

Site C Project Review



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Special Advisor to the BC Ministers of Finance and Energy,
Mines and Low Carbon Innovation

October 10, 2020

Minister of Finance
Minister of Energy, Mines and
Low Carbon Innovation

January 27, 2021

Dear Ministers:

Please find my attached report and summary of recommendations as of October 9, 2020, as well as appended supporting material. The review and report are consistent with the Terms of Reference from July 30, 2020.

This report has been prepared for the sole consideration of the Cabinet members of the Government of the Province of British Columbia.

I would like to express my appreciation to the Board members at BC Hydro, the officials and staff at BC Hydro, the Project Assurance Board, the team members at EY and the staff of the Ministry of Finance, and the Ministry of Energy, Mines and Low Carbon Innovation who provided a high level of cooperation and assistance during this review.

I hope this report will assist both of you in your efforts to deliver a successful project.

Your truly,

A handwritten signature in black ink, appearing to be 'Peter Milburn', written in a cursive style.

Peter Milburn
Special Advisor to the BC Ministers of Finance and Energy, Mines and Low Carbon Innovation

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Glossary of Terms

Cost Pressures List: All cost pressure list items are included in the CRA. Work Package Managers and Sub Project Managers identify items that have a cost increase that cannot be accommodated within the work package control budget and may result in funding being required from contingency, as well as cost savings identified that are no longer required within the work package control budget. Generally, items included in the cost pressures list have a **greater than 50% probability** of requiring (or returning) funding from (to) contingency, and the dollar amount **can** reasonably be estimated. It also includes items from the risk register with a residual **probability of consequence of 60% or more**. The Estimating team will assist in reviewing/validating amounts included in the cost pressures list.

Cost Risk Analysis (CRA): Cost of risk is the **cost of managing risk and incurring losses due to risk**. BC Hydro's CRA is the project team's most detailed, up-to-date forecast cost to complete the project and includes the forecast cost for all known and included risks. Inputs into BC Hydro's Cost Risk Analysis are: base budget, approved change notices, cost pressures, watch list, risk register, subject matter expert input, and assumptions. It does not include engineering design changes, changes in scope, or catastrophic events. Also, it does not include funding for potential future draws on contingency that have not yet been identified. It assumes key milestones will be reached, such as river diversion and project in service date.

Engineer Design Team: A multidisciplinary team who planned and designed the dam. The Geotechnical resources on the project include engineers on BC Hydro's Internal Owner's Engineering team and external Engineering Design Team resources primarily comprised of SNC Lavalin and Klohn Crippen Berger resources.

Engineering design services are provided to BC Hydro (BCH) for the Site C Clean Energy Project through the Engineering Design Services Agreement (EDSA) by SNC Lavalin Inc. (SLI) and Klohn Crippen Berger (KCB).

Under the EDSA, the services are provided through two teams, the Engineering Design Team (EDT) and Resident Engineering Team (RET). The EDT is governed by the Engineering Design Plan (EDP), and its companion Site C Quality Plan (QP).

Monte Carlo: Monte Carlo simulation is a **quantitative risk analysis technique** used to identify the risk level of completing the project. A Monte Carlo is run on BC Hydro's Cost Risk Analysis to determine incremental contingency requirements.

Risk Event: All projects have uncertainties that could have a negative impact on quality, schedule, budget, or any other performance objectives. An example of a risk event on this project is the possibility of slippage on the bedding planes.

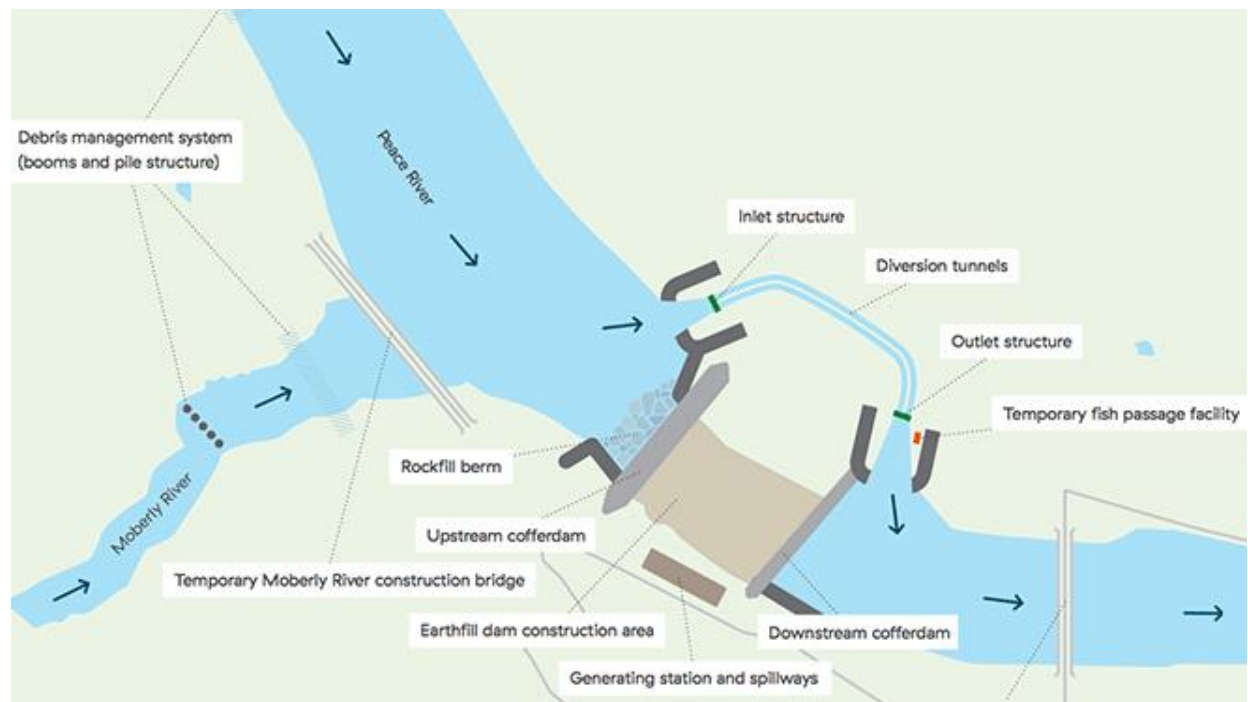
Risk Register: A risk register is a document used as a risk management tool. Commonly, projects use a risk register to provide details of the potential occurrence. It is a central depository of all project risk information that is generally accessible by those managing the project. It usually includes information about each risk, the nature of the risk, reference and owner, and mitigation measures.

For Site C, the risk register is a live application in SharePoint containing more than 1,000 risks, of which approximately 325 are currently active as of 2020 October. A complete description of all open risks in the risk register is provided to the Project Assurance Board (PAB) approximately twice a year. Risks rated 10.5 or above are reported to the Project Assurance Board once a month (Monthly Accountability Reports).

Schedule Risk Analysis (SRA): The purpose of a Schedule Risk Analysis is to understand the probability of achieving schedule outcomes for the project, such as river diversion and first power. Inputs into BC Hydro’s Schedule Risk Analysis: latest project schedule, risk register, subject matter expert input, and assumptions. SRAs are completed approximately twice a year.

Watch List: All information on the Watch List is included in the CRA. The Watch List items are identified using the same inputs as the Cost Pressures List: increased cost to the budget that may require funding from contingencies or identified cost savings. The difference between the Cost Pressures List and the Watch List is, generally, items included in the Watch List have a **less than 50% probability** of requiring or returning contingency funding, or the dollar amount **cannot** be reasonably estimated. If the probability of occurrence increases to over 50%, and the cost estimate is refined and can be reasonably estimated, the Watch List item will move to the Cost Pressures List. Also, the risk register is reviewed with a focus on those risks with a residual **probability of 30% or more**.

Work Package Manager: The Site C Project is broken down in a work breakdown structure, a Work Package Manager is assigned responsibility for each work package, and a scope, schedule, and cost are developed for each work package. The Work Package Manager is responsible for managing their budget within their Work Package Agreement.



Site C Plan View showing features associated with River Diversion

1.0 Executive Summary

1.1 Executive Summary

The BC Hydro Site C Clean Energy Project is one of the largest projects in the Province's history. It will be a third dam and generating station on the Peace River in northeast B.C. The project will provide 1,100 megawatts of capacity and about 5,100 gigawatt hours of energy each year to the province's integrated electricity system.

The Site C Project received approval from the Provincial Government in December of 2014 to proceed. The project budget established was \$8.335 B (including a \$0.794 B contingency allocation) and a project reserve of \$0.440 B to be overseen and controlled by Treasury Board. In the summer of 2017, a new Government was formed in British Columbia. The Premier asked for the project to undergo an extensive review by the BC Utilities Commission (BCUC) to determine the future of the project.

As a result of the review the Provincial Government approved the continuation of the project in December 2017.

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The updated Site C Project budget was established at \$10.7 B, consisting of a BC Hydro project budget of \$9.992 B (including a \$0.858 B contingency allocation) and a project reserve of \$0.708 B to be overseen and controlled by Treasury Board.

The January 2018 \$10.7 B Site C Project budget was \$1.925 B higher than the December 2014 Site C budget of \$8.775 B.

This report has been commissioned by the Minister Finance and the Minister of Energy, Mines and Low Carbon Innovation (Previously Minister of Energy, Mines and Petroleum Resources) to examine the period from January of 2018 until October of 2020. The Terms of Reference for the review include the following components:

1. Review and assess the governance and reporting structure in place for the project.
2. Examine the latest identified cost, schedule, geotechnical and scope risks and assumptions associated with the project.
3. Compare the findings of item 2 with the assumptions and risks identified in supporting material used to establish the project budget and reserve in January 2018.
4. Examine how and when actual and forecast assumptions and risks have changed since January 2018 to today (October 9, 2020).
5. Compare the findings of item 4 to various project progress reporting updates provided to the Project Assurance Board, the BC Hydro executive and Directors, the Minister responsible, and Treasury Board.
6. Review and assess risk management for the project, as well as contract supervision.

The Site C Clean Energy Project is divided into approximately 30 major contracts. These include onsite contracts for Main Civil Works, Generating Stations and Spillways Civil Construction, Turbines and Generators, Balance of Plant, and Worker Accommodation, as well as contracts for clearing, transmission lines and highway construction.

While most contracts are based on the traditional Design-Bid-Build model, a few departed from this approach. These include the contracts for Turbines and Generators (Design-Build) and Worker Accommodation (Design-Build-Operate with partial financing). Some contracts were directly awarded to First Nations.

Our team conducted the review based on the information received (5,500 documents). We did not conduct independent analysis in areas such as cost estimates, geotechnical issues, or construction schedules. We did examine the methods used and the reasonableness of the approach taken in each case. Due to COVID, limited site visits were conducted by members of the review team. The review team received excellent cooperation from the BC Hydro team and EY.

Since the December 2017 decision made by the Government of BC to continue the Site C Project, BC Hydro has experienced significant issues related to identified cost, schedule, procurement, geotechnical and scope risks associated with the project. These issues include geotechnical conditions, contract management challenges, procurement issues, and COVID 19. The majority of these issues have arisen within the Major Civil Works contract (MCW).

This contract was awarded to Peace River Hydro Partners (PRHP) (joint venture led by Acciona with Samsung, and Petrowest) at a value of approximately \$1.75 B. BC Hydro has rarely managed a civil contract of this size and has not completed one for many years.

This review is divided into four sections:

- Governance
- Geotechnical
- Risk
- Construction and Claims

1.1.1 Governance

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The first aspect of due diligence and enhanced oversight was the creation of a Project Assurance Board (PAB) to replace the existing Project Board. The second commitment involved the role of the Independent Oversight Advisor EY.

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. The PAB was to be comprised of up to five

BC Hydro Board members, two external experts with construction experience, the senior member of the Independent Advisor (EY) and two Government representatives.

BC Hydro structured the PAB to have no approval authority; its role was to provide advice and recommendations only. The goal was for the PAB to actively engage with the project team and provide a detailed level of due diligence on technical and strategic issues.

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PAB has provided thoughtful, strategic advice at its monthly meetings and has questioned and tested some of the technical aspects of the project.

However, there are a number of areas for potential improvement.

The PAB would likely benefit from more autonomy. Its members are highly qualified but have limited independence. The first PAB Chair was also the BC Hydro Chair and the second and current Chair previously had a senior role on the project. It is generally preferable that due diligence be provided by people with fresh eyes who are not attached to previous decisions.

The skill set on the PAB is certainly robust. However, it has been suggested by a number of PAB members and advisors that additional individuals with construction leadership backgrounds, particularly in the area of large civil projects would be helpful.

The role of due diligence requires many hours of detailed investigation and analysis on a project of this scale. The PAB plays a major part of the project due diligence. It appears that there may be a benefit to the PAB members expanding the time spent in fulfilling their role.

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EY commenced work on an assessment of the current state of project controls and risk systems. EY reported to the PAB in a report dated May 2018. The report identified many deficiencies in BC Hydro's systems. EY observed that "the Project Assurance Board is not provided with a clear view of project risk exposure and cost performance and pressure on contingencies".

BC Hydro disagreed with EY's report but partially adopted its recommendations. Within a few months EY was notified by BC Hydro that their contract would be terminated. A few months later the contract was rescoped to lessen the role that EY would have in overseeing the project.

Ultimately, BC Hydro determined the amount and type of oversight that they would receive from EY. S. 12

Although EY has continued to provide independent oversight, the cooperation they receive from BC Hydro appears to be limited at times. EY is not always involved in project analysis at an early stage and suggestions for improvements are not always acted upon.

EY has made numerous suggestions to the PAB for changes to the risk system including during a September 18, 2020 joint PAB / BC Hydro Directors' meeting S. 12

In the document EY tabled a number of suggestions for improvements to the risk system. The meeting ended without any discussion of the proposed changes.

1.1.2 Geotechnical

BC Hydro has been aware of the geotechnical challenges at Site C for decades. An extensive program of geotechnical investigations has been carried out over more than 40 years. Despite these investigations there have been a number of unexpected geotechnical conditions which have created pressures on the project.

As of September 2020, S. 12, 17 has been paid to the MCW contractor (PRHP) for geotechnical issues through Amending Agreements, Change Orders and Direct Work Orders. In addition, the tension crack issue encountered in 2017 caused one year of the project schedule float to be used.

The most challenging geotechnical issue is related to the foundation for the dam structures. BC Hydro has known for decades that the clay shale rock underlying the site has bedding planes shears and stress release fractures. The presence and continuity of bedding planes below the Roller Compacted Concrete (RCC) buttress were not known during the design of the dam. Previously, the rock was considered to be stable and the design relied on this assumption.

In mid-August of 2018 there was bedding plane movement below the shear key of the Powerhouse Buttress. This alerted the engineers to the potential for movements during excavation below the Spillway Buttress. In October of 2018, the Technical Advisory Board (TAB) informed the PAB of movement below bedding plane (BP)33.

“During the first phase of spillway excavation, prior to buttress construction, slip along several bedding planes was encountered. This was generally as anticipated except for slip at a depth below the deepest bedding plane (BP 33) that had been considered to be of concern. This slip on its own so far is not consequential. However, if slip along this plane is considered in a stability analysis with conservative design parameters, the design Factor of Safety is violated. Remedial measures are available but are costly and could impact schedule.”

The TAB’s presentation stated that the identified slip at BP 33e (approximately 5.5 m below BP 33, and 3.0 m below the RCC shear key intended to prevent such movement) was not considered in the existing design, and that the existing design “fails” when this slip is considered in the design. Furthermore, the design changes and subsequent impact to construction cost and the project schedule could be significant.

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The TAB and EDT anticipated that these refined design models together with potential grouting and drainage measures would likely provide an adequate factor of safety for the stability of the RCC Buttress. Over this period of time the PAB had a limited role in the review of this issue.

By January 2020, it became clear to the EDT that grouting and improved drainage would not be sufficient and that more robust structural mitigation was likely required. Between January and March 31, 2020, further engineering analysis of the possible mitigation measures were completed. In addition to requiring mitigation measures to address BP33e, the EDT recognized that measures would also need to address potential bedding planes below this elevation. As a result since March 2020 the remediation of BP33e and potential bedding planes issues below BP33e down to an elevation of 350 m has been one of the primary activities of the project EDT.

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Even though the EDT was optimistic that the problem could be solved, there was a risk of high mitigation costs that has come to fruition.

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1.1.3 Risk Management

Site C risk management is governed by an actively updated document that sets out the Risk Management Plan.

The purpose of the plan is to provide a common and consistent approach to risk management that aligns with BC Hydro's risk policy and enterprise risk management standards and also accounts for the complexities of the Site C Project.

The risk process workflow follows five steps:

- Risk identification
- Risk scoring
- Risk approval
- Risk QA /QC; and
- Risk reporting.

The key component or artifact of the risk system is the Risk Register. The Risk Register is designed to record all project risks and be actively updated as the project evolves.

The Risk Management Plan also references the Cost Risk Analysis (CRA) and Schedule Risk Analysis (SRA) processes. It should be noted that the CRA and SRA are quantitative risk analyses and that, while they appear to rely (as a starting point) on much of the information captured in the Risk Register, they are entirely separate analyses from each other. The CRA and SRA appear to be more focused on contingency management and usage than risk management.

One of the most important outputs from the risk system is the CRA. It is used to inform BC Hydro, the PAB, and Treasury Board on expected costs.

The CRA is very complex and has not been an accurate predictor of future costs. It has tended to underestimate risks for a variety of reasons.

The complexities of the CRA can be summarized as follows:

- The CRA requires the creation of three risk lists (Watch List, Cost Pressures List and Risk Register) instead of one risk register as is commonly the case in Provincial Government projects.
- Cost Pressure items, Watch List items, and Risk Register items have unique sets of rules to delineate between them.
- Which list a risk is located on depends not only on probability of occurrence, and probability to use contingency, but also on a difficult to define quality estimate.
- Watch List items below 30% probability of consequence are not generally considered in the CRA.
- It is unclear how consistency in the preparation of the various lists is maintained.
- Watch List items between 30% and 100% probability of consequence are all forecast to occur (i.e., have a probability of 100%) on every Monte Carlo analysis (simulation).
- Watch List item 3-point estimates that may be subject to adjustment based on an undefined assessment of probability of consequences.
- If risks are judged to have enough existing contingency available, (in a work package budget) they are not included on any list.
- Selection of risk items from the Risk Register is performed on a discretionary basis and in some cases selected risks do not exist in the Risk Register.
- Risk mitigation strategies are assumed to be 100% effective.
- The CRA has built in assumptions, including that the project will meet all major milestones, such as river diversion dates, on schedule.

The observations based on the above analysis are:

- The CRA is not a predictor of potential total project costs; the level of confidence that the project or PAB should have in it is difficult to determine.
- The CRA appears to be a tool that BC Hydro uses to manage requests for funding.
- It is different from the tools commonly used in the Provincial Government to manage risk which, generally, use only one list as a risk register and complete Monte Carlo risk analysis on all risks. Each risk goes through the Monte Carlo on the basis of the actual assessed probability of occurrence (not 100%). Risks below a threshold are generally not eliminated.
- The time it takes to produce the CRA is significant. This separate system, different from the Risk Register, is inefficient, and provides information that, at a minimum, is 2 months old. Given the questions about the methodology of calculating the Cost Pressure and Watch List items, it is reasonable to question its accuracy.

The value in any risk system is to provide warning of any threat to a project's quality, schedule, cost, or safety, and to provide a basis for building a response/mitigation plan to best address the risk. This allows the Project Board and other governance to review strategies to minimize the risk, secure funding, or make other project decisions.

In short, the CRA does not appear to effectively evaluate project risk but is more useful as a tool to evaluate funding.

The other primary risk tool used is the SRA. The SRA is a tool that creates a probability distribution of key project milestones, such as river diversion. Like the CRA, it is also performed using a Monte Carlo Analysis.

The SRA and the CRA are developed independently from each other. BC Hydro made an attempt to integrate them at the recommendation of the Independent Advisor; however, the integration was a difficult, complex and time-consuming process. Furthermore, based on the interviews, BC Hydro went to other utilities to better understand how they performed integrated Cost and Schedule Risk Analysis, and found that their peers were not doing it for similar reasons related to complexity and time. Ultimately, BC Hydro did not believe the output was reliable and stopped the integration.

1.1.4 Reporting of Risks

As part of its regular updates to PAB and TB BC Hydro reported risk, and particularly high rated risks. Each risk on the Risk Register is given a numerical value which is the sum of the probability of the risk occurring and the consequence if the risk is realized. This results in risks that are valued between 0 and 13.5. Those risks with a value of greater than 10.5 would be reported to the PAB on a monthly basis.

In this review we have tracked risks as they have occurred and been reassessed since January 2018. In February 2018, geotechnical risk associated with the Highway sub project was the only geotechnical risk that had an assessed residual risk level rating high enough to be reportable to the PAB. S. 12, 17

The February 2018 Risk Register did contain geotechnical risks for the MCW: Risk 182 - *Unknown ground/underground conditions impact design construction*; Risk 383 - *Excavated slope becomes unstable*; Risk 002 – *Actual Bedrock profile and other site conditions different from the base-lines*; and Risk 232 *Rebound and/or swell is greater than expected (Approach channel - Right Bank)*. However, these items were assigned residual risk ratings of 10, 10, 9 and 9, respectively, and they were not reportable to the PAB on a regular basis.

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when movement in bedding planes (including BP33e) was observed by the EDT in mid-August 2018 (as noted in the geotechnical section

herein), a new Risk 814 - *Geotechnical issues on work fronts other than the Left Bank Diversion Tunnel* was created that highlighted geotechnical risk in the MCW and was reportable to PAB with a residual risk rating level of 11. Shortly thereafter, on October 17, 2018, Risk 874 – *Additional MCW work needed to meet RCC buttress requirements* was created. This risk had a residual risk rating of 10, and so was not reportable to the PAB.

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As of October 2020, the Risk Register shows eight significant¹ geotechnical risks associated with the MCW contract but only two, Risks 874 and 927 – *Unstable Earthfilled Dam*, are reportable to the PAB.

It appears that initial risks are sometimes modified. At times, the risks are split and managed as separate risks or transferred to associated risks. The consequence of this carve out of individual risks appears to be that only a portion of the geotechnical risks are included in PAB briefings. This process may have resulted in the full extent of MCW geotechnical issues not being fully transparent to members of the PAB.

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¹ Taken as risks with a risk level rating of 9 or above i.e. Risks 002, 182, 232, 383, 437, 814, 874, and 927.

1.1.5 Construction and Claims Management

As previously outlined, there are many individual contracts that constitute the Site C Project. The largest contracts are for Main Civil Works (MCW), Generating Stations and Spillways (GSS), Turbines and Generators (T&G), Balance of Plant (currently in procurement), and Worker Accommodation.

Most of these contracts are proceeding reasonably well. BC Hydro has some experienced personnel, and the relationship with the contractors is generally good. The MCW contract is the exception.

The working relationship between PRHP (the MCW contractor) and BC Hydro could be improved. In numerous interviews with PAB and BC Hydro officials, the contractor has been described as aggressive. The ability to develop a partnership and problem solve together does not appear to have been fully achieved on this project. The contractor has been described as forceful, specifically with respect to claims and changes by numerous sources within BC Hydro.

