



Options Analysis for Highway 29 Re-Alignment

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1. Introduction

Highway 29 connects Hudson's Hope to Fort St. John and runs along the north side of the Peace River. Several segments of Highway 29 would be inundated by the proposed Site C reservoir or would be within various impact lines.

In Stage 2 (2007-2009), BC Hydro identified four segments of Highway 29 that would need to be realigned due to the creation of the Site C reservoir: Lynx Creek, Farrell Creek, Halfway River and Bear Flat/Cache Creek.

Since then, additional information from geotechnical investigations and impact line work identified two additional segments of Highway 29 that may require upgrades, relocation or monitoring: Dry Creek and Farrell Creek East (approx. 20 kilometres east of Hudson's Hope).

Five segments of Highway 29 will be realigned (Figure 1):

- Lynx Creek
- Dry Creek
- Farrell Creek
- Halfway River
- Bear Flat/Cache Creek

The Farrell Creek East segment may also need to be realigned, pending further geotechnical analysis.

For three of these sections - Lynx Creek, Halfway River and Cache Creek - multiple alignments are technically feasible. BC Hydro conducted a multiple account evaluation (MAE) to consider the potential impacts of the alignment alternatives and to select a preference at each of these three locations. The purpose of this report is to summarize the MAE process and the criteria used for the evaluation at all three locations, and to describe the re-alignment alternatives and the preferences selected for each location.

Figure 1: Highway 29 Re-Alignment Locations



2. Background

In Stage 2, Highway 29 was a public consultation topic and participants identified the following areas to be considered when evaluating the relocation of the highway: safety, environment, heritage sites, private property impacts, scenic views and costs. Additional consultation with property owners identified potential alternate routings in areas outside of the historical options.

During Stage 3, alignment alternatives have been analysed considering Stage 2 consultation, updated geotechnical information and input from Transport Canada on navigation criteria for proposed bridges.

The BC Ministry of Transportation and Infrastructure (MOTI), who will own, operate and maintain the re-aligned highway, has been an active participant in the re-alignment design process and selection of preferred alignments.

3. Methodology

In the MAE process, the relative safety, environmental impacts (including those on fish, wildlife and habitat), social impacts (including those on property, heritage and agriculture) and costs of each option were considered to arrive at a consensus for a preferred alignment. The indicators used to evaluate the options are shown in Table 1. Participants included representatives of BC Hydro, the Site C Integrated Engineering Team, MOTI, and engineering design consultants (R. F. Binnie & Associates, AMEC, MMM Group and Northwest Hydraulics). Names and affiliations of participants at each of the MAE sessions are shown in Appendix 1.

A description of the alignment alternatives and their evaluation for each of Lynx Creek, Halfway River and Cache Creek is provided below.

