McCullough Research

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Principal

Date: November 22, 2017

To: PVLA and PVEA

From: Robert McCullough

Subject: Would You Still Build Site C? Impact of Site C Decision on Present and Future Ratepayers

In the 1980s British Columbia Hydro made the rounds of the major utilities in the Pacific Northwest – both in Canada and the U.S. – and sought a buyer for Site C. They found no takers. I know, since as an executive at Portland General Electric I helped turn down the opportunity.

The problem with Site C has always been cost. It simply was more expensive than other alternatives. This is still true today.

Over the past decade the previous Liberal government decided to proceed with the project.

In 2008, the world was different: oil and natural gas prices were at all-time highs, renewables were expensive and unreliable, and options were few. The government's enthusiasm led them to believe no regulatory review was needed. This was an understandable mistake – few of us are prepared for massive economic changes until they actual present themselves at one's door. The previous Liberal government of British Columbia was astonished when conditions changed. Importantly, this still did not trigger a regulatory review by the British Columbia Utilities Commission (BCUC). Like corset manufacturers a century ago, they could not conceive of a future without corsets. Today of course, you do not see many corsets and – as the premier of Quebec said recently – we will not be seeing many new hydroelectric projects either.

The Liberal government lost the recent election and the new NDP government requested a regulatory review by the BCUC. As expected, the basis for Site C – roughly ten years behind the

times – fared poorly at the BCUC. Newer facts suggest different alternatives and offer new alternatives that are better, cheaper, and more deployable.[1]

The Site C Inquiry Process:

On August 3, 2017, Premier Horgan's government gave the British Columbia Utilities Commission an impossible charge. They were to review the then $8 billion Site C project (now the $10 billion site C project) in three grueling months.[2] Previously, little information was available about Site C. The calculations were opaque and idiosyncratic; the underlying forecasts confidential; and the cost components unknown outside the Crown Corporation.

The BCUC's first step was to assign the fact finding to the well-respected Deloitte firm which did an excellent job. Their first report clarified the morass the project was sinking into – identifying a likely year delay and the presence of massive cost overruns. Never has a prediction been so immediately validated when BC Hydro announced the delay of the river diversion and an additional $610 million cost overrun.[3]

The Commission held many public meetings, two days of expert presentations, gave a preliminary report, and considered thousands of pages of materials presented by British Columbia Hydro and other parties.

On November 1st my staff and I started reading the two hundred and ninety-nine-page Final Report. To put it mildly, we were impressed. Actually, we were more than impressed. The Commission had digested and reviewed the thousands of pages of submissions, winnowed the wheat from the chaff, and made some courageous decisions.

The Commission's final report is two hundred and ninety-nine pages long and addresses many different points raised in this proceeding. Overall, the Commission and their staff have earned an excellent grade for work under a debilitating schedule. Our testimony contributed to the final report in a variety of ways. The Commission accepted some of our comments and rejected others – as is completely appropriate. The result is that the BCUC sees no compelling reason to continue

[1] Deployable means that the lead time from need to completion are short – one to two years – not the ten years of a major hydroelectric project.
[2] BCUC. Site C Inquiry process. <http://www.sitecinquiry.com/inquiry-process/>
[3] Deloitte. Site C Construction Review. September 8, 2017. Page 2

with this $10 billion-dollar project.[4] Many of their decisions are conservative, erroring on the side of caution, but this is also appropriate. Subsequently issued errata are understandable given the timelines and correct minor errors which do not change the overall findings.

While the Commission did not make a formal recommendation, a careful review of the Final Report makes it clear that termination of Site C is less expensive and less risky than the alternatives. The actual content of the full report makes that very clear.

The BCUC states that:

1. Site C is over budget and behind schedule. The BCUC estimates costs are now at $10 to $12 billion.[5]
2. BC Hydro's load forecast is highly doubtful and the BCUC has recommended the use of the low forecast.[6]
3. The export assumptions are unrealistic. Again, the BCUC has recommended a much lower forecast.[7]
4. Wind, solar, and geothermal are realistic alternatives. Prices have declined significantly and will continue to fall.[8]
5. The alternative resources cost less and are more deployable.[9]
6. BC Hydro's planning methodology is undocumented and inaccurate.[10]
7. There is an excellent source of hydro-electric storage in the non-treaty storage agreement -- 25 times the storage of Site C.[11]

The balance of this report provides an overview of the key considerations in reaching a decision on whether or not to build Site C including Site C construction cost, opportunity cost of building Site C, electricity demand outlook, cost of alternatives, back-up storage, rate impacts, and credit ratings.

This is not a replacement for our more detailed submissions on these issues or the findings of the BCUC. At the end of this report you will find links to our more detailed assessment and submissions on these issues.

[4] Final BCUC Site C Report, Executive Summary, page 7.
[5] Ibid. Page 113.
[6] Ibid. Page 77.
[7] Ibid. Page 94.
[8] Ibid. Appendix A. Page 10-79
[9] Ibid. Appendix A. Page 25-70
[10] Ibid. Page 77.
[11] Ibid. Appendix A. Page 32.

Site C Costs:

Site C has experienced a rapid run-up in cost. This is consistent with hydroelectric projects elsewhere in Canada and throughout the world. Projects in Manitoba and Newfoundland are likely to hobble their economies for years to come. The experience in British Columbia is following a similar path:

