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Project Title:	Site C Clean Energy Project		
SAP Project #:	YM-80004	**Project Manager:**	[redacted]

Overview of 2014 Site C Cost Estimate Methodology and Approval

Prepared by:

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Commercial Manager - Site

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Note: This document was prepared in order to provide an easily-accessible overview of the 2014 Consolidated Cost Estimate. This document should not be considered as a replacement for the original source documentation on the cost estimate. Appendix 3 identifies the key source documentation and provides hyperlinks for ease of use.

1. Background

1.1. 2007 Cost Estimate

As part of Stage 1 work, in 2007 BC Hydro cost estimating produced a preliminary interim cost estimate. This 2007 estimate was based on a previous detailed, bottom-up, estimate published in 2003 (known as the "Red Book"). The Red Book was based on a historic design of the project developed over the 1989-90 period.

For the 2007 estimate, the Red Book estimate was escalated based on changes in market conditions in the interim period. A financial model was developed to estimate inflation and interest during construction using the red book direct costs.

The interim project cost estimate based on the Red Book was provided as a range from $5.0 to $6.6 billion. The range was based on uncertainty in market interest rates and the size of project reserve that would be applied to the project.

1.2. Partially Completed 2009 Estimate

As part of the deliverables for Stage 2 of Site C, BC Hydro began developing an updated cost estimate. This estimate was a bottom-up estimate primarily based on then-current market prices and quantities provided by the design team. The design, in-turn, was based on the 1980s historical design with added features (such as anchoring) to mitigate rebound and slope stability concerns that had been identified over the intervening years.

Partway through preparation of the 2009 cost estimate the Site C Engineering Team made a recommendation that a refined and updated design was required to meet current seismic, safety and environmental guidelines and to incorporate input from consultation. An optimized design was expected to produce a design solution that would provide a better balance between risk, cost and environmental considerations.

Based on this pending design optimization process, BC Hydro concluded it was not prudent to continue with the 2009 cost estimate as it would have been completed on a design that BC Hydro was no longer planning to build. As a result, BC Hydro ceased work on the 2009 estimate until the design optimization process was complete.

1.3. 2010 Capital Cost Estimate

The bottom-up cost estimate for Site C was developed in 2010 by a team of internal and external engineering and construction experts. Direct construction costs were calculated by estimators from the Integrated Engineering Team (IET). Indirect costs such as financing, inflation and reserves were developed by the finance team with support from internal and

external subject-matter experts. The cost estimate includes construction and development costs, mitigation and compensation, community and First Nations benefits, inflation, and interest during construction.

BC Hydro's Site C Estimating Team also completed a Monte Carlo analysis to determine an appropriate level of construction contingency. The analysis determined that a contingency of $730 million was appropriate (18% on direct costs and 10% on indirect costs). In addition, an estimate of an appropriate project reserve to cover risks that would not be expected to be covered by the base cost and/or contingency was developed by BC Hydro and Partnerships BC through a risk assessment and accompanying Monte Carlo analysis. As a result of this analysis BC Hydro recommended establishing a project reserve of $690 million.

The 2010 estimate underwent extensive internal and external peer review. This included a review of direct construction costs by estimators from BC Hydro Generation Engineering. KPMG also verified that the methodology for developing the assumptions and the construction of the financial model were appropriate. The cost estimate was presented to the Board of Directors and BC Hydro was authorized to refer this estimate to Government for approval.

Based on this cost estimate, in April 2011 Government approved $7.96 billion as the capital cost to be included in regulatory filings. This approval removed the project reserve and provided a decreased mandate for First Nations and Community Benefits.

2. 2014 Capital Cost Estimate – Methodology

The Capital Cost Estimate was most recently updated in May 2014. This estimate was led by Alan Le Couteur and the Site C Estimating Team. Refer to Appendix 1 to this memo for the list of estimators and key advisors.

The estimate update was conducted by preparing new estimates for each component of the project, including bottom-up, line-by-line estimates for major work packages. All changes to 2010 key assumptions, quantities and pricing were incorporated into the estimate. The refresh covered the following key areas:

- Quantity and scope changes
- Value engineering savings
- Regulatory schedule changes
- Commodity, labour and equipment prices
- Labour conditions and availability
- Inflation and interest rates
- Properties and all other indirect costs
- Changes to the contract packaging and procurement approach
- Risk management adjustments
- Project Contingency and Project Reserve risks

2.1. Construction Cost Estimate

For estimating purposes the project was divided up into multiple work areas, generally corresponding to the major contract packages identified in the approved 2012 Procurement Approach. These work areas were estimated separately by either the Site C Estimating Team or other Subject Matter Experts. For an overview of the estimating basis for each work area please refer to Attachment 2-A to this memo.