This issue likely underpins many of the problems that BC Hydro is experiencing.

The performance of the BC Hydro MCW field personnel is mixed.

On the right bank the BC Hydro personnel appear to be competent and to be working collaboratively with PRHP personnel. On the left bank, which includes an extensive amount of excavation and the diversion tunnel, it appears that the people on the ground working for BC Hydro lack the requisite experience to handle a large contract of this nature.

During the interviews with construction advisors, several comments were made about insufficient numbers of experienced resources in both the field and field office. BC Hydro needs to consider both the impact of additional resources on the ability to achieve project goals, as well as the impact on the project budget.

1.1.6 Claims Administration

The comments on claims administration are focused on the MCW Contract as it appears from the interviews and information reviewed, that claims made on the other contracts have proceeded in a normal manner and are not currently of significant concern.

BC Hydro took two separate approaches to claims settlement when reviewing PRHP's claims under the MCW Contract:

- **Contractual:** This approach focuses on what a contractor is legally entitled to under its

contract. Settlement usually results in a change order.

- **Commercial:** This approach involves payments, incentives or changes to contract terms that are beyond the contractor's legal entitlement. Commercial settlements usually address important business imperatives. On Site C, two of the main imperatives have been to avoid the anticipated cost of a one-year delay in river diversion and handover dates to other contractors.

With reference to contractual entitlement, we found the work of the BC Hydro team to be of high caliber and they have provided the negotiators with a good assessment of PRHP's contractual entitlement.

Their work has been thorough, and BC Hydro's evaluations are supportable.

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BC Hydro's commercial strategy required it to have a good understanding of the additional costs and impacts of schedule slippage. The materials prepared to analyze these points were difficult to understand.

The last aspect for discussion related to claims is the claims management process. We found that the BC Hydro's claims management may have benefited from a more timely evaluation of claims.

BC Hydro relied on a matrix-based team in Vancouver. In Amending Agreement #3, the claims team took approximately 10 months to gather information, review the information with PRHP and evaluate the claims before negotiations began.

Through the interview process, we have been informed that PRHP had 10 to 12 full time people dedicated to generating claims, who are supported by approximately 90 additional staff providing scheduling and costing analysis.

BC Hydro's responsibility for claims management and settlement has been divided among a number of individuals with significant operational responsibilities. These individuals must therefore split their attention between claims management and their primary duties

Restructuring the BC Hydro claims management approach would likely provide benefits moving forward in the project.

1.2 Summary

BC Hydro has a dedicated team who have expended a high level of effort to complete the Site C Clean Energy Project despite a high level of challenges. The Engineering Design Team has worked effectively on issues as they arise. There is a very high level of geotechnical expertise available to the project through the Technical Advisory Board.

Many aspects of the project are going well including the Turbine and Generators, Worker Accommodation, and the COVID response.

Most of the opportunities for improvement are related to the Main Civil Works contract and the geotechnical challenges. BC Hydro would likely have benefited from the addition of more personnel with a background in large civil projects at all levels in the project structure.

The CRA has not been an accurate predictor of costs on this project. The risk system would benefit from a “reset” [S. 12](#). This should be accomplished through a joint effort between EY and BC Hydro.

As it pertains to governance the PAB could benefit from greater independence and additional experienced people with heavy civil experience. Experienced senior people tend to have a strong intuition regarding where problems may emerge. PAB could benefit from this intuition.

1.3 Summary of Recommendations

Recommendation #	Recommendation
Recommendation 1 6.4.1.1 Skills	It is recommended that a skills matrix (inventory and requirements) be completed for the PAB. The skills matrix should identify any gaps that exist between current PAB skills and desired PAB skill level, specifically focusing on individuals with experience delivering major civil projects (as both owners and contractors), individuals with experience in commercial negotiations and construction related claims settlement.
Recommendation 2 6.4.1.2 PAB Composition	It is recommended that consideration be given to having more external, independent, and skill specific membership on the PAB.
Recommendation 3 6.4.1.3 Independence	Due Diligence and oversight require independent consideration. The current process appears to truncate the opportunity to properly explore problems and potential solutions. BC Hydro should consider providing PAB with more

Recommendation #	Recommendation
	autonomy and opportunity for independent due diligence and deliberations.
Recommendation 4 6.4.1.4 Orientation	It is recommended that the orientation process is formalized and includes formal feedback on content, quality and methodology.
Recommendation 5 6.4.1.5 Time Commitments	The PAB would likely benefit from the dedication of additional time to conduct due diligence and oversight. Consideration should be given to facilitating a more active and detailed review of key subjects by the PAB through the use of task assignments, workshops and/or subcommittees.
Recommendation 6 6.4.1.6 PAB Meeting Structure	The forward agenda should be reviewed by the PAB in a detailed manner to ensure that the topics that effect commercial strategy, quality, schedule and cost issues are tabled.
Recommendation 7 6.5 Final Governance Observations	It is recommended that the Independent Oversight and PAB functions be re-evaluated. Their terms of reference should then be updated and re-established to address the finding of this report.
Recommendation 8 7.8 Summary and Conclusion	It is recommended that BC Hydro consider value engineering the design prior to procurement of the foundation enhancements. This process has produced efficiencies and cost savings on other projects.
Recommendation 9 8.3.3 Site C Risk Management Plan	Given the overall impact that realized risks have had on the project, it is recommended that BC Hydro re-evaluate the size of its risk organization, and the amount of dedicated risk resources.
Recommendation 10 8.5.3 CRA Observation	<ol style="list-style-type: none"> 1. BC Hydro, with assistance and input from its Independent Advisor, should consider review of the CRA process and create a more complete, transparent and simple process. 2. BC Hydro should consider updating the Risk Register to include 3 point estimates to support their risk analysis which may allow the risk process to be conducted with greater frequency and in a more consistent manner.
Recommendation 11 8.7.4 Reporting Observations	The risk reporting policy outlines when risks are or are not reported and discussed with PAB, TAB, and BC Hydro Board of Directors based solely on a numerical value. When risks are split or are persistent at a value below the threshold (10.5) they will not be regularly reported. This potentially creates situations where high impact risks may not be consistently reported. It is recommended that BC Hydro re-evaluate its risk reporting framework in order to provide a higher degree of transparency.

Recommendation #	Recommendation
<p>Recommendation 12 8.9 Current Re-Baseline Activities</p>	<p>The Rebaselining exercise should include the following:</p> <ul style="list-style-type: none"> • Cost impacts of all the elements that were presented as key risks in the July update. • A narrative should be created outlining the methodology and assumptions utilized in the preparation of the rebaseline of both the cost estimate and schedule. Significant changes to previous process and/or methodology should be clearly noted. • The cost pressures and watch list items should also include schedule related cost impacts (based on the SRA’s anticipated completion date). • The Independent Advisor, EY, would have access to and oversight of the entire process.
<p>Recommendation 13 9.1.2.1.4 Earth Fill Dam</p>	<p>It is recommended that BC Hydro add additional skilled people with extensive experience to the construction management team. This additional resource when coupled with the Construction Advisors would add field capacity and could provide training for less experienced personnel.</p>
<p>Recommendation 14 9.1.2.1.5 Schedule</p>	<p>It is acknowledged that it is difficult to produce at times due to changes. However, we are of the view that requiring the contractors to produce a full schedule should be given a higher priority when working together on issues.</p>
<p>Recommendation 15 9.2.1 Cost of a river diversion delay</p>	<p>While the river diversion has been successfully accomplished there are many cost and schedule issues remaining. BC Hydro is currently conducting a Re-baselining exercise of the budget to complete the project and the risks.</p> <p>We recommend that there is an independent and transparent review of the estimates completed including the cost of delay.</p>
<p>Recommendation 16 9.2.2.3 Claims Administration</p>	<p>It is recommended that BC Hydro give consideration to restructuring their claims administration to include:</p> <ol style="list-style-type: none"> 1. A senior executive whose primary duty is claims negotiations. 2. A senior claims administrator whose sole responsibility is claims management and who has contractual and financial authority to negotiate claims subject to board approval. The senior claims administrator generally meets with his or her counterpart on a weekly basis. 3. A qualified and experienced onsite claims team, with sufficient onsite personnel and resources to respond to the contractor, and additional contract administration, document control, estimating, scheduling and legal support from head office. The leader of the onsite team

Recommendation #	Recommendation
	<p>should plan daily meetings with the contractor to address claims in a timely manner and to build a strong working relationship. This would allow Issues to be discovered and addressed promptly.</p> <ol style="list-style-type: none"> 4. Experienced field supervisors, particularly in the technical aspects of the onsite construction (looking forward, on Site C this would include main dam embankment preparation and construction). An experienced field supervisor can recognize changes for which the owner is responsible, address contractor issues as they arise, report any potential claims to the onsite claims team and collect information to support the owner’s position on claims. 5. An external experienced forensic engineering and claims specialist, to assist with strategy development and claim preparation. 6. Trained personnel whose duties include recording information and preparing meeting minutes, signing off on contractor work, and responding to contractor correspondence and claims.
<p>Recommendation 17 9.2.2.3 Claims Administration</p>	<p>BC Hydro should consider a formalized claims management plan and program to react, counter, and where possible proactively respond to claims.</p>

2.0 Terms of Reference and Restrictions

2.1 Terms of Reference

BC Hydro has experienced significant changes over the last 12 months in relation to identified cost, schedule, procurement, geotechnical and scope risks associated with the project. Some key drivers of these changes include:

- Impacts of COVID and resulting changes in operations.
- Impacts of emerging geotechnical challenges at the project site.
- Impacts of emerging contract management challenges with the Main Civil Works contractor (Peace River Hydro Partners (PRHP)).
- Impacts of emerging procurement challenges (e.g., estimates, bid prices, and size of bid market).

The Minister of Finance, in co-operation with the Minister of Energy, Mines and Low Carbon Innovation (responsible for BC Hydro and the Project), wish to engage the expert services of the Contractor. Amongst other activities the Contractor will review, clarify, and evaluate the impact of recent decisions and events at all levels on project schedule and budget, and make recommendations for mitigation measures.

The scope of the review will include the following activities:

1. Review and assess the governance and reporting structure in place for the project.
2. Examine the latest identified cost, schedule, geotechnical, and scope risks and assumptions associated with the project.
3. Compare the findings at item 2 with the assumptions and risks identified in supporting material used to establish the project budget and reserve in January 2018.
4. Examine how and when actual and forecast assumptions and risks have changed since January 2018 to today (October 9, 2020).
5. Compare the findings at item 4 to various project progress reporting updates provided to the Project Assurance Board; the BC Hydro executive and Directors; the Minister responsible, and to Treasury Board.
6. Review and assess risk management for the project, as well as contract supervision.
7. Prepare a draft and final report with findings based on the above analysis, as well as options and recommendations that mitigate project cost and schedule risks.
8. Prepare an Interim Report for review of the Minister and Minister of Energy, Mines and Low Carbon Innovation by 30 days after start of engagement.
9. Prepare a Final Report for review of the Minister and Minister of Energy, Mines and Low Carbon Innovation by 60 days after start of engagement.

2.2 Restrictions

This report has been prepared for the sole consideration of the BC Ministers of Finance and Energy, Mines and Low Carbon Innovation.

It contains information which has been sourced through BC Cabinet and Treasury Board materials.

It also contains information from BC Hydro, and EY which may be harmful to their commercial interests.

As per the Terms of Reference and instruction from the supervising Government officials this report was not prepared for the public but rather as confidential advice to Ministers and to Cabinet.

No part of this report should be released without the express written consent of the authors.

3.0 Review Team

The review team consists of individuals with specialized expertise. They have been part of major capital projects and understand the complexities of project delivery.

The team members are:

Peter Milburn (Former Deputy Minister of Finance, Deputy Minister of Transportation and Infrastructure. Previous Chair of numerous Project Boards including Surrey Memorial hospital, Interior Heart and Surgical Center, and Transportation Investment Corporation)

Rodney Chapman (Director of Construction and Maintenance for the Ministry of Transportation and Infrastructure) 46 years of experience with construction and claims issues.

Frank Margitan (Former Vice President of Kiewit Canada, former Chair of the Road Builders and Heavy Construction Association) 40 years-experience working in the heavy construction industry

Mike Oliver (Former Chief Geotechnical Engineer for the BC Ministry of Transportation and Infrastructure) Over 40 years of experience as a geotechnical engineer involved in the Province's most challenging soils issues.

Maureen Kelly (Former Principal and senior geotechnical engineer with Golder Associates Ltd, current senior geotechnical engineer with the Ministry of Transportation and Infrastructure). Over 30 years of experience solving complex geotechnical problems.

Bruce Mc Allister (Former Director of Operations and Procurement for the Ministry of Transportation and Infrastructure) Co-author/contributor to the provincial Capital Asset Management Framework (CAMF). Decades of experience in conducting all types of procurement and project reviews.

John Mendes (Construction lawyer since 1986) Established Lesperance Mendes in 1997. His construction law practice has included advising government agencies, private owners and contractors on the tendering and procurement of public, private, design-build and "P3" projects.

Shelley MacLean (Former Director, Executive Operations, Office of the Deputy Minister of Finance) Extensive experience with government operations including Treasury Board.

Guy Lembach (Partner, Capital Projects Leader, Deloitte LLP). Over 27 years of experience as an engineer, lawyer, and consultant in the areas of engineering, construction, project management, project management processes, construction cost and project management assessments, scheduling, and construction claims.

4.0 Approach

This review of the Site C Project was primarily conducted through two methods.

- 1) Examination of the records of the BC Hydro, the Project Assurance Board (PAB), EY, the Technical Advisory Board, and the Provincial Government.
- 2) Interviews with key individuals from the PAB, EY, Provincial Government, and BC Hydro.

In addition to reviewing existing documents, BC Hydro officials have also created documents to assist us in understanding complex issues.

The interviews that were conducted included questions on a variety of technical and governance topics. Our team gave the Individuals interviewed the opportunity to provide additional information that they felt would be relevant to this review. Some of the participants provided advice on documents and other information that they felt would be helpful. Our team conducted over fifty interviews. Contractors and other service providers were not interviewed as a part of the review, consistent with the Terms of Reference.

Our team conducted the review based on the information received (5,500 documents). We did not conduct independent analysis in areas such as cost estimates, geotechnical issues, or construction schedules. We did examine the methods used and the reasonableness of the conclusions reached in each case.

In our review of governance, we examined the processes used for elevating and reaching decisions, evaluated them against our own experience and compared them against other practices used in the industry today. We also examined the flow of communication between the various levels of the project structure including the Provincial Government.

We completed the analysis and review of risk in a very comprehensive manner. This required we place a high level of effort into understanding the system used, reviewing its effectiveness, and tracking the changes in risks over the period from January 2018 to October 2020. We also analyzed the methodology used on Site C against industry standards and the ability for the organization to understand the system and apply output in an effective manner.

We took into consideration all of the interviews and documents collected for this review to ensure the greatest level of understanding of current policies and practices at the Site C Project and their reporting structure.

Members of our review team have taken a lead role in areas of their expertise. They have conducted research and led interviews with the appropriate Site C personnel. After initiating their own analysis, the team has discussed issues and reached consensus on the observations in this report.

5.0 Overview and Background

5.1 Overview

The Site C Project has experienced a number of unexpected challenges. BC Hydro has been subjected to considerable strain as a result of this project. During the period of this review BC Hydro and the Site C project team have been managing very difficult engineering and technical challenges.

It is very apparent that BC Hydro is dedicated to the successful completion of this project. The project team appears to be focused on the work necessary to move the job forward.

It is our view that the challenges this project is experiencing are not the result of poor workmanship or a limited level of effort. We found the individuals working on this job to be hardworking and dedicated to the success of this project.

In responding to the terms of reference, we focused our effort on the key aspects of this project. The terms of reference do not ask us to comment on the accuracy of the estimates, verify the schedule, or independently assess the quality of the work.

Our team focused on four main subject areas:

Governance and Oversight – We have examined the structure of the governance system, the feedback from the participants, the effectiveness of the due diligence and oversight provided. In addition, the presentation materials, minutes, and communications were reviewed.

Geotechnical issues – Considerable effort has been extended to understand the complex geotechnical conditions on this project. We have created a detailed chronology to capture the timeframe of observations, assessments, actions, and communications arising from the problems which have emerged.

Risk – The risk system is very complex on this project. A detailed examination has been undertaken to understand and comment on all of the elements.

Construction, Supervision and Claims Management – The review undertaken includes the process of claims settlements, the role of the PAB, the information presented, and the management of the contractors on the project.

5.2 Background and Timeline

BC Hydro's Site C Clean Energy Project will be a third dam and hydroelectric generating station on the Peace River in northeast B.C. It will provide 1,100 megawatts (MW) of capacity, and produce about 5,100 gigawatt hours (GWh) of electricity each year — enough energy to power the equivalent of about 450,000 homes per year in B.C.

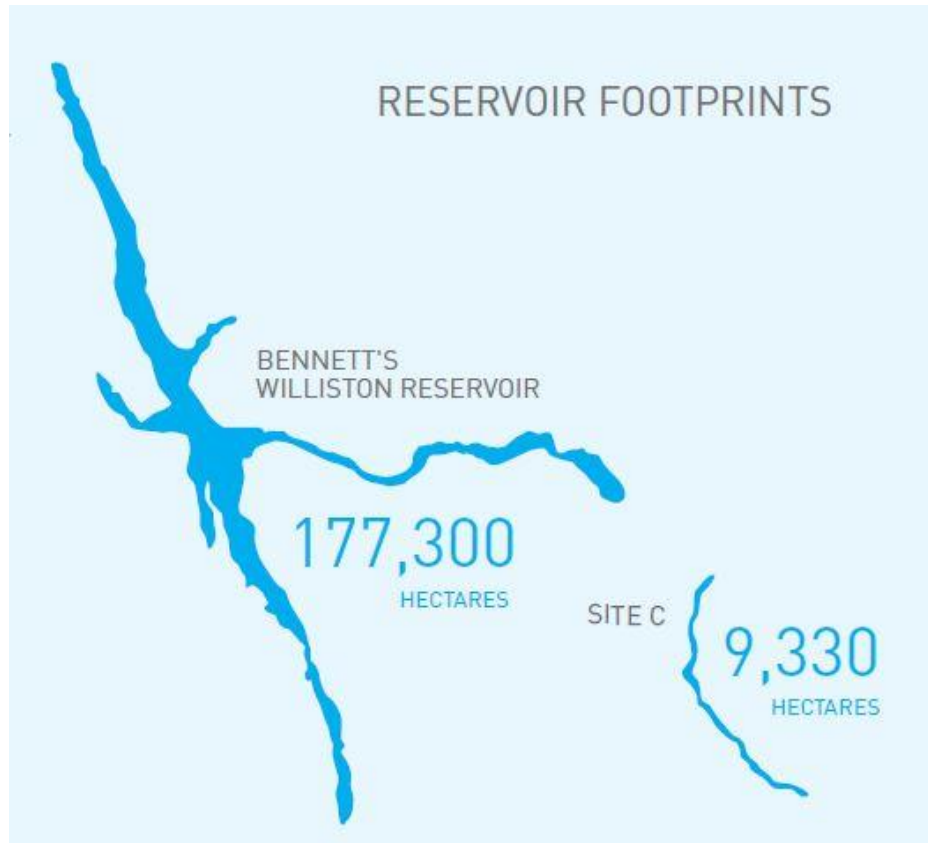


Figure 1 – Reservoir Footprints

As the third project on one river system, Site C will gain significant efficiencies by taking advantage of water already stored in the Williston Reservoir. This means that Site C will generate approximately 35 per cent of the energy produced at W.A.C. Bennett Dam, with only five per cent of the reservoir area.

In December 2014, the Site C Project received approval from the Provincial Government to proceed to construction.

Construction of the project started in summer 2015. (Source Site C website).

In the summer of 2017, a new Government was formed in British Columbia. The Premier asked for the project to undergo an extensive review by the BC Utilities Commission (BCUC) to determine the future of the project.

As a result of that review the Provincial Government approved the continuation of the project in December 2017.

In January 2018, the Province's Treasury Board approved a revised Site C project budget under oversight of BC Hydro, as well as a project reserve to be overseen by Treasury Board.

6.0 Governance and Oversight

6.1 Introduction to Governance – Crown Corporations and Large Capital Projects.

One of the key determinates of a project's success is the governance structure. The structure should show how authority, accountability and responsibility are determined, and clearly indicate how decisions are made.

The governance structure should also include timing, responsibility and distribution of project reports and other relevant information.

The membership of the boards, committees and management teams should have the appropriate skills and experience for the functions which they are designated to perform. Ideally, turnover of positions should be kept to a minimum.

British Columbia Capital Expenditures within the public service are guided by the *Financial Administration Act* and the Capital Asset Management Framework. The *Financial Administration Act* establishes Government's responsibility and accountability for managing public money across all program and service areas. It is the principal authority for capital financial management and administration.

Sections 4.1 and 6 of the *Financial Administration Act* authorizes Treasury Board and the Minister of Finance to provide central direction on capital management to direct Government and Government bodies, including Crown corporations and the broader public sector. The Province's approach to oversight is risk-based. This means the level of checks and balances established by central Government is proportional to the level of risk associated with an agency and/or specific capital project.

For a very large and complex project like Site C, the level of checks and balances would be expected to be robust.

Structurally, the governance should clearly connect the project owner (BC Hydro) with the project team and outcomes. The governance document that makes this connection between the Owner and the Project Team is the Statement of Objectives.²

The Project Director should be fully accountable for all aspects of the project.

6.2 Governance on Site C

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² See Appendix 1

6.3.1 BC Hydro Board of Directors⁴

With respect to the Site C Project, the BC Hydro Board of Directors (BC Hydro Board) has overall approval and oversight of project goals, scope, budget, and schedule. Their responsibilities include:

- Approving any significant changes to budget, scope, and schedule
- Approving contract awards over \$50 million and any subsequent draws
- Approving delegation of authority to management to use project contingency
- Providing recommendations on any draws on reserve subject to Treasury Board approval
- Approving any draws on Board Reserve
- Approving quarterly and annual project progress reports.

6.3.2 Site C Technical Advisory Board⁵

The Technical Advisory Board (TAB) is a global panel of engineering and construction experts appointed by the BC Hydro Board to advise the Executive Vice-President of the Site C Project, the President and Chief Operating Officer of BC Hydro, and the Project Assurance Board regarding the engineering and technical decisions related to project design consistent with best practices and current international guidelines. Their responsibilities include:

- Approve any significant changes to budget, scope, and schedule
- Provide technical review of key design milestones and ongoing external advice to supplement existing engineering and design and procurement expertise
- Report to the Project Assurance Board and Management following each

⁴ Terms of Reference as shown in Appendix 2

⁵ Terms of Reference as shown in Appendix 3

- meeting with a report of key findings and recommendations; and
- Prepare and submit Technical Reports as required to Management and the Board.