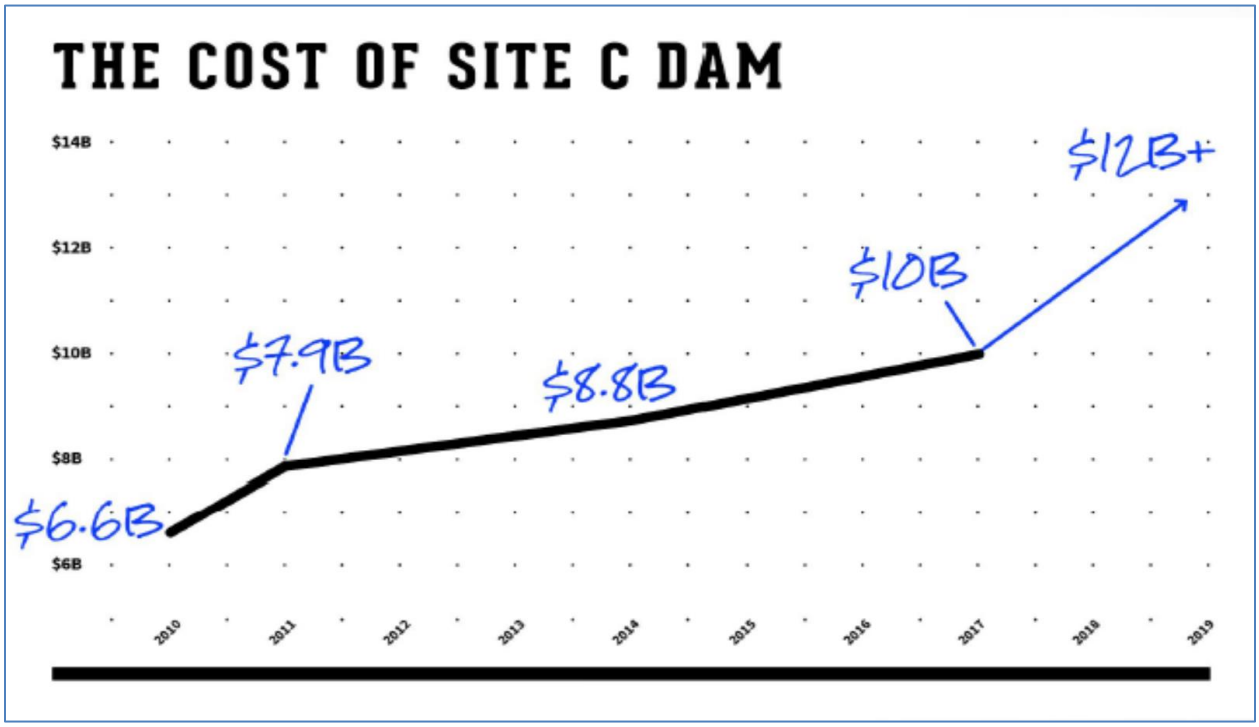

Figure 1: Historical estimated cost of the Site C dam and possible total cost in blue.[12,13]

[12] Vancouver Sun. Tab for Site C dam could hit $6.6 billion. 5 December 2007.
[13] Bennett, Nelson. "Editorial: Cost uncertainty a Site C certainty | Mining & Energy | Business in Vancouver". Biv.com.

There is a type of statistics called Bayesian Statistics named after a little-known cleric of the 18th century. He argued that the correct statistical approach was to update our forecasts as new information became available. This is what we have done here. BC Hydro argued that the cost was $8.8 billion until the BCUC review. During the BCUC review, Deloitte pointed out that it was very likely that Site C would miss a critical step in their time table. Soon afterwards, BC Hydro admitted that this was correct and the cost increased $600 million. As the BCUC has commented, the number of adverse announcements so soon in the project's construction indicates a probability that other delays and cost overruns are likely.[14]

Opportunity Cost:

Ten to twelve billion dollars seems like a large number. It is a large number. Many people find such a number inconceivable. Action movies often show a briefcase full of dollars. Ten to twelve billion dollars is a warehouse of such briefcases.

Economists call this "opportunity cost". What opportunity have we lost be pursuing Site C?

My staff has worked hard to put this number in a context that most of us can understand. For example, how many major hospitals can you build with this sort of money?

14 Ibid. Page 108

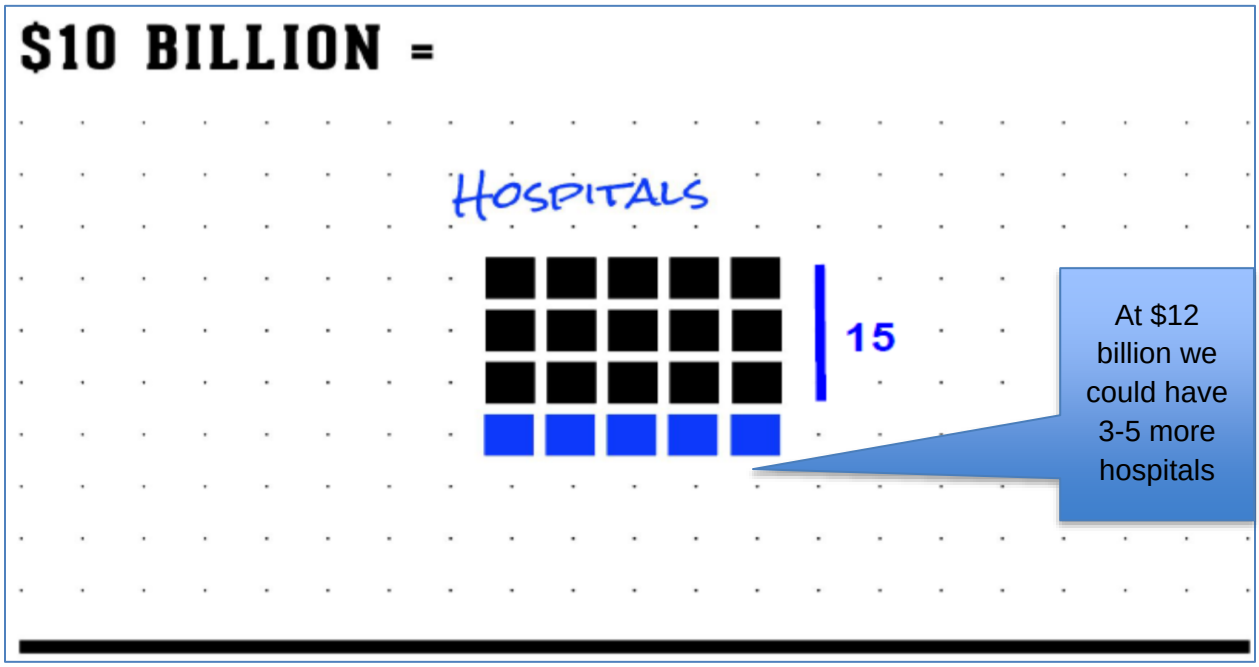

Figure 2: The number of hospitals we can build at a cost of Vancouver's Teck Acute Children's Hospital ($700M in $2017)[15]

15 Government of British Columbia. New Teck Acute Care Centre for B.C.'s Children Moves Forward. May 9, 2014. <https://news.gov.bc.ca/stories/new-teck-acute-care-centre-for-bcs-children-moves-forward>

This is the termination bonus that British Columbia will receive if we cancel Site C. We could have the opportunity to build 15 to 20 major hospitals.