For the two largest work packages (MCW and GSS), estimating work was undertaken in parallel by two estimating teams without coordination between them. Once these estimates were substantially complete, the two teams coordinated to compare estimating results and to arrive at a consensus estimate to carry forward as the base project estimate. This parallel process was intended to reduce the potential for estimating error and to improve the overall quality of estimating assumptions.

2.2. Contingency

In June 2014 a new Monte Carlo model was developed by Site C Estimating with input from relevant Site C teams and BC Hydro Estimating personnel. This Monte Carlo reviewed the potential cost variability associated with each work package due to the following areas of risk:

- Design Uncertainty: Potential variances caused by changes in design prior to procurement, as well as modifications to design required during construction.

- Labour: Potential variances caused by fluctuations in market conditions for labour, turnaround costs, contractor burdens, shift and overtime premiums, and usage of the worker accommodation facility.
- Estimate Accuracy: Potential variances due to changes in crew productivities, materials pricing, contractor overheads, and other factors.
- Markups: Potential differences in contractor profit expectations.

The output from the Monte Carlo model was assessed against the available contingency within the $7.96 billion budget previously announced, and determined that no further adjustments to project contingency were required at this time.

It should be noted that the contingency analysis provided for standard variances associated with normal economic conditions, and does not reflect the full range of potential outcomes in the event of a market shock or other extreme conditions.

2.3. Value Engineering

Through 2013 and 2014 a Value Engineering exercise was undertaken that examined cost saving opportunities throughout the capital cost estimate. This process was led by Site C Finance and included an assessment of savings opportunities and savings were pro-rated based on the likelihood of achieving the underlying scope reductions. At the time of estimate the IET had identified several anticipated design changes likely to result in reductions to the Site C cost estimate, however these design changes had not been formalized in the Definition Design reports. In order to capture the expected impact of these design changes, the Site C Finance team developed and maintained a list of the material anticipated design changes including conceptual-level estimates of anticipated direct cost savings as provided by the IET.

2.4. Cashflow and Loadings

Subsequent to the preparation of the construction cost estimate, the real dollar costs were then cash flowed based on the Project Schedule. The cashflows for each work area were combined in the Site C Financial Model to estimate inflation and interest during construction, and to provide a consolidated Project Cost Estimate. For an overview of key cost adjustments and the methodology for inflation and interest during construction, refer to Attachment 2-B to this memo.

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3. Internal Review and Identification of Key Variances

Components of the cost estimate were reviewed by the Site C team, BC Hydro Generation Estimating staff, and external advisors to validate key quantities and assumptions and to identify substantial variances to the 2010 cost estimate.

During Stage 3, a number of key cost pressures and risks were identified by the team including:

- Clearing quantities
- Site access (roads and construction bridge)
- Construction power and telecommunications infrastructure
- Gated spillway concrete volumes
- Penstock construction costs
- Change in tax law from HST to PST
- Risks with diversion tunnel sizing
- Risks associated with market labour conditions and camp quality

The above cost pressures were to a large extent offset by savings in the following areas

- Significant reduction in size / volumes of RCC buttress
- Significant reduction in left bank excavation volumes
- Removal of additional Spillway
- Reduction in hydro-mechanical costs from Spillway redesign
- Reduced costs for spillway gate redesign
- Optimization of cofferdam cut-offs
- Reduction of construction quantities due to shortening of spillway
- Decrease in auxiliary spillway and approach channel quantities
- Elimination of Project Access Road
- Reductions in forecasted interest expense during construction
- Management of environmental assessment scope

4. Reviews and Approvals

4.1. Third Party Review

Three external peer reviews were successfully undertaken in 2014 of the project's costs and risks.

1. Similar to the approach taken in 2010, KPMG completed a review of Site C's 2014 financial model and capital cost estimate.
2. Marsh Canada was asked to review and comment on the risk management approach and framework put in place by the Site C project. The review was conducted to ensure that Site C's framework aligned with industry best practices in developing the contingency amounts.
3. An additional review of the project's estimate of direct construction costs by a panel of experienced independent contractors was completed in October 2014. The panel was led by Frank Margitan, former Vice President at Kiewit with more than 40 years of experience in management and construction of heavy civil and mining projects.

