RESPONSE TO WORKING GROUP AND PUBLIC COMMENTS ON THE SITE C CLEAN ENERGY PROJECT ENVIRONMENTAL IMPACT STATEMENT

Technical Memo

SPATIAL BOUNDARY SELECTION

MAY 8, 2013

Subject: Spatial Boundary Selection

1. PURPOSE

A number of comments have been received during the Comment period regarding the spatial boundaries (in particular, the downstream boundaries) established for several environmental background topics and Valued Components (VCs) studied as part of the environmental assessment of the Site C Clean Energy Project. The EIS describes all boundaries for all VCs including the downstream boundaries used in the Fish & Fish Habitat, Vegetation & Ecological Communities, and Wildlife Resources Sections. BC Hydro has also considered the report prepared by Dr. Martin Carver for the Athabasca Chipewyan First Nation, Dene Tha' First Nation, and Mikisew Cree First Nation (Review of Hydrologic & Geomorphic Downstream Impacts of Site C, December 2012) and the Draft Technical Memorandum prepared by Kerr Wood Leidal on behalf of the Deninu Kue First Nation (Report Review – Site C Clean Energy Project, Potential Downstream Changes, January 2013).

The purpose of this memorandum is to respond to the comments received and Dr. Carver's report and the Kerr Wood Leidal report to provide clarification on the rationale for spatial boundary selection. This includes a description of:

1. the approach used to establish downstream spatial boundaries for the study of environmental background topics and Valued Components

2. the rationale for selection of spatial boundaries for key environmental background topics

3. the rationale for selection of spatial boundaries for Local and Regional Assessment Areas (LAAs and RAAs, respectively) for environmental Valued Components

2. APPROACH TO ESTABLISHING DOWNSTREAM BOUNDARIES

The spatial boundaries for the environmental background studies were developed considering preliminary results of the studies and a general understanding of the mechanisms by which the Project would influence the various physical characteristics of the water flow downstream of the dam site (e.g. magnitude and timing of flows, water temperature, suspended sediment concentrations). Conservative study areas were selected for modelling to account for the uncertainty in preliminary results of the studies. Final results of the studies were reviewed to confirm that the study area included the entire area in which the Project could lead to changes that could influence the Valued Components. Since this was the finding for all studies, revisions to the study boundaries were not required.

Table 1 summarizes the downstream boundaries of the technical study areas for several environmental background topics. Additional discussion about these downstream boundaries is provided later in this Technical Memo.

Table 1 – Downstream Boundaries of Technical Study Areas for Environmental Background Topics

Environmental Background Topic	Downstream Boundary of Technical Study Area
Surface Water Regime	Peace Point, Alberta
Thermal and Ice Regime	Fort Vermilion, Alberta

Fluvial Geomorphology and Sediment Transport	Peace Point, Alberta

The spatial boundaries for Fish & Fish Habitat, Vegetation & Ecological Communities, and Wildlife Resources were developed with consideration of preliminary results of various background environment studies (e.g. surface water regime, fluvial geomorphology and sediment transport, thermal and ice regime) as well as relevant biological information on the distribution, pattern of movement, habitat requirements, and sensitivity of the Valued Components to changes in physical habitat conditions. Using this information, the spatial boundaries for the Local and Regional Assessment Areas were established by taking into account the potential for the Project to result in changes to key aspects of effects for each of the Valued Components, as directed by the EIS Guidelines. Final results of the surface water regime, fluvial geomorphology and sediment transport, thermal and ice regime, and other background environment studies demonstrated that the spatial extent of each VC assessment fully captured the area in which the predicted change could influence the VC.

Table 2 summarizes the downstream boundaries of the Local and Regional Assessment Areas for the environmental Valued Components. Additional discussion about these downstream boundaries is provided later in this Technical Memo.

Table 2 – Downstream Boundaries of Local and Regional Assessment Areas for Environmental Valued Components

Environmental Valued Component	Downstream Boundary of Local Assessment Area	Downstream Boundary of Regional Assessment Area
Fish and Fish Habitat	Many Islands, Alberta	Vermilion Chutes
Vegetation and Ecological Communities	B.C.- Alberta Border	B.C.- Alberta Border
Wildlife Resources	B.C.- Alberta Border	B.C.- Alberta Border

3. ENVIRONMENTAL BACKGROUND STUDIES

3.1 Surface Water

The technical study area selected for the characterization of potential changes to the surface water regime as a result of the Project extends from the outlet of the Peace Canyon Dam to Peace Point, Alberta, over 1,000 km downstream. Peace Point is located approximately 108 km upstream of the confluence with the Slave River.

The final results of the surface water regime study demonstrated that changes predicted downstream of the Town of Peace River (located approximately 300 km downstream of the Site C dam site) are negligible, considering the magnitude of the predicted change in relation to the variability of the baseline flow regime. The EIS presents comparisons of various statistics with and without the Project including water levels on an annual and seasonal basis, timing of releases, magnitude and frequency of high and low flows, daily range of water levels, hourly rate of change of water level, wetted width, and average cross sectional velocity[1].

[1] EIS, Section 11.4 and Volume 2 Appendix D.

Additional figures and tables have been included in this technical memo to further illustrate the predicted changes and the reduction of the change with increasing distance downstream. Figure 1 illustrates the location of the Water Survey of Canada stations and the river chainage system that is used to identify locations on the Peace River. Chainage refers to the distance downstream of the W.A.C. Bennett Dam. Figures 2 and 3 show the average, minimum, and maximum daily flows predicted for the two future scenarios (with and without the Project), by month, for locations at the Site C tailrace; at Water Survey of Canada stations at Taylor, Alces River confluence (near the B.C. - Alberta border), Town of Peace River, and Peace Point; and at Many Islands which is located at river chainage 227 km. As shown on these plots, at Taylor, Alces, Many Islands, Town of Peace River, and Peace Point the predicted change in minimum, maximum, and average daily flows as a results of the Project are negligible for every month of the year relative to the range of historic and simulated flows. For reference purposes, Figures 2 and 3 also show the historic range of flows observed at these locations.