The composition of the TAB includes an international panel of experts in the development of major hydro-electric projects. They have experience on projects in Europe, Asia, Africa and North and South America. **S. 12**

6.3.3 Site C Project Assurance Board (PAB)⁶

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The PAB membership comprises five BC Hydro Board members, two Provincial Government appointees, two external expert advisors, and one member of the TAB.

While the PAB is largely advisory and has no approval decision making authority, it does make recommendations on contingency and project reserve requests.

The following excerpts from the Terms of Reference gives a description of the objectives and mandate of the PAB:

- Site C is completed on time and on budget.
- Risks are appropriately identified, managed, and reported on an ongoing basis; and
- Site C is completed safely and in compliance with applicable environmental standards and other requirements.

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To achieve these objectives, the PAB's Terms of Reference authorize its members to:

- Oversee Schedule and Cost Risk Analysis (SRA/CRA) over the life of the project to completion and in-service date.
- During meetings of the PAB ... engage in meaningful debate with BC Hydro management (Management); with other attendees including the Independent Oversight Advisor; and amongst themselves in order to provide *due diligence and to test the framework, methodology, inputs and outputs of the SRA/CRA, and their integration, on an ongoing basis and to recommend changes or seek clarification whenever appropriate* (emphasis added).
- Meet monthly and provide advice to BC Hydro's management and Board on:

⁶ Terms of Reference as show in Appendix 4

- a) SRA/CRA; monthly, quarterly and annually [sic] progress reports including major work packages; milestones; schedules; project budget; issues management; and specific risk and mitigation plans and actions.
 - b) *Ad hoc* reports to Government or the BC Hydro Board.
 - c) Requests to access the project contingency allocation (overseen by the BC Hydro Board); and
 - d) Requests to access the project reserve (overseen by Treasury Board).
- Review resolutions proposed for approval by BC Hydro's Board, and recommend to the Board whether such resolutions should be adopted.
 - Make financial approvals in line with any authority specifically delegated to the PAB by the BC Hydro Board; and
 - Help to ensure appropriate reporting is provided to the BC Hydro Board and Government, as required.

The PAB operates at a strategic level, meeting at least monthly to offer advice and direction to Management during the execution of the Site C Project to ensure it is delivered on time and on budget. In addition to PAB objectives and functions discussed above, their responsibilities include:

- Provide assistance to ensure appropriate notification to Government is undertaken, as required.
- Provide specific review and oversight of:
 - (a) Quarterly Reports, Annual Reports (including updated Management Plans), Project Communications Plans and Delegation Matrix
 - (b) Requests to access Project Contingency overseen and controlled by BC Hydro Board
 - (c) Recommend to the BC Hydro Board on contract awards over \$50 million and use of project contingency
 - (d) Requests to access the Project Reserve overseen and controlled by Treasury Board
- Review and provide advice to Management as needed regarding Exception Reporting and Monthly Project Progress Reporting, the latter of which includes progress on major sub-projects (collection of work packages), milestones, schedules, project budget, issue management and specific risk and mitigation actions.
- Approve financial decisions in line with any authority specifically delegated by the BC Hydro Board.
- Consider recommendations made and decisions taken relating to Site C in the context of both short term and long-term impacts; and,
- Remain in place until dissolved by the BC Hydro Board of Directors.

In short, the PAB acts in a role of Site C Project due diligence and oversight.

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6.4 Governance Discussion – Due Diligence and Independent Oversight

The remainder of the Governance Section will further explore due diligence and independent oversight on the Site C.

6.4.1 Project Assurance Board – Due Diligence and Oversight

The PAB has an important due diligence and oversight role on this project. Given The complexity and scale of the project and the importance of the PAB, a review of skills, composition, independence, orientation, time commitments, and meeting structure was evaluated and assessed.

6.4.1.1 Project Assurance Board Skills

The individuals on the PAB are talented individuals, and clearly have many skills. While they have been selected to serve on the PAB in a thoughtful manner, we have been unable to locate an inventory of skills held by PAB members. There also does not appear to be a documented PAB skills matrix.

The completion of a skills matrix allows the matching of desirable skills for the PAB against existing skills and determination of where gaps exist. This allows focused recruitment or training to fill any identified gaps in the current PAB skill set.

Through the interviews conducted, it became apparent that some of the members are concerned that material skill gaps exist on the PAB. The areas of concern identified include commercial negotiations and strategy, large civil construction, and/or senior project management experience.

Some PAB members indicated that when they raised these concerns, “the conversation was truncated”, and a satisfactory outcome was never reached.

In addition, EY produced a list of names for possible PAB members based on their experience with very large civil projects. However, EY advised our team that the list was not acted upon.

Recommendation 1:

It is recommended that a skills matrix (inventory and requirements) be completed for the PAB. The skills matrix should identify any gaps that exist between current PAB skills and desired PAB skill level, specifically focusing on individuals with experience delivering major civil projects (as both owners and contractors), individuals with experience in commercial negotiations and construction related claims settlement.

6.4.1.2 PAB Composition

It is not usually desirable for individuals conducting due diligence to be attached to the project structure through line authority. It appears that the PAB is currently acting more in its sub-committee capacity and less in its due diligence function.

Half of the PAB's members performing due diligence on the project also belong to the BC Hydro Board providing direction for the project. These overlapping roles can make independent oversight challenging.

It is also worth noting that the Chair of PAB from January 2018 until September 2018 was also the BC Hydro Chair. This was followed by the PAB Chair being filled by an official previously responsible for a substantial portion of the project.

It has been our experience that the strongest and most valuable due diligence comes from individuals who have not been associated with the project. Due diligence requires independence. Many organizations recruit for fresh eyes to conduct the due diligence.

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Based on our interviews, while EY has continued to provide support to the PAB, their lead partner is not a PAB member.

Through the interview process with BC Hydro leadership, we were advised that they thought it was desirable to have strong overlap between the BC Hydro Board and the PAB to minimize the opportunity of creating governance issues.

This could take the form of recommendations from the PAB that significantly differed with the BC Hydro Board. In reviewing the authority matrix from the project plan for the PAB, see Figure 2 below, it is apparent that they have no approval mandate.

While it is understandable that if the PAB is similar in membership to the BC Hydro Board you will have more efficient meetings and there will be less controversy. However, in our view that reduces the opportunity to explore alternative ideas and approaches that may be beneficial to the project.

Figure 2 – Project Plan Authority Matrix from Site C Project Implementation Plan April 24, 2018

Site C Reporting Matrix

Site C Reporting Matrix									
	Annual Report ¹	Quarterly Report	Monthly Project Management Report	Comm's Plan	Exception Reporting	Technical Reporting	Contingency Requests	Project Reserve Requests	EY monthly and quarterly reports
BCH Management	Develop	Develop	Develop & approve (internal doc)	Develop	Develop	Receive	Develop	Develop	Review
Ernst & Young	Review	Review	Review		Review		Review	Review	Develop
Technical Advisory Board						Develop & Approve			
Site C Project Assurance Board ²	Review	Review		Review	Notified	Receive	Review	Review	Review
BCH BOD	Approve	Approve		Approve	Notify	Notify as needed	Approve	Recommend	Review
MEMPR	Receive	Receive			Notify	Notify as needed	Assists Hydro Board with Approval	Recommend	Review
TB/TB Chair	Receive							Approve	
BCUC	Receive	Receive			Notify as needed			Notify	

(In a later version of the matrix, PAB is given authority to provide recommendations on financial requests to the BC Hydro Board)

Given the lack of decision authority and its mandate, it is not readily apparent why the PAB could not have more external membership. More external membership would allow the PAB to:

- Question previous decisions made by the BC Hydro Board
- Recruit to obtain specific and unique skills as required; and,
- Create a dynamic where individuals are motivated to discover, research, explore, and assist in solving issues.

Recommendation 2:

It is recommended that consideration be given to having more external, independent, and skill specific membership on the PAB.

6.4.1.3 Independence

An important feature of providing due diligence is the ability to work independently. This allows the PAB to be more candid and to express opinions without being inhibited by members of Management or the BC Hydro Board.

The approach taken on the Site C Project is to have monthly meetings of the PAB. The majority of the agenda items for those meetings appear to be largely informational. Typically, these presentations are done by Management and EY. The intention is for the Board to test the information presented and offer comments and suggestions. During interviews some PAB

members identified that they felt that the substantive and strategic discussions were not coming to the PAB. This is an area that will be discussed in greater detail later in the report Section 7 Geotechnical Review and Section 8 Site C Risk Management Review.

The PAB provide advice on technical topics such as claims and recommendations on items related to contract awards, contract increases, release of contingency, and authority to issue RFPs. These are generally documented in a written briefing note and presented to PAB for them to review and recommend approval to the Board. The Board approval will generally occur at the next quarterly Board meeting (in a separate meeting from PAB).

These meetings are very large (commonly greater than 30 people in attendance) and tend to have a full agenda and a limited time available. This is an area of concern. Through the interview process some PAB members indicated that this process was not allowing enough opportunity to fully explore the issues and create independent recommendations for the BC Hydro Board. Some PAB members felt frustrated by this process.

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Recommendation 3:

Due Diligence and oversight require independent consideration. The current process appears to truncate the opportunity to properly explore problems and potential solutions. BC Hydro should consider providing PAB with more autonomy and opportunity for independent due diligence and deliberations.

6.4.1.4 Board Orientation

The complexities of this project require extensive orientation to familiarize the members with all aspects of the project. Some PAB members expressed concern that the amount of time and the level of detail dedicated to the orientation process was insufficient, and that therefore some new PAB members felt it made it difficult to be effective in their roles. The orientation process generally follows the Board Governance Manual. However, expectations and subject areas are not documented and therefore may be inconsistently applied. Additionally, it appears through interviewing PAB members that some important history and information was not supplied during orientation. A key example of this was that a new member of the PAB was not supplied with EYs May 2018 report of Risk and Project Controls.

There appears to be an opportunity for improvement in formalizing how the orientation process will be conducted, the information and background provided, and the overall responsibilities and expectations of PAB membership.

Recommendation 4:

It is recommended that the orientation process is formalized and includes formal feedback on content, quality and methodology.

6.4.1.5 Time Commitments

This is one of the most complex projects delivered in recent history in British Columbia. It has geotechnical issues, claims management issues, schedule pressures, technical challenges, a risk register with over 1,000 entries (325 of which are open as October 9, 2020) and is being delivered in the middle of a worldwide pandemic.

In addition, the Risk Register, Cost Risk Analysis, Schedule Risk Analysis processes and budget management decisions are very detailed and complex. Having an accurate and responsive risk system and budgeting process is critical to the success of a project.

Site C project oversight is structured in a shared approach. EY is conducting a validation of risk inputs and systems that management is performing, whereas the more formal oversight and due diligence is being conducted by the PAB.

Due diligence and oversight on large projects require a significant amount of research and preparation time. Oversight on similar complex projects uses the establishment of regular workshops to discuss and evaluate issues; and/or the development of subcommittees or working groups focused specifically on high risk topics.

Recommendation 5:

The PAB would likely benefit from the dedication of additional time to conduct due diligence and oversight. Consideration should be given to facilitating a more active and detailed review of key subjects by the PAB through the use of task assignments, workshops and/or subcommittees.

6.4.1.6 PAB Meeting Structure

Some members of the PAB believed that the scope of review and agenda for the PAB meetings was limited at times. In reviewing the agendas there appears to be many project updates and informational items but limited agenda items regarding key project issues or strategic considerations.

This was particularly noted by the PAB members as it pertained to the first year of the Board (2018). Some PAB members expressed concern that the substantive issues were not coming before them and that their mandate was being curtailed by management.

It is also important to note that based on interviews it was the feeling of some PAB members that the leadership of BC Hydro placed an emphasis on quality, safety and schedule, and not cost control.

Recommendation 6:

The forward agenda should be reviewed by the PAB in a detailed manner to ensure that the topics that effect commercial strategy, quality, schedule and cost issues are tabled.

6.4.2 Independent Oversight – Due Diligence and Oversight.

In May of 2018, [S. 12](#)

EY prepared a report titled “Current State Assessment, Site C Project, Project Controls and Risk⁷.”

The report had been commissioned by BC Hydro to review how the project control disciplines of Cost, Schedule, Risk, and Change Management were currently being executed across the Site C Project and to provide recommendations for improvement.

The principal findings of the report were as follows:

- The limited size and on-site presence of the project controls function restricts the ability of BC Hydro to effectively manage a growing risk profile.
- The PAB is not provided with a clear view of project risk exposure relative to the performance management baseline to inform timely decision making.
- There is no single source of truth that is able to inform the level of progress achieved relative to key interfaces and milestones.
- Management information does not consistently show progress made relative to key interfaces and milestones.
- The PAB is not provided with a clear view of cost performance and pressure on contingency, over time, relative to contract budgets; and

⁷ See Appendix 6

It is the view of our team that there although the relationship has improved there is a friction that still exists between BC Hydro and EY today. We have noted occasions where BC Hydro is not involving EY in the development of key project deliverables such as cost and risk reports from the beginning of the analysis.

In the report EY found that “further work is needed to enhance the current state of Project Controls and Risk Management practices for the Site C Project, where current practice does not reflect what would traditionally be expected on a project of this scale”.

- Management is not supported by trend analysis to clearly indicate the consumption of contingency, relative to potential change over time.

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Based on interviews, this report was a “surprise” to BC Hydro. Although it appears that EY followed a detailed process including consultation and interviews to identify gaps.

EY created the “Site C – Project Control and Risk Workstream Plan and Approach” document dated 23rd January 2018 that laid out all the steps. Workshops were held in April and May of 2018 to go over the gaps and to also start the future state consultation.

The report was not well received. It marked the beginning of a strained relationship between BC Hydro and EY.

BC Hydro responded to the report by writing a letter to the PAB disagreeing with the conclusions reached by EY. (See Appendix 7)

It appears that the main issue was the process improvement suggestions which BC Hydro felt were inconsistent with a report completed two years earlier by EY. BC Hydro did not agree with the benchmark criteria used by EY and felt it was not of the same standard that BC Hydro had adopted, even though a section of the report compared Site C to BC Hydro’s own PPM standards.

BC Hydro’s response to an Independent Advisor was unusual. These reports are usually a starting point for discussion and an opportunity for improvement.

Both the letter and the EY report were presented to the PAB on June 7, 2018.

There was a review by management of some of the issues which was captured in the Annual Report and led to further sessions to identify improvement opportunities. BC Hydro stated in interviews that many improvements were instituted as a result of this report, other than those they did not agree with such as the size of the risk management team.

However, EY’s more recent report shows gaps still exist at the time of writing.⁸

⁸ EY Report on Risk – Appendix 8

The relationship between EY and BC Hydro suffered from further deterioration and resulted in EY being put on notice of termination on September 7, 2018. The letter of termination is included at Appendix 9.

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While the decision to terminate may have been due in part to the conclusions reached in EY's May 2018 report, during interviews some PAB members and BC Hydro officials expressed the view that there were other factors at play. BC Hydro officials made the case that the primary reason for the tension was cost, as they were not getting value for the money spent.⁹

EY provided a response to the assertion that their billings were excessive (see Appendix 11). It would appear after review of the two documents that BC Hydro was aware of EY's scope and cost of work being conducted.

EY continued discussions with BC Hydro on a new proposed Statement of Work in mid November 2018. The discussions were aimed at determining the nature of the oversight that EY would provide over BC Hydro. EY requested that they be provided "the opportunity to observe key contractor progress meetings with BC Hydro, specifically the MCW, GSS and BOP meetings, as in-person participation is critical to be able to truly assess the health of relationship and team dynamics." However, this aspect of independent oversight was not included in the reduced Statement of Work signed in January of 2019.

The new scope limited the input that EY would have on process issues and observing contractor progress meetings and largely focused their efforts on the review of the cost and risk analysis.

Ultimately, BC Hydro determined the amount and type of oversight that they would receive from EY. This appears inconsistent with the concept of independent oversight.

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⁹ See BC Hydro's Officials Comments – Appendix 10

S. 12

It is important to note that our team has found EY's advice and reports to be of good quality and valuable to the project. However, they may not have been used to their full potential. This is discussed further in the risk section of this report.

6.5 Final Governance Observations

S. 12

It appears that the PAB is functioning more as a sub-committee of the BC Hydro Board and less as a due diligence committee. Additional outside membership and greater opportunity for independence would allow the PAB to perform its due diligence role in a more effective manner.

Furthermore, management engaged EY to perform Independent Oversight, with a focus on organization, project controls, and risk. S. 12

Recommendation 7:

It is recommended that the Independent Oversight and PAB functions be re-evaluated. Their terms of reference should then be updated and re-established to address the finding of this report.

7.0 Site C Geotechnical Review

7.1 Introduction

British Columbia (BC) is a Province of unique and beautiful features, but these same features represent challenges from a geotechnical perspective. Constructing in BC places a large reliance on the geotechnical engineers who design the soil and rock foundations. Geotechnical engineering is a specialty discipline of civil engineering concerning the behavior and structural interconnected properties of geologic materials and groundwater. Geologic materials include natural soil and rock, but also include man-made materials such as compacted soil fill, crushed stone, concrete and manufactured stones.

The study of the geological material properties on a construction site are important to allow design and construction of stable structures that do not settle, deform or crack, or collapse due to foundation failure.

The frequency and impact of unpredicted geotechnical issues can be significant. This is particularly true in the less developed areas of the Province. This is largely because the features of the soils or rocks are hidden from view and techniques to analyze them generally only give the engineer a sample of the whole story. Often the only time the full picture is known is when you dig for the foundation or start work on site.

The Peace River area has a number of well-known geotechnical instabilities. The engineers who have been working on this project have understood this for many years. For decades extensive geotechnical investigative work has been conducted to understand the features that would allow for the dam to be constructed efficiently and safely.

Due to the challenging foundation geology, a significant amount of investigation was conducted by BC Hydro. These investigations focused on characterizing the shear strength, groundwater and other aspects of the foundation that could influence the project design.

7.2 Site C Geotechnical Challenges

Despite the investigations there have been a number of unexpected geotechnical conditions that have created pressures on the project.

As of September 2020, **s. 14 & 17** has been paid plus a one-year time extension has been granted to the Main Civil Works contractor for geotechnical issues through Amending Agreements, Change Orders and Direct Work Orders. The majority of these payments relate to tension cracks in the left bank that were encountered in 2017. These cracks resulted in BC Hydro redesigning the slopes and increasing excavation volumes and consumed a one-year

¹⁰ MCW Geotechnical Changes Cost Analysis, September 2, 2020, Rodney Chapman, P.Eng. attached at Appendix 12.

float in the project schedule. Additionally, there were geotechnical issues related to the diversion tunnel inlet/outlet and the right bank drainage tunnel.

Other geotechnical issues identified included slope stability, roof stability and foundation problems associated with weaker than expected rock found during the construction of an exploration tunnel, the construction of a diversion tunnel, and the construction of the left and right bank core trenches and spillway. Extensive excavation, rock bolts, grouting and shotcrete has been used to provide safety and stability in these areas.

The most challenging geotechnical issue is related to the foundation for the dam structures. It has been known for many years that the clay shale rock underlying the site has bedding plane shears and stress release fractures. The presence and continuity of bedding planes below the RCC buttress were not known during the design of the dam. Previously, the rock was considered to be stable and the design relied on this assumption.

The balance of the geotechnical section of this report will focus on the issues and events surrounding the foundation for the dam structures¹¹.

7.3 Geotechnical Uncertainties and the Observational Method

During the engineering of the dam structures, it was recognized that there were geotechnical uncertainties in the design of the RCC Buttress. The uncertainties included the potential of unknown bedding planes or shears that would only be realized after excavation, the frictional strength of bedding planes and the effectiveness of proposed drainage and grouting measures.

In order to evaluate and address these uncertainties the Observational Method was adopted. The Observational Method involves monitoring the ground response to construction and conducting assessments of whether the response is consistent with the assumptions made in the design.

In the case of the RCC Buttress, monitoring of the ground response was performed with instrumentation installed within the rock to monitor pore water pressures (piezometers) and ground movement with depth (extensometers and inclinometers). If the ground response was found to be not consistent with design assumptions, then the design may need to be modified. The scope and extent of the design modifications would be dependent on the specific circumstance. Given the nature of geotechnical uncertainties, these modifications could be extensive.

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7.4 Bedding Plane Movements

The adoption of the Observational Method assisted in identifying bedding plane movements. Movement on bedding planes below the Powerhouse RCC Buttress slope were observed in mid-February 2017 and as of April 2017 the movement was detected as low as what is described as Bedding Plane 33 (BP 33). BP 33, located at elevation 377.5 m, is 2.5 m above the bottom of the RCC shear key. These movements were distributed on different bedding planes and ranged from fractions of millimeters to tens of millimeters.

The record of movement under the powerhouse buttress was initially incomplete. Installation of the instrumentation from the Right Bank Drainage Tunnel (RBDT) was not completed prior to the start of excavation. As such, there may have been movement prior to instrumentation installation. These movements on their own were not overly concerning as they were observed to be above the base of the shear key and could be accommodated within the existing design. However, in October 2017, the Technical Advisory Board recommended that additional instruments be installed to clarify if displacements below the shear key were occurring.

7.5 Bedding Plane Movement Below Dam Structures

The movement along bedding planes below the shear key of the Powerhouse Buttress was first recorded in mid-August 2018. This alerted the designers to the potential for movements during excavation below the Spillway Buttress. This resulted in the decision to install three additional slope inclinometers to depths below elevation 375 m (base of shear key) in the Spillway Buttress.

The key geotechnical feature of concern was Bedding Plane (BP) 33e located at about elev. 372 m which is 3 m below the bottom of the shear key. The engineering design did not consider the potential for movement at the BP 33e level. A bedding plane below the RCC buttress was considered in the original design; however, it was assumed its strength (initial strength) was sufficient so that would not adversely affect the stability of the buttress.

In determining the strength of a bedding plane, it is important to consider whether the plane has been subject to any movement. Prior to movement a bedding plane has its highest strength (initial strength). This is partially due to interlocking features between the planes that create a frictional resistance. After the bedding plane moves this resistance is weakened and the plane will slide easier. This is referred to as residual strength.

Based on information that is currently available, BP33e is now considered to be at its residual strength, and as such is the source of concern regarding the buttress stability.

