vegetation clearing, filling and operating – would cause direct adverse effects to the active nests of migratory birds unless these activities are confined to outside of the nesting period, which is likely not feasible. These impacts would act cumulatively with existing levels of impact associated with current upstream operations (i.e. WAC Bennett and Peace Canyon reservoirs) and would be additive to the effects and impacts of other direct mortality (e.g. collisions), disturbance/displacement and habitat change.

The ability of individual migratory birds to survive and successfully breed when subject to a fluctuating water regime depends on a number of physical, biological, and ecological factors, including for example:

- Timing and extent of within-year and across-year reservoir flooding;
- Reproductive strategy (single versus multiple nester; nest site selection; precocial vs. altricial), i.e. overall population status and resilience to losses; and,
- Habitat quality (i.e. availability and effectiveness, competition for high versus low quality habitat)
EC is not aware of data that assess the impacts to locally breeding migratory birds due to WAC Bennett and Peace Canyon dams. However, the addition of the Project would likely add incrementally to the existing level of impact. While certain species breeding in the Project area are showing significant long term population declines, there are insufficient data to attribute these declines to impacts at the local population level in relation to the dams currently in operation on the Peace River.

While data are limited, existing information suggests that impacts of Site C reservoir operations to active nests are likely to be negligible at the level of national populations (Savard and Rioux in Calvert et al. 2013), and that impacts could be more serious at the local level for sensitive species, i.e. species identified as at-risk and/or showing significant population declines. Underlying this general issue, and specifically in relation to the Peace River system, is the lack of robust data on which to base credible mitigation (complete avoidance of the breeding season for the life time of the Project appears highly unlikely). In this regard, long-term, science-based monitoring programs are needed, and would lay the groundwork for the development of species-focused and habitat-focused mitigation programs. EC is of the opinion that this approach could be adopted at least in part from existing programs, such as those developed under the Columbia River Water Use Plan.

4.2.9.2 Transmission line

The Project would be expected to harm or destroy active nests if vegetation clearing to establish the right-of-way and routine vegetation maintenance during operations overlaps with the breeding bird season. Migratory birds would be harmed as a consequence of collisions and electrocution during operation of the transmission line.

Approximately 2.5 million to 25.6 million birds are killed per year due to collisions with transmission lines (Rioux et al. 2013), while approximately to 16,000 to 80,000 birds are electrocuted annually in Canada (Savard and Rioux in Calvert et al. 2013). Vegetation clearing for rights-of-way results in an estimated 2.5 million nest mortalities and the destruction of 400,000 nests/year during line maintenance (Savard and Rioux in Calvert et al. 2013).

Waterfowl, grebes, shorebirds, and cranes are most vulnerable to collisions with transmission lines (Rioux et al. 2013) due to their flocking behaviour, rapid flight, and large size. Slow maneuverability associated with younger birds and nocturnal migrants exhibit further vulnerability (Crivelli et a. 1988, Bevanger 1998, Erickson et al. 2001, Crowder and Rhodes 2002, Manville 2005, Jenkins et al. 2010).

Collisions are thought to be more common during migratory movements (Morkill and Anderson 1991), which suggests that a better understanding of impacts during migration is needed (Rioux et al. 2013). In addition, these impacts can be cumulative across the annual cycle; however, migration routes vary both within and across species, which leads to variation in cumulative risk of collision (Rioux et al. 2013). Estimating cumulative mortality for collisions risks for species that breed in Canada is consequently very challenging and requires both a better understanding of, and improved methodologies for, assessing impacts across the annual cycle (Rioux et al, 2013).

BC Hydro has characterized mortality risk to migratory birds and has identified mitigation to address transmission line collision and electrocution impacts to migratory birds and active nests for the construction and operation phases of the Project. The transmission line impact risk was assessed as: negative in direction, low in magnitude, local in geographic extent, moderate term in duration, monthly in frequency, reversible, high in resilience, low level of confidence, and high in probability.

To address the effects of the line, BC Hydro has proposed the following mitigation:
• Avoid clearing activities during the breeding season, which BC Hydro has defined as May 01-July 31 for songbirds and April 01-July 31 Trumpeter Swan and raptors;
• Where avoidance of the breeding bird season is not feasible, develop an active nest search protocol in consultation with the BC Ministry of Forests, Lands and Natural Resource Operations and EC;
• BC Hydro’s standard design has all of the conductors in the same horizontal plan. This configuration will be used unless there is a requirement to reduce the right-of-way; and,
• The standard phase-to-phase spaces (distance between the lines) for 500 kV transmission lines is approximately 10 metres and phase-to-ground (conductors in the tower body) is over 3 metres so the risk by electrocution by contacting two phases or one phase and the tower is virtually non-existent.

Recommendation 4.12

EC requests that the JRP recommend that BC Hydro prepare a Transmission Line Bird Collision Management Plan. The Plan would include an avian risk assessment and spatial analysis. The Plan would evaluate options for pre and post construction carcass monitoring, remote sensing technology, and line marking. The Plan would make recommendations on the findings of the aforesaid, and implement the technically feasible options. BC Hydro should consult with EC and other interested agencies and Aboriginal groups on the Plan.

EC suggests that BC Hydro evaluate the most up-to-date best management practice, including APLIC 2012, guidance in developing the plan identified under 4.12 above.

Technical Rationale

EC has, in the course of the review process, raised concerns regarding impacts of the transmission line to migratory birds and active nests. EC is of the opinion, supported by findings of Calvert et al. 2013, that impacts would occur during the operations phases; EC has requested BC Hydro provide a scientific rationale in support of its position that mortality (collisions) would not occur during the operations phase. In characterizing the operations phase, EC is of the opinion that impacts are not reversible, but that measures can be taken to reduce the impact (collision rate).

While several studies have concluded that collision mortality does not significantly impact selected bird populations (Meyer 1978, Thompson 1978, James and Haak 1979, Beaulaurier 1981, Faanes 1987, Alonso and Alonso 1999), Calvert et al. 2013 advise that the paucity of data on Canadian collision rates and mortalities (with emphasis on the inability to assess at the species level) precludes evaluating impacts at a population level with confidence. As the authors and others point out, improved monitoring and understanding of the nature and extent of effects are needed to understand the implications of the effects of transmission (and distribution) lines on migratory birds.

Notwithstanding the above, monitoring and mitigation guidance is available to industry to promote best management practices. For example, the Avian Power Liner Interaction Committee (APLIC 2012) identifies procedures when modifying existing power lines and planning new power lines, including for example:

• Collision monitoring to examine the causes and conditions associated with the risk and to help determine the type and effectiveness of modifications;
• Avian risk assessment and spatial analysis to prioritize lines segments for modification;
• Line marking to increase visibility of the line; and,
• Line configuration that reduces vertical spread of lines, clusters multiple lines in the same right-of-way, increases the visibility of lines, and/or decreases the span length if such options are feasible.

EC notes the measures BC Hydro has identified to reduce collision risk and electrocution. With respect to electrocution risk, EC agrees that the risk is low. For collision risk, EC points out the following: first, collision risk would likely be increased relative to the baseline condition because the transmission lines, and, in particular, the shield wire, would be located above the tree line rather than below it; and second, not aligning conductors and shield wires in the same horizontal plane would likely increase collision risk. Additional measures would be to determine the most effective line markers, and the use of remote sensing technology such as Bird Strike Indicators.

4.2.9.3 Direct and indirect mortality

Appendix 2, Section 2.3 (p. 120 of 266) states that direct and indirect mortality to adults, chicks and eggs is expected to occur. In this section, the examples of mortality causes are all direct and mechanical (e.g. mechanical vegetation removal, road mortality from vehicle collision, power line collision, rising water levels drowning nests and chicks). Indirect mortality can occur because of decreased habitat productivity, changes in ecological communities, changes in food accessibility, introduction of new species, poisoning, contamination, lessened habitat productivity, lower availability of food, predation, pollution, disturbance, habitat fragmentation, changes in food availability and abundance, etc. Information presented in other sections of the EIS point at obvious sources of indirect mortality but none of these is presented, discussed or considered in the context of their effects on migratory birds. Section 2 of the EIS does not present or discuss how indirect mortality could result from the Project. No references are provided on how altered ecological processes resulting from the construction of the reservoir would influence mortality and no information is provided on the expected magnitude and importance of mortality effects, except for ‘collisions’, which the EIS assumes to be ‘negligible’ except in instances for rare species. In EC’s opinion, the estimates of direct and indirect mortality that would result from the Project are potentially larger in scope and magnitude than reported in the EIS.

4.2.9.4 Roads

EC Hydro advises that the Project would require that approximately 30 km of Highway 29 be realigned, and the construction of access roads in relation to the transmission line and other works and activities.

Bishop and Brogan 2013 report an unadjusted estimate of 4.6 million birds killed/year by vehicle collisions during a 122 day breeding bird season, which translates to 1,167 birds killed/100 km during this period, on 1 and 2 lane paved roads outside of major urban centers in Canada. The volume of traffic, speed of vehicles, individual configuration of roads, and road density are the most frequently mentioned factors affecting bird mortality on roads (Clevenger et al. 2003, Erritzoe et al. 2003, Holm and Laursen 2011, Kociolek and Clevenger 2011). Options for reducing collision risk for the range of migratory birds and species encountered on the landscape has it challenges; notwithstanding, EC recommends that this issue not be discounted in relation to the Project, and on that basis, that consideration be given to mitigation where there is supporting habitat or bird data that supports it.
4.3 Species at Risk

4.3.1 Introduction and General Advice

Please note: Due to the timing of BC Hydro’s response to Additional Information Request #4, information from this request was unavailable for federal review as part of this written submission. EC believes, however, that this information is important for informing its advice regarding wildlife; as such, EC intends to review this information at a later date, and will make its findings available to the JRP as appropriate.