Figure 1 - Water Survey of Canada Station Locations and River Chainage

Figure 2 – Minimum, Average, and Maximum Daily Flows (Site C Tailrace, Taylor, Alces)

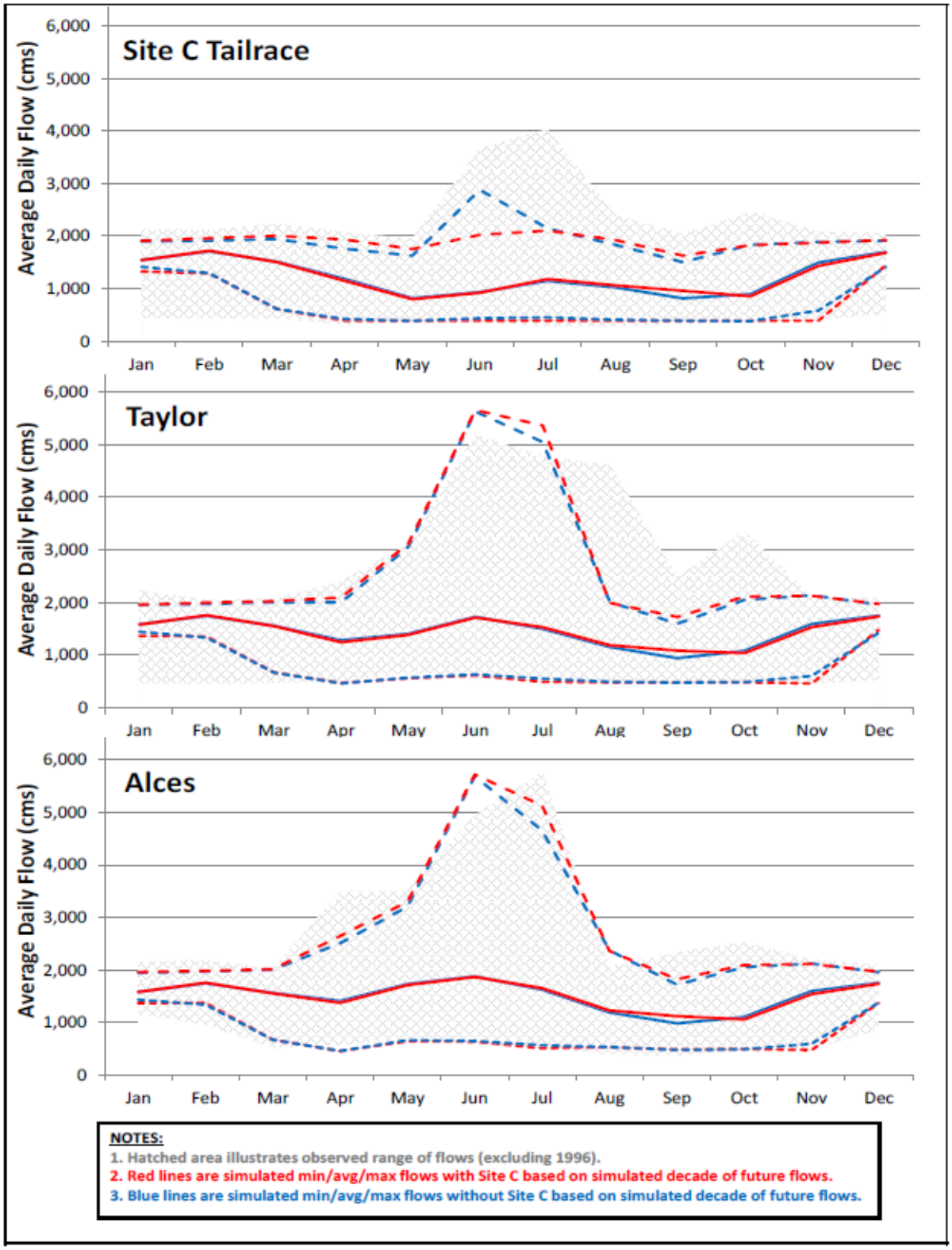
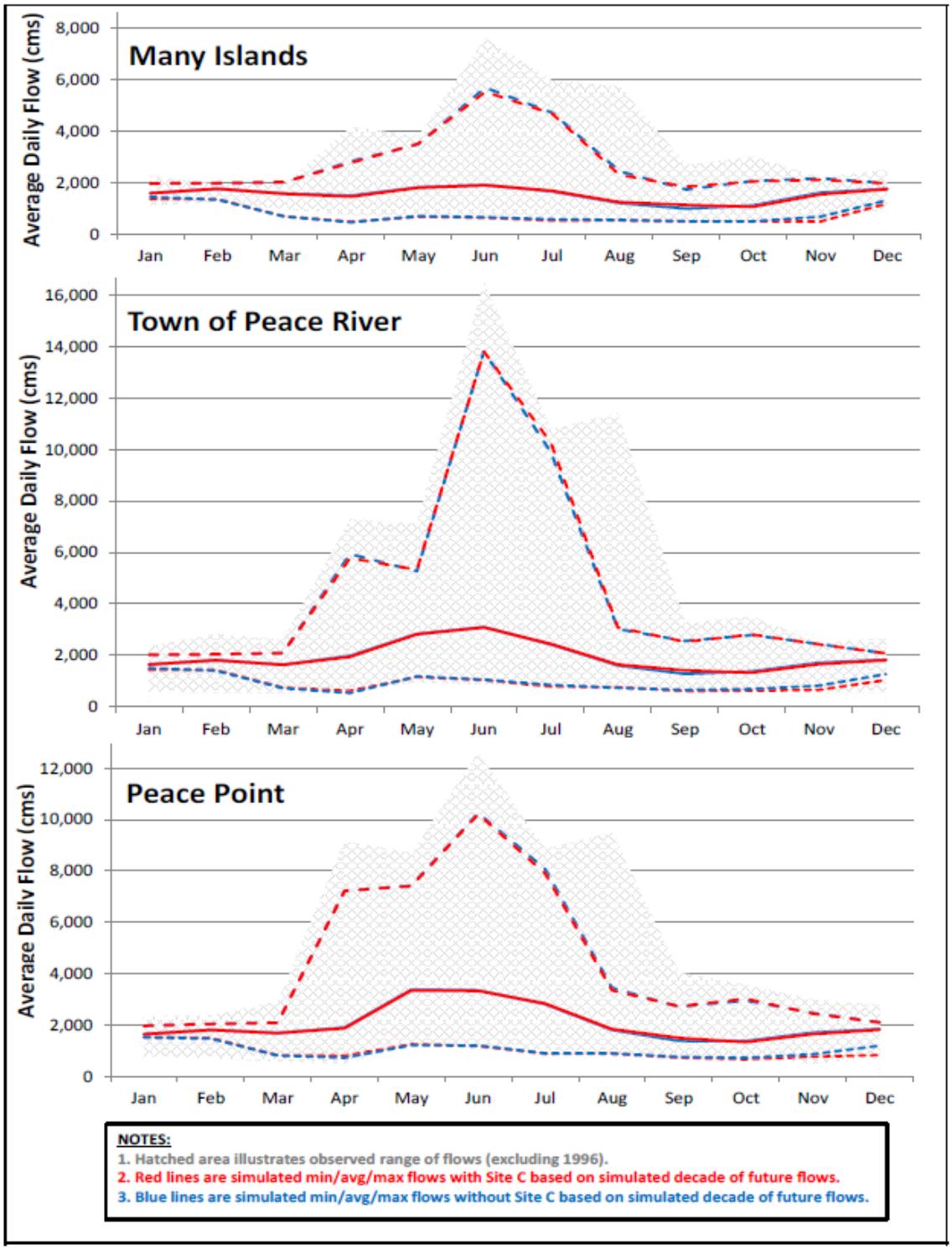