To approach the issue from a different direction:

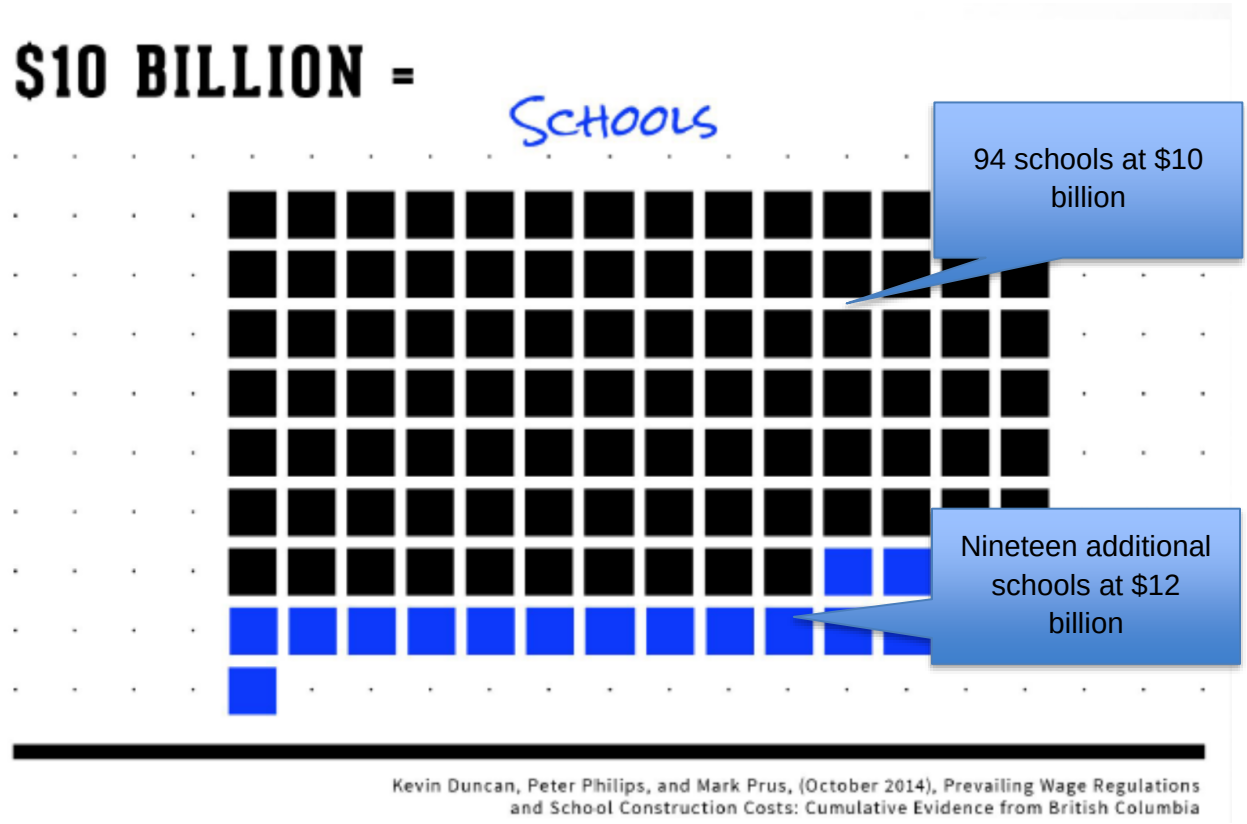

Figure 3: Number of high-end primary or secondary schools that could be build for Site C's estimated cost.[16]

16 CBC. B.C. to build controversial new high school in New Westminster. June 6, 2016.

This tells us that the opportunity cost of Site C is 94 schools with potentially 19 additional schools if Site C costs the province $12 billion dollars.

Another reasonable use for the termination bonus the province receives by not building Site C is 25,000 to 30,000 homes in the Vancouver area:

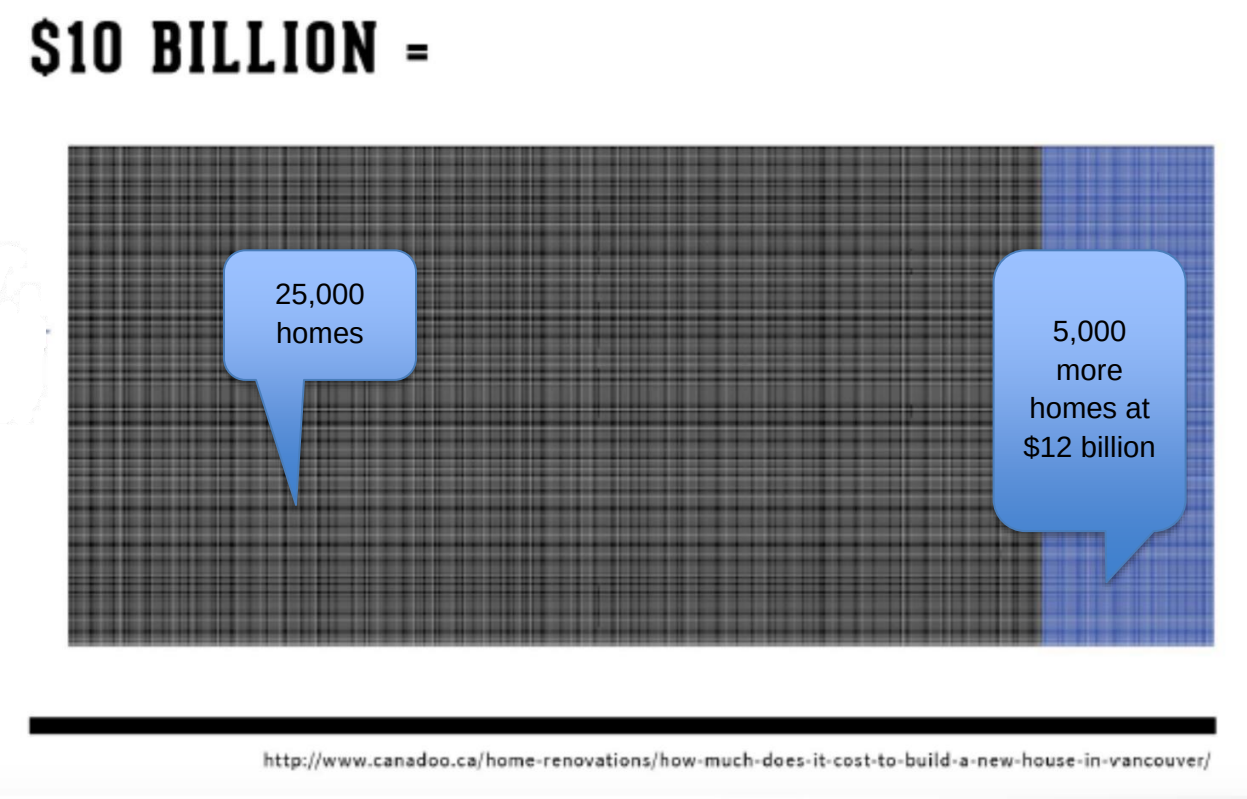

Figure 4: Number of homes that could be built at $230/ft^2.[17]

The bottom line is that this is an enormous foregone opportunity for an unnecessary hydroelectric project.