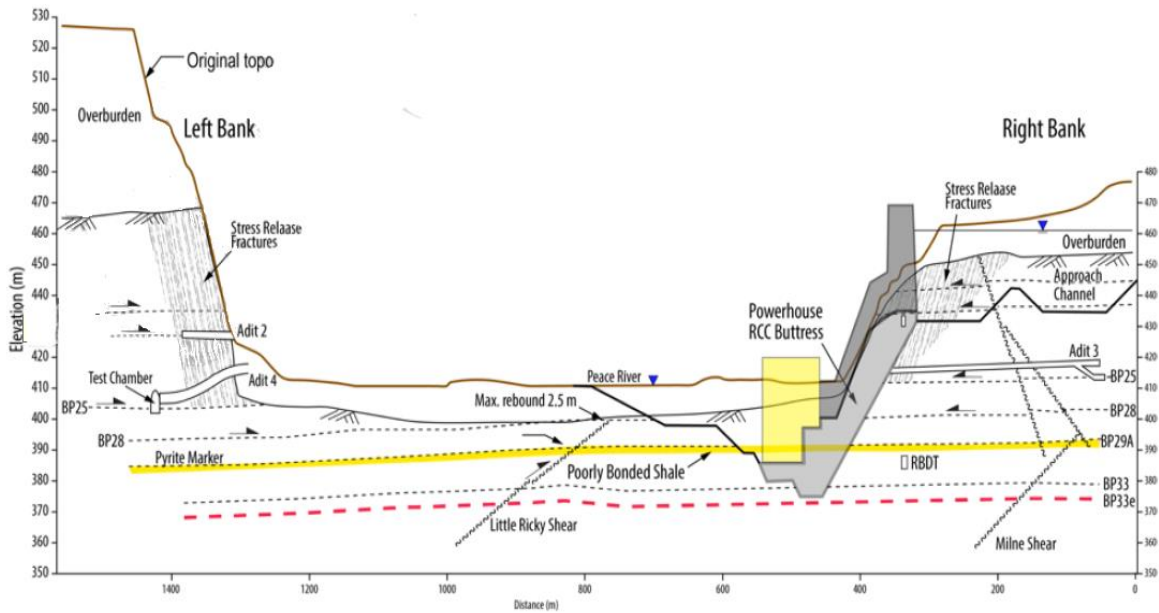


Figure 3 - Position of BP33e (red dashed line) as it relates to the bottom of the RCC Buttruss

7.5.1 Events after Movement

After the movement of BP33e was identified, the Site C Project Team and the Technical Advisory Board realized that this could represent a significant issue for the project. In October 2018, the Technical Advisory Board presented the following information to the Project Assurance Board (page 6):

“During the first phase of spillway excavation, prior to buttress construction, slip along several bedding planes was encountered. This was generally as anticipated except for slip at a depth below the deepest bedding plane (BP 33) that had been considered to be of concern. This slip on its own so far is not consequential. However, if slip along this plane is considered in a stability analysis with conservative design parameters, the design Factor of Safety is violated. Remedial measures are available but are costly and could impact schedule.”

While a layperson may not fully understand this information, the TAB’s presentation to the PAB states that the identified slip at BP 33e (approximately 5.5 m below BP 33, and 3.0 m below the shear key) was not considered in the existing design, and that the existing design “fails” when this slip is included in the design. Furthermore, the design changes and subsequent impact to construction cost and project schedule could be significant.

The engineering design team (EDT) and the Technical Advisory Board (TAB) investigated the options available to them in an attempt to mitigate this concern.

The first option was to deepen the shear key under the Spillway Buttress in order to stabilize the moving bedding plane. However, this was deemed not to be feasible due to both constructability and stability issues. The ramp to access the area was already steep.

Deepening the excavation and redesigning the access ramp would be expensive and cause delays to the project. Secondly, there were concerns that the excavation may trigger movements in deeper bedding planes. Based on this analysis it was not clear that deepening the shear key was an appropriate solution.

The second option considered pausing the excavation and construction including placement of RCC in the area while pursuing potential engineering solutions. This was not recommended by the Technical Advisory Board. BC Hydro commented that delay of placement of the RCC in the Spillway was not considered because:

“Delaying spillway buttress construction would have had an impact on the project schedule, likely requiring an extension of construction time and associated cost impact; there would have been additional costs to two contractors with this delay. The geological/geotechnical models are complex for this site. The requirements for mitigation and scale of the mitigation measures can only be defined once the updated geological model was determined, validated and alternates for mitigation considered. Important technical consideration with the construction sequence was to minimize the duration from excavation to placement of RCC to minimize relaxation of the shale because of the potential for further movements, formation of new relaxation joints and other processes.”

7.5.2 Detailed Work to Define the Extent of the Issue and Potential Solutions

As the first two options noted above were not suitable, BC Hydro focused on conducting more detailed engineering analysis on the displacement at BP33e.

The TAB recommended to the EDT the following course of action:

- Continue with observations as planned during the excavation of the spillway which is assumed to proceed in a top-down manner.
- Conduct a 3D stability analysis with the same inputs as used in the conservative 2D analysis.
- Develop a more realistic seepage pattern in the foundation consistent with the drainage boundary conditions.
- Synthesize past data for borings, televiwer logs and laboratory tests.
- Obtain undisturbed samples of core over the length of interest to evaluate visual characteristics and shear strength on the bedding plane(s); triple tube coring is likely necessary.
- Evaluate the spatial variability along the bedding plane by all available data.
- Review outcomes and evaluate whether design changes are necessary and, if so, what mitigative measures are appropriate.

Over the next 12 to 15 months, further engineering studies to assess these factors were discussed at a series of Technical Advisory Board meetings and conference calls.

In addition, detailed engineering analysis on BP33e sought to determine if:

- the bedding plane may have had higher strength deeper into the slope

- side resistance on a potential slip surface was higher (3 D effect); and
- there was higher breakout strength at the toe of bedding plane.

The Technical Advisory Board and Engineering Design Team anticipated that these refined models together with potential grouting and drainage measures would likely provide an adequate factor of safety for the stability of the RCC Buttress.

The role of the PAB over this intervening period is discussed in more detail in the Governance and Risk sections of this report.

By late 2019 / early 2020, the risk and the need for mitigative measures became apparent. By January 2020, it became clear that improved drainage would not be sufficient and structural mitigation was likely required. Between January and March 31, 2020, further engineering analyses of the possible mitigation measures were completed. In addition to requiring mitigation measures to address BP33e, it was recognized that measures would also need to address potential bedding planes below this elevation. As such, since March 2020, the remediation of BP33e and potential bedding planes issues below BP33e down to an elevation of 350 m has been one of the primary activities of the EDT.

During the evaluation of potential options and structural measures, observation of displacements and evaluation of strengths on bedding planes below BP33e and other analysis indicated that a shear key tunnel was not a viable solution.

Multiple options were considered, and a structured decision-making process was undertaken (multiple accounts analysis) to determine the preferred mitigation option for the Spillway and Powerhouse. The favored design is to remediate the joint plane by constructing a series of large diameter laterally loaded piles (dowels) across the bedding plane. If successfully completed these piles would prevent the planes from sliding by increasing the resistance to shear forces. Current details of the preferred mitigation measure are as follows:

- Spillway – 141 laterally loaded piles, 3 m diameter with a 22 mm wall thickness filled with concrete.
- Powerhouse - 114 laterally loaded piles, 3 m diameter with a 22 mm wall thickness filled with concrete.

At the spillway, the proposed mitigation method involves drilling through approximately 14 m of RCC then installing the piles to elevation 350m (for a pile length of approximately 38 m). Drilling through the RCC and shale is very expensive and highly specialized work. Based on conceptual designs completed in September of 2020, the mitigation measures for these bedding planes are estimated to cost upwards of [S. 12, 17](#)

¹²See Appendix 13 - 20200401 RB Major Changes Estimate V11 Piles Only

Early contractor engagement has been carried out with AFDE since most of the work will be within their geographical work area. A field trial is planned for early November 2020, in the Spillway to determine the response of the soil to lateral loads. The trial results will be used along with recent pressure and laboratory testing to further analyze and characterize the strength and stiffness of the rock.

The results of these tests will be used to optimize the design (pile size, numbers and depth). This trial will involve constructing two 2.6 m diameter shafts through the spillway RCC buttress, another two shafts in bedrock in the powerhouse tailrace area and testing the rock at depth with high capacity jacks.

S. 12, 17

, draft Terms of Reference for an independent review of the right bank foundation enhancements were put forward at the joint Project Assurance Board/Board of Directors meeting on September 18, 2020. It is proposed that one or two highly experienced engineers, not previously involved in the work at Site C, would review the work done performed by the Site C Project Team. The review would focus on the analysis carried out including:

- characterization of the rock
- review of the multiple accounts' evaluation leading to the preferred mitigation option; and,
- review of field trials and optimization of the preferred mitigation method.

The proposed review is intended to add a level of confidence to the proposed mitigation measures.

7.6 Chronology

The monitoring data collected during the excavation for the buttress and geological mapping data of the foundation led to increasing concerns about stability of the Right Bank structures. These concerns have been reported in the Technical Advisory Board reports (2018 – 2020) and the tracking log of comments and recommendations of the Technical Advisory Board (2010 – January 2020). The concerns are included verbatim below with observation/comments/ opinions on the key aspects.

7.6.1 Summary of Key Points in Chronology

- 1970 – 2014 BC Hydro and their consultants undertook site investigations for Site C that included large diameter boreholes (LDH) in the mid-1970's that were used to map and test bedding plane (BP) features that were key to the geotechnical design of the project. This work included review by world class experts.
- 2010 - A RCC buttress under the Right Bank Structures was added to the design in response to the concerns about unacceptable movement or failure along BPs; however, the tendered design only considered potential movement on very weak and continuous BPs shallower than BP33e.
- August/September 2018 - Slope inclinometers, instruments installed to measure lateral movement with depth, were monitored as part of the Observational Method as

excavation for the RCC Buttress proceeded. Movement was detected on BP33e at elevation 372 m during the excavation of the stilling basin at the toe of the spillway Phase 1 slope. Movement on a bedding plane at this depth was not anticipated and caused considerable concern. This movement coupled with stress release fractures (tension cracks) at the top of the Right Bank and unfavorably oriented shear features at the base of the buttress excavation formed the potential failure surface of concern. The TAB noted in October 2018 that remedial measures are available but are costly and could impact schedule. An investigation and analyses program ensued over the following year.

- January 2020 – Following investigation and analyses, it was concluded that improved drainage would not be sufficient and additional structural mitigation was likely required to address the potential slip on BPs.
- February 2020 – In a meeting with the PAB it is acknowledged that CRA#5 will not include the potential costs for mitigation measures because they were still in the early stages of development and cost estimated had not yet been prepared.
- March 31, 2020 – By the end of March further engineering analysis of the possible mitigation measures had been completed, and the costs for the mitigation measures increased from what had initially been expected in January 2020.

S. 12, 14, 17

- August/September 2020 – Following analysis of various options, the favored design to remediate potential slip on BPs is determined through a multiple account analysis to be a series of large diameter laterally loaded piles (dowels) installed through the RCC Buttress to approximately elev. 350m.
- September 18, 2020 – A draft Terms of Reference for an independent review of the right bank foundation enhancements is presented at the joint PAB/BOD meeting. It is proposed to have one or two highly experienced engineers known to BC Hydro but with no prior involvement in Site C carry out the review.

S. 12, 14, 17

- November 2020 – A field trial is planned for early November 2020, in the Spillway, to determine the response of the ground to lateral loads and to optimize the pile size, numbers, and depth. This trial will involve constructing four 2.5 m diameter shafts through the RCC buttress and testing the rock at depth with high capacity jacks.

A detailed chronology can be found at Appendix 14.

7.7 Key Risks:

S. 12, 14

7.8 Summary and Conclusion

The Site C project has experienced extensive serious geotechnical issues:

- left bank tension cracks.
- diversion tunnel inlet/outlet
- the right bank drainage tunnel; and
- movement below RCC Buttress.

The cost impact of mitigating these geotechnical issues is significant. At the time of writing the final cost is unknown; S. 12, 17

This is comparable with the budget of many major projects completed in recent times.

Unlike other project risks that may materialize during construction or perhaps be a result of actions taken during construction, the geotechnical issues on this project always existed. How these issues would manifest themselves in the design, however, was not fully understood by BC Hydro despite decades of research.

S. 12, 17

This review looked at whether BC Hydro produced an appropriate design for the geotechnical conditions known at that time. The geotechnical professionals on our team have conducted an extensive review of the investigation and design process.

A review of the logs of the 29 LDH's (Large Diameter Holes) drilled in the mid 1970's showed that of the 12 holes drilled to depths greater than elevation 380 m, BP33e was only logged in one hole. In addition, there is not persistence of other BP's lower than BP33 in these drill holes.

Based on the evidence available to the designer at the time and professional judgement, our geotechnical experts agree with the designer's statement that:

After careful review it is the opinion of our team that BC Hydro followed a reasonable process at the time of design in assuming that the bedding planes below the RCC Buttress would not be subject to movement.

“Bedding plane shears below this elevation were present but there was no evidence of continuity, and consequently, there was no evidence that their presence and shear resistance would impact the design”.

It is the view of the review team that BC Hydro followed a reasonable process in assuming that the bedding planes below the RCC Buttress would not be subject to movement.

Although the design was reasonable, BC Hydro realized that it may require modification depending on field observations. (Observational Method) BC Hydro underestimated this risk profoundly.

BC Hydro’s presentations to the Provincial Government have emphasized the significant amount of engineering study that has been completed in the area and how much is known about the geotechnical issues on this site. These assurances along with the low value placed on geotechnical risk likely gave a sense of security to the recipients of this information.

Our team finds it difficult to comment on the appropriateness of this confidence. With the benefit of hindsight, we can see that BC Hydro miscalculated the potential impact of the geotechnical issues. However, BC Hydro understood that the design may need to be modified depending on the field conditions encountered (Observational Method). Given this understanding It would appear that BC Hydro should have made a greater allowance for potential geotechnical risk when seeking project approval.

This is supported by the observation that over a period of decades many projects in the Peace River area have experienced unexpected geotechnical issues despite extensive investigation.

This review did not include a review of the proposed mitigation measures to address the movement in the bedding planes. It is understood that an external review is currently occurring.

Value Engineering is carried out in a facilitated workshop that brings together a multidisciplinary team to determine the most appropriate solution to an identified deficiency. The outcome of the workshop aims to minimize risks, provide the lowest life-cycle cost solution and enhance constructability. The multidisciplinary team is led by a skilled facilitator and is generally independent of the project’s management or design staff so that the team is able to perform an objective, critical review of cost, value, and constructability.

On this project there would have been a benefit to carry out Value Engineering (as described in the box above) at an early stage of mitigation development.

Recommendation 8:

It is recommended that BC Hydro consider value engineering the design prior to procurement of the foundation enhancements. This process has produced efficiencies and cost savings on other projects.

It is important to note that the risk of additional geotechnical issues on this project continue at the time of writing. The most substantive risk identified is the potential instability of the earth fill dam due to potential bedding planes with lower shear strength than assumed in design. Additional excavation has been specified for the dam foundation to provide a shear key on the right abutment of the dam and an observational approach will be taken with additional instrumentation and monitoring during construction for the remaining dam foundation.

The Design Team has indicated that the shell profile of the dam can be modified, and the construction staged if additional changes are required. [S. 12, 17](#)

8.0 Site C Risk Management Review

8.1 Introduction

The Special Advisor's mandate specifically asked for a review, evaluation, and comment on the risk management process, as well as the implementation and execution of risk management on the Site C Project. In doing so, we have:

- Considered the general expectations, and purposes of a risk management process on large capital projects.
- Reviewed the risk management approach and process on the Site C Project.
- Reviewed the impacts of risks on cost and schedule, including the Cost Risk Analysis, and Schedule Risk Analysis processes and implementation.
- Reviewed and evaluated the history of major risks on the Site C Project, with a specific focus on the reporting of project risks as it pertains to reporting to both the Project Assurance Board (PAB) and Treasury Board (TB); and
- Reviewed the role of the Independent Advisor as it pertains to Risk Management.

8.2 Risk Management on Capital Projects

Risk management on capital projects, particularly large, complex capital projects is a fundamental component of managing, controlling, monitoring, and reporting on a project. Risk management can, and typically does have a direct effect on other components related to managing the project, including: safety, quality, cost, schedule, contingency, claims, and changes. When risks become reality, they will influence project outcomes and goals. When risks are effectively managed, their overall impact to project outcomes and goals, can be reduced.

While there are number of standard and accepted risk management processes related to capital projects, the standards generally consist of the following:

- Identification
- Evaluation
- Response Planning
- Monitor and Control; and
- Communicate and Governance.

Identification includes determining which risks might affect the project and documenting their characteristics¹³. Identifying risks can be done by anybody on the project at any time, however the definition of the identified risk (i.e., there is the possibility that a risk will occur and have an impact on the project) is typically a technical exercise that is conducted by experienced project personnel and experts in the field. The process of identifying and defining risks initially includes workshops and challenge sessions, and the development of a consistent format of describing the risks. Each identified risk should be defined in detail stating the impact on

¹³ A Guide to the Project Management Body of Knowledge – 2000 Edition.

project performance objectives including, but not limited to, safety, cost, schedule, and quality. After initial workshops, individuals can identify risks at any time during the project.

Evaluation of these uncertainties is completed through a process referred to as Risk Analysis. Through this analysis the project team will assess how likely a risk event is to occur (Probability) and what would be the magnitude against performance objectives (Consequence).

During the evaluation, it is also important to determine linkages or correlations between risks where the occurrence of one event will potentially increase or decrease the probability or consequence of another risk. For example, the risk of one geotechnical instability could affect the risk of other geotechnical instabilities in the same geographic areas, have consequences on an activity on the critical path, or knock-on effects on subsequent critical path or near critical path activities.

Risk evaluation typically falls into two categories: Qualitative and Quantitative. Qualitative evaluation measures the risk consequence and risk probability against a scale of values. The output, typically the product of Probability and Consequence, of a qualitative risk analysis is a “heat map” that indicates the relative relationship and prioritization of the risks. Quantitative risk analysis includes the probability of the risk occurring against an estimated consequence (i.e., cost, schedule) of the risk. The output indicates a potential value or range of values of the risk (i.e., dollars, calendar days, etc.).

S. 12, 14, 17

Response Planning includes the development of procedures and techniques to enhance opportunities and reduce threats to the project’s objectives.¹⁴ When response planning, many people think of “mitigation” of risks; however, response planning can include various techniques to address in the risk, including: avoidance, transference, and acceptance. It is not uncommon to see response plans that include more than one response planning technique.

For an effective risk response plan, it is important for any project to define the accountability and responsibility for the response to a risk. This is typically done by determining a risk owner. The response plans should include a prioritization of the risk elements with appropriate attention from designated individuals ranging from field personnel, management to project board members. Furthermore, response plans should include information like the information needed to determine if and when a risk is “triggered”, the information needed to support the response plan, the timing of information and requirements, as well as the requirement for regular updates to the response plan. Furthermore, response plans should consider the budget/schedule needed to support the response and/or specific action plans. Lastly, the response plan should include the residual risk that remains after the plan has been implemented. Leading practice requires response plans for all risks, and at a minimum, specific response plans should be prepared for all significant risks.

Monitor and Control is the process of tracking identified risks, monitoring residual risks, identifying new risks, ensuring the execution of response plans, and evaluating the effectiveness of the risk management plan to reduce risks.¹⁵

These updates should go through the same rigor as the original risk identification process. The monitoring and updating is a scheduled procedure although can be done at any time if conditions change.

The importance of monitoring is key to an effective risk management program. It requires significant time and effort, and capable personnel. Furthermore, it must be reinforced at all levels in the project organization, from leadership to the field personnel. The focus needs to be on the strong, proactive, effective management of risk, not the mere administration of a risk process.

Communicate and Governance of risks is a process that informs and engages the appropriate levels of the project organization and sponsors. Generally, the higher probability and/or the higher the probability and consequence, then the higher up in the organization that the risks, response plans, and reporting should be. The risks that could significantly jeopardize the project budget, quality or schedule should be reviewed with the project board, and clients so they are aware of risks, and can provide input to response plans, and decisions related to risk

¹⁴ Ibid.

¹⁵ Ibid.

response techniques. Risk occurrences that have lower consequences would normally be the responsibility of more junior levels.

It is best practice for risk registers to be available and understood by various individuals, teams, and personnel on the project from the field to project leadership, to the organization executive, and finally, the governance officials.

8.3 Risk Management Approach

The review and evaluation of the risk management approach on Site C, commenced with understanding risk management at BC Hydro and ultimately how risk management is implemented on the Site C Project.

8.3.1 Risk Management at BC Hydro

BC Hydro and Site C Project have a multi-dimensional approach to risk management. At an enterprise level, risk management at BC Hydro starts with their Board Governance Manual.

The manual outlines risk management responsibilities of management, board, committees and subsidiaries and risk reporting including, risk related:

- Mandate
- Accountability
- Process
- Employee responsibility
- Policy application guidance; and
- Definitions.

At the enterprise level, the range of risks can be categorized as organizational risks, strategic risks, compliance risks, financial risks, operational and hazard risks.

One of the primary tools used in risk management at the Corporation is the BC Hydro Risk Matrix. This is a matrix that displays probability on the vertical axis and consequence on the horizontal axis (on a relative probability/consequence basis). The resultant intersection of the probability value and consequence value is assigned a score in the matrix which is used for ranking and organizational attention. Highest consequence and highest probability yield the highest score values.

Highest values go to the Board and Executive for information, review, action, or mitigation.

The Site C Project follows the same general framework and practices of BC Hydro's Enterprise Risk Group and BC Hydro's Project & Portfolio Management Practices (PPM)¹⁶.

¹⁶ BC Hydro has spent a considerable amount of time developing their PPM processes and have won awards for their processes.

8.3.2 Site C Risk Management Framework

Site C risk management is governed by an actively updated document that sets out the Risk Management Plan. The latest version dated June 5, 2020 is attached as Appendix 15.

The purpose of the plan is to provide a common and consistent approach to risk management that aligns with BC Hydro's risk policy and enterprise risk management standards, but also account for the complexities of the Site C Project.

The risk process workflow follows five steps:

- Risk identification
- Risk scoring
- Risk approval
- Risk QA /QC; and
- Risk reporting.

The plan also describes responsibility, accountability, consultation, and information for all envisioned steps in the workflow.

For Site C, risk management is described as the process of identifying, analyzing and then responding to any risks that arise during the life cycle of a project, to ensure the project achieves its objectives including scope, schedule, cost, and quality.

S. 12, 14, 17

The Risk Management Plan also references the Cost Risk Analysis (CRA) and Schedule Risk Analysis (SRA) process. Both the CRA and SRA will be discussed in more detail later; however, it should be noted that the CRA and SRA are quantitative risk analyses and, while they appear to rely (as a starting point) on much of the information captured in the Risk Register, they are entirely separate analyses. The CRA and SRA appear to be more focused on contingency management and usage than risk management.

8.3.3 Site C Risk Management Plan

Industry standards include the Project Management Institute, Association for the Advancement of Cost Engineering International (AACEI) and Construction Industry Institute (CII), and comparable organizations such as Partnerships BC (PBC), provide industry standard guidance for recommended risk management framework and practices. Individual project practices will typically depend on the nature, size, and complexity of each project but be guided by such frameworks¹⁷. The Site C Risk Management Plan appears to align with the industry standards, frameworks, and practices. It has been updated several times throughout

¹⁷ Based on discussions, BC Hydro's PPM is strongly aligned to AACEI and the PMBOK.

the project and is now on Version 7.

While the plan aligns with industry standards, there are concerns regarding the application of the Risk Management Plan on the project in a proactive manner, and in several other areas, including, how risks are reported and communicated to the Project Assurance Board (PAB) and Treasury Board.

Furthermore, based on discussions with BC Hydro, the complexity of the project and the magnitude of the project risks and related contingency, the overall size of the risk management organization on Site C appears to be under-staffed. The limited size of the risk management organization was also identified in EY's May 2018 report.