Figure 3 - Minimum, Average, and Maximum Daily Flows (Many Islands, Town of Peace River, Peace Point)



Statistics on daily range of water levels have also been extracted to illustrate the changes in the surface water regime downstream of the Town of Peace River, and to support the discussion of spatial boundaries for the assessment of potential impacts to Valued Components. Table 3 summarizes the average simulated daily range of water levels with and without the Project for winter and summer periods, defined as November 15 to May 15, and May 16 to November 14, respectively.

Table 3 Average Simulated Daily Range of Water Levels (with and without the Project)

	Winter (Nov 15 – May 15)			Summer (May 16 – Nov 14)		
Location	**Without the Project**	**With the Project**	**Difference**	**Without the Project**	**With the Project**	**Difference**
Site C Tailrace	0.43 m	0.89 m	+0.46 m	0.53 m	1.13 m	+0.60 m
Taylor	0.39 m	0.69 m	+0.30 m	0.46 m	0.84 m	+0.38 m
Alces	0.46 m	0.75 m	+0.29 m	0.54 m	0.95 m	+0.41 m
Many Islands	0.36 m	0.51 m	+0.15 m	0.43 m	0.64 m	+0.21 m
Town of Peace River	0.14 m	0.17 m	+0.03 m	0.18 m	0.22 m	+0.04 m
Peace Point	0.05 m	0.05 m	0.00 m	0.09 m	0.09 m	0.00 m

Statistics (duration curves) of wetted width, average cross sectional velocity, and hourly rate of change of water level are provided in the EIS[2].

3.2 Downstream Ice Regime

The technical study area for the downstream ice regime study extended from the Peace Canyon Dam (for the case without the Project) or the Site C dam (for the case with the Project) to Fort Vermilion, Alberta, approximately 730 km downstream of Site C. Fort Vermilion was selected as the downstream boundary of the study as it is the farthest downstream location at which reliable and consistent observations of the ice front location are recorded in each ice season. Also, preliminary results of the study indicated that this location was well downstream of where the Project would influence the ice regime. It is relevant to note that the downstream ice study conducted for the proposed Dunvegan Hydropower Project used the same downstream boundary for the same reasons[3].

Results of the downstream ice study indicate that there would be no change in the ice regime of the Peace River as a result of the Project downstream of Carcajou, Alberta, which is located approximately 550 km downstream of Site C and approximately 180 km upstream of Fort Vermilion. This finding held true for a simulated future scenario taking into account predicted climate change[4].

Consideration was also given to the potential influence of the Project on the frequency of break-up ice-jamming in the lower reaches of the Peace River that can lead to flooding of the Peace-Athabasca Delta. Although the downstream ice study predicted no change in the ice regime downstream of Carcajou, that study did not consider the changes in flow regime which were predicted as part of the surface water regime study. This was an appropriate assumption for the study of potential changes to ice conditions, and the CRISSP model used in that study cannot predict dynamic break-up events in

[2] EIS, Volume 2 Appendix D, Part 2 Downstream Flow Modelling (1D).

[3] *Effects of Dunvegan Hydropower Project on the Ice Regime of the Peace River*. Northwest Hydraulic Consultants Ltd., Sept 2006.

[4] EIS, Section 11.7 and Volume 2 Appendix G.

any case. As described in the EIS[5], and further in the Peace Athabasca Delta technical memo[6], the predicted changes in flows would not influence the frequency of ice-jam flooding in the lower reaches of the Peace River.

3.3 Fluvial Geomorphology and Sediment Transport

The downstream boundary for the study of fluvial geomorphology and sediment transport was Peace Point, Alberta, corresponding to the downstream boundary of the closely related surface water regime study area. This boundary was selected largely based on an understanding of the current fluvial geomorphology and sediment transport regime of the Peace River gained through research conducted at the University of British Columbia[7].