Pursuant to section 79(1) of the SARA, a proponent must notify the Minister of Environment where an adverse effect is likely to a listed species or its critical habitat and, pursuant to section 79(2), avoid or reduce any adverse effects and monitor. The measures must be taken in a way that is consistent with any applicable recovery strategy and action plans.

EC recommends tracking updates to COSEWIC and SARA listings, as well as recovery planning processes currently, or soon to be, underway for species known to occur in or proximate to a project area. It is also important to be aware of critical habitat identification for SARA-listed species in the region in which a project is located. Critical habitat on federal lands must be legally protected; on non-federal lands critical habitat must be effectively protected.

As noted above, updates in relation to the SARA (COSEWIC re/assessments, Schedule I, posting of recovery strategies and action plans) occur continuously. For this reason, it would be important for BC Hydro to track these changes in relation to the Project. And while critical habitat has not been identified for many species, successful species conservation maintains multiple healthy, genetically robust, populations across the range of the species in representative ecological settings (Redford et al. 2011). In the table below is a preliminary list of COSEWIC assessed and SARA listed species relevant to the Project area for BC Hydro’s information.

<table>
<thead>
<tr>
<th>English Name</th>
<th>Scientific Name</th>
<th>BC Status</th>
<th>COSEWIC Status*</th>
<th>SARA Status**</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Birds</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bank Swallow</td>
<td>Riparia riparia</td>
<td>Yellow</td>
<td>T (2013)</td>
<td>No schedule</td>
</tr>
<tr>
<td>Barn Swallow</td>
<td>Hirundo rustica</td>
<td>Blue</td>
<td>T (2011)</td>
<td>No schedule</td>
</tr>
<tr>
<td>Horned Grebe</td>
<td>Podiceps auritus</td>
<td>Yellow</td>
<td>SC (2009)</td>
<td>No schedule</td>
</tr>
<tr>
<td></td>
<td>(BC CDC: Falco peregrinus anatum)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Amphibians</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Western Toad</td>
<td>Anaxyrus boreas</td>
<td>Blue</td>
<td>Calling</td>
<td>Both calling</td>
</tr>
</tbody>
</table>
### Mammals

<table>
<thead>
<tr>
<th>Species</th>
<th>Scientific Name</th>
<th>Status</th>
<th>Year</th>
<th>Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grizzly Bear – Western population</td>
<td><em>Ursus arctos</em></td>
<td>Blue</td>
<td>SC (2012)</td>
<td>No schedule</td>
</tr>
</tbody>
</table>

### Arthropods

<table>
<thead>
<tr>
<th>Species</th>
<th>Scientific Name</th>
<th>Status</th>
<th>Year</th>
<th>Schedule</th>
</tr>
</thead>
</table>

### Mosses

<table>
<thead>
<tr>
<th>Species</th>
<th>Scientific Name</th>
<th>Status</th>
<th>Year</th>
<th>Schedule</th>
</tr>
</thead>
</table>

**Additional lichen and moss species possible – survey required**

<table>
<thead>
<tr>
<th>Species</th>
<th>Scientific Name</th>
<th>Status</th>
<th>Year</th>
<th>Schedule</th>
</tr>
</thead>
</table>

* Information is on status and year assessed. SC- Special Concern, T – Threatened, E – Endangered
** Information is on Schedule listed (1 or no schedule), status, and year added to SARA. SC- Special Concern, T – Threatened, E – Endangered

### 4.3.2 Issues Related to Species at Risk

#### 4.3.2.1 Mosses and Lichens

EC has reviewed the information provided for vascular and non-vascular plant species at risk. Although there are no SARA-listed plant species reported, in EC’s opinion that there is insufficient information/detail provided from which to determine what non-vascular plant species (mosses, lichens) were recorded in the Project area in the 2008 survey, i.e. the only year in which that group of species was targeted for inventory. Further, EC advises that, based on a preliminary survey conducted over one year (2008), non-vascular taxa comprised nearly 30% of the overall (combined vascular and non-vascular) plant taxa reported. Considering that 42% of the potentially-occurring target rare plants are non-vascular species (i.e. Volume 2 Appendix R, Part 1 Appendix E), existing surveys are, in EC’s opinion, insufficient to evaluate potential Project impacts, and similarly insufficient on which to base avoidance or mitigation for non-vascular plants. EC also advises that downstream areas could also be potentially
impacted by factors other than simply inundation levels; for example, by runoff, sediment deposition, or deposition of alien invasive propagules on newly exposed soils.

### 4.3.2.2 Amphibians

BC Hydro indicated that additional road surveys were planned (gov_0018_071). EC has, to date, been unable to locate these data. Sufficient data are essential to ensure all habitats that amphibians use during their life cycle, including breeding, migration and overwintering sites, are identified. This information is important for the purposes of identifying potential effects and mitigation for amphibians, including and perhaps in particular for the Western Toad.

### 4.3.2.3 Migratory Birds

EC agrees with BC Hydro that there will be significant residual adverse effects to both federal and provincial migratory bird species at risk (EIS Volume 2 Sections 14.5.2, 14.5.3). BC Hydro has identified Yellow Rail, Canada Warbler, Cape May Warbler, Bay-Breasted Warbler and Nelson’s Sparrow specifically. Based on data included in Table 14.9 Habitat Loss: Migratory Birds (EIS Volume 2 Section 14.3.1.3), it appears to EC that the Project would result in significant adverse effects to the provincially-listed Le Conte’s Sparrow as well, given that this species would lose the equivalent amount of habitat as for Nelson’s Sparrow and Yellow Rail. This needs to be clarified; refer to the recommendations below.

EC is of the opinion that the adverse effects are potentially of greater magnitude than assessed through the habitat suitability models given that models were developed using ‘broad habitat types’ that likely do not capture the causes for the restricted distribution of the species. This needs to be verified. EC is also of the opinion that the Project has the potential to result in significant adverse effects to a broader suite of migratory birds than the above Key Indicator species are meant to represent. Further, EC has concerns with BC Hydro’s evaluation of significance for listed wildlife species, specifically BC Hydro’s conclusion that habitat is available in large amounts in upland areas (refer to Volume 1 Section 14.5.3).

EC has concerns that the loss of nesting habitat to migratory birds and species at risk has not been fully assessed. For example, the Short-eared owl (*Asio flammeus*, SARA Schedule 1 Special Concern) requires large areas, and is therefore sensitive to habitat fragmentation (Wiggins et al. 2006). This species is a ground nester and is susceptible to increased predation pressure (Wiggins et al. 2006). Habitat fragmentation can cause an increase in nest predation of grassland birds and contribute to the decline in grassland birds (Herkert et al. 2003). EC was unable to determine how habitat fragmentation was taken into account in the assessment of impacts to Short-eared owl. While BC Hydro has provided a definition of habitat fragmentation, the question of how habitat fragmentation was considered in the analysis does not appear to have been addressed.

As noted above, BC Hydro has advised that the Project would result in significant adverse effects to the Canada Warbler (listed as Endangered on Schedule I), Cape May Warbler, and Bay-Breasted Warbler. The latter two migratory bird species are provincially-designated as at-risk. To address the anticipated habitat impacts to these species, BC Hydro is referred to ‘EC’s Operational Framework for Use of Conservation Allowances’ (Environment Canada).

### 4.3.2.4 Bats

COSEWIC emergency-listed species - Little Brown Bat (*Myotis lucifugus*) and Northern Myotis (*Myotis septentrionalis*) - are known to occur (breed) in the Peace region, and were detected in the LAA during BC Hydro surveys. The provincially red-listed Eastern Red Bat (*Lasiurus borealis*) was also detected during these surveys. From the data collected to date, EC is unable to determine peak migration periods or the location of migration corridors in the LAA. This information, in combination with an evaluation of
hibernacula and roost sites (for which BC Hydro has collected some data), is important for the purposes of identifying mitigation and compensation measures. The EIS does not provide estimates of population size or distribution for bats during the breeding season or associated with any hibernacula identified to date. In the absence of a population size estimate, and the number and distribution of hibernacula in the LAA, EC does not agree that the magnitude of construction- and operations-related effects would necessarily be low, i.e. with an expected change of less than 10%. Given that the emergency-listed *Myotis* species have low reproduction rates, and are highly vulnerable to mortality, EC is of the opinion that the risk to these species is likely greater than has been reported. The residual effects of habitat loss, disturbance and displacement, and mortality, are potentially significant threats. Further, it is unclear to EC how effective the proposed mitigation of creating hibernacula and roosting sites would be (as referenced in Volume 2 Section 14 Table 14.15, IR #88).

### 4.3.2.5 Caribou

BC Hydro has advised that the Project would not impact important habitats noted in recovery planning for caribou, including in relation to the West Pine Quarry (IR #54). Although the Project, as BC Hydro has advised, does not fall within important habitats or within designated winter ranges for caribou, the Project does intersect caribou range. In EC’s opinion, it is therefore important that BC Hydro ensure that the Project does not impact migration routes, Aboriginal traditional use rights, or areas where future recovery efforts would likely be directed. EC notes that BC Hydro has offered mitigation to reduce potential disturbance impacts to caribou, but not to address potential habitat loss that would arise from expansion of the West Pine Quarry.

**Recommendation 4.13**

EC requests that the JRP recommend that BC Hydro identify, in table form and maps, the individual locations of all surveyed species considered at risk together with the associated mapped ecosystem unit for each Project component, differentiating in the LAA where habitat would be permanently lost, fragmented (e.g. by roads or transmission lines), and where habitat would be expected to remain intact.

**Recommendation 4.14**

EC requests that the JRP recommend that BC Hydro, in support of the mitigation (including compensation) strategy/plans, provide estimates of density and abundance prior to vegetation clearing and during Project operations for species at risk.

**Recommendation 4.15**

EC requests that the JRP recommend that BC Hydro track the status of species as assessed by COSEWIC and SARA and consult with the appropriate jurisdictions involved in SARA recovery planning processes, including with respect to the identification of critical habitat.