Table 1: Indicators Used in Highway 29 MAE

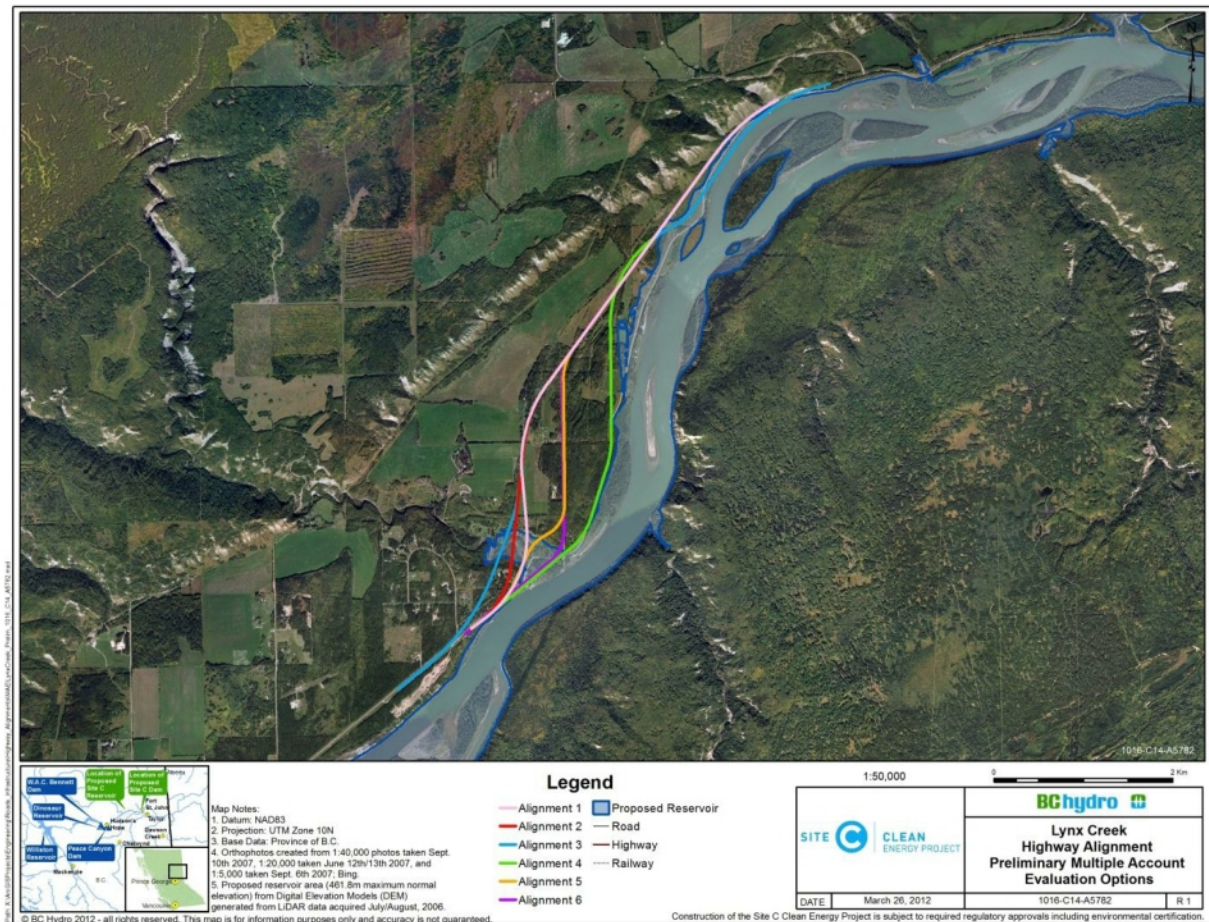
Engineering	Environment	Archaeology	Property	Agriculture
Capital cost	Area of aquatic and riparian habitat affected	Number of known sites within 50 metres of alignment	Number of private holdings affected	Area of land within ALR occupied by right-of-way
Life cycle cost	Area of in-stream works	Number of known sites directly affected	Number of private holdings severed	Net length of actively farmed land severed
Geotechnical risk	Area of forest removed	Area of alignment with high or moderate potential	Area of private land affected	
Landslide induced wave impact	Area of field removed		Area of Crown land affected	
Operational safety	Area of other habitat removed			
Public and worker safety	Area between alignment and reservoir			

4. Lynx Creek

4.1. Alternatives and Considerations

At Lynx Creek, approximately 8 km of highway would require re-alignment. Four alignments were considered during Stage 2. During public consultation in 2008, property owners expressed a preference for using the existing Millar Road, so two additional alignments using Millar Road were considered during Stage 3. Each alignment alternative has short bridge/causeway combination and long bridge only options. The alignments were located in three corridors based on their relative locations at the mouth of Lynx Creek – alignments 1, 2 and 3 inland at the toe of the bench above the flood plain; alignment 4 along the proposed reservoir shoreline; and alignments 5 and 6 located between the other two corridors and using Millar Road (Figure 2).

Figure 2: Lynx Creek Potential Alignments for Preliminary MAE



4.2. Evaluation of Alternatives

Based on preliminary MAE analysis, one alignment was selected from each corridor for further study.

4.2.1. Inland Corridor (alignments 1, 2, and 3 located at the toe of the bench above the flood plain)

Alignment 3 was selected from the inland alignment alternatives for further engineering because it has the lowest potential environmental and social effects and there are no significant differences in safety and costs between the alternatives.

A short bridge was selected over a long bridge because:

- it is safer due to a shorter distance within the Wave Impact Line¹;
- the costs are significantly lower; and
- the environmental and social impacts are not significantly different.

4.2.2. Shoreline Corridor (alignment 4 along the reservoir shoreline)

Alignment 4 has the lowest overall potential environmental and social effects out of all six alignment alternatives. However, since it lies within the preliminary Wave Impact and Stability Impact Lines², it would be associated with a high risk to safety. Work was still underway at the time of the preliminary MAE to better locate the Wave Impact Line and Stability Impact Line. Therefore, it was decided to retain both the short and long bridge options of alignment 4 for further engineering and analysis with respect to the refined impact lines.

¹Wave Impact Line is the boundary beyond which land use is not expected to be affected by waves caused by landslides. It is applied to three areas on the north bank (Lynx Creek, Farrell Creek and Halfway River). In these areas, waves that are generated by a landslide on the opposite bank could temporarily flood land between the reservoir and the wave impact line. The Wave Impact Line has been determined as part of the impact lines approach adopted by BC Hydro. Preliminary impacts lines are based on information gathered as part of historical and recent geotechnical investigations and analyses of erosion, seepage and slope stability.