Regarding geomorphology or channel shape, the Fluvial Geomorphology and Sediment Transport Study concludes that the Project is not expected to result in any changes in channel erosion or deposition patterns other than possible local erosion of the channel bed in the first few kilometers downstream of Site C under unusually large flow conditions. In terms of suspended sediment transport, changes due to the Project would diminish in a downstream direction due to the moderating influence of water and sediment inputs from tributaries. Sediment yields from tributaries on the Alberta Plateau (downstream of the Site C dam site) are known to be higher than tributaries of the proposed Site C reservoir[8]; as such the reduction in suspended sediment load due to the formation of the Site C reservoir was expected to be small in comparison to the sediment loads entering the Peace River downstream. The results of the Fluvial Geomorphology and Sediment Transport Study demonstrated that the reduction in the mean annual suspended sediment load at both the Town of Peace River and at Peace Point would be in the order of 2%[9] which is considered to be negligible relative to the natural variability in annual suspended sediment load that is observed between years. As an example, the estimated annual suspended sediment loads at the B.C.-Alberta border during the 10 year simulation period ranged from approximately -84 % to +234 % of the 10-year mean annual load. Similar variability would also be expected at other locations along the river.

3.4 Water Quality

The technical study area for the assessment of the potential for the Project to change water quality parameters of the Peace River extended from Peace Canyon Dam downstream to the confluence of the Peace River and the Alces River. The selection of the downstream boundary for water quality assessment (Alces River confluence) was based on the following considerations: 1) a review of historical information on water quality of the Peace River and its tributaries; 2) geographic location and characteristics of tributaries to the Peace River downstream of the proposed Project, with consideration for the relative scope for mixing of mainstem flows with tributary flows; 3) judgment of experienced professional biologists on the sensitivity of Valued components (predominantly Fish and Fish habitat) to potential water quality changes; 4) recommendations about sensitivity of aquatic life to water quality changes based on water quality guidelines (CCREM, BC).

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5 EIS, Section 11.4.5.2.4, pages 11-80 and 11-81.

6 Technical Memo on the Peace Athabasca Delta, BC Hydro 2013.

7 Church 2011.

8 Church 2011.

9 EIS, Section 11.8.5.2, Table 11.8.5, page 11-141.

Changes to water quality were predicted using a two dimensional water quality model, CEQUAL-W2 which extended from the Peace Canyon Dam to the Alces River confluence. The downstream boundary coincided with the Water Survey of Canada hydrometric station which provides a long term surface water quality monitoring record which permitted calibration of the model outputs. Between Site C and the Alces River confluence, three large tributaries (Pine, Beatton and Kiskatinaw Rivers) contribute considerable flow volume, nutrients concentration, and suspected sediment loads to the mainstem of the Peace River.

As described in the EIS, the CEQUAL-W2 model predictions confirmed: 1) the attenuating effect of these tributaries on water quality as predicted changes due to the Project diminish between the Site C Dam location and Alces River; and, 2) predicted changes to specific water quality parameters at the Alces River were 10% or less. Further attenuation would occur downstream of the Alces River confluence due to contributions from the Alces, Pouce Coupe, Clear and other major tributaries of the Peace River as well as lands draining directly into the Peace River.

A detailed analysis confirming the sufficiency of the downstream boundary is presented in the EIS[10].

4. ENVIRONMENTAL VALUED COMPONENTS

4.1 Fish & Fish Habitat

Spatial boundaries for the Fish and Fish Habitat Valued Component were selected by taking into account the nature of the VC, the appropriate scale and spatial extent of the capacity of the Project to cause adverse changes (LAA), and the potential for interaction with effects of other projects (RAA) on fish and fish habitat. Boundaries were selected based on information derived from a variety of biological and physical studies and data sources that characterized: 1) the existing distribution of fish populations in the Peace River with consideration of life history, habitat requirements, and observed patterns of habitat use; and 2) the potential for the project to alter physical conditions both within the project area and downstream from it. This information, was used with an understanding of the sensitivity of the Valued Component (in particular, the aspects of fish habitat, health and survival of populations, and fish movement) to changes to the physical environment, to inform the technical judgment of professional biologists on the selection of the spatial boundaries for Fish and Fish Habitat.

As described in the EIS[11], the LAA for assessing the potential adverse effects to Fish and Fish Habitat was defined as the Peace River downstream from the Peace Canyon Dam to Many Islands, Alberta, including the tributaries entering the proposed reservoir. Analysis of existing information on fish populations of the Peace River, combined with baseline fish and fish habitat studies for the Project indicated that the fish populations that could potentially be adversely affected by the Project were located between the Peace Canyon Dam and Many Islands[12].

[10] Volume 2 Appendix P Aquatic Productivity Reports Part 2 Hydrodynamic, Water Quality and Productivity Modeling, Section 4.5, page 44

[11] EIS Section 12.1.5.

[12] EIS Section 12 and Volume 2 Appendix O.

4.1.1 Fish Communities of the Peace River

A principal factor supporting the preliminary selection of the spatial boundary for the assessment was the distinct distribution of fish communities in the Peace River in B.C. and Alberta. As discussed in the EIS[13] two distinct communities of fish are observed in the Peace River in the Project area. "Coldwater" species typically require low temperature conditions, large-textured sediments and clean, well-oxygenated water to complete their life requisites typical of the Peace River flowing from the Rocky Mountains. "Coolwater" species typically are able to tolerate higher water temperatures and are better adapted to cope with higher suspended sediment loads as found in the Peace River, typical of the reach of the Peace River flowing across the Alberta Plateau. The transition zone for the two distinct fish communities is located near the Pine River, approximately 16 km downstream of the proposed dam site. This zone forms due to the inflow of water, nutrients and suspended sediment from the Pine, Beaton, Kiskatinaw, Alces, Clear and Pouce Coupe Rivers. This transition zone does not act as a complete barrier to movement of fish, but defines distinct habitat conditions which define the typical resident fish communities which inhabit them. Coldwater species dominate the fish community primarily upstream of the Pine River confluence, and are only infrequently found downstream in Alberta. The presence of coolwater species increases downstream of the Pine River, with populations residing between the Beatton River and Many Islands. Downstream of Many Islands, fisheries studies associated with the Dunvegan project have demonstrated the general absence of the coldwater species and an overall decrease in total abundance of the fish community. Some species of coolwater fishes have been observed to undertake extended migrations in the mainstem Peace. Specifically, limited numbers of fish from Goldeye and Walleye populations will migrate as far downstream as Vermilion Chutes to forage, and can temporarily reside upstream of the Many Islands before returning to overwintering and spawning locations farther downstream on the Peace River in Alberta [14].