Something easier to visualize is the number of public works projects we could build with the money:

17 Times Colonist. B.C. wildfires fanning construction costs on Vancouver Island. August 5, 2017.

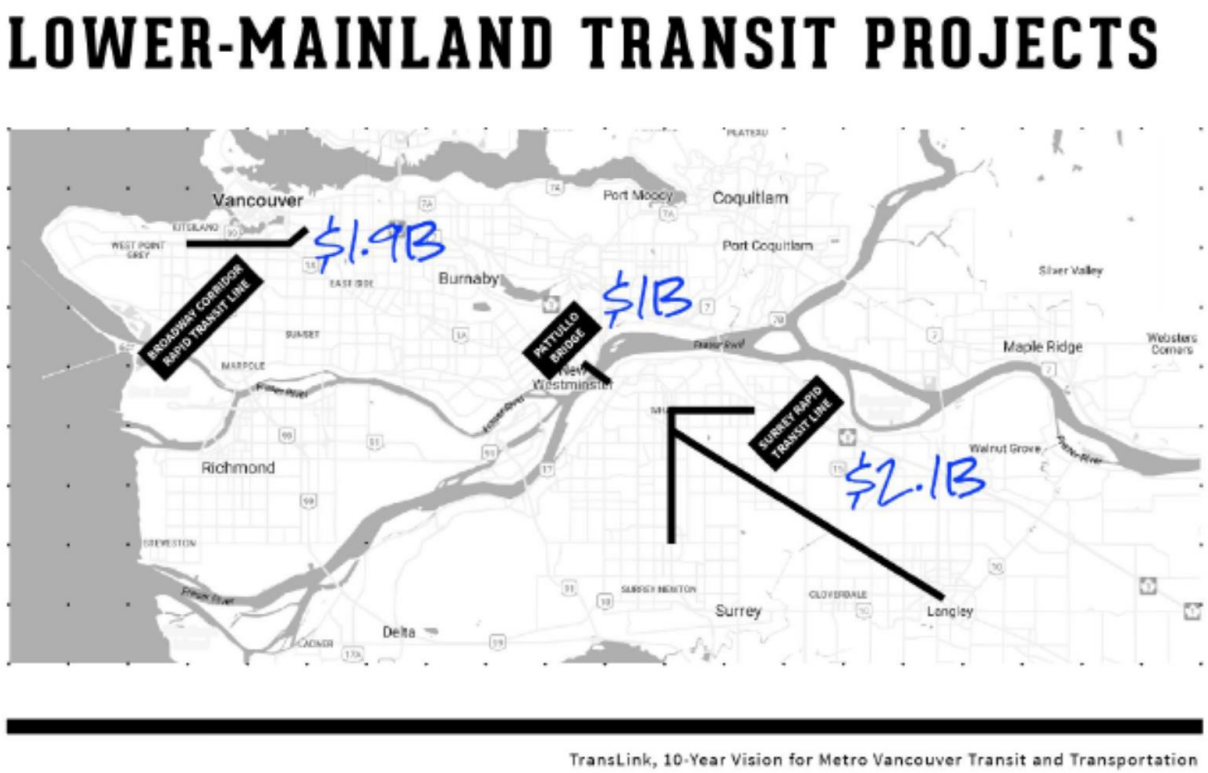

Figure 5: Translink's requested upgrades to Vancouver's transit system and the estimated cost of those upgrades.[18]

So why are we building Site C?

The answer we found during the Site C inquiry is that BC Hydro load forecasts have frequently predicted an exaggerated growth in electric demand and the current BC Hydro load forecast is no different:

18 Translink. 10-year vision for Metro Vancouver Transit and Transportation.

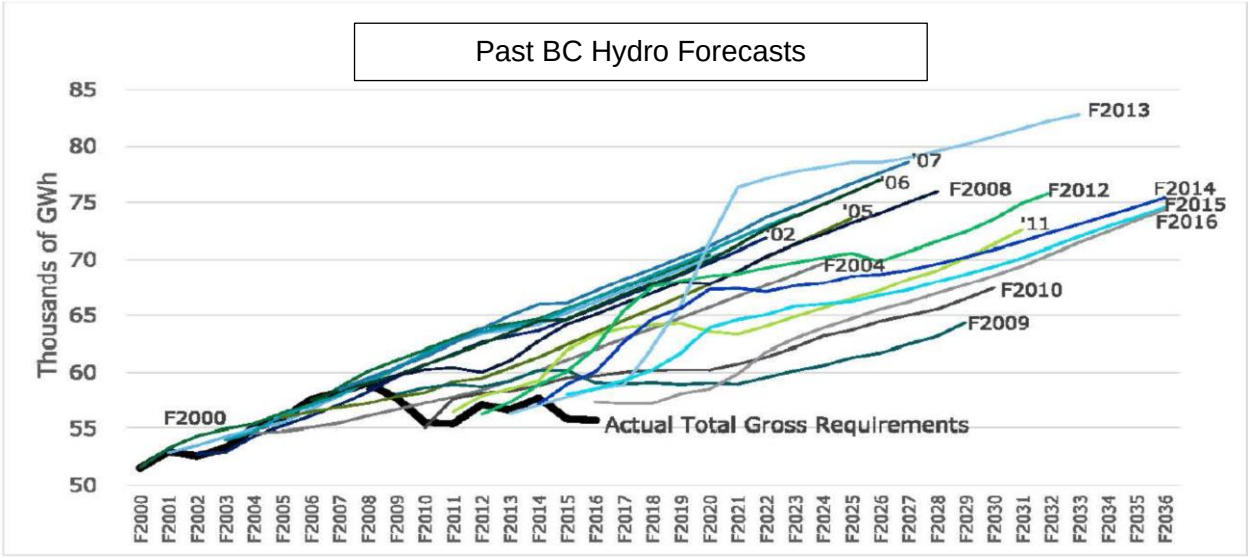

Figure 6: BC Hydro's historical load forecasts. Note that nearly all of them grossly overestimate electricity requirements.[19]

The problem is that almost all North American utilities are experiencing very little load growth – generally as a result of demand management programs and new technology. One particularly important new technology is the LED luminaire (Technical talk for light bulb). The LED bulb produces 100% of the light for 10% of the energy.

BC Hydro's proposed load forecast looks a bit like a hockey stick – where the last decade is flat – the blade – and the forecast is the stick:

19 Deloitte. Site C - Alternative Resource Options and Load Forecast Assessment. September 8, 2017. Page 63.

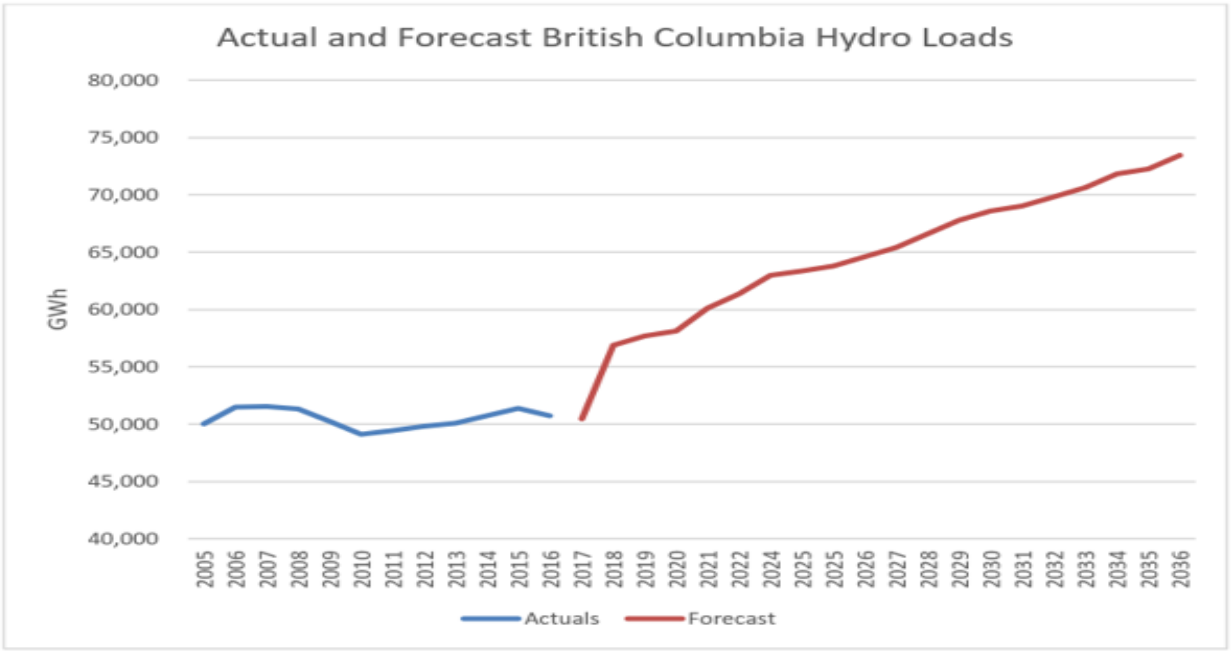

Figure 7: BC Hydro's mid-forecast and actual historical load.[20]

The BCUC developed a more realistic demand forecast based on the extensive evidence before it, as well as an alternative portfolio which initially focuses on increased demand side management (energy conservation) followed by deployment of wind power. It is now clear that new power infrastructure is not needed until 2037, 13 years later than the projected completion date for Site C.

Competitive Resource Prices Have Fallen Precipitously:

Even worse news for Site C is that the prices of the alternatives – significantly wind and solar – have declined precipitously. Lazard, a Wall Street investment firm publishes actual resource costs for a variety of resources. These numbers are not forecasts. They reflect actual transaction for each year since 2006. The decline in renewable prices is surprising. And importantly, if increased demand beyond the BCUC approved load forecast does materialize, lower cost renewables can be easily deployed and sized to meet the additional demand.

20 McCullough Research. What we have Learned about Site C. September 13, 2017. Page 29.

Since 2010 the cost of solar has fallen 87% and the price of wind farms has fallen 66%:

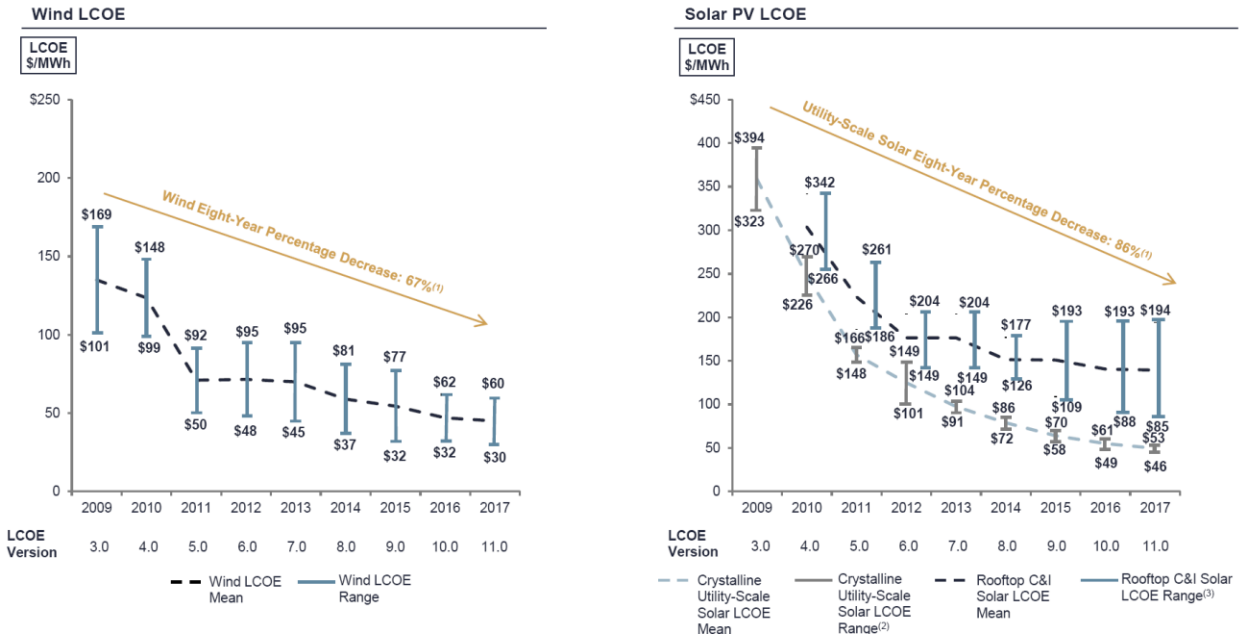

Figure 8: Lazard LCOE cost for wind and Solar.[21]

Why not replace Site C with Canadian Entitlement to Non-Treaty Storage that has already been paid for?

An important conclusion from the BCUC Inquiry is that while Site C is not the best choice, the presence of the Canadian Entitlement means that there is no reason to choose. The arrangements between the U.S. and Canada concerning existing hydroelectric dams and reservoirs mean that we can already depend on deliveries from the U.S. of Canadian hydro from Canadian reservoirs that are larger than Site C.

An even better option is to use the additional non-treaty storage in Canada that is not committed to the Canadian Treaty.

The non-treaty storage at the Mica Dam is considered an attractive option for shaping alternative energy sources:

21 Lazard. LCOE analysis 5.0-11.0. March 2010-November 2017. Page 11.

> The Panel also notes McCullough's evidence regarding the additional storage at the Mica dam that has been sold to Bonneville Power Authority under a contract expiring in 2024, and that it could subsequently be used by BC Hydro to meet domestic needs (provided its use does not reduce CRT flood control and power benefits).[22]

And further:

> …the Panel considers that the additional Mica storage may have the potential to reduce the PV cost of the Illustrative Alternative Portfolio. [23]

The BCUC concludes that Site C is not necessary to help shape an alternative portfolio.