4.2. Board Approval

The results of the refresh were presented to the Board during cost and risk workshops held in June 2014. The workshops concluded with the following conclusions and recommendations from the project team:

- While there have been cost pressures since 2010, the Capital Cost Estimate remains appropriate and is within the capital cost of $7.96 billion approved by Government for the regulatory filing in 2011.
- $110 million in contingency (out of $730 million available contingency) is notionally allocated to mitigate labour and schedule risks.
- $620 million in remaining contingency is adequate (confirmed by performing an updated Monte Carlo analysis).
- The 2014 refresh did not incorporate the $200 million impact associated with the change in tax law from HST to PST, which requires Government direction on how to proceed.

4.3. Provincial Final Investment Decision

The provincial Final Investment Decision was announced on December 16, 2014 to approve and advance the Site C Clean Energy (Site C) Project to construction. As part of this announcement, the Province also announced:

- An adjusted project schedule with a construction start date of summer 2015;
- An updated project cost estimate of $8.335 billion to account for:
    - the change from HST to PST ($200 million) and
    - the adjusted project schedule ($175 million);
- The establishment of a $440 million Project Reserve, held by the Treasury Board, to account for events outside of BC Hydro's control that could occur over an eight-year construction period, such as higher than forecast inflation or interest rates.

5. Approved Site C Cost Estimate

The total cost estimate approved for Site C is $8,335 million. In addition to this cost, the provincial Treasury Board holds a Project Reserve of $440 million for a total cost of $8,775 million.

A summary breakdown of key component areas of the cost estimate is presented in Table 1.

Table 1 Project Cost Estimate (rounded to nearest $5 million)

Project Cost Estimate Component	Inflation & Contingency Separated (millions)	Inflation & Contingency Distributed (millions)
Dam & Associated Structures	[redacted]	
Power Facilities		
Offsite Works		
Construction Management & Temporary Services		
Total Direct Construction Costs (May 2014 dollars)	**4,470**	**5,695**
Indirect Costs	1,130	1,235
Contingency	680	n/a
Total Capital Costs (2014 real dollars)	**6,275**	**6,930**
Inflation	650	n/a
Interest During Construction	1,405	1,405
Total Construction and Development Costs (nominal dollars)	**8,335**	**8,335**
Project Reserve	440	440
Total Costs including Project Reserve (nominal dollars)	**8,775**	**8,775**

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Appendix 1 – Site C Estimating Team

The 2014 Cost Estimate was prepared in collaboration with a number of subject matter experts and reviewers. Key personnel were as follows:

- [redacted] Original 2010 estimate, materials flows, civil works equipment productivities
- [redacted] Original 2010 estimate, concrete works
- [redacted] Reviewed original 2010 estimate, provided original 2010 estimate of Construction Management and Management & Engineering costs, reviewed and provided input on MCW, GSS, and other estimate elements, prepared updated penstock estimate, developed craneage plan
- [redacted] Reviewed original 2010 estimate, reviewed and provided input on MCW, GSS, and other estimate elements.
- [redacted] Prepared estimate for transmission works, including PCN GIS expansion, 500 kV transmission line and Site C substation
- [redacted] Led development of revised Worker Accommodation estimate, in coordination with SSA and others
- [redacted] Maintained and updated Bill of Quantities, prepared elements of estimate
- [redacted] Incorporated and revised concrete estimate amounts provided by [redacted], developed revised costs for tunnel modifications
- [redacted]: Reviewed and provided input on MCW, GSS and other estimate elements. Developed labour force curves and provided input on cashflows.
- [redacted] Maintained and updated financial model and loadings costs.
- [redacted]: Developed and maintained direct construction costs model, developed contractor indirects for MCW and GSS elements, developed revised contingency model.

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Appendix 2-A – Estimate Methodology – Construction Costs