Based on the distinct differences in the distribution of coldwater and coolwater fish communities in relation to the location of the Project, the movement patterns of the some species of the coolwater community, and the preliminary assessments of predicted changes to the physical environmental resulting from the project, the downstream boundaries of the LAA and RAA were established at Many Islands and Vermilion Chutes, respectively. The establishment of the RAA boundary at Vermilion Chutes was intended to capture the maximum downstream distribution of potential Peace River fish populations that may be affected by cumulative effects.

4.1.2 Potential to Alter Physical Environment

Confirmation of the downstream boundary of the LAA considered the extent of potential changes to the physical environment that could result from the Project, as stated in the EIS[15], including:

- Surface water regime (i.e. minimum and maximum flow, seasonal flows, rate of flow and stage change)
- Water quality (i.e. nutrients available for trophic production, total dissolved gases)
- Water temperature (magnitude of change, seasonal thermal regime)
- Geomorphology and sediment transport (river channel morphology, bedload and suspended sediment transport)

13 EIS Volume 2, Section 12.3.2.1.

14 EIS Volume 2 Appendix O Section 6.1.1.4 Downstream Peace River Studies.

15 EIS Section 12, page 12-5.

- Downstream ice regime

Considerations for each of those physical environmental factors are provided below.

The Surface Water Regime study concludes that the most notable changes expected as a result of the Project are as follows[16]:

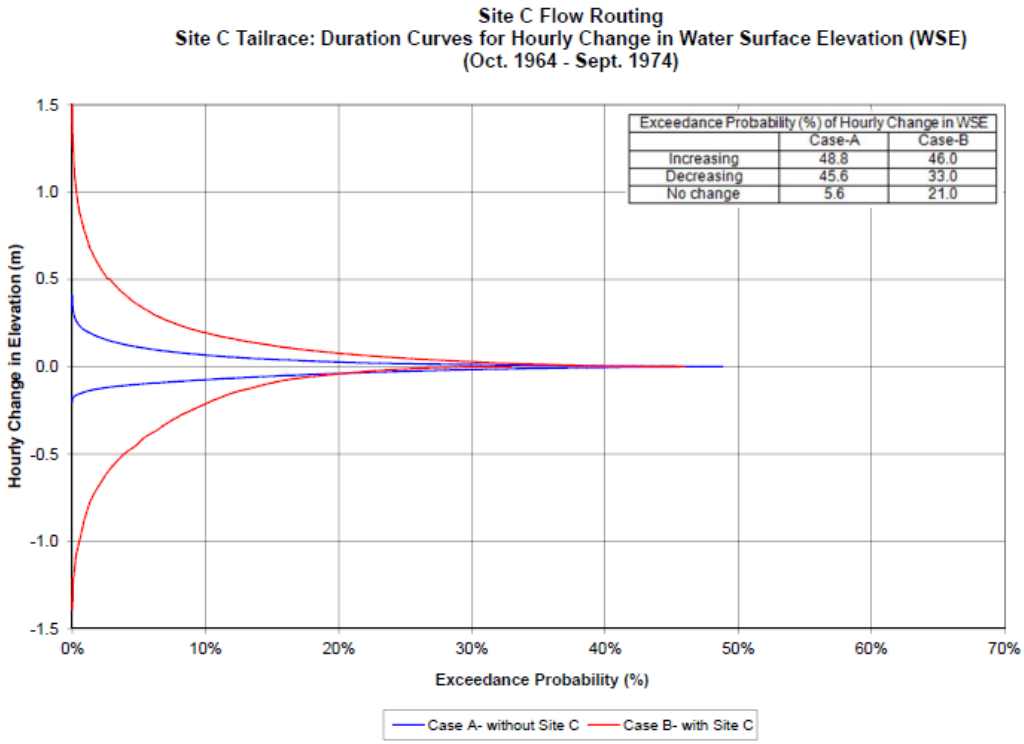
- Reduction in the magnitude of peak flows; negligible change downstream of the Pine River confluence
- More frequent high flows; negligible change at Taylor and further downstream
- More frequent low flows; negligible change at Taylor and further downstream
- Increase in daily range of water levels; negligible change at the Town of Peace River and further downstream.