**Recommendation 4.16**

EC requests that the JRP recommend that BC Hydro provide EC with the full list of plant species records and that pre-construction surveys to address remaining information gaps be completed in support of the development of avoidance and mitigation for all SARA-listed vascular and non-vascular plant species, as well as any additional species assessed by COSEWIC as at risk.
Recommendation 4.17

EC requests that the JRP recommend that BC Hydro submit amphibian survey data for review for the purposes of directing future survey effort and in support of the identification of mitigation and monitoring, including for the Western Toad (Special Concern, Schedule I).

Recommendation 4.18

EC requests that the JRP recommend that BC Hydro develop a Migratory Bird Compensation Plan, after all avoidance and mitigation measures have been identified, to address residual significant adverse effects to non-wetland associated migratory birds: Canada Warbler, Cape May Warbler, and Bay-Breasted Warbler. The Compensation Plan should be consistent with EC’s Operational Framework for Use of Conservation Allowance (Environment Canada 2012b). EC also recommends that:

a) In completing the final Plan, BC Hydro incorporate consultation with EC and other interested and implicated agencies and Aboriginal groups in relation to migratory birds and species at risk.

b) The final Plan should be submitted no later than three months prior to construction, should the Project proceed, that the Plan and the timing of its submission be made a commitment under the CEAA 2012; and

c) In relation to the new information garnered through 4.13-4.17 above, BC Hydro should assess the potential effects and possible residual adverse effects to the following at risk species: Olive-sided Flycatcher, Common Nighthawk, and Bank Swallow and incorporate the results into the Migratory Bird Compensation Plan.

Recommendation 4.19

In consideration of the number of aerial insectivores and wetland-associated species at risk, EC requests that the JRP recommend to BC Hydro that chemical spraying to maintain vegetation be avoided for the Project.

Recommendation 4.20

EC requests that the JRP recommend to BC Hydro that an inventory of the COSEWIC-assessed Myotis bat species be completed for the purposes of estimating population size and distribution in the LAA, and an evaluation of hibernacula and roost sites (for which BC Hydro has collected some data) be completed for the purposes of identifying and implementing mitigation and compensation measures.

In relation to recommendations 4.13 and 4.14 above, it would be important that, in support of the mitigation and compensation strategy/plan, wildlife survey data and ecosystem mapping be provided for proposed measures in relation to habitats located outside of the LAA (IR #43). Further, any predictive modelling related to the assessment of effects and options for future mitigation should follow the advice provided earlier in this submission, and include specific details on geography, habitat structure, habitat species, and other key ecological features required.

In relation to recommendation 4.18 above, mapping of all listed ecological communities would assist and support the identification of COSEWIC assessed and SARA-listed vascular and non-vascular plants, and lichens.
**Technical Rationale**

As advised in earlier comments, EC has concerns regarding the robustness of the sampling program in terms of species at risk distribution and abundance across the LAA, in particular in areas where habitat would be permanently lost (e.g. reservoir footprint). The sampling strategy in relation to migratory birds, species at risk, habitats or ecosystems within the Project footprint, the broader LAA and the RAA, does not appear to meet the requirements of the model objectives (Guisan and Zimmermann 2000) that were used to assess effects of habitat change and fragmentation. EC was unable to locate scientific validations of the habitat models used, including any verifications using novel data. Birds were documented in ‘unsuitable’ habitat, but EC was unable to determine whether any attempts were made to substantiate conclusions or recognize inaccuracies and limitations in the models. This is a significant concern because of some apparent discrepancies between the habitats modelled and where Key Indicator species, to which significant adverse effects have been assigned, were observed. Bay-breasted Warbler (Volume 2 Appendix R Maps 1.7.5 and 1.7.6); Canada Warbler (Volume 2 Appendix R Maps 1.7.9 and 1.7.10); Cape May Warbler (Volume 2 Appendix R Map 1.7.12); Connecticut Warbler (Volume 2 Appendix R Map 1.7.13); Rusty Blackbird (Volume 2 Appendix R Maps 1.7.15 and 1.7.16); Le Conte’s Sparrow (Volume 2 Appendix R Maps 1.7.27 and 1.7.28); and, Nelson’s Sparrow (Volume 2 Appendix R Maps 1.7.29 and 1.7.30).

Without an evaluation of habitat loss, it is not clear how a non-significance evaluation has been evaluated (IR #29) for the Olive-sided Flycatcher (listed as Threatened on Schedule I of SARA). Species-specific mitigation to address environmental effects (Volume 2 sections 14.4.1-14.4.3, Tables 14.15-14.17) are general in nature and, as such, do not address impacts at the level of the species (similarly for Table 14.22, which identifies mitigation to address significant residual effects). Along the same lines, for the Common Nighthawk (listed as Threatened on Schedule I of SARA), BC Hydro advises that 2571.8 ha of habitat would be lost during construction and operations, equating to a 17.8% reduction in habitat availability in the LAA. Based on BC Hydro’s significance threshold of 20% habitat loss, a precautionary approach would suggest species-specific mitigation for this species given its listing status on Schedule I. This would be similar for the Bank Swallow given its recent assessment by COSEWIC as Threatened.

EC agrees that the SARA-listed species identified have broad national distributions, which in the case of the warbler species extend over the Canadian boreal. It is important to note, however, that the Project is located at the western extent of the range of a number of these species. For example, the distribution of Canada Warbler has been found to date within relatively discrete areas of the British Columbian component of Bird Conservation Region 6 only (for more, refer to Bird Studies Canada Breeding Bird Atlas maps available at: [http://www.birdatlas.bc.ca/english/index.jsp](http://www.birdatlas.bc.ca/english/index.jsp)). The ranges of these SARA-listed species are therefore not broad in the British Columbia context, but instead confined to discrete areas of the northeast part of the province.

In managing a project with SARA-listed species, EC advises proponents to identify and evaluate likely species occurrences (e.g. conduct baseline surveys), assess environmental effects, develop strategies to avoid and minimize impacts, and conduct follow-up monitoring. Mitigating both local and regional effects on species at risk is relevant as they are more likely to have been adversely affected by a combination of threats throughout their range and adverse impacts are more likely to have negative population-level consequences. As a result, any contribution of the Project to cumulative habitat loss, displacement/disturbance or mortality of species at risk should be mitigated. To do so, EC recommends a systematic, rigorous and hierarchal approach to mitigation that first considers avoidance, then minimization of effects, and lastly, when all other measures have been implemented, compensation.
CHAPTER 5 – AQUATIC ENVIRONMENT

5.1 Introduction

This chapter presents EC’s review of the aquatic sections of the EIS, Amendments to EIS, Additional Information Requests and other supporting documents available on the Project registry as they relate to EC’s mandates and interests. EC has a mandate to protect water quality and aquatic ecosystem health.

The responsibility for the administration (including the enforcement) of the pollution prevention provisions of the *Fisheries Act* (including subsection 36(3)) has been assigned to the Federal Minister of the Environment. Subsection 36 (3) of the *Fisheries Act* specifies that, unless authorized by federal regulation, no person shall deposit or permit the deposit of deleterious substances of any type in water frequented by fish, or in any place under any conditions where the deleterious substance, or any other deleterious substance that results from the deposit of the deleterious substance, may enter any such water. EC conducts a number of other programs to fulfill this mandate including administering Environmental Effects Monitoring programs for industries regulated under the *Fisheries Act*.

EC’s reviews of environmental emergencies planning considerations respecting accidents and malfunctions are based on the Department’s mandated interests as they relate to the *Canadian Environmental Protection Act (CEPA) 1999*, the pollution prevention provisions of the *Fisheries Act*, and the *Migratory Birds Convention Act, 1994*.

EC offers the analysis and advice in Chapter 5 in the context of Section 5 of CEAA, 2012. Water quality falls under sections 5(1)(a) for its potential to impact fish, aquatic species and migratory birds; under 5(1)(b)(ii) for its potential to cause an environmental change outside the province of the Project; and under 5(1)(c) for its potential to affect Aboriginal uses and interests.

EC identified the following broad water-related issues as being of primary concern for our review related to water quality, and each is discussed in more detail below: groundwater quality, geochemistry, nutrients, and environmental emergencies (potential accidents and malfunctions).

5.2 Groundwater Quality

The potential effects on groundwater water by the Project were modelled by BC Hydro. The groundwater modelling completed was for pre- and post-construction/filling of the reservoir. The potential changes on the groundwater regime could take several decades to establish a new equilibrium. The changes in groundwater over this time are not modelled and thus not known. This information is important for the development of the Groundwater Protection Plan during the permitting stage, to assist in the determination of areas where the Project will have the potential greatest impacts on groundwater levels and directions, and on contaminant transport.

The location of water wells and existing or potential contamination are important factors in assessing potential impacts to groundwater. More importantly, the hydrogeological characteristics of existing wells (construction details, screen design and length, geological formation (i.e. aquifer) in which the well is screened, well depth, water level, water chemistry) are key to understanding potential impacts from the Project to groundwater and surface water receptors. The EIS contains some information about the location of water wells that could be affected by changes to the groundwater regime (e.g. on figures in Volume 2, Appendix F).
Information about the presence of contaminated or potentially contaminated sites within the zone adjacent to the proposed reservoir where the groundwater table may rise (i.e. 2 km buffer zone) as a result of the Project, is presented in Volume 2, Appendix F. The contaminated sites report is a supporting document to the Groundwater Regime Technical Data Report (Volume 2, Appendix F). The brief contaminated sites report provides a table (Table 2) that lists potentially contaminated sites by property use; however, no information about the location of these sites (e.g. table, coordinates, figures) is provided. This information is publicly available and should be collected and used in the Groundwater Protection Plan. This would allow better assessment of the potential risk of groundwater contamination as a result of Project activities and facilitate the identification of locations where there could be an impact of concern as a result of contaminated groundwater.