Cost Component	Estimating Basis
DIRECT COSTS	
Land & Rights – Property Acquisitions Relocations and Rights	• Estimate provided by Site C Properties team based on expected requirements and then-current market rates. • Includes off-setting revenue from sale of surplus properties purchased by BC Hydro that are not required post-construction. These revenues are only for those properties capitalized as part of Site C – not historical purchases.
Land & Rights – Water Rights	• Estimate calculated by Site C Finance team based on water rental rates publicly posted by Comptroller of Water Rights
Land & Rights – Royalties	• Estimate of royalties amounts developed for the major work areas expected to attract royalties • Estimate based on quantities of materials expected to incur royalties, with royalty rates applied based on: o B.C.'s Crown Land Operational Policy: Aggregate and Quarry Materials o B.C.'s Crown Land Operational Policy: Waterpower
Worker Accommodation	• Capital cost estimate prepared by Spiegel Skillen and Associates on the basis of the indicative design prepared by Radloff and Associates. • Operating cost estimate prepared by Radloff & Associates based on database of costs from Alberta-based construction camps, and labour curve as supplied by IET.
Highway Realignment	• Estimate prepared by RF Binnie and Associates on the basis of a unit rate determined based on knowledge of the cost of similar work, applied to the identified kilometer of road.
Clearing	• Estimate provided by BC Hydro Clearing Specialist based on market unit rates applied to clearing requirements determined by field-truthing exercise
Early Works	• Estimate of most early works components developed by Site C Estimating Team based on: o Assessment of market conditions for labour, equipment, and commodities o Procurement via multiple DBB contracts o Detailed bill of quantities, in turn based on the design provided in the Site Preparation Definition Design Report, as well as executed design change notices completed at the time of cost refresh • Estimate of road and bridge construction costs provided by Tetratech based on a 90% Design using unit rates based on information from previous work by MOTI.

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Appendix 2-A – Estimate Methodology – Construction Costs

Cost Component	Estimating Basis
DIRECT COSTS	

Main Civil Works	• Estimate developed by Site C Estimating Team based on:
	  ○ Assessment of market conditions for labour, equipment, and commodities
	  ○ Procurement via a single DBB contract
	  ○ Detailed bill of quantities, in turn based on the design provided in the Main Civil Works Definition Design Report, as well as executed design change notices completed at the time of cost refresh

Generating Station & Spillways	• Estimate developed by Site C Estimating Team based on:
	  ○ Assessment of market conditions for labour, equipment, and commodities
	  ○ Procurement via a single DBB contract with DB elements for components of Balance of Plant
	  ○ Detailed bill of quantities, in turn based on the design prepared for the 2010 Estimate, with modifications based on:
	  ▪ Preliminary design drawings provided by IET
	  ▪ Design change notices completed at the time of estimate refresh

Turbine & Generators	• Estimate by Site C Estimating Team based on quotes obtained during preparation of 2010 cost estimate, adjusted for changes in labour costs, information from model testing, and review of supply and transportation costs.
Transformers	• Estimate by Site C Estimating Team based on quotes obtained during preparation of 2010 cost estimate, adjusted for estimated inflation and escalation over intervening period
Substation	• Estimate provided by BC Hydro T&D Estimating (Sep 16, 2013). • Cost allocation between Site C and rest of BC Hydro as described in T&D Estimating memo.
Peace Canyon 500kV Upgrade	• Estimate provided by BC Hydro T&D Estimating (Sep 16, 2013). • Cost allocation between Site C and rest of BC Hydro as described in T&D Estimating memo.
500 kV Transmission Line	• Estimate provided by BC Hydro T&D Estimating (Sep 16, 2013). • Cost allocation between Site C and rest of BC Hydro as described in T&D Estimating memo.

Miscellaneous Items	• Transmission / power components:
	  ○ Estimate provided by BC Hydro T&D Estimating (Sep 16, 2013).
	  ○ Cost allocation between Site C and rest of BC Hydro as described in T&D Estimating memo.
	• Other components based on identified scope at the time of estimating including high-level adjustments made by Site C estimators
	• Security estimate provided by BC Hydro corporate security

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Appendix 2-A – Estimate Methodology – Construction Costs

Cost Component	Estimating Basis
DIRECT COSTS	
Construction Management	• Estimate based on 2010 Construction Management estimate by Generation Cost Estimating, with adjustments for: ○ CPI Inflation between 2010 estimate and 2014 estimating date ○ Adjustment to timing of spending to reflect updated project schedule ○ Inclusion of ~$15 million cost increase as recommend by advisor during preparation of 2010 estimate (also included in 2010 estimate)

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Appendix 2-B – Estimate Methodology – Loadings and Cost Adjustments