> The Illustrative Draft Alternative Portfolio includes 444 MW (low load forecast) and 591 MW (high load forecast) of wind generation. BC Hydro states that Site C (capacity 1,145 MW) can integrate 900 MW of wind. However, the Panel notes that BC Hydro's existing modest level of wind penetration (780 MW) and high levels of hydro generation providing reserves (GM Shrum, Mica and Revelstoke with a combined capacity around 8,000 MW) means that BC Hydro would not be expected to need Site C to integrate these additional wind farms.[24]

The storage at Site C is only 4/10ths of one percent of the storage at the nearby Williston Dam. A far better source of storage is the Non-Treaty Storage that BC Hydro currently provides to the Bonneville Power Administration for a very minor recompense.

Rate Increases:

Site C is a massive investment with equally massive rate impacts. The alternatives range from a zero impact – use of existing Canadian Entitlement energy and capacity – to small increases – Demand Side Management programs with additional wind resources:

22 Final BCUC Site C Report. November 1, 2017. Appendix B. Page 7.

23 Final BCUC Site C Report. November 1, 2017. Appendix B. Page 7.

24 Final BCUC Site C Report. November 1, 2017. Appendix A. Page 32.

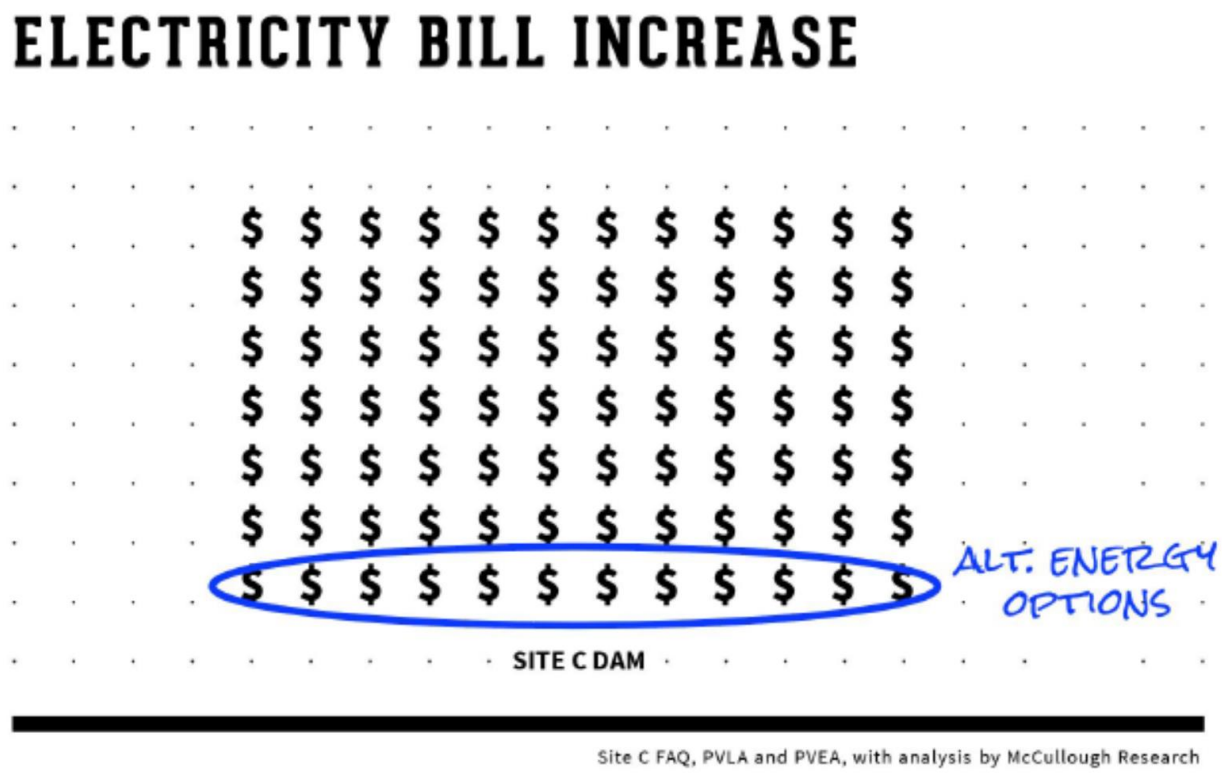

Figure 9: The cost to supply BC with renewable electricity is significantly less than the cost to construct Site C.[25]

Recently, British Columbia Hydro has argued for the need for a ten percent rate increase to pay for Site C costs already incurred and the costs of reclamation.[26] The rate increase is both unjustified – literally – and inconsistent with the BCUC's analysis. It is important that while BC Hydro may be recommending this as an attempt to justify Site C, the rate increase is subject to the BCUC's approval.

At the heart of this debate is the amortization period for Site C investments. BC Hydro has argued that the Main Civil Works be amortized over seventy years unless, of course, they are stopped now. If stopped, they argue that the amortization period should be reduced to ten years. In the detailed analysis of the British Columbia Utilities Commission, an amortization period of thirty years was used:

25 BCUC Final Report. November 1, 2017. Appendix A.

26 The proposed rate increase only represents the first year of the amortization period. In year ten and thereafter, their proposed rate increase would fall to 0%.