Recommendation 9:

Given the overall impact that realized risks have had on the project, it is recommended that BC Hydro re-evaluate the size of its risk organization, and the amount of dedicated risk resources.

8.3.4 The Risk Register

The foundational piece of Site C's Risk Management Plan is the single Risk Register containing over 1,000 risks, of which approximately 325 are active as of October 9, 2020. This Risk Register is available to all project team members on a Microsoft SharePoint site, and a complete description of all open risks in the Risk Register is provided to the PAB approximately twice a year. In accordance with the Site C Project Risk Matrix, **those risks with a score more than 10.5 are reported to the PAB on a monthly basis.**

For each risk in the Risk Register, a risk owner has been identified, who is responsible to manage and monitor the risk, on a monthly or more frequent basis. For risks that warrant development of a risk response, or "treatment plan", the risk owner or a delegate is responsible to prepare and manage the treatment plan.

Each risk is also assessed from probability of consequence¹⁸ and consequence severity¹⁹ if the risk should be realized. This qualitative assessment prioritizes the project risks based on the sum (addition) of probability and consequence.

As stated above, BC Hydro has an established Risk Management Plan. Expectations are documented and are readily available for project personal to review.

The following gaps were noted in the Risk Register:

- The risk register focuses on qualitative assessment of risk, while focused quantitative

¹⁸ "Probability of consequence" is frequently referred to as "probability" or "likelihood".

¹⁹ "Consequence severity" is frequently referred to as "impact".

assessment appears to be part of the CRA process and not the day-to-day administration of the Risk Register and Risk Management Plan. Three-point estimates (low, most-likely, high) are not included Risk Register, and are only prepared for a portion of the CRA. The CRA will be discussed in more detail later in this report.

- Until recently, the “treatment plans” as they are referred to by BC Hydro were relatively high level and prepared primarily for the highest ranked risks, not all risks.
- It does not appear that response plans consistently consider the cost/schedule consequences of implementing and executing the response plan²⁰; furthermore, it is unclear where the costs and schedule implications of managing the risks are actually being tracked and managed.
- BC Hydro does not appear to track the effectiveness of response plans.
- Lessons learned and/or key performance indicators were not provided to evaluate response plans.
- Based on information provided in interviews, no analysis or analytics were performed to evaluate the overall effectiveness of the Risk Management Plan.

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Limitations in the information

provided in the Risk Register, include:

- Not all closed risks on the Risk Register have a clear explanation of whether the risk has expired, been realized, replaced or omitted.²¹
- Risks continue to be modified on the Risk Register after the risk has been closed;²²
- The highest probability of consequence in the Risk Matrix is >60%.
- Many risks on the register overlap, meaning that some risks have sub-risks and others “roll-up” to larger risks. This inconsistency creates an issue with visibility, and the reasoning behind the separation and aggregation of risks does not appear to be consistent.²³

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Based on review of the documentation provided and the interviews performed, these concerns are shared by the Independent Advisor, EY, who identified a number of areas of potential improvement in the Site C risk management processes as detailed in Appendix 6²⁴.

8.4 Site C Risk Management – Cost, Contingency, & Schedule Impacts

The effective management of project risk has a direct impact on the overall success of the project. Where this impact is greatest is on project cost (including contingency), and the project schedule.

8.4.1 Site C – Cost and Contingency Management

On Site C, there are four key components to cost and contingency management: original budget, approved changes, cost pressure list, and watch list as shown in Figure 4. These key components are also the key inputs to the Cost Risk Analysis (CRA).

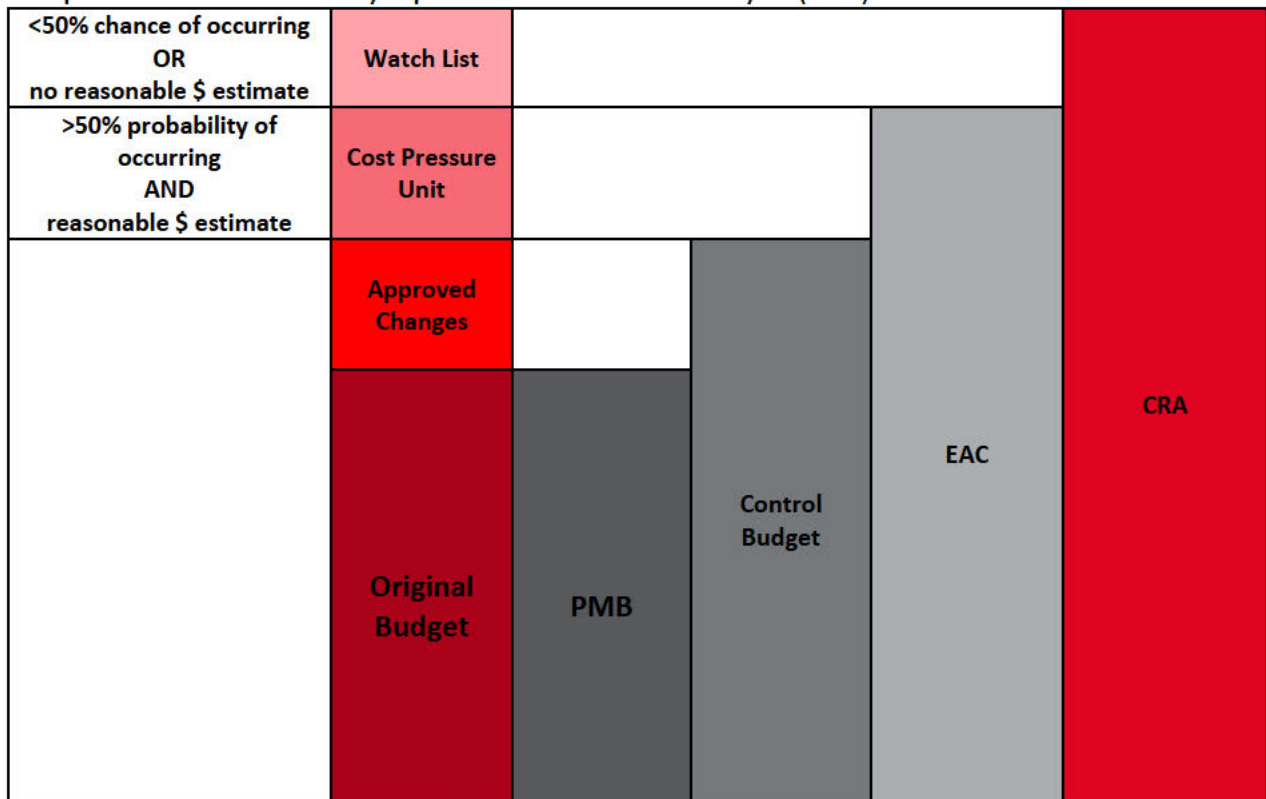


Figure 4 - Site C Cost Management²⁵ (Source: Site C Risk Management and Cost Management)

²⁴ As is discussed in more detail in this section of the report and in the Governance section of this report, the Independent Advisor submitted a report in May 2018 identifying a number of deficiencies in Risk Management and Project Controls. Based on interviews with BC Hydro, “many” of the suggested recommendations were implemented. The Independent Advisor has continued to make recommendations for improvement. A comprehensive document that showed what recommendations were implemented, what was implemented, and what wasn’t was not identified.

²⁵ Appendix 16 – Site C Risk Management and Cost Management.

8.4.2 Original Budget

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8.4.3 Approved Changes

Approved Changes represent the approved change notices, settlement of claims, and approved amendments on the project. The funding for Approved Changes comes from contingency and/or project reserve²⁶. Claims settlement is discussed in Section 9.0, Construction and Claims Management, of this report.

The original budget and approved changes make up the Control Budget.

8.4.4 Cost Pressure List

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²⁶ It is understood that Project Reserve funds have yet to be allocated.
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8.4.5 Watch List

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The Control Budget plus a Monte Carlo analysis of the Watch List items is the CRA.

8.5 Cost Risk Analysis (CRA)

The CRA is the project team's most detailed forecast cost to complete. It is prepared approximately twice a year and requires approximately 8 weeks to complete. The last CRA was started in December 2019 and completed in January 2020. A CRA is currently underway and it was started in September 2020³¹.

The CRA includes:

- Base Budget
- Approved Changes
- Cost Pressure items; the CRA analysis assumes that every identified Cost Pressure List item occurs (100% probability), and the value of the Cost Pressure List item in the CRA is represented by 100% of the single point estimate for the Cost Pressure List item; and,
- Watch List items; the CRA analysis assumes that every identified Watch List item occurs (100% probability) and the Monte Carlo value of the Watch List item in the CRA is represented by a three-point estimate (optimistic, most likely, pessimistic).

³⁰ S. 12, 14, 17

³¹ It is understood the September 2020 CRA has been completed. As part of this work, the September 2020 CRA has not been reviewed as it was completed after October 7, 2020.

A key assumption of the CRA is that key schedule milestones (i.e., River Diversion) will be achieved.

The CRA does not generally include³²:

- Engineering design changes
- Unforeseen changes in scope
- Catastrophic events; and,
- Risk items with a residual risk below 30%.

The results are presented to all levels in the governance structure. However, it is not clear that the various levels of governance fully understand the impact that the exclusions can have on the project.

Risk probabilities considered, and potentially included³³, in the Cost Pressure and Watch Lists are detailed in Table 1 below, full details of which can be found at Appendix 17.

Table 1: Risk Inclusion in Cost Pressure and Watch lists

Risk Register – Residual Probability of Consequences	Cost Pressure List	Watch List
60% (likely – more than even chance to occur)	Yes	No
30% (Fairly Likely – often occurs)	No	Yes
10% (Possible – could well occur)	No	No
1 % (Remote – may occur)	No	No
0.1% (Very Unlikely – not expected to occur)	No	No

Source: Response from BC Hydro re relationship between Risk Register and Cost Pressure and Watch Lists

8.5.1 CRA – As Part of Risk Management

The CRA appears to be a tool for budgeting and/or the evaluation of funding, for largely known, expected, or occurring risks.

It appears the cost consequence(s) of Cost Pressure items are likely to be over-estimated in the CRA as it assumes a 100% probability of occurrence of a single point estimate for all items. While this conservative approach may be warranted, it is unclear, based on BC Hydro’s experience, what impact this has on the overall accuracy of the CRA, or whether BC Hydro has attempted to evaluate the impact.

Similarly, Watch List items are likely over-estimated as the CRA also assumes a 100% probability of occurrence for all Watch List items when modeled through a Monte Carlo simulation using a 3 point estimate of the optimistic, most likely, and pessimistic values of

³² See Appendix 19 - Dec 1, 2019 CRA Memo page 6 and Appendix 16 - Risk Management and Cost Management.

³³ Subject to estimating requirements defined for inclusion in the Cost Pressure and/or Watch List.

funding required, even though, to be included as Watch List items, they generally have only an assessed probability of consequence of greater than 30%. Again, this conservative approach may be warranted, but this impact on the overall value of the CRA appears not to have been evaluated.

Furthermore, based on discussions and explanations provided by BC Hydro,³⁴ the “probability of consequence” is not part of the Monte Carlo simulation that models the estimated value of Watch List items that is included in the CRA calculation. However, it appears that if there is “a reasonable probability” that a risk may not materialize, the most optimistic value of the 3 point estimate used in the Monte Carlo simulation would typically be set to zero, which would lower the overall value of the final estimate produced, although that estimate is included in the CRA calculation at a 100% probability of requiring funding.

Conversely, the excluded items, and risk items that have a probability of consequence below 30%, or that have a higher probability than 30% but which the project considers cannot be reasonably estimated, may not be included in the CRA potentially resulting in an under estimation of the potential impact to the CRA of those items.

Additionally, the assumptions³⁵ and specific exclusions in the CRA, including potential cost impacts of delays to key milestones, will also likely result in an under estimation of the CRA.

As such, the CRA likely contains a number of over and underestimated elements, and it does not appear that BC Hydro has performed additional analysis to determine the overall impact of these “pluses and minuses” to gauge the overall impact they have on the CRA, or identified a level of confidence that the project, the executive, the PAB, and the BC Hydro Board should have in the value presented. Based on discussions and interviews, the overall trend is for the CRA value to increase over time and as detailed later in this report, the Independent Advisor is of the view that the CRA process underestimates the likely cost impact on the project due to excluded risks and overly restrictive assumptions.

The PAB has expressed concerns regarding the inputs to the CRA in interviews. Furthermore, correspondence between from the Independent Advisor to both BC Hydro and the PAB have expressed similar concerns.

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The CRA does not generally include:

- Engineering design changes
- Unforeseen changes in scope
- Catastrophic events

The CRA assumes that key schedule milestones will be achieved:

- River Diversion
- Project in service date

³⁴ See Appendix 20 - Additional Information Related to CRA document provided by BC Hydro.

³⁵ For example, the CRA assumes key schedule milestones will be met even when the Schedule analysis predicts a likelihood that milestones will be missed and therefore potential delay costs are not included in the estimated cost at completion.

8.5.2 Complexities of the CRA

The CRA is a complex and unique analysis. While periodic quantitative risk assessments are a relatively standard process, the CRA as performed is unlike one typically seen on other large complex projects. S. 12, 14, 17

The complexities of the CRA can be summarized as follows:

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- Requires the creation of three risk lists (Watch List, Cost Pressures List and Risk Register) instead of one Risk Register as is commonly the case in Provincial Government projects.
- Cost Pressure items, Watch List items, and Risk Register items have unique sets of rules which creates division between them.
- The risk location depends not only on probability of occurrence, and probability to use contingency, but also on a difficult to define and subjective ability to prepare a quality estimate.
- Watch List items below 30% probability of consequence are not generally considered in the CRA.
- It is unclear how consistency in the preparation of the various lists is maintained.
- Watch List items between 30 and 100% probability of consequence are all thought to occur (i.e., have a probability of 100%) on every Monte Carlo analysis.
- Watch List item 3 point estimates may be subject to adjustment based on an undefined assessment of probability of consequence.
- If risks are judged to have enough existing contingency available, (in a work package budget) they are not included on any list.
- Selection of risk items from the Risk Register is performed on a discretionary basis and in some cases selected risks do not exist in the Risk Register.
- Risk mitigation is assumed to be 100% effective.
- The CRA has built in assumptions, including that the project will meet major milestones such as meeting river diversion dates, on schedule.

8.5.3 CRA Observations

Our Team expended a considerable amount of effort to review, understand, and evaluate the CRA process.

In order to be effective a process as complex as the CRA would need to be both accurate and well understood by team members and the PAB. However, based on information provided by participants in interviews, it appears to be neither accurate nor well understood.

The scope of the CRA is limited through built-in assumptions. Particularly, the schedule assumptions around river diversion and first power being met which could have a profound effect on cost. These are not catastrophic events. In the last Schedule Risk Analysis, the probability of missing the in-service date was 35%, yet the financial impact of this was not captured in the CRA.

The following observations are based on the above analysis and review:

- The CRA is not a predictor of potential total project costs; the level of confidence that the project should have in it is difficult to determine.
- The CRA appears to be a tool that BC Hydro uses to manage the requests for funding.
- It is different from the common tools used in the Provincial Government to manage risk where, generally, there is only one list referred to as a Risk Register and risk analysis is

completed by running a Monte Carlo on all the risks. Each risk goes through the Monte Carlo on the basis of the actual assessed probability of occurrence (not 100%). Risks below a threshold are not eliminated.

- The time it takes to produce, is significant; this separate system, different from the Risk Register is inefficient, provides information that, at a minimum, is 2 months old; and, given the questions about the methodology of calculating the Cost Pressure and Watch List items, results in questions to its accuracy.
- The value in any risk system is to provide warning of any threat to a projects quality, schedule, cost, or safety, and provide a basis for building a response/mitigation plan to best address the risk. This allows the Project Board and other governance to review strategies to minimize the risk, secure funding, or make other project decisions.

In short, the CRA is not an evaluation of project risk and contingency, it is a tool to evaluate funding.

Recommendation 10:

1. BC Hydro, with assistance and input from its Independent Advisor, should consider review of the CRA process and create a more complete, transparent and simple process.

2. BC Hydro should consider updating the Risk Register to include 3 point estimates to support their risk analysis which may allow the risk process to be conducted with greater frequency and in a more consistent manner.

8.6 Schedule Risk Analysis (SRA)

The SRA is a tool that creates a probability distribution of key milestones, such as river diversion on this project. Like the CRA, it is also preformed using a Monte Carlo Analysis.

The SRA is used to identify the probability of various schedule outcomes. The process has value as there are numerous interfaces on the project and delay has a significant cost. However, its accuracy is dependent on having a current schedule from the contractors, and the quality of the information entered.

The inputs to the process are:

- Latest project schedule
- Construction Progress to date
- Project Risk Register; and
- Inputs from Subject Matter Experts.

The actual risk analysis is completed using Oracle Primavera Risk Analysis which creates a probability distribution of various dates. While the SRA process appears to more closely follow a project schedule Monte Carlo process in that it includes likely schedule risk and scenario

analysis; it is unclear how likely cost impacts of the analysis are included in forecast project costs as noted above.

The SRA and the CRA are developed independently from each other. There was an attempt to integrate them based on advice from the Independent Advisor that an integrated CRA/SRA was leading practice. However, the integration was a difficult, complex and time-consuming process. Furthermore, based on the interviews, BC Hydro went to other utilities companies, to better understand how they performed integrated Cost and Schedule Risk Analysis, and found that their peers were not doing it for similar reasons related to complexity and time. Finally, BC Hydro did not believe the output was reliable, and as such, it was stopped.

8.7 History of Risks and Risk Reporting

As noted, the risk register has approximately 1,000 risks, with 325 still active (open). As projects progress it is expected that new risks will be added to Risk Register, that the evaluation of risks will change, and finally, that risks will be closed. This section looks at the history of risks on the project as well as how those risks are being reported.

8.7.1 Risk Reporting January 2018

In January of 2018 the project had completed its review conducted by the BC Utilities Commission and was under consideration for approval by the Provincial Government.

BC Hydro acknowledged that the project could not be completed for the previously budgeted amount of \$8.335 Billion. Extensive work was completed to update estimates and conduct risk analysis on the project.

The result was a request to increase the total budget from \$8.775 Billion to \$10.700 Billion. The breakdown is shown in Table 2:

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The four main drivers to cost increases were:

1. Increased costs and contingency for the Main Civil Works
2. Increased cost for Generating Station & Spillway Civil contract scope, based on

- actual bids received
3. Other Changes to Direct and Indirect costs, based on updated detailed analyses; and
 4. Adjustments to Contingency and Interest-During-Construction.

The risk analysis with respect to the Main Civil Works and Generating Station & Spillway contracts will be discussed in more detail below.

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8.7.1.2 Risk Modelling

As a part of the revised budget BC Hydro had completed revised risk modelling. The modelling showed that, the project could be completed under the budgeted amount of \$10.70 Billion with a P90 level of confidence⁴¹.

The methodology used to assess the risks was as described in the previous section of this report via the CRA process.

The updated budget report that was presented to the Joint BC Hydro / PAB meeting of January 11, 2018, outlined the key risks, with a focus on the largest active contracts, in the following manner:

8.7.1.2.1 Main Civil Works (MCW) Risk Analysis

With respect to the MCW, the January 2018 risk analysis findings are summarized as follows:

- Schedule delay risks are the most significant risks to the MCW contract that must be included in contingency funding.
- Other risks (namely commercial risks of claims/settlements awarded against BC Hydro and contractor overhead rate increases), geotechnical risks and design and scope change risks are moderately high risks to be covered by contingency.
- Labour and resource as well as interface risks are present but are low in comparison to the other risk; and
- S. 12, 17

Monte Carlo simulations were prepared and produced the following result (in \$millions):

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⁴¹ P90 – 90% probability that the project budget would be under 10.7B, and 10% probability it would be over. Taking the P90 is a conservative value. Given the nature of the project, and the issues encountered to date, requesting funding on the P90 value was appropriate.

8.7.1.2.2 Generation Station and Spillway (GSS) Risk Analysis

Similar to the MCW, the GSS was also identified as a major area of risk in the January 2018 risk analysis. S. 12, 17

The Monte Carlo analysis that was conducted on the entire GSS scope showed that most of the contingency required was related to three key risks:

- Interface risk S. 12, 17
- Risk of Design and Quantity Variances S. 12, 17
- Schedule risk S. 12, 17

Interface Risk

Design & Quantit
Variance

Other Schedules
Risk

Bonuses and LD

Figure 6 - Tornado Chart for Generating Station & Spillway Risks (\$ millions) (Source: PAB Jan 11, 2018)

The key findings of the analysis and risk ranking from the Monte Carlo analysis with respect to the GSS are summarized as follows:

- Interface-related risks are the highest risks with a broad range between the P10 and P90. Interface risks are primarily driven by the potential for schedule impacts and delays resulting from other contracts. These delays are not expected to occur all at one time but across the total construction period and may require additional costs to accelerate in order to meet the overall project milestones.
- Design changes and quantity variations are the second highest risks. The variation around these risks is, by comparison to the Interface-relegated risks, relatively modest; and
- Similar to the MCW Contract, Schedule delay was also a significant risk.

8.7.2 Risk Reporting (February 2018 to October 2020)

As part of its regular updates, BC Hydro, reported risk, and particularly highly rated risks.

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8.7.2.1 Risk Reporting to PAB

In February 2018, the top project risks reportable to the PAB, as listed on the risk register⁴², were as follows:

⁴² Based on "Top Risks 2018 to Sept 2020" pdf provided by BC Hydro (showing risks with a rating of 10.5 or higher)

As noted previously, project risks are only reported to the PAB if a risk has a Residual Risk Level Rating of 10.5 or higher. The rating is the sum of the probability and consequence ratings. All the risks listed above were reportable to the PAB.

Risk reporting to the PAB has undergone a series of changes and evolutions throughout the project's life to date. Prior to August 2018, no information regarding specific risk ID, risk rating, probability or consequence appears to have been provided in the PAB reports in the overall project summary risk section but was provided in each sub-project risk section.

From August 2018 onward, the PAB reports included risk reporting in the overall project summary section only, which included specific risk ID's associated with a risk together and the consequence and probability of the risk, and, from September 2018, they also included the residual risk level rating.

In May 2019, the reporting was changed again with the omission of the probability and consequence reporting, leaving only the residual risk level rating to give an indication of the significance of the risk, in addition, trend arrows were added to indicate how the risk rating compared to the previous report. Additionally, a further risk table was added to the report that detailed the risks both pre- and post- application of contingency via the cost pressure list⁴³.

The further risk table is now provided as optional reading and the content of the PAB risk report summary appears to have remained consistent.

The risks reported to the PAB at six-month intervals as compared to those at February 2018 are as follows in Table 5⁴⁴:

⁴³ PAB also receives information on risks when they review the British Columbia Utility Commissions quarterly reports

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Table 5 above shows that within six months of the 17 risks communicated to the PAB in February 2018, only four still remained reportable to the PAB i.e., the risk had a residual risk rating level of 10.5 or higher. Of the non-reportable risks, six were closed and seven treated such that the residual risk rating was below 10.5 (of which three risks have been subsequently closed).