²Stability Impact Line is a boundary beyond which land is not expected to be affected by landslides caused by reservoir impoundment and operations. The Stability Impact Line has been determined as part of the impact lines approach adopted by BC Hydro. Preliminary impacts lines are based on information gathered as part of historical and recent geotechnical investigations and analyses of erosion, seepage and slope stability.

4.2.3. Central Corridor (alignments 5 and 6 using portion of Millar Road)

Alignment 5 was selected from the central corridor for further engineering because it has lower overall potential environmental and social effects, it is less costly and there are no significant differences in safety between the alternatives.

A short bridge was selected over a long bridge because it is safer due to a shorter distance within the Wave Impact Line, the costs are significantly lower and the environmental and social impacts are not significantly different.

4.2.4. Final Evaluation

Further engineering was done on the remaining options and a final MAE was then conducted. The alignments considered in the final MAE are shown in Figure 3.

In the final MAE alignment 4 was eliminated because of its location immediately adjacent to the proposed reservoir shoreline and within the Wave Impact Line, resulting in an unacceptably high safety risk.

Although alignment 5 has a higher cost than alignment 3, alignment 5 was selected as the preferred option because it:

- utilizes a portion of the existing Millar Road alignment and therefore has lower private property effects;
- has lower field footprint and a relatively small forested land footprint, resulting in lower potential wildlife effects;
- requires no in-stream works and therefore is associated with minimal aquatic or riparian habitat effects;
- has lower potential for wildlife crossing; and
- has lower potential agricultural effects.

A short bridge is preferred over a long bridge due to lower capital and maintenance costs.

Legend

- Alignment 1
- Alignment 2
- Alignment 3
- Proposed Reservoir
- Road
- Highway
- Railway

Map Notes:

1. Datum: NAD83
2. Projection: UTM Zone 10N
3. Base Data: Province of B.C.
4. Orthophotos created from 140,000 photos taken Sept. 10th 2007, 120,000 taken June 12th/13th 2007, and 15,000 taken Sept. 6th 2007. 8m
5. Proposed reservoir area (461.8m maximum normal elevation) from Digital Elevation Models (DEM) generated from LIDAR data acquired July/August, 2006

Scale: 1:50,000

Scale Bar: 0 to 2 Km

North Arrow: S

Map Information:

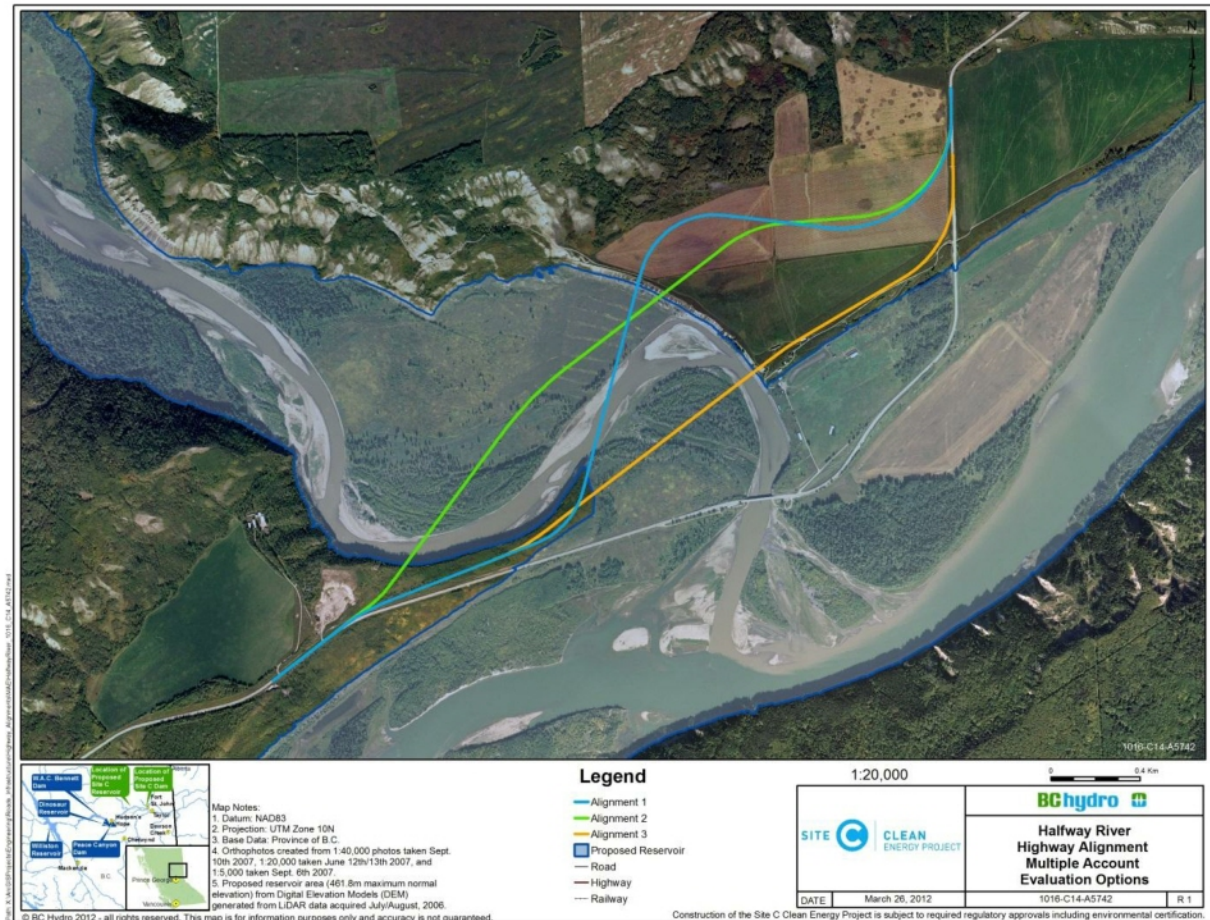
SITE C	CLEAN ENERGY PROJECT	BC Hydro	
		Lynx Creek Highway Alignment Multiple Account Evaluation Options	
DATE	March 26, 2012	1016-C14-A5741	R 1