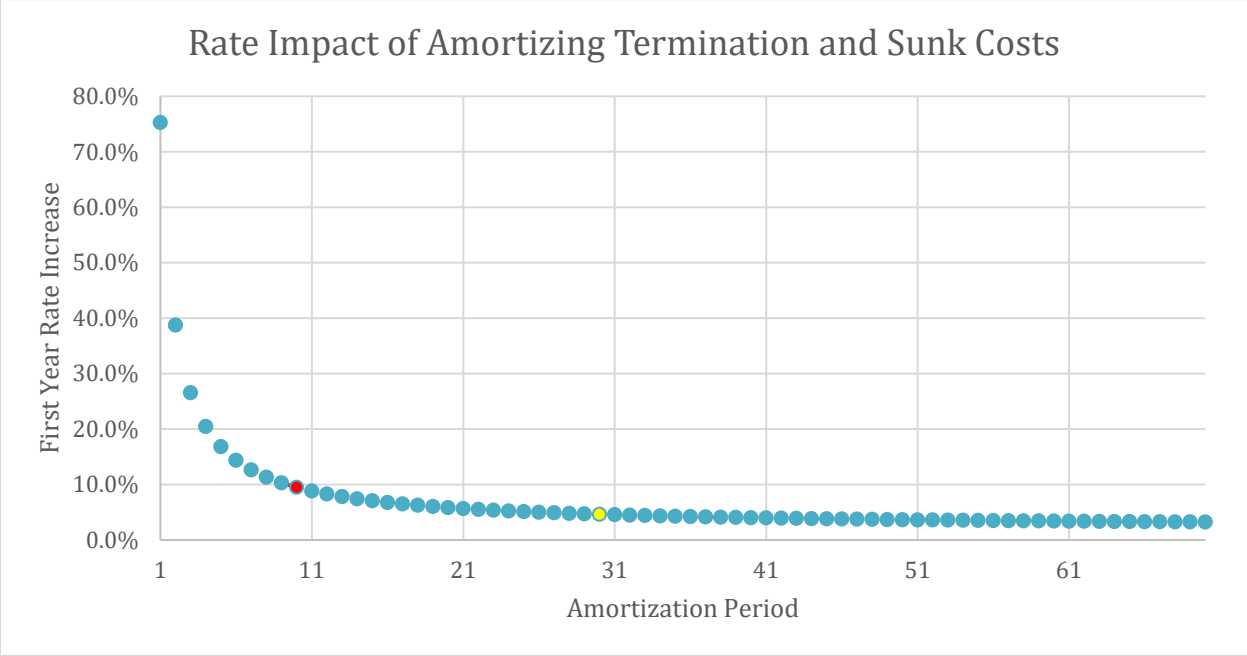

Figure 10: The potential electricity rate increase from sunk costs on Site-C depending on how soon BCH wants to pay off the debt. See explanation below.

The chart above shows the impact of this arbitrary assumption. BC Hydro feels that the first-year rate increase should be increased to 9.5% in the first year from the 4.6% assumed in the BCUC studies. Their assumption is shown by the red dot on the chart above. The BCUC's assumption is shown by the yellow dot. And, of course, if the same costs are recovered if Site C is continued, the first-year rate recovery is assumed to be 3.2%.

One expert recently remarked that if BC Hydro wants to punish its customers by choosing the less costly alternative resources, they should request a one-year recovery period to inflict a bruising 75.3% rate increase. Luckily, such an outlandish threat would be subject to the approval of the BCUC which would require a more temperate response.

Jobs and More Jobs:

A common misconception about cancelling Site C is that we'll lose construction jobs. The reality is that while some of the construction jobs will end on Site C, more than twice the person years of employment will be created with investment into alternative energy projects across the province.

Most renewable projects require additional employment over the life of the project. Evidence from a variety of studies indicates that the job impacts are likely to be considerably greater from the alternative case designed by the BCUC than Site C:

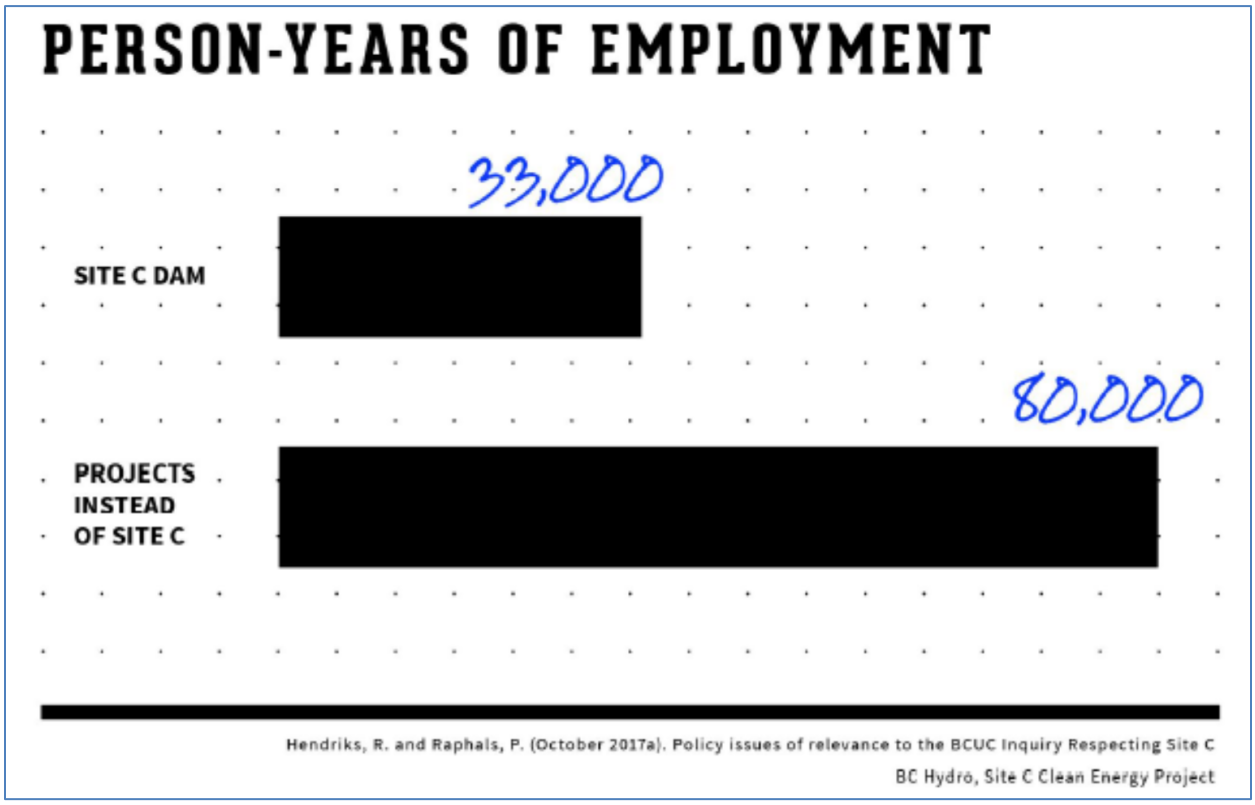

Figure 11: We can employ far more people for far less than the cost of Site C. All of the examples below come from the BC government's list of public projects.[27]

The Red Willow Wind Farm near Tumbler Ridge is proposed to bring 300 construction jobs at a cost of $480 million to build.

The Deltaport terminal road and rail upgrade that is currently underway has created 400 construction jobs for a cost of $280 million.

The proposed Sooke wind project will bring 300 construction jobs at a cost of $750 million.

27 Government of British Columbia. BC Major Projects Inventory. See column W ("CONSTRUCTION_JOBS") under sheet "FULL_DATA". https://www2.gov.bc.ca/gov/content/employment-business/economic-development/industry/bc-major-projects-inventory

The Fairview Container Terminal expansion project, currently underway in Prince Rupert, has created 3000 construction jobs for a building cost of $200 Million.

And the Penticton hospital redevelopment has brought almost 2000 construction jobs to the area with a project cost of $312 Million.

These 5 projects provide far more construction jobs Site C has created for a fraction of the investment.

This not only provides more jobs, but it also means jobs for a wider range of specializations, rather than just in energy and resource development.