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In February 2018, geotechnical risk associated with the Highway sub project was the only geotechnical risk that had an assessed residual risk level rating high enough to be reportable to the PAB. While hindsight is a luxury not afforded to the project, it is apparent that the MCW contractor was experiencing significant geotechnical issues in 2017, and the MCW contract has turned out to be the area of highest geotechnical risk on the project. The February 2018 Risk Register did contain geotechnical risks for the MCW in Risk 182 - *Unknown ground/underground conditions impact design construction*, Risk 383 - *Excavated slope becomes unstable*, Risk 002 – *Actual Bedrock profile and other site conditions different from the base-lines*, and Risk 232 *Rebound and/or swell is greater than expected (Approach channel - Right Bank)* but, with residual risk ratings of 10, 10, 9 and 9 respectively, they were not reportable to the PAB⁴⁵.

Notwithstanding the existence of Risk 182, when, in mid-August 2018 movement in bedding planes (including BP33e) was observed (as noted in the geotechnical section herein), a new risk 814 - *Geotechnical issues on work fronts other than the Left Bank Diversion Tunnel* was created that highlighted geotechnical risk in the MCW and was reportable to the PAB with residual risk rating level of 11. Shortly thereafter, on October 17, 2018, Risk 874 – *Additional MCW work needed to meet RCC buttress requirements*⁴⁶ was created which had a residual risk rating of 10, so was not reportable to the PAB.

BC Hydro have stated that Risk 874 – *Additional work to meet Approach Channel, Powerhouse & Spillway RCC stability buttress requirements*, is the summary risk associated with the MCW foundation enhancements required because of the movement within BP33e. It was not until June 2019 that Risk 874 became reportable to the PAB when its residual risk rating increased to 10.5 although, based on the Accountability Reports, this risk does not appear to have been reported until August 2019. However, Risk 814 - *Geotechnical issues on work fronts other than*

⁴⁵S. 12, 14

⁴⁶ Risk 874 description has undergone the following changes to date: in June 2019, the description was changed to *Additional MCW work to meet Powerhouse, Dam & Spillway RCC buttress requirements*; in November 2019, the *Approach Channel* was added; in February 2020, the *Dam* was omitted; in April 2020 *MCW* was omitted; and in May 2020, *stability* was added. Risk 874 is currently described as - *Additional work to meet Approach Channel, Powerhouse & Spillway RCC stability buttress requirements*

the Left Bank Diversion Tunnel, which was created in August 2018, was reportable to the PAB with residual risk rating level of 11, appears to have been the main risk advising the PAB of potential geotechnical issues in the MCW. Risk 814 remained at a residual risk level rating of 11 until January 2020 when it increased to 11.5 and then, in February 2020, the Right Bank RCC Buttress was expressly excluded from the risk and its residual risk level rating fell to 9.5 and was no longer reportable to the PAB.

The numerical rules regarding when risks are elevated to the PAB appear very mechanical for a complex project. The numerical value of a risk may be downgraded by separating it into sub-risks (such as geotechnical risk), and each of the sub-risks may not reach the value requiring Board attention.

As of October 2020, the Risk Register shows that there appears to be eight significant⁴⁷ geotechnical risks associated with the MCW but only two, Risk's 874 and 927 are reportable to the PAB.

As such, it appears that initial risks are modified with risks elements associated with specific areas and elements being managed as separate risks or transferred to associated risks. The consequence of this carve out of individual risks appears to be that only a portion of the geotechnical risks were included in the PAB briefings which may have resulted in the full extent of the geotechnical issues associated with the MCW not being fully transparent to members of the PAB due to the application of the risk management process.

Further, the timing of the identification of new risks and the subsequent inclusion in watch and cost pressure listings appears largely to be based on current events on the project⁴⁸. AACEI defines a risk as *"an uncertain event or condition that could affect a project objective or goal"* as compared to a concern, defined as *"something that worries a stakeholder because it may give rise to a risk event or condition"*, or an issue, defined as *"a risk that has occurred or an unplanned question or decision that needs to be addressed by a process other than risk management"*. As such, while current events should be used to inform the risk management process, it appears the Site C Risk Management process may be being applied more as an issue and contingency management process rather than a proactive, forward-looking approach to risk management.

In addition, due to the changing description of individual risks and that some risks appear to be closed and then reopened as a different risk with no reference to the previous risk⁴⁹, it is

⁴⁷ Taken as risks with a risk level rating of 9 or above i.e., Risks 002, 182, 232, 383, 437, 814, 874, and 927.

⁴⁸ As an example, in addition to the geotechnical events noted above, Risk 1012 – "Stabilization needed for slide located within natural slope adjacent to the L3 gully", relates to the need to address an area that was subject to a natural slide and required stabilization work i.e., the risk has occurred and only funding is required.

⁴⁹ S. 12, 17

challenging to track and understand risk history, development, and trends, and if such trends are due to reduced or increased scope of risk being reported.

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⁵¹ Site C Risk Management Plan V7 (2020) page 19

⁵² Risk 803 - *Ongoing Main Civil Works Contractor Claims* was reported to PAB in July 2018 with a Residual Risk Level rating of 12. The risk was then not reported again until May 2019 as the assessed risk rating fell below 10.5 (varying between 9.5 and 10). It appears that both the assessed probability and potential cost consequence were reduced significantly from the multiple assessment in July, resulting in the lower risk rating.

8.7.3 Reporting of Geotechnical Risks

As outlined in the Geotechnical Section of this report, geotechnical related risks have had, and will continue to have, significant impacts on the project. Given the importance of this area of risk the following section discusses the history and reporting related to geotechnical risks, more specifically, Risk 874 and Risk 814.

A significant portion of the Geotechnical section of this report is related to the identification, engineering analysis, evaluation of potential mitigation options, and current plan to address movement below BP 33, and on BP 33e. As discussed, the TAB initially presented this issue to the PAB in October 2018, noting that the “if slip along this plane is considered in a stability analysis with conservative design parameters, the design Factor of Safety is violated. Remedial measures are available but are costly and could impact schedule.”⁵⁶

BC Hydro has advised that the risk associated with BP33e was included in Risk 874. Following the report to the PAB in October 2018, and due to its risk level rating, Risk 874 was not reported to the PAB until August 2019 when its’ residual risk rating level increased to 10.5. As

⁵⁶ October 2018 TAB report to PAB, page 6.

discussed in the Geotechnical section, impacts and potential mitigations were being regularly monitored, assessed, and evaluated by BC Hydro and TAB. While it appears that the preliminary focus on the mitigation was grouting and drainage, it is unclear from the Risk Register if the consequences of the potential requirement for more significant mitigation measures were also contemplated. **S. 12, 17**

That Risk 874 was not reported, due to its risk rating being below 10.5, in a qualitative risk analysis, appears to highlight the limitations in the BC Hydro risk reporting framework. Furthermore, the lack of a quantitative assessment of the risk, with an attempt at a low, most likely, high estimate determination, again appears to highlight a gap in the Risk Management framework.

The potential issues and gaps with the CRA process are discussed above; however, it should also be noted that the December 2019 CRA excluded any additional potential cost impacts of Risk 874.

The issues related to the right bank geotechnical issues appear to have been initially reported to PAB as part of Risk 814. Table 10 below details the residual risk rating level and risk comments reported to the PAB from January 2019 to June 2020 in respect of Risks 814 and 874⁵⁷.

Table 10 – Details of reporting to the PAB from January 2019 to June 2020 for Risks 814 and 874

Date	Risk	Level	Comments
January 2019	814	11	<i>Performance and response of the excavations on the right bank are under assessment to confirm with the design basis for foundation conditions and/or determine any adjustments. Outcome of assessment may result in changes in drainage measures or grouting later in project schedule. The results to date indicate the depth of the shear key is sufficient; however, requires continued monitoring and geology mapping during excavations.</i>
February 2019	814	11	<i>Performance and response of the excavations on the right bank are under investigation to confirm with the design basis for foundation conditions and/or determine any adjustments. Outcome of investigation may result in changes in drainage measures or grouting later in project schedule. The results to date indicate the depth of the shear key is sufficient; however, requires a hydrogeological study, continued monitoring and geology mapping during excavations</i>
March 2019	814	11	<i>Performance and response of the excavations on the right bank are under investigation to confirm with the design basis for foundation conditions and/or determine any adjustments. Outcome of investigation may result in changes in drainage measures or grouting later in project schedule. BC Hydro has issued a revised design for the spillway roller-compacted concrete buttress shear key. This requires additional monitoring; continued monitoring and geology mapping during excavations.</i>

⁵⁷ Based on PAB reports issued for the period.

Date	Risk	Level	Comments
April 2019	814	11	BC Hydro awaiting outcome of the right bank buttress investigation that may result in changes in drainage measures or grouting later in project schedule. BC Hydro will continue monitoring and geology mapping during excavations.
May 2019	814	11	No update
June 2019	814	11	No update
July 2019	814	11	No update
August 2019	814	11	No update
	874	11	Initial work on deformation and seepage modelling completed with more modelling work being undertaken. Some geotechnical instrumentation has been installed with water testing within the rock still to be undertaken.
September 2019	814	11	Additional horizontal drains are needed in the right bank core trench; this work is currently underway. There was a shotcrete fallout in the right bank drainage tunnel; currently safe work procedures are under review by WorkSafeBC. Once the procedures are accepted, the tunnels will undergo an engineering review and remediation plans will be put in place. BC Hydro will continue monitoring and mapping the geology during excavations.
	874	11	Deformation modeling of the Roller Compacted Concrete dam buttress is complete and was presented to the Technical Advisory Board in early September 2019. Additional analyses and monitoring is ongoing, and testing is planned for early 2020 and is expected to be complete by the end of summer 2020.
October 2019	814	11	Horizontal drain installation in the right bank core trench is ongoing. BC Hydro and Peace River Hydro Partners are still working to resolve the right bank drainage tunnel shotcrete fallout in order to move forward with remediation. BC Hydro will continue monitoring and mapping the geology during excavations.
	874	10.5	Engineering is completing assessments of the roller-compacted concrete buttresses drainage and grouting and the initial findings are scheduled to be presented to the project Technical Advisory Board in January 2020.
November 2019	814	11	A safe work procedure for remediation of the right bank drainage tunnel shotcrete fallout has been developed and work is currently underway.
	874	10.5	Design changes on the right bank is likely and to include deeper grout holes, additional drainage and adjustments in the approach channel grouting platform. Updates are underway and will be presented to the project Technical Advisory Board January 2020.
December 2019	814	11	In terms of the drainage and grouting, the analysis is not completed. Current status indicates increase likelihood for additional measures. This will include additional tunneling or other measures to achieve drainage and stability criteria.
	874	10.5	We are working through the impacts of the roller-compacted concrete buttress changes with the main civil works contractor. Analysis suggests that additional measures may be needed (i.e. changes to water stops and a till blanket).
January 2020	814	11.5	Analysis in ongoing regarding to the foundation performance on the right bank. The results from the recent analyses and the project team's preliminary recommendations were presented and discussed in detail with the Technical Advisory Board during Meeting 21 in January 2020. Additional mitigations measures are likely.
	874	10.5	No update
February 2020	874	11.5	Engineering is investigating options to enhance the foundations under the powerhouse and spillway roller-compacted concrete buttress.
March 2020	874	11.5	Engineering is continuing to investigate options to enhance the foundations under the powerhouse and spillway roller-compacted concrete buttress.

Date	Risk	Level	Comments
April 2020	874	12	<i>Conceptual design Spillway and Power Buttresses mitigation measures were presented to Technical Advisory Board on March 27, 2020 and on April 2, 2020 a Technical Advisory Board follow-up meeting to discuss the right bank measures and assessments underway for the earth fill dam foundation. Earth filled dam analysis is continuing to address possibility of high pore pressures during construction and continued characterisation from recent mapping of the strength and stability of the foundation including stability on deeper bedding planes. Technical Advisory Board conference call workshops are planned for May 2020 and a meeting in June 2020.</i>
May 2020	874	12	<i>Engineering is investigating and preparing options; Estimating is working in parallel to initiate cost estimates.</i>
June 2020	874	13	<i>Work is continuing on the options for the foundation enhancements for the right bank structures, including recommendations on criteria and evaluation of options to meet project requirements. The project team is holding regular meetings with the TAB to discuss progress and obtain their input.</i>

From the above, and as confirmed in TAB reports, BC Hydro took the risk seriously and performed extensive investigation, monitoring, analysis, and engineering over a significant period of time to determine the extent of the foundation problems and identify options to mitigate and/or address the risk/issue. By the end of 2019, early 2020, the project was aware that additional measures to address the issue were likely although these, and their potential financial implications to the project, do not appear to have been discussed much, if at all.

The cost information available to the PAB regarding the potential cost impact of the MCW geotechnical risk to the project appears to be limited to information in the risk summary. As reported to the PAB in May 2020, Risk 874 had an estimated severity of S. 12, 17 and a probability of Likely (60% probability of occurrence). A month later in June 2020 this had increased to an estimated severity of S. 12, 17 and a probability of Likely (60% probability of occurrence).

S. 12

BC Hydro has been working to define the scope of the problem and remedial measures required for two years. However, under the CRA process the potential cost of this risk has not been identified. Furthermore, the risk management process did not identify the current magnitude of the potential additional cost until June 2020. This appears to be a significant limitation in the current risk management and CRA processes.

Since the potential for costly foundation enhancements was well known and actively being researched for an extended period of time, it may have been appropriate to alert Treasury

Board to the potential costs, or a range of potential costs, associated with this risk at an earlier date.

Currently BC Hydro is preparing a CRA and new, bottoms up estimate to complete the project or the fall of 2020, after the submission of this report.

S. 12

Recommendation 11:

The risk reporting policy outlines when risks are or are not reported and discussed with PAB, TAB, and BC Hydro Board of Directors based solely on a numerical value. When risks are split or are persistent at a value below the threshold (10.5) they will not be regularly reported. This potentially creates situations where high impact risks may not be consistently reported. It is recommended that BC Hydro re-evaluate its risk reporting framework in order to provide a higher degree of transparency.

8.8 Independent Oversight of Risk Management Process

The following section will review the undertakings provided by BC Hydro, concerns and comments raised by EY on the processes utilized and their overall effectiveness.

8.8.1 Risk Management Reset

S. 12

⁵⁸ PAB Interviews.

Furthermore, the working relations between BC Hydro and the Independent Advisor has experienced a degree of strain.

Based on discussions with BC Hydro, many of the recommendations in the May 2018 EY report were implemented.

EY previously identified a number of areas in the risk management process that would benefit from improvement as detailed in Appendix 8. While some of EY's recommendations have been implemented a number have not yet been addressed.

At the BC Hydro and PAB meeting held on September 18, 2020, EY prepared a slide detailing recommendation for improvement of the CRA and SRA process as per Figure 8 below.

S. 12

Figure 8 – EY Recommendations for improvement of the CRA and SRA process

The meeting ended without the slide being presented.⁵⁹ It is understood that the slides are available to the PAB. While it is apparent that some progress has, and continues to be made, it does not appear to amount to a “joint comprehensive reset of risk management” given the nature of the current recommendations some two and a half years after S. 12

⁵⁹ Peter Milburn was in attendance.

8.9 Current Re-baseline Activities

As noted, the project is currently (October 10, 2020) undergoing both an update to the CRA, and a re-baseline of the project budget.

Rebaselining is the process of updating the project budget and divisions between Base Budget, Contingencies and Reserve to reflect the current project status and anticipated cost to complete. As risks are realized they need to be funded. As it is apparent that contingencies will be spent, they should be identified as part of the base. This is necessary so funds are appropriately placed into “Base Budget” when it is known that spending is due to rescoping, new features, or contract awards.

As noted, the project is currently undergoing both an update to the CRA, and a re-baseline of the project budget. **S. 12**

As existing risks are closed or are realized, and the new risks identified, the silos between Base Budget Contingencies and Reserve need to be revisited and updated. This is necessary so that funds are appropriately placed into “Base Budget” when it is known that spending is due to rescoping, new features, or contract awards.

At the September 18, 2020 joint BC Hydro and PAB meeting it became clear that, while BC Hydro’s re-baselining work was fully underway, EY had not been involved in, or reviewed, any portion of the work.

S. 12

When developing a new baseline BC Hydro should take into account anticipated project performance, known and anticipated issues, challenges and risks, in order to develop the most

accurate estimate of the final cost at completion

Recommendation 12:

The Rebaselining exercise should include the following:

- ***Cost impacts of all the elements that were presented as key risks in the July update.***
 - ***A narrative should be created outlining the methodology and assumptions utilized in the preparation of the rebaseline of both the cost estimate and schedule. Significant changes to previous process and/or methodology should be clearly noted.***
 - ***The cost pressures and watch list items should also include schedule related cost impacts (based on the SRA's anticipated completion date).***
 - ***The Independent Advisor, EY, would have access to and oversight of the entire process.***
-

9.0 Construction and Claims Management

9.1 Construction

The construction of the Site C dam is one the largest and most complex projects in the Province's history.

As would be expected, a project of this size and complexity has numerous components, the key components include:

- Access roads in the vicinity of the site and a temporary construction access bridge across the Peace River at the dam site.
- Construction of two temporary cofferdams across the main river channel to allow for construction of the earth fill dam.
- Worker accommodation at the dam site, with other workers being housed off site and, in the region.
- The realignment of six segments of Highway 29 over a total distance of 30 kilometers
- Shoreline protection at Hudson's Hope.
- Two new 500 kilovolt transmission lines that will connect the Site C facilities to the existing Peace Canyon Substation, along an existing right-of-way.
- Construction of the Site C South Bank substation.
- Three 1-kilometre 500 kilovolt transmission lines to connect the Site C Substation to the Site C Powerhouse.
- Two 10.8 meter diameter diversion tunnels and associated intake and outlet structures.
- Slope stabilization of the north bank above the dam site.
- A buttress of roller-compacted concrete to support the valley wall, provide the foundation for the concrete structures and form the south abutment of the earth fill dam.
- An earth fill dam, approximately 1,050 meters long and 60 meters high above the riverbed.
- A 1,100-megawatt generating station with six Francis turbine generating units and associated intake structures, penstocks, and spillways; and,
- An 83-kilometre-long reservoir that will be, on average, two to three times the width of the current river.

The project is divided into approximately 30 major contracts. These include onsite contracts for Main Civil Works, Generating Stations and Spillways Civil construction, Turbines and Generators, Balance of Plant, and Worker Accommodation, as well as contracts for clearing, transmission lines and highway construction.

While most contracts are based on the traditional Design-Bid-Build model, a few departed from this approach. These include the contracts for Turbines and Generators (Design-Build) and Worker Accommodation (Design-Build-Operate with partial financing). Some contracts were direct awards to First Nations.

In a Design Bid Build (DBB) contract model the design is completed independently under the direction of the owner (BC Hydro). Each contract also has specific risks identified and allocated to either the owner or the contractor. Therefore, any design errors or changed conditions are generally BC Hydro's responsibility for risks retained by the owner. The structure of the contracts provides proponents with payment on a unit price basis for most activities, with a few being paid on a lump sum basis.

The two largest DBB contracts (Main Civil Works and Generating Stations and Spillways Civil) went through a Request for Qualifications and Request for Proposals procurement process. This process reduces the proponents down to a smaller group based on ability to complete the work. It also ensures that the entities bidding on the work are qualified and capable of completing the work.

9.1.1 Description of Main Contracts

9.1.1.1 Main Civil Works (MCW)

BC Hydro awarded the MCW Contract at approximately \$1.75 billion to Peace River Hydro Partners (PRHP) a joint venture led by Acciona (Spain), Samsung (Korea), and Petrowest (Canada). Petrowest went into receivership in 2017 and is no longer part of the joint venture. PRHP must complete the main dam work by July 1, 2023 in order to fill the reservoir and commission the powerhouse units.

The contractor is a joint venture led by Acciona from Spain and Samsung from South Korea. The partnership is titled Peace River Hydro Partners (PRHP)

The scope of the MCW contract includes the construction of the following major components:

- Diversion works, including two concrete-lined, 10.8-meter diameter tunnels. Tunnel No. 1 is 700 meters in length and Tunnel No. 2 is 790 meters in length.
- Diversion tunnel inlet and outlet portals, and approach channels.
- Excavation and bank stabilization.
- Relocation of surplus excavated material (including management of discharges).
- Dams and cofferdams (including a zoned earth embankment dam 1,050 meters long and 60 meters above the present riverbed, and stage 1 and 2 cofferdams).
- Roller-compacted concrete (including a buttress approximately 800 meters long made up of approximately 1.7 million cubic meters of concrete).
- Haul Roads.

9.1.1.2 Generating Station and Spillways (GSS)

The GSS contract was awarded March 2018 for approximately \$1.60 billion to a four-company joint venture of Aecon, Flatiron, Dragados and EBC (AFDE). [S. 12, 17](#)

Prior to the COVID period the

majority of the GSS contract scope was trending two weeks ahead of schedule except for the penstock installation was 3 months behind schedule.

The GSS scope of work includes the construction of the following major components:

- Generating station and spillways civil works.
- Powerhouse: Concrete placements, installation of structural steel, installing hydraulic gates.
- Inlet headworks: Concrete placements, construction of the penstocks, and installing hydraulic gates.
- Spillways: Concrete placements and installing hydraulic gates.
- Cranes, which includes the supply and commissioning the powerhouse cranes.
- Tailrace gantry crane, and headworks gantry crane.
- Hydromechanical equipment, including the supply of all gates.

9.1.1.3 Turbines and Generators (T&G)

The T&G contract, a design-build contract was awarded in March 2016, for approximately \$464 million to Voith S. 12, 17

The scope of work for turbines and generators includes the complete design, fabrication, supply, installation, testing and commissioning of six turbines, generators, governors, and exciters.

9.1.1.4 Balance of Plant (BOP)

S. 12, 17

The Balance of Plant contract scope includes the work and equipment required to complete the construction of the generating station and spillways that is not included in the scope of work of the generating station and spillways civil works contract and the turbine and generator contract, including:

- Installation of mechanical and electrical water-to-wires equipment supplied by others.
- Provision of mechanical and electrical systems.
- Installation of protection, control, telecom, security, and similar systems. Provision of miscellaneous items and structures, including the permanent fish passage facility.
- Provision of building systems, such as fire detection and protection; heating, ventilation, and air conditioning (HVAC); domestic water; etc.
- Completion of interiors to the specified finished state.
- Temporary construction, decommissioning and site clean-up.

The Balance of Plant contract includes design-bid-build, design-build, and supply-install components.

BC Hydro has specified its requirements by providing performance specifications, reference drawings, and interface requirements, and the contractor(s) will be responsible for designing and supplying the equipment in accordance with these requirements.

9.1.1.5 Worker Accommodation

The Worker Accommodation contract was awarded to ATCO Two Rivers Lodging Group Limited in September 2015, as a Design Build Operate Finance Maintain Contract. The contract has a completion date of December 2023. The awarded value was approximately \$463.5M.

The Site C worker accommodation camp was originally designed to house 1,600 workers with services and utilities to accommodate a total capacity of 2,200. The contract appears to be functioning well and was not examined as a part of this review.