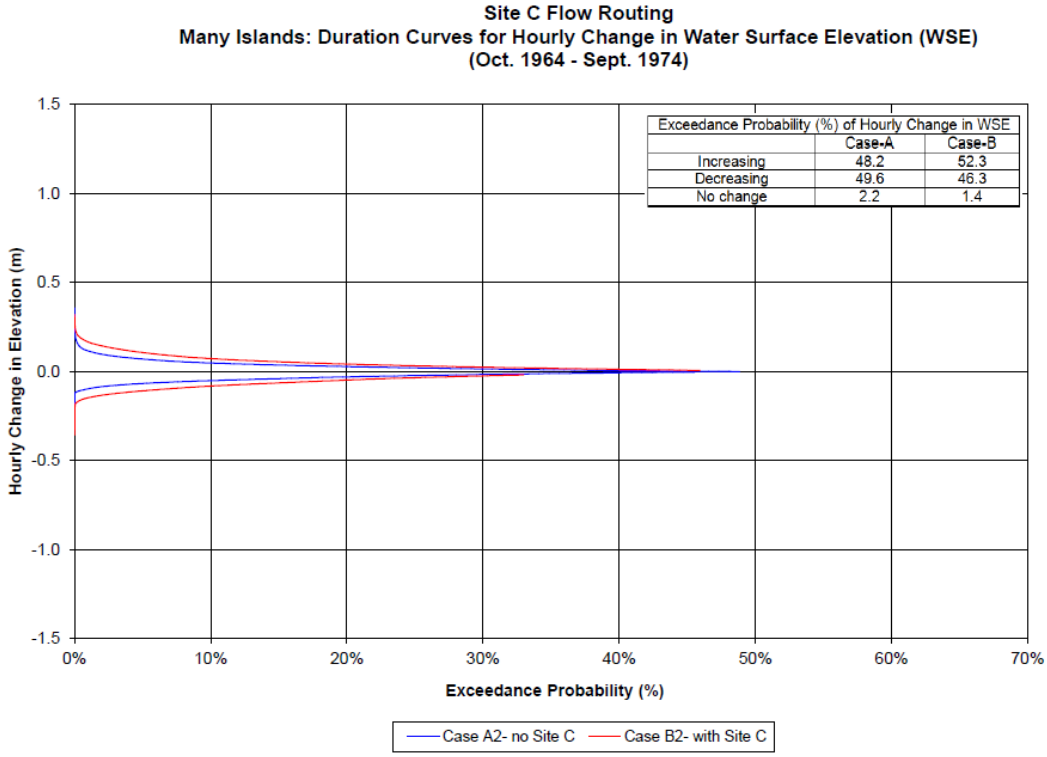
Additional results of the surface water regime modeling are presented in this technical memo to describe predicted changes in daily flows at locations relevant to boundary selection (i.e. Many Islands). The predicted change in minimum, maximum and average daily flows at Many Islands as a result of the Project are negligible every month of the year relative to the range of historic and simulated flows (see Figure 3).

In regards to the predicted hourly rate of change of water levels, Figure 4 illustrates the predicted frequency of various rates of hourly stage change with and without the Project at the Site C tailrace and at Many Islands. This figure demonstrates the attenuation of the influence of the Project on rates of stage change with increasing distance downstream. These results confirm that, as discussed in the EIS[17], the increase in stranding risk due to the Project would be most prominent in the section of the Peace River near the Site C Dam and these changes are largely attenuated by Many Islands.

16 EIS Section 11.4.5.2.7.
17 EIS Section 12.4.4.1, page 12-58.

Figure 4 - Duration curves for hourly change in water surface elevation at Site C Tailrace and Many Islands.





Based on the above results, Many Islands is considered an appropriate downstream boundary for assessing the potential adverse effects to fish and fish habitat from surface water regime changes.

Changes to water quality, nutrients, and aquatic productivity were assessed using a water quality model (CEQUAL-W2). This assessment predicted that changes to these parameters attenuated downstream to the Alces River, and beyond which changes were predicted to be 10% or less. The EIS provides a detailed analysis and comparison for individual water quality parameters[18]. Data from the Peace River and other evidence provided in the scientific literature[19] are consistent in showing that tributary inflows are important in attenuating downstream effects of dams on water quality and aquatic productivity in rivers. Tributaries downstream of the Site C Dam include the Pine River, Beatton River, Kiskatinaw River, Alces River, Pouce Coupe River and numerous other inflows in Alberta. Given the importance of tributary inflows in providing invertebrate recruitment, it is estimated that the distance for benthic invertebrate biomass to recover would be about 60 km downstream of Site C, thus it is predicted effects of changes to water quality on aquatic productivity (i.e. food for fish) would be attenuated upstream of the Many Islands LAA boundary.

Based on the total dissolved gas information provided in the EIS[20] it is expected that during the infrequent predicted spills events, total dissolved gas supersaturation levels would be attenuated from tributary inflows between Site C and Many Islands. This assumption will be tested with a total dissolved gas monitoring program as described in the EIS[21].

Changes to downstream water temperature were predicted with the CE-QUAL-W2 model and a summary of predicted annual and seasonal changes in water temperature are shown in the EIS[22]. The model predictions for water temperature changes at the Alces River meet the guidelines for the protection of aquatic life (< 1 degree C change), and are thus not judged to have a measureable effect on fish or fish habitat, as discussed in the modeling report. Therefore, the selection of Many Islands for the downstream boundary is sufficient for the assessment of the potential effects on Fish and Fish Habitat resulting from potential changes to water temperature.

The potential adverse effects to fish and fish habitat resulting from changes in geomorphology and suspended sediment due to the Project are captured within the LAA for Fish and Fish Habitat. A summary of expected changes in suspended sediment and Peace River morphology are described in the EIS[23]. As summarized above, changes to channel morphology and suspended sediment are expected to be limited to the Peace River immediately downstream of the dam and upstream of the Pine River. Turbid conditions in the Peace River would be restored upstream of Many Islands due to relatively high suspended sediment contributions from tributaries downstream of Site C (Pine and Beatton Rivers).

The expected ice regime downstream of Site C is described in EIS[24]. As described in the EIS Fish and Fish Habitat Section 12.4, subsection 12.4.2.2, page 12-46 the operation of the Project would move the average maximum extent of the ice front downstream by approximately 40 km. The estimated

18 EIS Volume 2 Appendix P Part 2, Section 4.5, page 45.
19 EIS Volume 2 Appendix P Aquatic Productivity Reports: Future Aquatic Conditions in the Peace River.
20 EIS Section 12.4.3.4 and 12.4.4.3.
21 EIS Section 12.8, page 12-96.
22 EIS Volume 2 Appendix P Aquatic Productivity Reports Part 2 Hydrodynamic, Water Quality and Productivity Modeling, Section 4.5, page 46 of 121 and EIS Volume 2 Section 11.7 Thermal and Ice Regime, subsection 11.7.3.3.3, page 11-113.
23 EIS Section 11.8.7, page 11-143.
24 EIS Section 11.7.3.3.5, page 11-114.

probability of the ice front reaching Many Islands changes from approximately 70% of the time without the Project to approximately 30% of the time with the Project [25]. The changes in the ice front and potential effects on the fish populations in the Site C project area are captured in the Many Islands downstream boundary because reduction in the upstream ice front is predicted to increase fish wintering habitat and overwintering survival rate upstream of this point[26].