Construction of the Site C Clean Energy Project is subject to required regulatory approvals including environmental certification.

5.1. Alternatives and Considerations

An overriding concern at Halfway River is the potential effect of a landslide induced wave on a bridge and its support structures. For each of the alternatives the costs of mitigating the effects from the impact of a landslide induced wave are included in the capital cost estimate.

Figure 4: Halfway River Potential Alignments



5.2. Evaluation of Alternatives

A preliminary MAE was also conducted for Halfway River. Only the long bridge option for alignment 2 was eliminated because its cost was significantly greater than for any other option. Further engineering was done on the remaining options and a final MAE was then conducted.

Alignment 3 was selected as the preferred alignment because it has a good balance between environment and social indicators and the lowest overall cost. Alignment 3 has:

- the lowest area of in-stream works;
- no private property impacts;
- no agricultural land severance; and
- relatively lower loss of Agricultural Land Reserve (ALR) land.

A short bridge is preferred over a long bridge due to lower capital and maintenance costs.

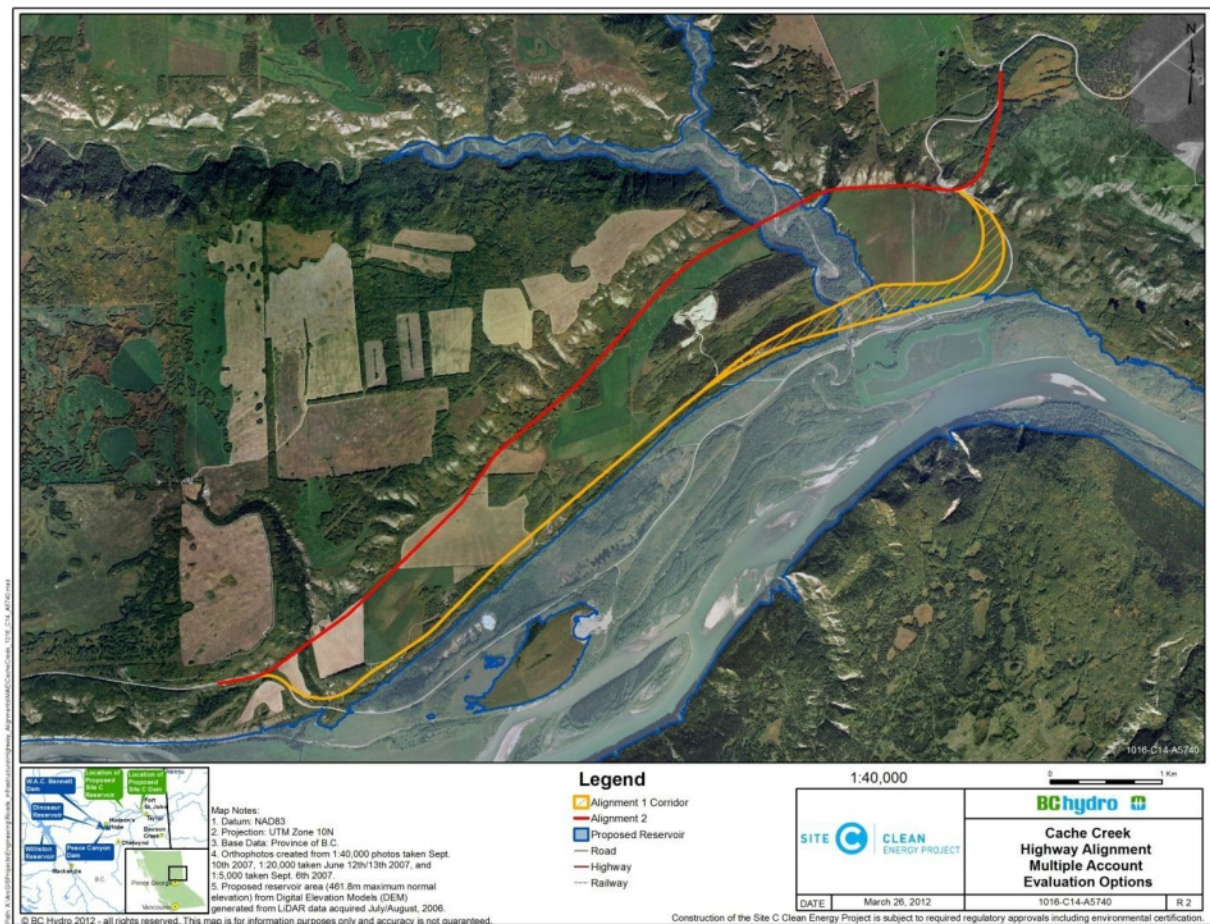
6. Cache Creek

6.1. Alternatives and Considerations

At Cache Creek approximately 9 km of highway would require re-alignment. During Stage 2 two alignment concepts were considered. In Stage 3 the alignments were updated to current standards for safety and reliability. One alignment follows the future reservoir shoreline and the other traverses the valley escarpment (Figure 5).

The escarpment at the edge of the valley is known to be unstable and is prone to sliding and sloughing.

Figure 5: Cache Creek Potential Alignments



6.2. Evaluation of Alternatives

Alignment 2 has significantly greater technical challenges than alignment 1 due to the unstable escarpment that alignment 2 follows. This results in substantially higher costs and construction risks. Alignment 1 also has:

- lower area of private land impacted;
- significantly less length of actively farmed land severed; and
- less area of Agricultural Land Reserve (ALR) land needed for the right-of-way.

Alignment 1 with a short bridge was selected as the preferred alignment.

It should be noted that several routing refinements are possible with alignment 1 and that participants selected it as a preferred corridor.

7. Summary and Conclusions

The options selected as preferred alignments are:

- Lynx Creek – alignment 5 with a short bridge;
- Halfway River – alignment 3 with a short bridge;
- Cache Creek – alignment 1 corridor with a short bridge.

Appendix 1: Participants in MAE Meetings

Lynx Creek and Halfway River Preliminary MAE, July 28, 2011

BC Hydro:

Environment - Anne McIntosh

Socio-Economics – Erin Harlos

First Nations Engagement - Seanna McConnell

Properties - James Thomas, Randy Wenger

Facilitator – Al Strang

Integrated Engineering Team: Don Wharf, Alex Izett, John Bodnarchuk, Sarah Simon, Robin Taylor, Joe Shook, Barry Bergstrom, Allison Mason

MOTI: Bill Eisbrenner; Don Shaw; Greg Woollacott; Ed Cienciala

R. F. Binnie & Associates: Gordon Wagner; Edoardo Ballarin

MMM Group: Jianping Jiang

AMEC: Nick Polysou

Lynx Creek, Halfway River and Cache Creek Final MAE, October 28, 2011

BC Hydro:

Environment - Anne McIntosh

Socio-Economics – Dave Hunter

First Nations Engagement - Seanna McConnell

Properties – Judy Reynier, James Thomas

Facilitator – Al Strang

Integrated Engineering Team: Don Wharf, Alex Izett, John Bodnarchuk, Sarah Simon, Robin Taylor, Joe Shook, Barry Bergstrom, Andre Fillion, Larry Louis, Marina Matic

MOTI: Tony Bennett; Don Shaw; Greg Woollacott; Gord Hunter; Bert Van Mook

R. F. Binnie & Associates: Gordon Wagner; Edoardo Ballarin; Maurizio Ponzini

MMM Group: Jianping Jiang

AMEC: Nick Polysou; Jamie Ford; Libor Michalak; George Der

Northwest Hydraulics: Des Goold