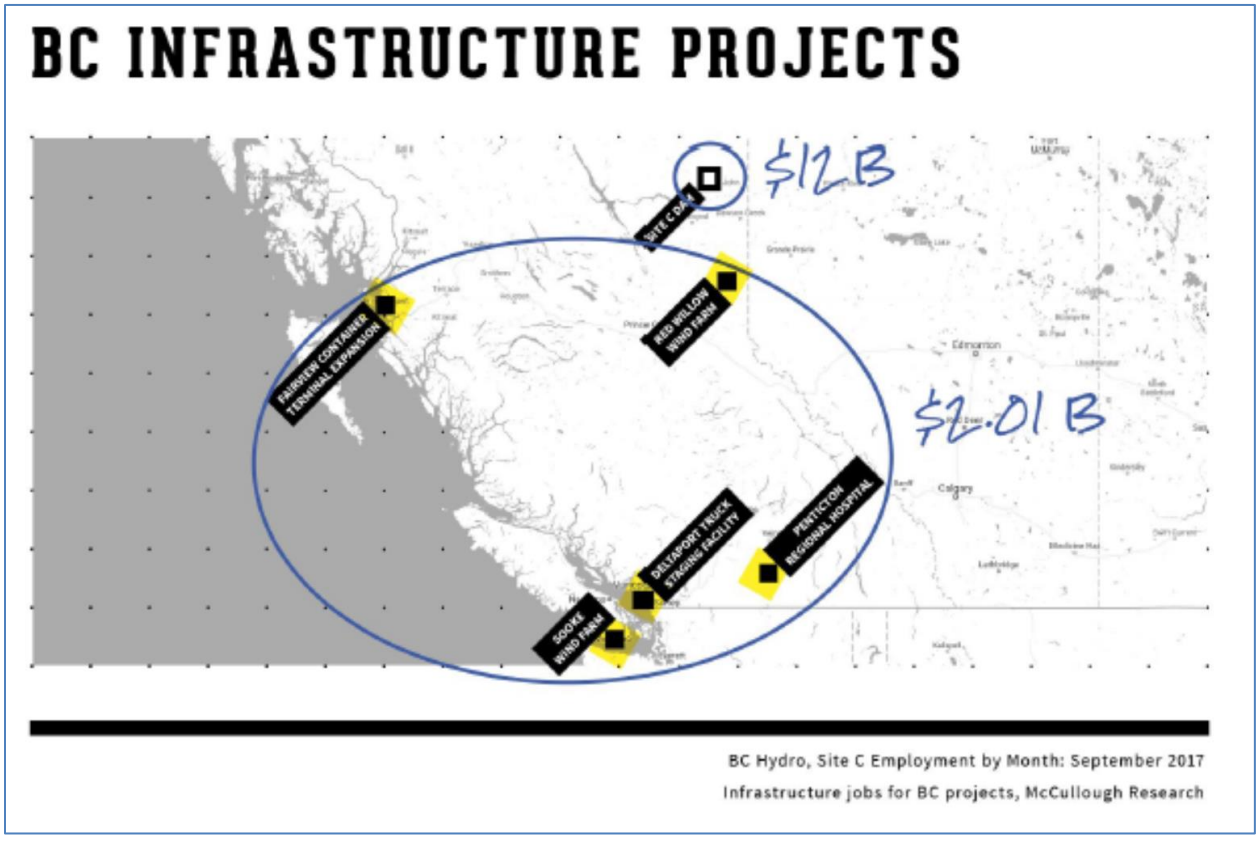

Figure 12: Location of the public works projects listed above with their total cost at right.

Rate Impacts:

The calculation of rate impacts can be daunting. A good way to start is to realize that the $2.1 billion actually spent is spent. Nothing we can do can recover the $2.1 billion dollars. The going ahead cost of Site C is $10 billion minus the $2.1 billion already spent.

The decision to terminate Site C exposes the province to an additional $1.8 billion in reclamation and contract termination payments. This is an actual cost that must be paid for the alternatives to Site C.

The difference between $7.9 billion (Site C) and the sum of the termination payment and the alternative resource costs defines the termination dividend that Site C receives. For example:

The termination dividend for the low load forecast case (the case deemed most likely by the BCUC) is equal to $10 billion minus the $2.1 billion in sunk costs minus the $1.8 billion in termination costs and minus $1,995 billion in alternative resource costs. The termination dividend to British Columbia is $4.5 billion.

The following table displays the termination dividend for each of the load forecast scenarios.

Comparison of Alternatives:								
			Commission Scenarios					
	Site C		**Low LF**		**Medium LF**		**High LF**	
Original Cost	**$**	**8,775**						
Plus, Cost Overrun	**$**	**1,225**						
Minus, Sunk Costs	**$**	**(2,100)**						
Cost of Continuation	**$**	**7,900**	**$**	**1,995**	**$**	**3,253**	**$**	**3,522**
Termination Cost			**$**	**1,395**	**$**	**1,395**	**$**	**1,395**
Actual Cost	**$**	**7,900**	**$**	**3,350**	**$**	**4,648**	**$**	**4,917**
Termination Dividend			**$**	**4,550**	**$**	**3,252**	**$**	**2,983**

These are conservative scenarios. If, as we recommend, the Canadian Entitlement or the Non-Treaty Storage is used to replace Site C, the cost of the alternative scenarios is vastly less.

Credit and Prudence:

British Columbia has recently confirmed its AAA credit rating due to its strong financial management, its strong economy, and its record of balance budgets.[28] There will be no credit downgrade if Site C is cancelled. This is because British Columbia has the financial strength to deal with the $3.9 billion in cancellation costs. Continuing a single project that could add $12 - $15 billion dollars to the province's debt is the greater risk to credit ratings.

It will be far better to show fiscal prudence by not spending on Site C as opposed to the massive borrowing that Site C implies.

Conclusion

The evidence is clear that it is not in the best interests of present and future ratepayers to build Site C.

BACKGROUND

McCullough Research Submissions to Site C Inquiry:

F35-2	PVLA and PVEA	August 30, 2017
F35-3	PVLA and PVEA	August 30, 2017
F35-5	PVLA and PVEA	September 13, 2017
F35-6	PVLA and PVEA	September 21, 2017
F35-7	PVLA and PVEA	September 27, 2017
F35-8	PVLA and PVEA	September 27, 2017
F35-9	PVLA and PVEA	September 28, 2017
F35-10	PVLA and PVEA	September 28, 2017
F35-11	PVLA and PVEA	September 29, 2017
F35-12	PVLA and PVEA	September 29, 2017
F35-13	PVLA and PVEA	October 2, 2017
F35-14	PVLA and PVEA	October 11, 2017
F35-17	PVLA and PVEA	October 11, 2017
F35-19	PVLA and PVEA	October 10, 2017
F35-20	PVLA and PVEA	October 14, 2017

McCullough Research Submissions Following the Final Report:

Memorandum to Premier Horgan -Deputy Ministers' Inquiries Respecting Site C - November 16, 2017 -

Site C - Frequently Asked Questions on Site C - November 14, 2017 -

[28] https://www.moodys.com/credit-ratings/British-Columbia-Province-of-credit-rating-622300