4.2 Conclusion

The downstream boundary of the assessment of the effects of the Project on Fish and Fish Habitat (Many Islands, Alberta) is suitable given that all potential adverse changes to Fish and Fish Habitat are predicted to attenuate upstream of Many Islands. This conclusion is aligned with the federal Department of Fisheries and Oceans preliminary review of the Site C downstream boundaries for fish and fish habitat assessment areas (http://www.dfo-mpo.gc.ca/csas-sccs/Publications/ScR-RS/2012/2012_017-eng.pdf). That review concluded that the downstream boundaries for the review of the impacts of the Project had been determined to be reasonable, although some revision to the LAA may be needed if further analysis indicates impacts to fish and fish habitat could occur downstream of the proposed boundary. The analyses presented in the EIS, together with the additional output in this memo, confirm the suitability of the boundaries for the LAA.

In addition, the choice of RAA is appropriate because the Site C Project is unlikely to have any impact on fish or fish habitat in the Peace River downstream of Many Islands, other than the infrequent occurrence where fishes from the coolwater community undertake extended movements upstream into the LAA.

5. VEGETATION AND ECOLOGICAL COMMUNITIES AND WILDLIFE RESOURCES

Several questions regarding the downstream boundary used for assessing the potential Project effects on Vegetation and Ecological Resources and Wildlife Resources have been raised. Specifically questions were asked why the LAA ended at the Alberta border. The LAA is defined in the EIS[27] as follows:

> "Local Assessment Area (LAA): the area within which the potential adverse effects of the Project are assessed. The LAA encompasses the Project activity zone, buffered by an additional 1,000 m. This buffer is larger than was suggested in Table 11.2 of the EIS Guidelines. A 1,000 m buffer was selected to allow adequate characterization of the terrestrial environment surrounding the Project activity zone, and extends far enough to include all potential direct and indirect effects at all construction sites and during operations. This includes new roads, roads requiring upgrades, quarries, the dam site, and the transmission line. For the proposed reservoir, the erosion impact line has a 1,000 m buffer.
>
> The LAA also extends downstream from the dam to the Alberta border, and includes a 1,000 m buffer on both the south and north banks of the Peace River (Figure 14.1). This considers potential effects on riparian areas that could be affected by reductions in the magnitude of peak flows, and more frequent high and low flows from the dam

25 EIS Volume 2 Appendix G Downstream Ice Regime Technical Data Report, Figure 8.

26 EIS Volume 2, Section 12 Fish and Fish Habitat.

27 EIS Section 13.1.5.1, page 13-7 and Section 14.1.5, page 14-12.

> downstream to the Pine River confluence (see Section 11.4 Surface Water Regime in Volume 2 Section 11 Environmental Background).

The process used to define and validate this boundary is described below.

The LAA was defined as per Section 8.4 of the EIS-Guidelines taking into account knowledge of the Project location and associated activities, including results of the surface water regime analysis. The physical location of the Project ends upstream of Taylor, B.C.[28]

Habitat alteration and fragmentation was the key aspect used to assess potential effects of the Project on Vegetation Resources and was one of the three key aspects used to assess potential effects of the Project on Wildlife Resources. Habitat alteration and fragmentation was defined for vegetation in the EIS[29] as:

> "a temporary or permanent removal or loss of habitat or a reduction in habitat suitability. Fragmentation involves the 'separation' of habitat patches into one or more pieces – a process that requires some portion of the original habitat patch or rare plant occurrence to be lost or transformed into a less favourable or inhospitable habitat."

For Wildlife Resources habitat alteration was defined in the EIS[30]as:

> "as the permanent removal or loss of habitat or a reduction in habitat suitability for a species. Alteration of habitat can also lead to an increase in predation, decrease in security cover, and removal of seasonal forage, roost, nest, birthing, and den sites."

The LAA includes a 1,000 m buffer around the project activity zone to "include all potential direct and indirect effects at all construction sites and during operations". Most effects are a result of physical works, and associated noise, except for potential changes to Peace River flows downstream of Site C. A review of scientific and management information was first conducted to determine appropriate buffers for species known to occur in the area. The provincial raptor Best Management Practices (BMP) recommends a 1,000 m buffer for active nests during courtship/egg-laying when blasting is occurring. Disturbance buffers suggested in other BMPs for a number of other species (including species groups known to occur in the LAA) and habitats, range between 30 m and 500 m so it was believed 1,000 m was conservative. The 1,000 m buffer was chosen as a distance for the inclusion of all anticipated effects.

Results of the analysis of predicted changes to surface water regime (downstream flows and water levels) were used to consider potential changes in riparian vegetation communities and associated wildlife species that use them. These potential changes in riparian vegetation communities were evaluated based on predicted changes to wetted width. It was assumed that a change in the maximum wetted width downstream of the Project during operations could result in changes to downstream terrestrial ecosystems by extending the area that is subject to surface inundation, overbank flooding and changing characteristics of the water table. Such a change could, in the long term, result in habitat alteration to existing terrestrial ecosystems adjacent to the Peace River.