Information on baseline seasonal variability of groundwater quality has not been presented. Establishing such variability is important for the overall interpretation of groundwater conditions at the site and to establish the expected range of data variability. This will allow more reliable interpretation of groundwater monitoring results during the life of the Project and support the determination of impacts to groundwater quality resulting from the Project.

If the JRP should wish to reduce uncertainty in the groundwater analysis, EC suggests that JRP consider the value of BC Hydro carrying out transient groundwater modelling of the effects of the reservoir in the operations phase of the Project to assist and direct the development of the proposed Groundwater Protection Plan and future groundwater monitoring locations.

EC also suggests that the JRP consider the value of BC Hydro using information from all ongoing groundwater monitoring in the area, all known contaminated sites, and all known registered and unregistered wells in developing its Groundwater Protection Plan.

5.3 Geochemistry - Acid Rock Drainage and Metal Leaching

The Project includes the excavation, relocation and replacement of approximately 8 million cubic metres (cms) of presently competent bedrock plus 26 million cms of unconsolidated overburden material over a seven year period. Newly exposed bedrock, especially, can become a source of metals and metalloids, which are Parameters of Potential Concern (POPC’s) as newly-exposed mineral surfaces react with oxygen in the atmosphere and/or water to release metals/metalloids to surface water and/or groundwater and eventually to the receiving environment. The commonly referred to process which describes the release of metals/metalloids from rock, Acid Rock Drainage/Metal Leaching (ARD/ML), is important in the context of making available metal/metalloid POPC’s for transport via water pathways to receptor organisms such as fish and wildlife. It is important to understand that the release of metals/metalloids can occur both by ARD mechanisms (with the generation of acid resulting in subsequent release of metals/metalloids) and under neutral (or even alkaline) drainage conditions (i.e. metals/metalloids may be released from certain minerals – notably secondary minerals and mineral salts created as a result of natural chemical weathering processes—with or without the interaction of oxygen). Water may act both to promote the release of metals/metalloids (with or without oxygen) and as a transport medium transferring metal/metalloid POPC’s from source rocks to receiving environments and those organisms which depend upon a healthy environment in order to survive.

BC Hydro provided updated results and analysis from geochemical testing of rock units and overburden in July 2013 (Klohn Crippen Berger & SNC Lavalin; July 2013; Report BKS-03-068, Site C Clean Energy Project, Definition Design, Geochemical Characterization – Status at the End of 20-12, Revision 1). While the majority of rock units identified at the Project area have undergone static and kinetic geochemical testing and subsequent analysis of results, there are some units where kinetic testing has not been
completed and other units where additional testing needs to be undertaken in order to better understand geochemical variability. Authors of the report recognize a need to provide additional geochemical testing and analysis, and EC agrees that additional effort is required of BC Hydro and their consultants, pre-construction, in order to add confidence in the analytical data and thereby better understand potential adverse effects of the Project due to geochemical processes interacting with excavated rock and overburden, for appropriate mitigation design.

In order to gain greater confidence in the data, the JRP may wish to consider the value of BC Hydro completing geochemical characterization of rock and overburden prior to Project construction, in order to gain a fuller understanding of the potential release of selenium and other metals/metalloids of interest.

A number of metals/metalloids of interest have been identified through geochemical testing as potentially reporting to test leachates at elevated concentration levels. While BC Hydro have identified the potential for release to contact water of selenium and other POPC’s from waste rock and overburden, there hasn’t been any predictive work to evaluate levels or concentrations of metals/metalloids in the Peace River as a result. The authors of the geochemical characterization report (at page xxv of Klohn Crippen Berger & SNC Lavalin report BKS-03-068) recommend that “...[w]ater quality modelling be completed to evaluate the effectiveness of the proposed material management strategies to limit or mitigate ARD/ML to protect the receiving environment.” This study component was also partially captured in the EIS guidelines prepared for the Project (in section 9.2.1 Geology, Terrain and Soils at page 38) whereby it was expected that the EIS “…predict drainage chemistry through time for each management unit.” While normally available at the project review stage, EC understands that water quality modelling continues to be useful to help “fine-tune” mitigation measures via setting quantifiable objectives and evaluating outcomes for proposed mitigation. An appropriate mass-balance approach, which predicts metal concentrations at various nodes or reaches of the Peace River, at different stages of project development and operation, and during those times of the year when organisms in the receiving environment may be most sensitive, should provide insight to understand the potential environmental impact due to the release of metals/metalloids and other POPC’s and to evaluate the potential effectiveness of proposed mitigation measures.

BC Hydro’s commitment to and details for monitoring water quality for ARD/ML parameters of interest are unclear. Pages 173-174 of the geochemical characterization report (Klohn Crippen Berger & SNC Lavalin report BKS-03-068) only suggests that “…frequency of monitoring and the parameters and analytes to be analyzed for, will be developed in consultation with aquatic scientists and fisheries biologists.” EC recognizes the value of a water quality monitoring program that describes background/ambient water quality conditions; responds to discharges from waste rock, overburden and other sources to describe concentrations and loads of metals/metalloids and other parameters of interest; and anticipates and describes water quality in the receiving environment. As such, a monitoring program that closely tracks sources of metal/metalloid contamination is an important management tool to inform and enable mitigation measures where required. Additionally, a well-developed water quality monitoring program can provide some assurance that mitigation is appropriate for receiving environment needs. Thus it important that BC Hydro provide details of a water quality monitoring program that describes ambient/background conditions, measures loads from POPC sources, enables mitigation response as needed, and measures and demonstrates receiving environment health.

The JRP may wish to encourage BC Hydro to conduct a water quality modelling and monitoring program for metal/metalloid parameters and other Parameters of Potential Concern. Both modelling and monitoring should represent all Project phases from ambient (present) condition through
5.4 Nutrients

BC Hydro provides adequate information on the environmental background levels of standard water quality parameters (nutrients, dissolved oxygen, total suspended solids, alkalinity, pH and temperature). Information on available federal and provincial guidelines, e.g. Canadian Council of Ministers of the Environment, BC and Alberta guidelines for the protection of aquatic life) provide for comparison with baseline levels of these parameters. The water quality information supports the hydrodynamic, water quality and productivity modelling (Volume 2, Appendix P, Part 2), which predicts changes in phytoplanктon and periphyton (measures of primary production).

This information is in turn used to predict potential changes to secondary (invertebrate) production and biomass, and total fish production, biomass and species composition. This information, combined with the background total dissolved gas pressure (also included in the environmental background water quality parameters) supports BC Hydro’s assessment of Fish and Fish Habitat.

The model selected (CE-QUAL-W2) makes reasonable assumptions of the water quality information to predict potential changes from existing conditions to expected conditions as an operating reservoir, calibrated using observations from the Dinosaur Reservoir and Peace River. The key to confirming the predicted outcome will be to implement a good follow-up monitoring program to verify the accuracy of the model predictions.

The JRP may wish to encourage BC Hydro to conduct a water quality monitoring program that includes attention to such parameters as nutrients, total suspended solids, and dissolved oxygen during the Project operations phase. As part of such a program, if monitoring results significantly differ from the results predicted by the CE-QUAL-W2 model, it should be determined whether the differences are adversely impacting water quality and mitigation actions should be taken as appropriate.

5.5 Environmental Emergencies – Potential Accidents and Malfunctions

CEAA 2012 requires that all designated projects consider: “the environmental effects of the designated project, including the environmental effects of malfunctions or accidents that may occur in connection with the designated project and 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.”

Proponents of all such designated projects must therefore take into account their project’s potential for unintentional spills and releases of hazardous substances and consequential harm to the environment and to human health and life. The assessment of environmental effects that results from potential accidents and malfunctions should be guided by the need to ensure compliance with the general prohibitions against the deposit of a deleterious substance into waters frequented by fish and against the deposit of oil, oily wastes or any other substance harmful to migratory birds in any waters or any area frequented by migratory birds.

EC’s reviews of environmental emergencies planning considerations respecting accidents and malfunctions are based on the Department’s mandated interests as they relate to the Canadian Environmental Protection Act (CEPA) 1999, the pollution prevention provisions of the Fisheries Act, and the Migratory Birds Convention Act, (MBCA) 1994. EC’s comments and recommendations to project
proponents are provided with a direct view to preventing and mitigating environmental effects that may occur as a result of an accident or malfunction.

Overall, BC Hydro has met EC’s general expectations for environmental emergency planning with respect to potential spills of hazardous substances resulting from accidents and malfunctions. EC’s review of Volume 5 of the amended EIS, Section 3S Summary of Environmental Management Plans; Volume 5 of the amended EIS, Section 37.2Potential Accidents and Malfunctions; as well as BC Hydro’s responses to the three EC information requests have verified that BC Hydro has addressed the essential environmental mitigation considerations in the development of the Project’s Environmental Management Plans, with the exception of the following:

During EC’s review of the Project, EC Comment #gov_0018_258 was made pursuant to EIS Volume 5, Section 37.2.4.1.2, subsection Worst Case Oil Spill, page 37-69, lines 15-23:

Comment #gov_0018_258:
“Further information regarding the worst case scenarios developed and presented by the Proponent is requested. EC recommends that the Proponent provide information on worst case scenarios in a manner that is consistent with the Risk Management Guide for Major Industrial Accidents (CRAIM 2007). For example, in calculating worst case scenarios, the Guide recommends that active mitigation techniques not be included.”

BC Hydro Response:
BC Hydro indicates that “The worst case scenario for Oil Spill in Volume 5, Section 37.2.4.1.2 page 37-69 was completed in accordance with S. 23.2 of EIS Guidelines. This comment will be considered in the development of the Environmental Management Plans and final design of the oil containment systems.”