In 2018, various scenarios were modelled to forecast required bed nights, and these indicated peaks in camp capacity greater than 1,600 beds occurring in 2020, 2021 and 2022 based on forecasted work volumes. As a result, in 2019 the first phase of a two-phase expansion was completed which added 150 beds. Phase 2 added a further 450 beds in June 2020. [S. 17](#)

9.1.2 Observations

In this section we will provide observations related to the major contracts of the Site C Project. The evaluation and comments that follow are derived from a review of the documents provided, interviews of PAB members, project team members, and the Construction Advisor. Limited field independent field visits were conducted due to COVID restrictions, although many team members have visited the site in the past and are familiar with it.

9.1.2.1 Major Civil Works (MCW)

9.1.2.1.1 Background comments

Civil construction is generally subject to more unknown risks than other forms of construction. Geotechnical issues, weather, production problems all create risks for the contractor and owner.

9.1.2.1.2 Contractor Performance

Based on discussions and the information provided, it appears the contractor has generally produced quality results. [S. 12, 14](#)

9.1.2.1.3 BC Hydro Field Supervision of (MCW) Contractor

The performance of the BC Hydro field personnel is viewed as mixed by our construction expert, Frank Margitan, and BC Hydro's Construction Advisors.

On the right bank the BC Hydro personnel appear to be competent and are working collaboratively with PRHP personnel. On the left bank, which includes an extensive amount of excavation and the diversion tunnel, it appears that the people on the ground working for BC Hydro lacked the requisite experience to handle a large contract of this nature. BC Hydro supervision personnel should be skilled and have experience with managing the equipment and conveyor systems on site.

It was also noted that BC Hydro personnel appear to be spending too much time in the field office and did not have enough time in the field to adequately monitor and supervise the contractor's work.⁶⁰ Similar comments have been written in the Construction Advisor's reports to the PAB.

During the interviews, several comments were made about insufficient numbers of experienced resources in both the field and field office. BC Hydro needs to consider both the impact of additional resources on the ability to achieve project goals, as well as the impact on the project budget.⁶¹

9.1.2.1.4 Earth Fill Dam

Having experienced and effective field supervision will be the key to success on the Main Dam. There are several potential risks which could have a negative impact on both cost and schedule. These include potential disputes related to cleaning up of the river bottom, embankment quality, and weather impacts.

⁶⁰ Steve Summy Report – See Appendix 23

⁶¹ Frank Margitan Report – See Appendix 22

Based on information gathered during this review, it is our opinion that currently there is an insufficient number of experienced personnel within BC Hydro at the time of writing of this report. This view is also held by BC Hydro’s Construction Advisors. As this work will probably be scheduled as a double shift 7 days per week, more people with Dam construction experience should be added.

Recommendation 13:

It is recommended that BC Hydro add additional skilled people with extensive experience to the construction management team. This additional resource when coupled with the Construction Advisors would add field capacity and could provide training for less experienced personnel.

S. 12, 14, 17

9.1.2.1.5 Schedule

BC Hydro has had difficulty in securing a timely work schedule from PRHP.

. This has been identified as a key issue by all of the Construction Advisors.

Recommendation 14:

It is acknowledged that it is difficult to produce at times due to changes. However, we are of the view that requiring the contractors to produce a full schedule should be given a higher priority when working together on issues.

9.1.2.1.6 Contractor Relationship

It is clear that the working relationship between PRHP and BC Hydro could be improved. S
1

The apparent lack of a developed partnership may underpin many of the problems BC Hydro is experiencing. Employees describe communication as poor and describe the ability to work together to solve problems as limited.

This topic will be discussed again in this section.

9.1.2.2 Generating Station and Spillways (GSS)

9.1.2.2.1 Background Comments

The GSS contract is a form of civil construction that BC Hydro is very familiar with and has experienced field personnel. The contractor AFDE has completed many similar installations.

The AFDE team has senior people from each of the companies in the joint venture. All these people have extensive Powerhouse and Spillway experience with most of them having worked exclusively in Canada on major hydro projects. In addition, some of the managers have experience on several projects with BC Hydro.⁶²

9.1.2.2.2 Contractor Performance

Through the interview process it was apparent that the contractor supervision team is perceived to be a highly competent group producing quality work and productivity.

The AFDE craft people also received positive comments. AFDE craft labour is locally sourced, and the contractor has been able to leverage existing relationships. As of October 2020, AFDE has approximately 600 craft people onsite. Through the interview process positive comments related to the quality, productivity and safety of the craft labour was received.

9.1.2.2.3 BC Hydro Field Supervision of GSS Contractor

The BC Hydro team is also experienced, including extensive Canadian hydroelectric construction experience. The team appears to be effective in their supervision of the contractor. Quick decision making by BC Hydro was also cited as positive contributing factor.

9.1.2.2.4 Field Supervision and Contractor Relationship

The field relationship between the contractor and BC Hydro appears to be positive. The Project Directors for the two organizations have worked together on previous projects. A team effort was evident between the two parties and full cooperation is evident. The BC Hydro team understands the work and is quick to recognize and make decisions. It has also been noted that BC Hydro personnel are actively involved in the work and engaged in jointly solving issues.⁶³

9.1.2.3 Turbine and Generator (T&G)

The Turbine and Generator contract was awarded in 2016 at \$464 million to Voith S. 17

The Contractor is a joint venture with the partners Aecon-Flatiron- Dragados-EBC. They are commonly referred to as AFDE.

⁶² Frank Margitan Report

⁶³ Steve Summy Report

BC Hydro appears to be managing this contract well and is positioned to successfully deliver this sub-project. Voith and BC Hydro have extensive experience working together. In addition, Voith and BC Hydro have skilled and experienced supervision and craft labour.

Testing has been completed in the Voith laboratory in Lausanne Switzerland. This laboratory is recognized as a world-class facility so it is our view that the risk of performance or output issues should be minimal.⁶⁴

9.1.2.4 Balance of Plant (BOP)

The balance of plant contract is in the procurement stage. It should be noted that supply of key equipment (step up transformers, generator terminal equipment, AC/DC station service equipment, protection and control panels, circuit breakers, large valves etc.) is not included in the Balance of Plant contract. These supply contracts were issued through separate procurement processes and are in progress.

Voith is a globally active engineering company. With its broad portfolio covering plants, products and industrial services, Voith supplies essential markets: energy, oil & gas, paper, raw materials and transport and automotive.

S. 12, 17

has its own risks.

This approach

⁶⁴ Frank Margitan Report

⁶⁵ Frank Margitan Report

9.2 Claims Management

The comments on claims administration are focused on the MCW Contract as it appears from our interviews and the information reviewed that claims made on the other contracts have proceeded in an appropriate manner and are not currently of significant concern.

BC Hydro took two separate approaches to claims settlement when reviewing PRHP's claims under the MCW Contract:

- **Contractual:** This approach focuses on what a contractor is legally entitled to under its contract. Settlement usually results in a change order.
- **Commercial:** This approach involves payments, incentives or changes to contract terms that are beyond the contractor's legal entitlement. Commercial settlements usually address important business imperatives. On Site C, two of the main imperatives have been to avoid the cost of a one-year delay in river diversion and handover dates to other contractors.

S. 12, 17

9.2.1 Cost of a river diversion delay

S. 12, 17

S. 12, 17

⁶⁶ BC Hydro Submission to the British Columbia Utilities Commission Inquiry into the Site C Clean Energy Project, page 39. When these submissions were prepared, diversion was to take place in the fall of 2019.

S. 12, 17

It would appear that there is opportunity for improvement to the accuracy and quality of cost and schedule information presented to the PAB.

Recommendation 15:

While the river diversion has been successfully accomplished there are many cost and schedule issues remaining. BC Hydro is currently conducting a Re-baselining exercise of the budget to complete the project and the risks.

We recommend that there is an independent and transparent review of the estimates completed including the cost of delay.

9.2.2 Analysis of Contractual Entitlement Claims Process

9.2.2.1 Claims Review

We have conducted extensive interviews with the project team members who analyzed the contractual claims submitted by the contractor. We found their work to be of high caliber and they have provided the negotiators with a good assessment of PRHP's contractual entitlement. Their work has been thorough, and BC Hydro's evaluations are supportable.

9.2.2.2 Timeliness

BC Hydro did not respond to some claims in a timely manner.

BC Hydro relied on a matrix-based team in Vancouver.⁶⁸ On Amending Agreement #3 the claims team took approximately 10 months to gather information, review the information with PRHP and evaluate the claims before negotiations began.

⁶⁸ August 31, 2020 interview of BC Hydro Contract Administration Team.

S. 12, 17

S. 12, 14, 17

9.2.2.3 Claims Administration

S. 12, 14

BC Hydro's responsibility for claims management and settlement has been divided among a number of individuals with significant operational responsibilities. These individuals must therefore split their attention between claims management and their primary duties. Moving forward, we find that implementing these practices would likely lead to improved claims administration and settlement.

Recommendation 16:

It is recommended that BC Hydro give consideration restructuring their claims administration to include:

- 1. A senior executive whose primary duty is claims negotiations.***
- 2. A senior claims administrator whose sole responsibility is claims management and who has contractual and financial authority to negotiate claims subject to board approval. The senior claims administrator generally meets with his or her counterpart on a weekly basis.***
- 3. A qualified and experienced onsite claims team, with sufficient onsite personnel and resources to respond to the contractor, and additional contract administration, document control, estimating, scheduling and legal support from head office. The leader of the onsite team should plan daily meetings with the contractor to address claims in a timely manner and to build a strong working relationship. This would allow Issues to be discovered and addressed promptly.***
- 4. Experienced field supervisors, particularly in the technical aspects of the onsite construction (looking forward, on Site C this would include main dam embankment preparation and construction). An experienced field supervisor can recognize changes for which the owner is responsible, address contractor issues as they arise, report any potential claims to the onsite claims team and collect information to support the owner's position on claims.***
- 5. An external experienced forensic engineering and claims specialist, to assist with strategy development and claim preparation.***
- 6. Trained personnel whose duties include recording information and preparing meeting minutes, signing off on contractor work, and responding to contractor correspondence and claims.***

Recommendation 17:

BC Hydro should consider a formalized claims management plan and program to react, counter, and where possible proactively respond to claims.

9.2.3 Amending Agreement #3
S. 12, 14

S. 12, 14

-

9.2.3.1 Contractual Entitlement Claims Evaluation

S. 12, 17

S. 12, 14

⁶⁹ June 4, 2018 PAB Meeting materials, p. 60.

⁷⁰ At page 2.

S. 12, 14, 17

9.2.4 Amending Agreement #7

S. 12, 14, 17

⁷¹ At page 12.

⁷² Briefing Note, p. 8.

9.2.4.1 Contract Entitlement Claims Evaluation

S. 12, 14, 17

9.2.4.2 Commercial Settlement

S. 12, 14, 17

⁷³ November 8, 2019 PAB Meeting materials.

⁷⁴ See “change in direction” at October 3, 2019 meeting, Briefing Note, page 5.

⁷⁵ Briefing Note, page 12.

⁷⁶ Briefing Note, page 21.

⁷⁷ Briefing Note, page 12.

⁷⁸ Briefing Note, page 12.

9.2.5 Future Claims
S. 12, 14, 17

⁷⁹ July 6, 2020 PAB Meeting Materials page 17.

10.0 Summary

BC Hydro has a dedicated team who have expended exceptional effort to complete the Site C Project despite a high level of challenges. Our team found no evidence of neglect, or dereliction of duties. Everyone interviewed provided information in an open and assisting manner. The Engineering Design Team were honest about the challenges on this project but have worked effectively on issues as they arise. The Technical Advisory Board has a high level of geotechnical expertise available to them.

Many aspects of the project are going well, including the Turbine and Generators, Worker Accommodation, and the COVID-19 response.

Most of the opportunities for improvement relate to the Main Civil Works contract and the geotechnical challenges. BC Hydro would likely benefit from the addition of more personnel with a background in large civil projects at all levels in the project structure including the Project Assurance Board (PAB).

The cost and risk systems have not been effective on this project. The CRA has not been an accurate predictor of costs. The risk system would benefit from a “reset” as BC Hydro committed to in January 2018. This could be accomplished through an effective joint effort between EY and BC Hydro.

We believe that BC Hydro would benefit from considering all of the recommendations contained in this report. It is recognized that BC Hydro may not wish to implement all of the recommendations of this report for valid reasons including availability of resources, time for implementation, feasibility or changes of circumstances.

Additional Considerations for Provincial Government

As noted above, PRHP is currently comprised of Acciona and Samsung. Acciona has been active in the BC marketplace and been awarded a number of large construction contracts, including the Pattullo Bridge Replacement Bridge Project, the Broadway Subway Line, and the Northshore Wastewater Treatment Plant. Samsung has not been as active in the local market. The agencies and governmental organizations that own or manage these projects, including BC Hydro and the Transportation Investment Corporation should consult with each other, and share lessons learned in order to develop strategies for a better partnership with Acciona.

11.0 Appendices (Attached)

11.0 Appendices Site C

Appendix Listing

Appendix 1 – Statement of Objectives		Governance 6.2
Appendix 2 - BC Hydro Board of Directors Terms of Reference		Governance 6.3.1
Appendix 3 – Site C Technical Advisory Board Terms of Reference		Governance 6.3.2
Appendix 4 – Site C Project Assurance Board Terms of Reference		Governance 6.3.3
Appendix 5 – EY Statement of Work		Governance 6.3.4
Appendix 6 – EY Current State Assessment of Project Controls and Risk, May 2018		Governance 6.4.2
Appendix 7 – BC Hydro Letter Disagreeing with conclusions reached by EY		Governance 6.4.2
Appendix 8 – EY Report on Risk		Governance 6.4.2
Appendix 9 – EY Letter of Termination		Governance 6.4.2
Appendix 10 – BC Hydro Officials’ Comments (re EY excessive billing)		Governance 6.4.2
Appendix 11 – EY response to Assertion of Excessive Billings		Governance 6.4.2
Appendix 12 – MCW Geotechnical Cost Analysis		Geotechnical 7.2
Appendix 13 – 20200401 RB Major Changes Estimate V11 Piles Only		Geotechnical 7.5.2
Appendix 14 – Geotechnical Detailed Chronology		Geotechnical 7.6
Appendix 15 – Site C Risk Management Plan V7		Risk Management 8.3.2
Appendix 16 - Site C Risk Management and Cost Management		Risk Management 8.4.1
Appendix 17 - Response from BC Hydro regarding relationship between Risk Register and Cost Pressure and Watch Lists.		Risk Management 8.4.4
Appendix 18 – Site C Project Change Control and Contingency Management Memo		Risk Management 8.4.4
Appendix 19 – Dec 1, 2019 CRA Memo		Risk Management 8.5
Appendix 20– Additional Information Related to CRA		Risk Management 8.5.1
Appendix 21 - Correspondence between EY and responses from BC Hydro (highlighted in yellow).		Risk Management 8.5.1
Appendix 22 – Frank Margitan Report		Claims 9.1.2.1.2
Appendix 23 – Steve Summy Report		Claims 9.1.2.1.3

Appendix 1
Statement of Objectives

Project Title:	Site C Clean Energy Project		
SAP Project #:	YM-80004	Executive	
		Vice-President, Site C:	Ken McKenzie

1. Project data

1.1 Standard References

Project Phase:	Implementation
Originating Organization:	Site C
Project Initiator:	Mark Poweska
Project Sponsor:	Chris O'Riley
Executive Vice-President, Site C:	Ken McKenzie

1.2 Statement of Objectives Revision History

Phase/Stage	Revision No	Date
Implementation Phase	0	December 11, 2015
Implementation Phase	1	May 31, 2016
Implementation Phase	2	July 5, 2016
Implementation Phase	3	July 5, 2018

1.3 Project Background

BC Hydro will develop a dam and hydroelectric generating station on the Peace River in northeast British Columbia; referred to as the Site C Clean Energy Project (Site C or the Project). Site C will be the third hydroelectric generating station on the Peace River and would be located downstream of existing generating facilities at G.M. Shrum and Peace Canyon and their respective Williston and Dinosaur reservoirs.

Given the long lead time and the scope of evaluation and development work required for a major hydroelectric facility, BC Hydro adopted a multi-stage approach for the planning and evaluation of Site C. This approach provides multiple decision-making points during project development, and focuses on specific deliverables and objectives at each stage.

- Stage 1: Review of Project Feasibility (2004 to 2007). The review of project feasibility concluded that it would be prudent to continue to investigate Site C as a potential resource option to address the growing electricity supply gap within the province.
- Stage 2: Consultation and Technical Review (2007 to 2009). Stage 2 included comprehensive consultations with Indigenous groups, the public and stakeholders, as well as advancing environmental studies, field studies, engineering design and technical work.
- Stage 3: Environmental and Regulatory Review (2010 to 2014). Stage 3 included a cooperative federal-provincial environmental assessment, including an independent Joint Review Panel process.
- Stage 4: Stage 4 included obtaining approval to proceed to construction from the provincial government as well as other regulatory permits and approvals.

- Stage 5: Construction. The final stage includes construction, project commissioning, site reclamation, and demobilization.

The Site C project received federal and provincial environmental approvals in October 2014. These approvals followed a rigorous three-year review that concluded the effects of the project are justified by the long-term benefits it would provide.

The final investment decision by BC Hydro's Board of Directors and the Shareholder was issued in December 2014. Site preparation activities started in June 2015, with full project construction beginning in spring 2016.

2 Project Initiator's Statement of Summary Requirements

2.1 Statement(s) of the business problem or opportunity and the required response

Opportunity

The opportunity for Site C has been described and evaluated multiple times over Stages 1 through 4 of the project. The opportunity at the time of the decision to proceed to the implementation phase of the project was based on analysis completed as part of three processes:

- The 2013 Integrated Resource Plan (2013 IRP)
- The Site C Environmental Impact Statement (EIS) and the associated Joint Review Panel (JRP) process
- The review process to support the Government Final Investment Decision (FID) on the Site C project.

Both the 2013 IRP and the EIS/JRP process were performed on a common underlying basis, which included:

- The 2012 Load Forecast
- The 2013 IRP assessment of existing and committed resources
- The 2013 Resource Options Update
- Site C ratepayer costs prior to the 10-year Rates Plan.

The 2013 IRP and EIS/JRP concluded that Site C offered the best combination of financial, technical, environmental and economic development attributes as compared to portfolios of comparable resource options, and is the preferred option to meet the need for energy and dependable capacity within the planning horizon.

The FID analysis used the same underlying basis as the 2013 IRP and EIS/JRP but reflected updated information developed as part of the FID process, including:

- Review of the impacts of the 2014 Load Forecast on the economic case for Site C
- Extending portfolio modelling for the full 70-year economic planning life of the Site C project from the 30-year basis in the 2013 IRP
- Updated project schedule and capital cost reflecting changes made by Government during the Site C FID process
- Potential lower costs of IPP resources

- Reflection of the impact to ratepayer cost of Site C from the 10-year Rates Plan.

The FID analysis resulted in the same conclusion as the 2013 IRP and EIS/JRP – that Site C was the preferred option to meet the need for energy and dependable capacity within the planning horizon.

The results of these analyses are consolidated and described in the Business Case to support the Financial Investment Decision of December 2014. As per this business case, electricity demand in B.C. is expected to increase by approximately 40 per cent over the next 20 years, excluding any load from liquefied natural gas (LNG) facilities and before accounting for Demand Side Management (DSM) energy and associated capacity savings. Load from new LNG facilities that may request service from BC Hydro would further increase this load. BC Hydro looks to DSM as its first resource to meet customer demand, and the approved 2013 IRP sets an aggressive DSM target of 7,800 gigawatt hours per year (GWh/year) of energy savings and 1,400 megawatts (MW) of associated capacity savings by Fiscal (F) 2021:

- With DSM, it is projected that there will be a shortfall in BC Hydro's ability to meet peak capacity demand commencing in 2019, and a shortfall in total supply of energy commencing in 2022, using a mid-range load forecast and an expected LNG demand of 3,000 GWh/year.
- With DSM and without LNG the capacity shortfall remains the same (2019) and the energy shortfall begins in 2028.

In order to meet these energy and capacity Load-Resource Balance gaps, additional resources are required to meet both the energy and capacity needs of BC Hydro's customers.

As previously stated, based on the analysis of alternative resource options in the 2013 IRP and confirmed through due diligence completed at the FID, Site C provides the best combination of financial, technical, environmental and economic development attributes and is therefore the preferred option to meet the need for energy and dependable capacity within BC Hydro's planning horizon. Site C was identified as having the lowest levelized Unit Energy Cost at \$82 per megawatt hour (MWh) (\$62 per MWh on a cost of service basis), the lowest present value cost under expected conditions, the lowest projected impact on ratepayers, and the lowest level of greenhouse gas emissions from all of the portfolios of alternatives considered. Site C would also optimize the use of the Williston Reservoir, enabling Site C to deliver approximately 35 per cent of the energy produced at the W.A.C. Bennett Dam, with only five per cent of the reservoir area.

Refer to the Site C Business Case in Appendix E for further details.

Required Response

Build Site C for the earliest in service date of F2025 in order to add an earthfill dam and generating facility to the BC Hydro system, with the following characteristics:

- Six Francis turbines capable of providing the following:
 - An average of approximately 5,100 GWh/year of annual energy to the BC Hydro system
 - Approximately 1,100 MW of dependable capacity

- An operating life of more than 100 years
- Spillway capacity of 16,500 m³/s at Maximum Flood Level 466.3 m
- An earthfill dam that will impound a reservoir with the following characteristics:
 - Maximum normal operating level of 461.8m
 - Minimum normal operating level of 460.0m
- Substation and transmission infrastructure to connect the Site C generating station to the Peace Canyon switchgear building

Site C shall be constructed in accordance with the detailed User Requirements developed for the project which can be found in Appendix K of the Project Plan.

The construction of Site C is subject to obtaining all appropriate permits required to undertake the work and fulfilling the Crown's duty to consult, and where appropriate, accommodate Indigenous groups.

2.2 Safety, Security (Critical Infrastructure Protection) and Confidentiality Requirements

- Comply with NERC protection standards during construction of all critical infrastructure
- Incorporate Safety by Design principles into the dam, powerhouse, station and transmission design and construction
- Provide perimeter security during the construction of critical infrastructure

2.3 Maintenance and Operational Requirements

The Maintenance and Operational Requirements for the Project are embedded in the User Requirements which can be found in Appendix K of the Project Plan.

2.4 Indigenous Relations Engagement Strategy Requirements

The Indigenous Group Engagement Plan for the Project can be found in Appendix U of the Project Plan. The plan describes the approach to engagement with Indigenous groups by the Site C Indigenous Relations team during the construction of the Project.

2.5 Project Initiator's Interim Decision Requirements

No interim decisions have been identified.