28 EIS Section 4, Figure 4.11.

29 EIS Section 13.3.1, page 13-13.

30 EIS Section 14.3.1, page 14-15.

Annual and seasonal duration curves of simulated hourly wetted width with and without the Project for Taylor and Alces hydrometric gauge locations were examined to determine if the maximum wetted width of the Peace River was predicted to change with the Project[31]. Changes to minimum wetted width of the flowing river are not believed to alter or fragment riparian habitats. The duration curves for Taylor illustrate that the wetted width would be similar with and without Site C except low wetted widths would be experienced more frequently with Site C (e.g. wetted widths of 400 m or less would be experienced approximately 7 % of the time without the Project and 10 % of the time with the Project). At Alces (near the Alberta border), the predicted difference between scenarios is smaller than at Taylor. At both locations the maximum wetted width does not change as a result of Project operations.

The potential for the Project to cause changes in sediment transport and deposition and the ice regime downstream of the dam were reviewed in assessing the appropriateness of the LAA as changes in these parameters could cause changes to ecosystems and vegetation communities. The analyses conclude that:

> "Changes in river flows due to the Project are not expected to influence the erosion and deposition patterns; therefore, no incremental changes to the dynamic baseline patterns are predicted."[32].

Several questions regarding the boundary used to assess potential cumulative effects of the Project (the RAA), have also been raised. The RAA is defined in the EIS[33]as follows:

> "Regional Assessment Area (RAA): the area within which projects and activities – the residual effects of which may combine with residual effects of the Project – are identified and taken into account in the cumulative effects assessment. The proposed dam, reservoir, transmission line, Highway 29 realignment, temporary access roads, and quarries occur within five Wildlife Management Units – designated 7-31, 7-32, 7-33, 7-34, and 7-35 (Figure 14.1). The Wildlife Management Unit boundaries provide a larger RAA boundary than what was suggested in Table 11.2 of the EIS Guidelines. The updated boundary includes most of the Peace Lowlands ecosection and incorporates all Project components and activities."

Wildlife Management Units were selected to define the boundaries of the RAA. These units were selected, and truncated at the B.C. - Alberta border for the following reasons:

- The Project and areas within which activities occur that result in residual effects that may combine with residual effects of other projects and activities is located within these five Wildlife Management Units
- The provincial government uses the Wildlife Management Units for population level management (e.g., hunter/ harvest targets)
- Baseline data collected for the Project indicates that wildlife with large home ranges were always located within the five Wildlife Management Units defining the RAA

31 EIS Volume 2 Appendix D Part 2 Downstream Flow Modelling (1D), Appendix F.

32 EIS Section 11.8.6, page 11-145.

33 EIS Section 13.1.5.1, page 13-8 and Section 14.1.5, page 14-12.

5.1 Conclusion

The operation of the Project would not result in a change in the current maximum wetted width of the Peace River downstream from Taylor (downstream of the Pine River) or further downstream at Alces. Nor would it result in changes to erosion and deposition patterns. Therefore, Terrestrial Vegetation and Ecological communities and use of these communities by Wildlife Resources downstream are not projected to change as a result of Project operations. For these reasons, the termination of the LAA boundary at the Alberta border is considered appropriate and represents a conservative approach.

Based on above rationale, the selection of the RAA is considered appropriate for the assessment of the potential for cumulative effects of the Project on Vegetation and Ecological Communities and Wildlife Resources.

6. SUMMARY

The final results of the environmental background studies (i.e. surface water regime, downstream ice regime, fluvial geomorphology and sediment transport, and water quality) were reviewed and it was confirmed that the study areas include the entire area in which the Project could lead to changes that could influence the Valued Components and are thus appropriate. The LAA and RAAs for the Fish & Fish Habitat, Vegetation and Ecological Communities, and Wildlife Resources Valued Components were also determined to be appropriate.

Related Comments / Information Requests:

This technical memo provides information related to the following Information Requests:

gov_0010-331	gov_0008-082	gov_0008-160	gov_0010-060	gov_0010-316
gov_0012-011	gov_0010-431	gov_0010-513	gov_0011-009	gov_0012-006
gov_0014-002	gov_0013-030	gov_0013-036	gov_0013-049	gov_0013-051
gov_0016_006	gov_0015-001	gov_0015-005	gov_0016_002	gov_0016_005
gov_0018_206	gov_0016_007	gov_0016_008	gov_0016_010	gov_0018_177
pub_0476-002	pub_0254-002	pub_0465-004	pub_0473-002	pub_0474-001
pub_0597-001	pub_0478-008	pub_0478-010	pub_0478-011	pub_0596-001
pub_0910-001	pub_0603-001	pub_0613-001	pub_0865-001	pub_0897-001
ab_0001-222	pub_0980-001	pub_0984-001	pub_1018-001	ab_0001-186
ab_0001-338	ab_0001-250	ab_0001-260	ab_0001-311	ab_0001-324
ab_0002-009	ab_0001-419	ab_0001-521	ab_0001-549	ab_0002-006
ab_0004-001	ab_0003-020	ab_0003-052	ab_0003-236	ab_0003-269
ab_0004-013	ab_0004-002	ab_0004-007	ab_0004-009	ab_0004-010
ab_0004-018	ab_0004-014	ab_0004-015	ab_0004-016	ab_0004-017
ab_0004-025	ab_0004-019	ab_0004-020	ab_0004-021	ab_0004-023
ab_0004-048	ab_0004-030	ab_0004-031	ab_0004-040	ab_0004-047
ab_0004-061	ab_0004-050	ab_0004-056	ab_0004-059	ab_0004-060
ab_0004-076	ab_0004-062	ab_0004-066	ab_0004-067	ab_0004-071
ab_0008-013	ab_0004-094	ab_0004-101	ab_0005-004	ab_0008-009
ab_0012-008	ab_0009-022	ab_0011-001	ab_0012-001	ab_0012-006
ab_0012-013	ab_0012-009	ab_0012-010	ab_0012-011	ab_0012-012

ab_0012-036	ab_0012-017	ab_0012-018	ab_0012-025	ab_0012-029
ab_0004-084	ab_0001-522	ab_0001-543	ab_0002-011	ab_0003-294
ab_0012-002	Response to Sierra Club and Yellowstone to Yukon Conservation Initiative (Y2Y)			