Any contingency plans should focus on worst–probable-case scenarios (e.g. timing of spill incidents that coincide with 1) migration periods involving high concentrations of migratory birds, 2) spawning periods involving high concentrations of fish, 3) presence of sensitive wildlife and/or sensitive habitat). Accident scenarios considered as part of the risk assessment process should take into account the possibility of human and technological errors, as well as the possibility of natural disasters and/or deliberate acts (e.g. sabotage, terrorism, vandalism or theft) that could trigger an accident or malfunction to occur. The assessment of environmental effects that result from potential accidents and malfunctions should also include a consideration of all possible spill incidents throughout all months of the year. Based on these analyses, the scenario assessments should describe the precautions that will be undertaken and the contingency measures that will be implemented to avoid or reduce the identified impacts to water resources, fish, wildlife and their habitats.

In support of environmental emergency planning needs, the JRP may wish to encourage BC Hydro to consider a worst-probable-case scenario within the final Environmental Management Plans once the final design of the oil containment system (volume) has been determined. Worst-probable-case scenarios should be considered in a manner that is consistent with the Risk Management Guide for Major Industrial Accidents (CRAIM 2007). In the documenting worst-probable-case scenarios and in developing the associated spill contingency plans for such, site-specific conditions and sensitivities should be taken into account. The Canadian Standards Association publication, Emergency Preparedness and Response, CAN/CSA-Z731-03, is a useful reference in this regard.

CHAPTER 6 – ATMOSPHERIC ENVIRONMENT
6.1 Introduction

This chapter presents EC’s review of the atmospheric environment sections of the EIS, Amendments to EIS, Additional Information Requests and other supporting documents available on the Project registry as they relate EC’s mandate and interests.

With specific reference to air quality, the Canadian Environmental Protection Act (CEPA 1999; schedule 1) provides a list of pollutants of concern that are subject to legislative control and management. CEPA 1999 has also legislated that these pollutants be reported to the National Pollutant Release Inventory (NPRI). EC plays a critical role with provinces to implement the national Air Quality Management System (AQMS) to ensure air pollution is effectively addressed.

EC plays a key role in addressing climate change through supporting research, science and development of regulations to reduce greenhouse gas (GHG) emissions. EC scientists investigate Canada's past, present and future climate to determine how our climate is changing, as well as the causes and effects of this change. In addition, EC develops the science needed to understand the impacts of climate change on Canada, and how we can adapt to these changes. Greenhouse gases are discussed in Section 6.4 of this chapter while Climate Change (linked to water quantity) is discussed in Chapter 3, Section 3.4.

EC identified the following broad atmospheric environment issues as being of primary concern for our review, and each is discussed in more detail below: weather and climate monitoring, microclimate modelling, air quality, and greenhouse gases.

6.2 Weather/Climate

6.2.1 Weather and Climate Monitoring

BC Hydro installed seven weather stations around the proposed Site C reservoir to support an evaluation of the climate of that part of the Peace River valley. This network of stations has been fully active since early 2011. The first full year of data was collected by 15 January 2012. All seven stations measured wind speed and direction at a height of about 10 metres. Six stations measured a suite of weather variables including air temperature, relative humidity, precipitation, snow depth, atmospheric pressure. Three of these six weather stations also measured solar radiation, soil temperature, soil moisture and soil heat flux. Data from these stations, along with measurements and observations from the long-term Fort St. John Airport weather station are used in many aspects of the proposed project.

The engineering design of numerous components of this Project made use of climatological statistics and information. Statistics generated from the Fort St. John Airport weather station are used, along with data from other sources, to design structures that can withstand 30 to 200 year extremes for rain, snow, wind and temperature. The accurate observation and modelling of weather is also important to many engineering, construction, maintenance and operational elements of the Project.

Precipitation Measurement

Six project weather/climate stations measure precipitation using Tipping Bucket Rain Gauges (TBRG) and one station, Attachie Flat Upper Terrace (Site 1), also has a Pluvio weighing precipitation gauge. This gauge was installed by BC Hydro after they found that the TBRG recorded 31.5% less wintertime precipitation than the gauge at the Fort St. John Airport weather station.
TBRG gauges are usually better at recording the instantaneous rate of rainfall than the total daily precipitation (MacDonald and Pomeroy, 2007; Sevruk, 1996). Additionally, the TBRGs have significant limitations in detecting, measuring and reporting solid and mixed precipitation, in particular when unheated. While heated TBRGs are available, their ability to detect and measure solid precipitation is still limited by their location, wind speed, presence and type of a wind shield around the gauge, precipitation intensity, air temperature, the snow type, and heating applied.

Weighing gauges (e.g. Pluvio) are better at measuring cumulative precipitation amounts. All gauges tend to under-catch in windy conditions (Sevruk et al., 2009) while the under-catch for liquid precipitation is usually a minor factor, measurement of solid or mixed precipitation has a large error which is strongly correlated to the wind speed.

BC Hydro reported the precipitation totals for the first year of operation for six gauges installed along the edge of the proposed reservoir (EIS Table 3.2.1, p. 40, Volume 2, Appendix K). They found that the TBRG at site 1 caught 19% less precipitation than a co-located Pluvio weighing precipitation gauge. Even after adjusting the TBRG precipitation upwards by 19%, the precipitation measured at site 1 was still about 10% less than the amount measured at the airport. Over a ten-week winter test period (21 Dec 2011 to 2 Mar 2012) the TBRG at BC Hydro site 1 observed 26.9 mm, the colocated Pluvio caught 33.2 mm and the Fort St John Airport station recorded 48.5 mm. During the test period the best performing gauge, the Pluvio, recorded just 68.5% of the precipitation measured at the airport.

Scientific studies have demonstrated that accurate reporting of precipitation amounts over various time periods can be achieved through the combination of a weighing gauge with an appropriate wind shield configuration and the application of adjustments to account for systematic errors due to the adverse effects of wind, evaporation, etc. These adjustments are specific to gauge and shield configuration, as well as the temporal resolution of the data.

BC Hydro is employing a single alter type wind shield at the gauges in this network, which is only moderately useful at low to moderate wind speeds and of little use for solid or mixed precipitation at wind speeds of 5 m/s and above (MacDonald and Pomeroy, 2007; Sevruk et al., 2009; Sevruk, 1991). Double alter wind shields have been shown to improve the catch efficiency for a weighing precipitation gauge (Rasmussen et al. 2012). The currently recognized precipitation measurement standard is a weighing gauge installed at the centre of a double octagonal fence structure with a diameter of 12 m., referred to as a Double Fence International Reference (DFIR). This structure reduces turbulence and increase the precipitation catch efficiency (Sevruk et al., 2009; Strangeways, 2007).

The five BC Hydro stations only equipped with TBRGs are expected to under-catch by a significant amount when the precipitation is mixed or solid. It is important to note that when an instrument is unable to detect falling snow, under-catch corrections, even if available, cannot be applied. To date there have been limited studies on their ability to detect snow, and the characteristics of their under-catch (Rasmussen et al., 2012). There will be an occasional under-catch for rain and a much greater, and more irregular, under-catch for snow. These under-catch errors are expected to diminish the accuracy and reliability of precipitation observations from the Project weather stations which could, in turn, affect construction- and operation-phase hydrological analysis and modelling that make use of these data.

BC Hydro, in response to an EC Information Request about the accuracy of precipitation measurements by TBRGs, indicated that

“the purposes of the Site C in valley climate station network are to measure baseline climate and to monitor changes when the reservoir is constructed. The instrumentation is acceptable for the
BC Hydro has signalled their intention to use data from the climate network to forecast flows and manage risks during the construction and operation of the Project. EC expects that the use of this precipitation data to manage risks would imply that precipitation measurement accuracy would be a priority.

**Recommendation 6.1**

EC requests that the JRP recommend that BC Hydro improve the catch efficiency of the on-site precipitation gauges within the BC Hydro Site C climate monitoring network, prior to the start of construction.

In order to better achieve the above recommendation, EC offers the following advice:

- add a weighing precipitation gauge at the five reservoir area climate stations that currently monitor precipitation solely using a tipping bucket rain gauge; and
- surround each weighing precipitation gauge with at least a Single Alter wind shield. If the use of the precipitation data for risk management activities critically depends on the data accuracy, then each gauge should be surrounded by a Double Alter wind shield or even a Double Fence International Reference wind shield, installed in accordance with World Meteorological Organization (WMO) observational protocols.

The precipitation observation program would also benefit from the addition of a precipitation occurrence or precipitation type sensor that would assist in adjusting the precipitation amounts reported by the gauges.

### 6.2.2 Microclimate Modelling

A meteorological numerical modelling study was conducted by BC Hydro to predict the likely changes to the local meteorology and microclimate that would result from the construction of the proposed dam and the formation of the reservoir. A numerical model is a computer program that takes, as input, data from a variety of measurements of atmospheric and surface conditions and predicts a future state of the atmosphere based on the laws of physics. These models are used in operational weather prediction and can also be used to simulate past weather events or to conduct detailed process studies. For the EIS, BC Hydro used the Weather Research and Forecasting (WRF) model. WRF is a community mesoscale model which is used by many users throughout the world for weather prediction and research on meteorological phenomena at various scales.

BC Hydro conducted a one-year baseline simulation, whereby the past weather for one consecutive year was simulated, and results were compared to climatological values of relevant weather elements (surface temperature, winds, and precipitation) and values measured at several stations in the study area, between Hudson's Hope and Fort St. John. It was shown that the baseline case simulation reasonably reproduced the observed meteorology in the study area and had measurable forecast skill for some fields, such as surface temperature and winds, but showed no skill for simulating precipitation. Note, in this context “skill” refers to the ability of a given technique (here, the WRF model simulation) to provide a better prediction than the climatological (30 year) average.
As part of the baseline simulation, BC Hydro modeled 1495 hours with visibility of less than 500m at Fort St. John Airport over the one-year period. In contrast, visibility of less than ½ mile (800m) was observed at Fort St. John Airport 396 times (including both full-hour and partial-hour observations) during the same period. The climate normal observations for Fort St. John Airport (1971-2000) show that visibility less than 1 km typically occurs 130 hours per year. The BC Hydro modelling employed a more restrictive visibility threshold for fog occurrence and yet modeled the incidence of fog to be four times greater than was actually observed. The large discrepancy between the modeled hours of fog and the corresponding incidence of observed fog indicate that the modelling approach had difficulty in properly representing fog conditions.