Cost Component	Estimating Basis
INDIRECT COSTS	
Definition & Regulatory Phase (Sunk Costs)	• Majority of costs were sunk at time of estimate, and drawn from Site C cost reports • Remaining costs estimated by Site C Finance based on staffing plan and rates for April 2014 to November 2014
Management & Engineering	• Estimate based on 2010 Management & Engineering estimate by Generation Cost Estimating, with adjustments for: o CPI Inflation between 2010 estimate and 2014 estimating date o Adjustment to timing of spending to reflect updated project schedule
Construction Insurance and Bonding	• Estimate based on 2010 estimate by BCH Corporate Treasury Manager, as confirmed through market sounding exercise with BC Hydro insurance advisor (Marsh)
Regulatory Mitigation and Compensation	• Estimate provided by Site C Finance reflecting based on planned mitigation and compensation scope, based on commitments made in Environmental Impact Statement.
First Nations and Community Benefits	• Amount provided in Mandate from Government. • Details of estimate provided by estimate maintained by Site C Finance, reflecting: o Payments and IDC during construction period, o Present value costs of payments made following the project in-service date.
ADJUSTMENTS FOR UNCERTAINTY	
Contingency	• Amount in budget based on available contingency after adjustments to other costs. • Contingency validated by a new Monte Carlo analysis performed during the 2014 Cost Refresh based on the updated direct costs, procurement strategy, and resulting identified areas of risk. • A separate cashflow was developed for the contingency on each major work package, and included in the overall project cashflow (see below).
Value Engineering	• Estimate based on anticipated design changes and conceptual-level cost estimates as provided by IET. • Individual value engineering estimates were assigned probabilities of the savings being realized, which was in-turn used to calculate the overall expected value of value engineering savings. • Once value engineering estimates had been developed for each work package, they were applied to the project cashflow (see discussion below) by pro-rating monthly payments by the value engineering adjustment.

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Appendix 2-B – Estimate Methodology – Loadings and Cost Adjustments

Cost Component	Estimating Basis
SCHEDULE, CASHFLOW AND LOADINGS	

Schedule	• Schedule was based on approved project schedule as of May 2014
	• Key schedule milestones were:
	  ○ Diversion to occur in 2019
	  ○ First unit in-service in December 2022
	  ○ Final unit in-service in November 2023

Cashflow	• Cashflow for direct costs was determined by the Integrated Engineering Team and reviewed by the Site C Estimating Team. A cashflow forecast was developed for each work package based on identification of the timing of key milestones and components of work using the project schedule. • Cashflow for indirect costs was determined by Site C Finance. A cashflow was developed for each identified cost element using identified shaping functions. • Cashflow is based on expected timing of payments to contractors. This cashflow does not reflect the potential accounting general ledger entry timing (i.e. accrual-based), which may be difference in situations where there is substantial contractor financing and/or advance payments.
Inflation	• Inflation was calculated by the Financial Model based on the cashflows provided by the IET. • Anticipated inflation was based on rates provided by Corporate Finance on the "Common Rates Sheet"
Interest During Construction	• Interest During Construction was calculated by the Site C Financial Model based on the cashflows provided by the IET. • Anticipated interest rates were based on rates provided by Corporate Finance on the "Common Rates Sheet" • Interest During Construction was calculated until specific assets entered service. In-services dates were based on the project schedule.

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Appendix 2-B – Estimate Methodology – Loadings and Cost Adjustments

Cost Component	Estimating Basis
COST ADJUSTMENTS	
Change from HST to PST	• A line-item assessment was performed by Site C Finance and the Integrated Engineering Team on the original cost estimate to determine what amounts are subject to PST. • Applicable PST was applied to the above amounts based on the posted PST rate. • Project cashflow as pro-rated by the total PST adjustment to arrive at post-PST estimates.
Schedule Delay	• The cost of a 1-year schedule delay was calculated as part of a broader analysis for Treasury Board of the potential costs and benefits of a delay to the Final Investment Decision on Site C. • The 1-year delay cost was an indicative estimate based on the project monthly spending rate for staffing and IDC costs, with some adjustments to staffing levels to control costs and additional costs due to disruption. • A 1-year delay was later modelled in the Site C Financial Model, with cashflows for individual work packages adjusted to reflect the delayed schedule and additional direct costs included for periods of delay. This analysis validated the earlier high-level estimate of the cost of a 1-year delay.
Project Reserve	• The Project Reserve was estimated based on advice provided to BC Hydro and the Treasury Board from KPMG on an appropriate level of project reserve to carry on a project like Site C. • This reserve estimate was validated by Site C Finance through an evaluation of several scenarios that would be expected to be covered by a reserve – specifically a) a period of hyper-inflation in construction costs, b) a period of rapid increases in interest rates, and c) a one year delay to the project schedule. • The Project Reserve is a below-the-line estimate – it does not have a cashflow, and includes inflation and IDC. • The Project Reserve in the MEM submissions was $220 million. However, this was increased to $440 million in the final approved cost estimate.

Appendix 3 – Location of Key Analysis Documents

Cost Estimate Summary Memos	LINK
Site C Financial Model	LINK
PST Analysis	LINK
Board of Directors Presentation	LINK
KPMG Review Documents	LINK
Independent Contractor Review Documents	LINK
Final Investment Decision Support Documents	LINK