BC Hydro then conducted an effects analysis by re-running the one-year simulation but with modified surface fields in the model to mimic the effects of the reservoir. Comparisons were made between the baseline case simulation (without the reservoir) and the “future case” simulation (with the reservoir) to evaluate quantitatively the expected effects on the local meteorology.

Based on a statistical analysis of the baseline and future case simulations, BC Hydro concluded that “there would be no changes more than one kilometre from the proposed reservoir that are statistically distinguishable from year-to-year variations”. Within 1 km of the reservoir, slight changes were predicted to occur for near-surface air temperature, winds, and humidity. For the number of hours of fog and reduced visibility in particular, they conclude that the construction of the reservoir would likely lead to a decrease at several locations, except at Fort St. John Airport and Taylor Bridge, where the number of fog hours was predicted to increase.

EC finds that there were some major limitations with the specific configuration of the WRF model, as used in the EIS that make conclusions based solely on the modelling study questionable. It should be stressed here that the WRF model, with the general modelling strategy used for the study, is indeed capable of providing reliable predictions and conclusions of the type that were made by BC Hydro. However, there are many possible configurations of WRF and the appropriate configuration is very specific to the given problem under investigation. There is no such thing as a default WRF configuration; the user must select the configuration appropriately. Running WRF with a configuration that is simply not appropriate for a given study will produce results on which meaningful conclusions cannot be drawn.

The main configuration problems with the modelling study were the size of the inner model domain, the horizontal grid spacing, and the vertical grid spacing. Other aspects, such as the lack of demonstrated forecast skill for precipitation indicate that they may be other problems as well, but the following are sufficiently problematic so as to undermine the reliability of many of the modelling results.

**Domain Size**

The inner (1 km) domain of the WRF model set-up is relatively small (108 x 68 grid points). To avoid errors near the lateral boundaries of a nested grid, the inner nest should generally be larger than the area of interest. However, in this case the inner nest is exactly the same size as the study area. How much larger it should be depends on the type of weather being simulated. For this study that includes a wide range of weather including small scale convective storms in the size range of 10-20 km. In this set-up, the south-west end of the proposed reservoir appears to be approximately 15 km from the southern lateral boundary. Strictly speaking the grid is too small for the given study. It may be the case that the problems described above are not that important for this particular case, but no evidence was provided to demonstrate this and justify the use of the small grid.

**Horizontal Grid Spacing**
The configuration for this study must not only be sufficient to produce an acceptable baseline simulation, it must also be appropriate to sufficiently model the effects of the feature being studied, in this case the presence of the reservoir. For this study, the model configuration is almost certainly insufficient to conduct the effects analysis correctly. Specifically, the horizontal grid spacing of 1 km is too coarse to study the effects of the reservoir whose width is also approximately 1 km wide. It is commonly understood in numerical modelling that the resolution of a model is typically around 7-10 times the horizontal grid spacing. This means that for a model with a horizontal grid spacing of 1 km, the effective maximum resolution is around 7 km. This is analogous to a digital photograph; a single pixel is insufficient to represent anything (except perhaps a small box), but with 7 x 7 pixels it starts to be possible to represent simple shapes. So introducing a forcing feature on the scale of the model grid spacing (1 km) – in this case changing the surface points from land to water for grid points corresponding to the location of the reservoir – means that forcing is being added at a scale that the model is incapable of resolving.

**Vertical Grid Spacing**

The issues of the number of vertical model levels and the resulting vertical resolution are exactly the same as for horizontal resolution. BC Hydro used 35 vertical levels. This is inadequate to study processes happening in a shallow layer near the ground, such as surface fog. WRF is indeed capable of simulating surface fog, but only if the model horizontal and vertical grid spacing is such that the small-scale processes leading to its formation can be resolved. For comparison, EC’s operational two-day forecast model system currently uses a horizontal grid spacing of 10 km and 80 vertical levels; no forecast products for reduced surface visibility due to fog are even considered since it is well recognized that the model resolution (horizontal and vertical) is insufficient.

Earlier in this section we noted that there was a discrepancy between the modeled versus observed frequency of fog at Fort St. John during the baseline period. More fundamentally the coarse configuration of the WRF model used by BC Hydro for this study cannot produce meaningful projections about fog frequency.

Despite the limitation of the modelling component, BC Hydro’s microclimate study provides thorough and convincing physical arguments that in fact support the conclusions regarding the limited effects of the reservoir. EC agrees with BC Hydro that, based on their physical reasoning, the effects of the creation of a reservoir will most likely be limited to within 1 km from the reservoir. In summary, the creation of the reservoir would change the conditions of the earth’s surface over this area, with reduced surface heating from the sun across the water surface, more evaporation of water into the atmosphere, and reducing the surface friction. Thus, as BC Hydro correctly states, “it is expected that the proposed reservoir would moderate temperature by creating cooler summers and warmer winters, increase atmospheric humidity ..., and create higher wind speeds over and close to the water surface.” However, due to the nature of how changes to the atmosphere in the lowest layer near the surface are transmitted horizontally, the distance from the reservoir that any effects will be observable are essentially that of the characteristic width of the reservoir (1 km), with an upper bound of around 10 km as “a reasonable estimate for the extent of the reservoir influence.”

### 6.3 Air Quality

The construction and operation of the Project has the potential to change local and regional air quality. EC has reviewed the Amended EIS for the Project and is satisfied that BC Hydro’s management
procedures will adequately mitigate predicted air quality impacts.

Sources of the air emissions during construction will include the construction of the dam will include construction of the dam, generating station and spillway, quarried and excavated construction materials, road and rails accesses and transmission lines. Construction vehicles, equipment and activities related to clearing and burning debris will be sources of combustion and fugitive dust emissions.

During operations, fugitive dust entrainment could occur during dry periods due to wind erosion from exposed areas. BC Hydro conducted dispersion modelling using the CALMET/CALPUFF model to predict concentrations of criteria air contaminants and dust fall deposition rates during the project construction phase. For estimating emissions from project operations accepted sources for emissions factors were referenced. EC is satisfied with the information presented.

### 6.4 Greenhouse Gases

EC has reviewed the BC Hydro calculation of GHG emissions associated with construction and operation of the Project. These calculations are reasonable, and EC agrees with the BC Hydro determination that the residual adverse effect of the Project on GHG emissions is low.

EC also agrees with BC Hydro that the electricity produced as a result of the Project will have a substantially lower GHG emission intensity in relation to most other electricity generation options. As stated in Section 15.4.1, Table 15.11 of the Amended EIS, the estimated GHG emissions intensity for the Project ranges from 10.5 – 14.3 g CO₂e/kWh compared to an average GHG emissions intensity from Natural Gas of 545 g CO₂e/kWh or from Modern Coal of 1,000 g CO₂e/kWh. This finding is consistent with the 2012 special report of the Intergovernmental Panel on Climate Change (IPCC) entitled “Renewable Energy Sources and Climate Change Mitigation.” The IPCC report re-affirms the importance of renewable energy supply choices such as hydropower that will be an important element of any strategy aimed at stabilizing and reducing GHG levels in the future.

In reaching its own conclusions, the Panel is encouraged to consider the 2012 IPCC report findings and the role of available technologies with low GHG emission intensities, such as hydropower, in meeting ongoing and future energy demands. In addition, existing international initiatives, such as the IPCC, provide a forum for contextualizing and addressing global GHG emission concerns.
CHAPTER 7 – SUMMARY OF RECOMMENDATIONS

CHAPTER 3  SURFACE WATER REGIME AND CLIMATE CHANGE

3.1 EC requests that the JRP recommend that BC Hydro predict the impacts of filling the reservoir on downstream flow and water levels to the Peace Point study boundary with reference to average, best and worst case scenarios. This work should be undertaken before Project construction.

3.2 EC requests that the JRP encourage BC Hydro to operate the Project in a manner that ensures fall and winter flows do not increase relative to present conditions so that ice jam flooding potential in the Peace-Athabasca Delta is not impacted.

CHAPTER 4  WILDLIFE AND VEGETATION

4.1 EC requests that the JRP recommend that BC Hydro undertake the following, for the purpose of updating and informing its mitigation (including compensation) strategy/plans:

a) Report on migratory bird use and impacts using the habitat terminology described in Volume 13 Vegetation and Ecological Communities (and supporting technical reports). Habitat units should be standardized for all wildlife resources, is verifiable by real data, and follow provincial standards and classification systems to support a comprehensive ecosystem assessment and complementary mitigation measures for multiple valued components; and

b) Complete the assessment, including providing estimates of abundance, of the baseline condition for migratory bird species (including species at risk and species of Aboriginal interest), their associated habitats, and across seasons, including differentiating and providing LAA statistics of where habitat would be permanently lost or fragmented, (e.g. by roads or transmission lines) and where habitat would be expected to remain intact.

4.2 EC requests that the JRP recommend that BC Hydro undertake an assessment of the habitat values of the LAA in support of the development of mitigation (including compensation) strategy/plans to address the habitat needs of migrating and wintering migratory birds. This should include:

a) An undertaking to quantify migrant and wintering bird abundance in the LAA (i.e. generate abundance estimates, by species and groups of species); identify and characterize important migration and wintering habitats; and determine habitat-species associations at the habitat type and habitat feature levels; and

b) An assessment of the impacts resulting from the loss of habitat due to the reservoir, transmission line, roads and ancillary sites at the regional level.

4.3 For the purposes of updating and informing its mitigation (including compensation) strategy/plans, EC requests that the JRP recommend that BC Hydro provide a summary of the field surveys conducted in all the habitat types identified in EIS Tables 13.4, 13.5 and 13.6, indicating the data collection efforts by habitat, at both coarse and broad scales.

4.4 EC requests that the JRP recommend that BC Hydro identify, in table form and maps, the individual locations of all surveyed species together with the associated mapped ecosystem unit for each Project component, differentiating in the LAA: where habitat would be permanently lost; where habitat would be fragmented (e.g. by roads or transmission lines); and, where habitat would remain
intact. BC Hydro should also provide the same for each species where associated mapped ecosystem units were not surveyed for the LAA.

4.5 EC requests that the JRP recommend that BC Hydro produce an effects pathway that demonstrates the rationale and how the indicator species represent the ecological needs of the larger suite of migratory birds and species of Aboriginal interest. This should include individual models of representative migratory waterfowl and landbirds associated with each of the freshwater habitats (river habitat and fish-waterfowl) and terrestrial habitats (including grasslands, riparian shrub habitat, and mature and climax floodplain forest).

4.6 EC requests that the JRP recommend that BC Hydro produce a scientifically defensible and statistically-based sampling framework to support predictive models for use in a comparative assessment at multiple scales. This should use standardized surveys and counts to produce estimates of population size (as noted prior in this submission), by which to improve the ability to describe and validate relative patterns of habitat suitability to support comparisons between the effects of different activities over different habitats and scales that in turn support the mitigation, including compensation strategy/plans.

4.7 EC requests that JRP recommend that BC Hydro develop mitigation measures specific to migratory birds and bird species of Aboriginal interest that address the changes in aquatic and riparian-related food resources associated with the change from a fluvial to a reservoir system. This could include:

a) designing and implementing a long-term tracking program for fish-eating and insectivorous birds by which to assess the ecological changes associated with the reservoir and downstream of the dam; and

b) taking into account Peace River floodplain features and habitats that are of importance to individual species (as defined in the literature, analyses of available data and/or from future surveys), including for example limiting factors (other than nest sites) and future recreational use of existing features.

4.8 EC requests the JRP recommend that BC Hydro, in conjunction with pre-construction and operations wetland monitoring (to assess potential impacts to structure and composition), conduct migratory bird and species at risk (plants, lichens, and animals) pre-construction and operations monitoring to assess potential changes in wetland functions. BC Hydro should consult with EC on the duration and frequency of monitoring in relation to migratory birds and species at risk.

4.9 Further to Recommendation 4.8, EC requests that the JRP recommend that BC Hydro complete a Wetland Compensation Plan that includes and addresses any temporary or permanent changes in wetland structure and composition currently not predicted or unknown in relation to construction or operation of the reservoir, transmission line, or any other activities associated with the Project, and defined as extending over and beyond an ecologically relevant period (in the order of five years), that change or impair functions supporting migratory birds and/or species at risk. BC Hydro should:

a) incorporate consultation with EC and other interested and implicated agencies and Aboriginal groups in relation to migratory birds and species at risk

b) submit the final Wetland Compensation Plan no later than three months prior to construction, should the Project proceed; the submission and its timing should be made a commitment under the CEAA 2012.
c) ensure that the Wetland Compensation Plan achieve a full replacement of the wetlands lost in terms of area and functions

4.10 EC requests that the JRP recommend that BC Hydro conduct follow-up monitoring of mercury trends in belted kingfisher and other fish-eating wildlife of importance to local stakeholders is made a condition for the Project approval. Such follow-up would be the responsibility of BC Hydro, and designed and evaluated jointly by the BC Hydro, relevant government agencies, Aboriginal groups and local stakeholders.

4.11 EC requests that the JRP recommend that BC Hydro develop a monitoring-mitigation strategy to address the loss of active nests due to the reservoir and downstream of the dam.

4.12 EC requests that the JRP recommend that BC Hydro prepare a Transmission Line Bird Collision Management Plan. The Plan would include an avian risk assessment and spatial analysis. The Plan would evaluate options for pre and post construction carcass monitoring, remote sensing technology, and line marking. The Plan would make recommendations on the findings of the aforesaid, and implement the technically feasible option. BC Hydro should consult with EC and interested other agencies and Aboriginal groups on the Plan.

4.13 EC requests that the JRP recommend that BC Hydro identify, in table form and maps, the individual locations of all surveyed species considered at risk together with the associated mapped ecosystem unit for each Project component, differentiating in the LAA where habitat would be permanently lost, fragmented (e.g. by roads or transmission lines), and where habitat would be expected to remain intact.

4.14 EC requests that the JRP recommend that BC Hydro, in support of the mitigation (including compensation) strategy/plans, provide estimates of density and abundance prior to vegetation clearing and during Project operations for species at risk.

4.15 EC requests that the JRP recommend that BC Hydro track the status of species as assessed by COSEWIC and SARA and consult with the appropriate jurisdictions involved in SARA recovery planning processes, including with respect to the identification of critical habitat.

4.16 EC requests that the JRP recommend that BC Hydro provide EC with the full list of plant species records and that pre-construction surveys to address remaining information gaps be completed in support of the development of avoidance and mitigation for all SARA-listed vascular and non-vascular plant species, as well as any additional species assessed by COSEWIC as at risk.

4.17 EC requests that the JRP recommend that BC Hydro submit Amphibian survey data for review for the purposes of directing future survey effort and in support of the identification of mitigation and monitoring, including for the Western Toad (Special Concern, Schedule I).

4.18 EC requests that the JRP recommend that BC Hydro develop a Migratory Bird Compensation Plan, after all avoidance and mitigation measures have been identified, to address residual significant adverse effects to non-wetland associated migratory birds: Canada Warbler, Cape May Warbler, and Bay-Breasted Warbler. The Compensation Plan should be consistent with EC’s Operational Framework for Use of Conservation Allowance (Environment Canada 2012b). EC also recommends that:

a) In completing the final Plan, incorporate consultation with EC and other interested and implicated agencies and Aboriginal groups in relation to migratory birds and species at risk.
b) The final Plan should be submitted no later than three months prior to construction, should the Project proceed, that the Plan and the timing of its submission be made a commitment under the CEAA 2012; and

c) In relation to the new information garnered through 4.13-4.17 above, BC Hydro should assess the potential effects and possible residual adverse effects to the following at risk species: Olive-sided Flycatcher, Common Nighthawk, and Bank Swallow and incorporate the results into the Migratory Bird Compensation Plan.

4.19 In consideration of the number of aerial insectivores and wetland-associated species at risk, EC requests that the JRP recommend to BC Hydro that chemical spraying to maintain vegetation be avoided for the Project.

4.20 EC requests that the JRP recommend to BC Hydro that an inventory of the COSEWIC-assessed Myotis bat species be completed for the purposes of estimating population size and distribution in the LAA, and an evaluation of hibernacula and roost sites (for which BC Hydro has collected some data) be completed for the purposes of identifying and implementing mitigation and compensation measures.

CHAPTER 6 ATMOSPHERIC ENVIRONMENT

6.1 EC requests that the JRP recommend that BC Hydro improve the catch efficiency of the on-site precipitation gauges within the BC Hydro Site C climate monitoring network, prior to the start of construction.
CHAPTER 8 – REFERENCE LIST


BC Species and Ecosystems Explorer Database, http://a100.gov.bc.ca/pub/eswp/


Beaulaurier, D. L. 1981. Mitigation of bird collisions with transmission lines. Bonneville Power Administration, Portland, Oregon, USA.


E-bird, http://ebird.org/content/ebird/


James, B. W., and B. A. Haak. 1979. Factors affecting avian flight behavior and collision mortality at transmission lines. Western Intestate Commission for Higher Education-Bonneville Power Administration, Boulder, Colorado, USA.


Meyer, J. R. 1978. Effects of transmission lines on bird flight behavior and collision mortality. Western Interstate Commission for Higher Education-Bonneville Power Administration, Portland, Oregon, USA.


and Saskatchewan, 176 pp.


Western Hemisphere Shorebird Reserve Network, http://www.whsrn.org/

1. Introduction

The mandate of EC is determined by the statues and regulations assigned to it by Parliament through the Minister of Environment. In delivering this mandate, the Department is also responsible for the development and implementation of policies, guidelines, codes of practice, inter-jurisdictional and international agreements and related programs. The following lists specific legislation and national environmental policies and programs administered or adhered to by EC that influenced the content of this submission.

2. Legislation and Policies

**Department of Environment Act**
The mandate of EC is defined by the *Department of the Environment Act* (DOE Act) which provides EC with general responsibility for environmental management and protection. The Department’s obligations extend to and include all matters over which Parliament has jurisdiction and have not, by law, been assigned to any other department, board or agency of the Government of Canada. The DOE Act delegates responsibility to the Minister of the Environment for:

- Preservation and enhancement of the quality of the natural environment, including water, air, and soil quality;
- Renewable resources including migratory birds and other non-domestic flora and fauna;
- Water;
- Meteorology;
- Enforcement of any rules or regulations made by the International Joint Commission related to boundary waters and questions arising between the United States and Canada, as they relate to the preservation and enhancements of the quality of the natural environment; and
- Coordination of policies and programs respecting preservation and enhancement of the quality of the natural environment.

The DOE Act states that EC has a mandated responsibility to advise heads of federal departments, boards and agencies on matters pertaining to the preservation an enhancement of the quality of the natural environment. As such, EC’s mandate is broad.

**Canadian Environmental Assessment Act, 2012**
Section 20 of the *Canadian Environmental Assessment Act, 2012* sets out EC’s obligation as a Federal Authority (FA) as follows:

Every federal authority that is in possession of specialist or expert information or knowledge with respect to a designated project that is subject to an environmental assessment must, on request, make that information or knowledge available, within the specified period, to

(a) the responsible authority;
(b) the review panel;
(c) a government, an agency or body, or a jurisdiction that conducts an assessment of the designated project under a substituted process authorized by section 32; and
(d) a jurisdiction that conducts an assessment, in the case of a designated project that is exempted under subsection 37(1).
**Canadian Environmental Protection Act, 1999**
The *Canadian Environmental Protection Act, 1999* (CEPA) provides the Government of Canada with tools to protect the environment and human health and establishes strict deadlines for controlling certain toxic substances. Determine a substance to be toxic under CEPA is a function of its release or possible release into the environment, the resulting concentrations in environmental media and its inherent toxicity. Section 64 of CEPA defines a substance as toxic “if it is entering or may enter the environment in a quantity or concentration or under conditions that:

- Have or may have an immediate or long-term harmful effect on the environment of its biological diversity;
- Constitute or may constitute a danger to the environment on which life depends; or
- Constitute or may constitute a danger in Canada to human life or health.

CEPA also regulates environmental and human health effects from products of vehicle engine and equipment emissions, fuels, hazardous wastes, environmental emergencies, and other sources of pollution.

**Fisheries Act – Subsection 36(3)**
The responsibility for the administration (including the enforcement) of the pollution prevention provisions of the *Fisheries Act* (including subsection 36(3)) has been assigned to the Federal Minister of the Environment.

Subsection 36 (3) of the *Fisheries Act* specifies that, unless authorized by federal regulation, no person shall deposit or permit the deposit of deleterious substances of any type in water frequented by fish, or in any place under any conditions where the deleterious substance, or any other deleterious substance that results from the deposit of the deleterious substance, may enter any such water. In the definition of deleterious, the *Fisheries Act* includes “any water that contains a substance in such quantity or concentration, or that has been so treated, processed or changed, by heat or other means, from a natural state that it would, if added to any other water, degrade or alter or form part of a process of degradation or alternation of the quality of that water so that it is rendered or is likely to be rendered deleterious to fish or fish habitat or to the use by man of fish that frequent that water.”

Meeting the requirements of the *Fisheries Act* is mandatory, irrespective of any provincial regulatory or permitting system. The release of substances with the potential to be “deleterious,” as identified in Subsection 34(1) of the *Fisheries Act*, from the construction, operation, reclamation or decommissioning stages of the Project in any waters frequented by fish, may constitute violations of the *Fisheries Act*.

**Migratory Birds Convention Act, 1994**
EC’s mandate includes the protection of migratory birds, nests and eggs. EC administers and enforces the *Migratory Birds Convention Act, 1994* (MBCA) and *Migratory Birds Regulations* (MBR).

The purpose of the MBCA is to implement the Migratory Birds Convention between Canada and the United States by protecting and conserving migratory birds, as populations and individual birds and their nests. The MBR provide for the conservation of migratory birds and for the protection of individuals, their nests and egg. A prohibition against the disturbance, destruction, or taking of a nest, egg or nest shelter of a migratory bird is set out in subsection 6 (a) of the MBR.

**Species at Risk Act**
EC administers and enforces the federal *Species at Risk Act* (SARA), in partnership with the Department of Fisheries and Oceans, and the Parks Canada Agency. There are different ministers responsible for species listed under the SARA depending on the type of species and their location. They are referred to
as “competent ministers” under the Act. The Minister of Fisheries and Oceans is responsible for aquatic species at risk other than individual in or on federal lands administered by the Parks Canada Agency. The Minister of the Environment as Minister responsible for Parks Canada Agency is responsible for species at risk found in national parks, national historic site or other protected heritage areas. The Minister of the Environment is also responsible for all terrestrial species at risk on lands not administered by the Parks Canada Agency.

The purpose of the SARA is to prevent wildlife species from becoming extirpated or becoming extinct, to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity, and to manage species of special concern to prevent them from becoming endangered or threatened. Schedule 1 of the SARA provides a list of wildlife species at risk in Canada that are considered extirpated, endangered, threatened, or of special concern.

The SARA provides automatic protection for aquatic species and birds protected by the MBCA, if they are listed as extirpated, endangered or threatened, under sections 32 and 33 of the Act, which apply whether these species are on federal, provincial or territorial lands.

**The Federal Policy on Wetland Conservation**

The Federal Policy on Wetland Conversation was adopted in 1991. The objective of this policy is to promote the conservation of Canada’s wetlands to sustain their ecological and socio-economic functions, now and in the future. The policy is a shared federal responsibility that directs all departments to sustain wetland functions in the delivery of their programs, services or expenditures.
APPENDIX 2 - FEDERAL POLICY ON WETLAND CONSERVATION – ENVIRONMENT CANADA ADVICE

(A) The key policy objectives of the Federal Policy on Wetland Conservation (the Wetland Policy) relevant to federal environmental assessment can be found in the section on strategy related to federal lands and water and in the section on ‘other federal programs’. These include:

*Commit all federal departments to the goal of no net loss of wetland functions (i) on federal lands and waters, (ii) in areas affected by the implementation of federal programs where the continuing loss or degradation of wetlands has reached critical levels, and (iii) where federal activities affect wetlands designated as ecologically or socio-economically important to a region. Due to local circumstances where wetland losses have been severe, in some areas no further loss of any remaining wetland area may be deemed essential (Government of Canada 1991).*

(B) The Wetland Policy applies to federal departments addressing the potential loss of wetlands and wetland functions. Projects and activities of the Government of Canada are subject to the Policy, including those projects and activities considered under the *Canadian Environmental Assessment Act, 2012* (CEAA 2012) For projects on non-federal lands and waters, such losses are evaluated (1) in terms of the scope of any federal permits, licenses, authorizations and other instruments under federal jurisdiction which may be applicable, and (2) where the associated wetland functions support areas of federal jurisdiction (for Environment Canada, for example, these include migratory birds and species at risk). To be clear: the Policy does not apply to wetlands in the absence of either of these two above links to federal jurisdiction.

(C) The Wetland Policy is underpinned by a no-net-loss of wetland functions objective, and as such, necessitates a consideration of all wetland functions which could be impacted. For Environment Canada, functions of specific interest include those supporting migratory birds and species at risk. To inform the applicability of the Wetland Policy, Environment Canada recommends that BC Hydro describe the natural processes of potentially impacted wetlands (physical and chemical) and perform an assessment of the potential impacts and mitigation.


(D) The Wetland Policy is applied on a regional basis to reflect current conditions. The Policy applies to natural, degraded, and artificial wetlands. In British Columbia, for example, the geographic areas where continuing loss or degradation of wetlands has reached critical levels are defined as:

- **Delivery Areas under the Pacific Coast Joint Venture**;
- **Delivery Areas under the Canadian Intermountain Joint Venture**;
- **Delivery Areas under the Prairie Habitat Joint Venture**;
- **Lower Mainland / Fraser River region**;
- **East Vancouver Island and Gulf Islands**;
- **Okanagan Valley**; and,
- **Portions of the Columbia Valley**.
In British Columbia, ecologically or socio-economically wetlands important to a region are defined as:

- All marine coastal wetlands, saltmarshes, eelgrass (Zostera subspecies) beds; and,
- Red- and blue-listed wetland ecological communities.

With respect to the two definitions provided above, Environment Canada’s Canadian Wildlife Service (Pacific and Yukon) will provide more detailed guidance to project proponents as and when requested.

(E) Three mitigation strategies should be used to achieve a no-net-loss of wetland functions for the three situations identified above. In order of application, these strategies¹ are:

1. **Avoidance of impacts**;
2. **Minimization of unavoidable impacts**; and,
3. **Compensation for unavoidable impacts**.

Due in part to the broader wetland policy objective of promoting the conservation of Canada’s wetland functions, now and in the future, and given the important role that wetlands play in sustaining populations of migratory birds and SARA-listed species, in addition to the foregoing no-net-loss considerations of the Wetland Policy, Environment Canada recommends that avoidance and minimization of impacts to ecological wetland functions be broadly considered in project design.

It is important to note that application of the Wetland Policy is separate and distinct from a significance evaluation under the *Canadian Environmental Assessment Act, 2012*. The Wetland Policy is based on a no-net-loss of wetland functions, whereas the significance evaluation under the Act uses threshold-based criteria. The Wetland Policy applies to all wetland types, regardless of size; to all impact types, whether small or large, short duration or long, or direct or indirect. Specifically, the no-net-loss goal applies to the temporary loss of wetland functions. Monitoring programs need to sufficiently robust to ensure effective implementation of mitigation measures and successful recovery of wetland functions.

(F) The Wetland Policy applies to CEAA 2012 to the extent of the application of federal jurisdiction as described under (B). With specific reference to section 5 of CEAA 2012 then, the relevant sections are sections 5(1)(a), 5(1)(b) and 5(2)(a). With respect to section 5(1)(a), there must be link between areas of federal jurisdiction as described (B).

Environment Canada’s Canadian Wildlife Service recommends that a Wetland Compensation Plan (WCP) be submitted with an Environmental Impact Statement for review in the environmental assessment process. Amongst other things, the WCP should describe the wetland ecological communities and functions potentially impacted to which the Wetland Policy applies; application of the mitigation hierarchy; identification of residual effects; identification of a compensation ratio; identification of the location and timing of implementation of compensation projects (where feasible); and, the parties responsible for implementation (including monitoring) and review.

At a minimum, a compensation ratio of 2:1 is used; however, this ratio varies on a project-by-project basis. Consultation with the Canadian Wildlife Service is recommended to ensure the appropriate

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¹ For more information on the mitigation hierarchy, refer for example to the Federal Policy on Wetland Conservation Policy Implementation Guide for Federal Land Managers (1996), available through the following web link: http://www.ec.gc.ca/nature/default.asp?lang=En&n=132ADBFC-1&parent=0C1743A2-4D49-4183-AC5F-1DE909D2FEB1
ratio is identified. In order of priority, the Canadian Wildlife service recommends wetland restoration over enhancement and enhancement over creation.

(G) In summary, Environment Canada advises proponents that the Wetland Policy applies to the federal departments and agencies when addressing the loss of wetlands. It will be used to inform the environmental assessment process and will be considered by Environment Canada when assessing the appropriate measures to be taken to mitigate the adverse environmental effects of the Project under CEAA 2012, the Canadian Environmental Protection Act, the Migratory Birds Convention Act, the International River Improvements Act and the Species at Risk Act.