3 Executive Vice-President's Proposed Summary Objectives to Achieve Requirements

3.1 Scope Objectives

The scope of the Project is summarized below:

Site Preparation Activities:

- Clearing of the Dam site area, reservoir, and transmission line corridor
- Construction of access at the dam sites and for the clearing work
- Construction of a temporary construction bridge across the Peace River near the dam site
- Upgrades to Ministry of Transportation & Infrastructure roads (OFR, 240, 269 and 271 Roads)
- Construction, operation and decommissioning of a worker accommodation camp
- Installation of construction power and telecommunications

Construct and Commission:

- An earthfill dam, approximately 1,050 metres long and 60 metres high;
- A buttress of roller-compacted concrete to support the valley wall, provide the foundation for the concrete structures and form the south abutment of the earthfill dam;
- Two 10.8 metre diameter diversion tunnels and associated intake and outlet structures;
- Slope stabilization of the north bank above the dam site;
- A 1,100-megawatt hydroelectric generating station with six Francis turbine generating units and associated intake structures, penstocks and spillways;
 - Spillway capacity of 16,500 m³/s at Maximum Flood Level 466.3 m
- An 83-kilometre-long reservoir with a maximum surface area of 9,330 ha;
 - Maximum normal operating level of 461.8m
 - Minimum normal operating level of 460.0m
- Erosion protection at Hudson's Hope and locations adjacent to Highway 29 as required;
- Realignment of six sections of Highway 29 over a total distance of approximately 30 kilometres;
- Construct the Site C South Bank Substation;
- Two 75-kilometre 500kV transmission lines to connect the new Site C substation to BC Hydro's existing Peace Canyon switchgear building including clearing and access;
- Three 1-kilometre 500kV transmission lines to connect Site C Substation to Site C Powerhouse;

- Expansion of the Peace Canyon Gas Insulated Switchgear;
- Upgrades at various stations; and
- Relocating reservoir utilities including transmission and distribution lines.

General Management:

- Implement all engineering, design, procurement, environmental, regulatory and permitting and construction activities as detailed in the general management work packages.

Mitigation and Compensation:

Address Environmental Assessment Certificate and Canadian Environmental Assessment Act conditions, and as applicable permits and authorisations, and includes the following work packages:

- Implement all of the authorized regulatory conditions including all the agreed mitigation and compensation requirements and benefits agreements
- Fish and Fish Habitat, including construction of temporary and permanent fish passage facilities, habitat mitigation programs and follow-up monitoring
- Vegetation and Wildlife, including habitat mitigation and compensation, retention of conservation lands, and follow-up monitoring
- Community Legacy Benefit Agreements and Community Impact Agreements
- Social and Land Programs, including the Agricultural Fund and measures to monitor transportation and community infrastructure and address impacts should they arise, recreation funding and reservoir boat launch replacements, and community infrastructure impacts
- Physical Environment Monitoring, including water quality, groundwater quality, air quality, noise, climate, and greenhouse gas emissions reporting during construction
- Heritage, including mitigation of paleontological, archaeological and historical sites, and provision of compensation funds to support local museums.

General Rights, Taxes and Grants:

- Acquire the properties and rights necessary for construction and operation of all Site C assets.

Indigenous Relations:

- Consult with Indigenous groups consistent with the honour of the Crown; and
- Negotiate and conclude agreements with Indigenous groups that meet goals and interests of the parties, and which fulfill Environmental Assessment process requirements

Site Reclamation, Demobilization and Project Closure

- In accordance with the Construction Environmental Management Plan, restore and revegetate disturbed construction areas to a safe and environmentally

acceptable condition as appropriate to the Project's temporary and permanent land use objectives

- Prepare project deliverables for acceptance by Generation and Transmission, Distribution & Customer Service in accordance with Generation Operating Order 1G-30 (Plant) and System Operating Order 1T-35 (Switchyard)
- Testing and commissioning
- Verify deficiencies are completed
- Prepare and issue Project Completion Report
- Perform project documentation archiving
- Complete all financial account transfers and closeout of project accounts.

3.2 Schedule Objectives

The schedule is described below.

Date	Description	Milestone Code
October 2020	5L5 500kV Transmission Line In-Service	1.01
November 2020	Site C Substation In-Service	1.01
August 2023	5L6 500kV Transmission Line In-Service	1.01
December 2023	Unit #1 In-Service	1.01
February 2024	Unit #2 In-Service	1.01
May 2024	Unit #3 In-Service	1.01
July 2024	Unit #4 In-Service	1.01
September 2024	Unit #5 In-Service	1.01
November 2024	Unit #6 In-Service	1.01

3.3 Cost Objectives

The total Expected Cost for implementing the project is \$9.992 billion. The total Authorized Amount for the project is \$10.7 billion in loaded, nominal dollars. The Authorized Amount includes a reserve held by Treasury Board of \$708 million (nominal).

Appendix 2

BC Hydro Board of Directors Terms of Reference

Duties and Responsibilities

Commercial Interests and Public Policy

The shareholders of a commercial enterprise elect a Board of Directors to represent their ownership interests. In contrast, Government, as the representative of the public at large, is the sole shareholder of a crown corporation and Cabinet has responsibility for appointing suitable Directors to govern that Corporation. In its representative capacity, Cabinet must ensure that the business affairs of its crown corporations are conducted in the public interest.

The positioning of a crown corporation raises unique challenges for its governance. Commercial crown corporations such as BC Hydro, are governed not only by financial results but also by expectations of corporate behaviour consistent with standards that apply to the public sector.

BC Hydro applies sound business practices to manage its operations and develop corporate strategies that result in a profitable business enterprise. It is also committed to discharging the public policy responsibilities that are assigned to it by its shareholder, the Government, and agreed upon by the Corporation.

One of the major challenges of the Board and its management is to ensure the Corporation is operated in a commercial manner while fulfilling its public policy responsibilities.

Government's Mandate

Government's *Governance Framework for Crown Corporations* establishes guiding principles for the governance of its Crown agencies. The framework also identifies roles and responsibilities for the Shareholder and its Crown corporations and provides for a *Government's "Mandate Letter"* to be jointly developed.

The *Mandate Letter* confirms the shared understanding of the Shareholder, represented by the Minister of Energy and Mines, and BC Hydro, on issues of corporate mandate, public policy, strategic priorities and performance expectations. The *Mandate Letter* also serves as the basis of agreement between the Shareholder and BC Hydro on those issues, priorities and expectations and will, as a result, be utilized in the development of BC Hydro's annual Service Plan.

All Directors are required to sign the *Mandate Letter*. The current *Mandate Letter*, which is issued annually and amended as required, is located at Tab 31.

The following subsections describe various areas of the Board's responsibilities, and specify the role of the Board, to be exercised either directly or through its Committees, in respect of those responsibilities:

Selection of Management

The Board has the responsibility to:

- a) Appoint and replace the President & CEO and monitor and evaluate her or his performance.
- b) Approve the President & CEO's compensation.
- c) Provide advice and counsel to the President & CEO in the execution of the her or his duties.
- d) Ensure plans are made for management succession and development.

Strategy Determination

The Board has the responsibility to:

- a) Annually review with management, and approve the Corporation's strategic business plan, taking into consideration the public policy responsibilities of the Corporation.
- b) Safeguard the Corporation's resources by approving annual operating and capital budgets, and major new project proposals while maintaining a focus on customer service.

Monitoring and Acting

The Board has the responsibility to:

- a) Monitor BC Hydro's progress towards the objectives set in the corporate strategic business plan, operating and capital plans, and to revise and alter its direction through management in light of changing circumstances.
- b) Direct management to ensure that systems are in place for maintaining the integrity of and implementing BC Hydro's internal financial control and management information systems.

Risk Oversight

The Board is responsible for risk oversight across the entire portfolio of activities and risks engaged in by the Corporation, including understanding the relationship between the principal risks. With input from management, the Board identifies principal risks to BC Hydro achieving its objectives, endorses management's recommendations around risk tolerance and ensures that systems are in place to manage and monitor those risks. Through its review of reports from the Chief Risk Officer and with input from the Board Committees, the Board of Directors will assess the appropriateness and consistent application of systems to manage principal risks within the Corporation and ensure that key matters of risk are brought forward for action by the Board and management.

The President & CEO of the Corporation, with advice from the Chief Risk Officer, is responsible for establishing processes, procedures and mechanisms by which key matters of risk are identified, and ensuring that strategies are developed to manage such risks.

The Board will receive quarterly reports from the Chief Risk Officer, and from other areas of the Corporation as it considers appropriate or timely.

Policies and Procedures

The Board has the responsibility to:

- a) Approve and monitor, through management, compliance with all significant policies and procedures that govern BC Hydro's operations.
- b) Approve and act as the guardian of BC Hydro's corporate values.
- c) Direct management to implement systems designed to ensure that BC Hydro operates at all times within applicable laws and regulations, and to the highest ethical and moral standards.

Corporate Communications

The Board must pay particular attention to the fact that it operates within a highly public environment. The actions of the Corporation have a significant public impact and there is a need to ensure communications with the public and Government are effective and appropriate.

The Board has the responsibility to:

- a) Ensure the Corporation has in place a policy to enable management and the Board to communicate effectively with the Government, stakeholders and the public generally.

TERMS OF REFERENCE BOARD OF DIRECTORS

Purpose

BC Hydro is a provincial crown Corporation established by the **Hydro and Power Authority Act** (the “**Hydro Act**”). The Directors and Chair are appointed by and accountable to Government. The Corporation also falls under the jurisdiction of the provincial Government through the **Utilities Commission Act, Financial Administration Act** and the **Financial Information Act**.

While the **Hydro Act** allocates the responsibility to “*manage the affairs of the Authority or supervise the management of those affairs*” to the Board, the Board delegates to the President & Chief Executive Officer the responsibility for the day-to-day leadership and management of the Corporation.

Directors are stewards of the Corporation. They have the responsibility to oversee the conduct of business, supervise management and endeavor to ensure that all major issues affecting the business and affairs of the Corporation are given proper consideration. In performing its functions, the Board also considers the legitimate interests in BC Hydro held by other stakeholders including employees, suppliers, customers and communities.

In supervising the conduct of business, the Board, through the President & Chief Executive Officer, sets the standards of conduct for BC Hydro and ensures the safety of its operations.

Procedures and Organization

The Board operates by delegating to management certain of its authorities, including spending authorizations, and by reserving certain powers to itself. Current approval authority levels are contained in the board-approved Financial Responsibility & Approval Policy.

The Board retains responsibility for managing its own affairs including the responsibility to:

- a) Annually review, in conjunction with the President & CEO, the skills and experience represented on the Board in light of the strategic direction of the Corporation, for the purpose of recommending the criteria Government should consider when appointing Directors.
- b) Make recommendations to the Chair and to Government regarding the criteria it should consider in making appointments to the Board.
- c) On the recommendation of the Chair, appoint, determine the composition of, and set the mandate for, Board Committees.
- d) Implement an appropriate process for assessing the effectiveness of Board governance, Committees and the contribution of Directors.
- e) Assume responsibility for the Corporation’s corporate governance practices and ensure they meet the needs of Government, the Corporation, and the public.

The Board of Directors has specific responsibility for environmental matters that have a bearing on the business of BC Hydro. On 23 May 2008, the Board adopted a standard that sets out these roles and responsibilities. In addition, certain environmental responsibilities were delegated by the Board of Directors to the Chief Executive Officer.¹ Please refer to Tab 5.

¹

- b) Ensure the financial performance of BC Hydro is adequately and promptly reported to the Government, the public, security holders and regulators.
- c) Ensure financial results are reported fairly and in accordance with generally accepted accounting principles.
- d) Ensure timely reporting of any other developments that have a significant and material effect on the performance of BC Hydro.
- e) Report annually to the Government on the Board's stewardship for the preceding year through the Service Plan Report.

General Legal Obligations of the Board of Directors

The Board is responsible for directing management to ensure legal requirements have been met, and documents and records have been properly prepared, approved and maintained. Legal duties are imposed on Directors. The basic legal duties are imposed at common law.

Directors are under a fiduciary² duty to BC Hydro to carry out the duties of their office:

- Honestly and in good faith.
- In the best interests of BC Hydro.
- With the care, diligence, and skill of a reasonably prudent person.

Directors have specific statutory duties and obligations under employment, environmental and financial reporting law as well as under the withholding provisions of taxation law.

² without being legally precise, a fiduciary duty is duty to act for the benefit of another, like a trustee

Appendix 3
Site C Technical Advisory Board Terms of
Reference

BC Hydro's Terms of Reference for the Site C Technical Advisory Board (TAB) and the basis for meeting agendas are as follows:

- The purpose of the TAB is to provide expert advice to BC Hydro. The TAB will report to BC Hydro's President and BC Hydro will appoint a representative to deal with the coordination of the TAB.
- There will be approximately two TAB meetings per year. Each meeting will generally be 3 to 5 days in duration at schedules suitable to BC Hydro, the TAB and the Project team. Depending on the topic(s) to be discussed, some meetings or additional meetings may be held with selected members of the TAB. Meetings will generally be held in Vancouver B.C. and/or at the Project site by Fort St. John. TAB meetings will include presentations by the Project team, inspections of constructed works, works under construction, and open discussions. Wherever possible, information packages will be prepared and issued to the TAB in advance of each meeting.
- The TAB will participate in periodic telephone conference calls with the Project team in between full TAB meetings as required to review specific technical issues. Each conference call will be about 1 to 2 hours in duration. Wherever possible, information packages will be prepared and issued to the TAB in advance of each conference call.
- The TAB will review the information packages provided by BC Hydro and become familiar with relevant information including project arrangement, site conditions and technical studies.
- The TAB will consider the key conclusions and recommendations made by the Site C Project team with respect to the proposed project arrangement and design, including overall suitability, consideration of site conditions, life cycle risks and uncertainties, safety, reliability and precedent.
- Based on the individual and collective experience and knowledge of the TAB members, reflect on the details of design and construction solutions presented by the Project team, consider and identify gaps in the scope and completeness of the solutions presented, the supporting engineering and construction studies and analyses, contractual arrangements, the nature of the risks and uncertainties, the potential consequences, and how these and other factors might contribute to or have influenced the selection of the recommended design and/or construction and contractual approach. At the end of each TAB meeting, the TAB will provide a verbal briefing and written report summarizing the advice of the TAB to BC Hydro.
- Specific questions may be posed in writing to the TAB to provide them with direction and focus for the key issues relevant at the time. The TAB will provide expert advice to answer these questions insofar as it is possible, but any such questions should not be limiting for the advice to be provided.

At the request of BC Hydro's Project Assurance Board, the TAB will designate, in consultation with BC Hydro, a single member to sit as a non-voting advisor to the Project Assurance Board, consistent with the TAB mandate. The TAB designate is not expected to participate in discussions of or advise on issues that are not properly within the mandate of the TAB and may be asked to recuse him or herself from meetings or discussions that involve confidential or

privileged information. The TAB designate will also be responsible to consult with the TAB, as deemed required by the TAB designate or requested by the Project Assurance Board, in order to provide the TAB advice directly to the Project Assurance Board

Appendix 4
Site C Project Assurance Board Terms of
Reference

TERMS OF REFERENCE SITE C PROJECT ASSURANCE BOARD

Establishment and Purpose

- The Site C Project Assurance Board (the “PAB”) was established by the BC Hydro Board of Directors (BC Hydro Board) as provided for under Tab 24 of the BC Hydro Board Governance Manual and pursuant to Treasury Board’s instructions to the Minister of Energy, Mines and Petroleum Resources in March 2018¹ to have the BC Hydro Board implement a new PAB oversight function to help ensure that the Site C Project (“the Project”) is completed on time and on budget, and that risks are appropriately identified, managed and reported on an ongoing basis.
- The purpose of the PAB is also to oversee the Project to ensure it is completed safely and in compliance with applicable environmental standards and other requirements.
- As part of its enhanced oversight work, the PAB will oversee Schedule and Cost Risk Analysis (SRA/CRA) over the life of the Project to completion and in-service date.
- For greater clarity, during meetings of the PAB, members are empowered to engage in meaningful debate with BC Hydro management (Management); with other attendees including the Independent Oversight Advisor; and amongst themselves in order to provide due diligence and to test the framework, methodology, inputs and outputs of the SRA/CRA, and their integration, on an ongoing basis and to recommend changes or seek clarification whenever appropriate.
- To discharge its purposes, the PAB will:
 1. meet monthly, or at such other times as may be agreed upon by the PAB;
 2. review and provide advice and recommendations to Management and the BC Hydro Board on the following elements related to the Project:
 - SRA/CRA;
 - monthly, quarterly and annually progress reports including major work packages; milestones; schedules; Project budget; issues management; and specific risk and mitigation plans and actions;
 - ad hoc reports to Government² or the BC Hydro Board;
 - requests to access the Project contingency allocation (overseen by the BC Hydro Board); and
 - requests to access the Project reserve (overseen by Treasury Board).
 3. provide advance review of any Project-related resolutions proposed for approval by the BC Hydro Board before those resolutions are provided to the BC Hydro Board, and to make a recommendation to the BC Hydro Board regarding whether or not the PAB believes the BC Hydro Board should adopt the particular proposed resolution;
 4. make financial approvals in line with any authority specifically delegated to the PAB by the BC Hydro Board;
 5. help to ensure appropriate reporting is provided to the BC Hydro Board and Government, as required; and

¹ Following Treasury Board’s January 25th, 2018 approval of the updated Site C Project budget. Cabinet ratified the approval January 31, 2018.

² The Quarterly and Annual Project Progress reports to include for the period outlined: an overview of the status and health of the Project; including overall progress; major accomplishments; work completed; key decisions and issues; update on in-service dates; update on Project costs and financing; forward looking plans; material project risks and trends in risk exposure; and risk mitigation strategies, TAB reporting summary for that year (Annual Report); and the Annual Compliance report (Annual Report). The format and content of the Quarterly and Annual Reports may change over the life of the project to reflect the current project stage, activities

6. remain in place until dissolved by the BC Hydro Board with Government's input.
- The PAB must adhere to the 2015 Reporting and Accountability Framework (as further amended in 2016 and again in 2018 - see Footnote 3).

Composition & Administration

Membership

- The PAB consists of:
 - a) such BC Hydro Directors as may be appointed by the BC Hydro Board from time to time;
 - b) two advisors from Government: one appointed by the Ministry of Energy, Mines and Petroleum Resources (MEMPR); and one appointed by the Ministry of Finance;
 - c) up to two independent External Advisors with expertise in capital project construction and management, whose appointments are to be jointly agreed to by the Ministry of Energy, Mines and Petroleum Resources and the BC Hydro Board;
 - d) a member of the Technical Advisory Board (TAB); and • From time to time, and acting on the advice of the PAB and/or Government, as appropriate, the BC Hydro Board may elect to appoint other External Advisors.
- From time to time, and acting on the advice of the PAB and/or Government, as appropriate, the BC Hydro Board may elect to appoint other External Advisors.
- The PAB is led by either a chair or by two co-chairs, depending on the joint agreement of the Government and of the BC Hydro Board from time to time,
 - For greater clarity, in a situation where the PAB is led by two co-chairs, it is acceptable for one of the co-chairs to be a PAB member and a non-BC Hydro Director, provided one is a PAB member and a BC Hydro Director.
- The Corporate Secretary of BC Hydro will serve as secretary to the PAB.
- The President & COO of BC Hydro will be invited to all meetings unless the meeting is in-camera.
- If the Executive Chair of the BC Hydro Board is a member of the PAB, he or she will act expeditiously to ensure any recommendations made by the PAB are considered by the BC Hydro Board in a timely way.

Meetings & Compensation

- The provisions of Tab 18 (Guidelines for Committees of the Board of Directors) will apply to the PAB and determine its procedures.
- The PAB Chair or Co-chairs is/are authorized to determine the appropriate level of compensation for any External Advisors, which the PAB may engage, provided such compensation is reasonable and generally aligned with industry standards and PSEC Guidelines as applicable and appropriate.

Accountability

- Meeting materials are to be provided to members at minimum 5 business days ahead of any PAB meeting.
- Minutes of the PAB's meetings will be maintained by the Corporate Secretary's office and will be made available in the same manner as are Board and Committee minutes.
- The authority of the PAB is limited to providing advice to Management regarding exception reporting and monthly project progress reporting and for making recommendations to the BC Hydro Board.

Reporting & Accountability Framework³

PAB

- As outlined above.

BC Hydro Management (Management)

- Accountable to the BC Hydro Board and the PAB for day-to-day management and delivery of the Project (including preparation of Quarterly and Annual Reports, Monthly Project Management Reports, ad hoc reports, and providing information to the PAB and the Independent Oversight Advisor on an as needed basis).
- Accountable for administering the Project budget and approved contingency and Project reserve draws.
- Receives, considers and where appropriate, actions advice, directions and recommendations of the BC Hydro Board, the PAB, the Independent Oversight Advisor; the TAB and Government (through the MEMPR Minister Responsible).
- Assists MEMPR with preparation of Monthly Reports to the Government Chair of Treasury Board
- Develops the Project Communications Plan⁴ jointly with MEMPR.
- Reviews reports of the Independent Oversight Advisor and provides advice to the PAB on any recommendations contained in those reports, as appropriate.

Independent Oversight Advisor

- Accountable to the PAB and Government.
- Since November 2017, the PAB has been engaging the services of an Independent Oversight Advisor to identify areas for improvement in Management's current project delivery and control framework (schedule and budget); emerging issues; etc. and to suggest strategies to mitigate associated risks.
- The Independent Oversight Advisor also reports directly to Government on an as-needed basis, in addition to making quarterly progress reports to the Government Chair of Treasury Board.
- Any work proposed to be undertaken by an Independent Oversight Advisor is to be presented to the PAB in a format that clearly identifies the work to be undertaken, timeframes for completing the work, budget and deliverables (collectively the detailed Project services proposal). Following its review, the PAB will determine whether to approve the detailed Project services proposal, or whether to direct that further changes be made.
- Once approved, the detailed project services proposal of the Independent Oversight Advisor is to be incorporated into and be in compliance with, the standing Terms of Engagement between BC Hydro and the Independent Oversight Advisor.
- The Independent Oversight Advisor receives information, analysis and such other reports, records and material from Management and other sources, as may be required in order for the Independent Oversight Advisor to fulfil its obligations under the Terms of Engagement, as well as any other independent reporting obligations that the Independent Oversight Advisor has to Government.
- if requested by MEMPR, the Independent Oversight Advisor will be available to support MEMPR in discharging its obligation to provide monthly reports to the Government Chair of

³ Updated from 2015 Reporting & Accountability Framework provided by MEMPR to reflect current status of Project.

⁴ The Project Communications Plan to include: Communications and engagement plan developed jointly with BC Hydro and the Ministry of Energy, Mines and Petroleum Resources using existing budgets that maximizes public exposure to the visible and meaningful work that benefits the Peace region, First Nations, communities, the public, agriculture, local governments, and other stakeholders. The plan will be updated annually and continue to 2024/25. Note: here is an obligation (on EMPR and Hydro) to report back to TB in the Spring 2019 (delayed from the Fall 2018) on continuation measures – this communications plan piece is tied to that report out.

Treasury Board following PAB meetings. Such reporting will include relevant key information presented to the PAB monthly, in addition to independent verification that the Project budget, schedule, engineering and risk management objectives are being achieved as planned.

Technical Advisory Board (TAB)

- Accountable to BC Hydro Board and PAB and has its own Terms of Reference.⁵
- The TAB is a panel of global engineering and construction experts that provides independent technical review of key design milestones and expert advice to supplement existing engineering, design and procurement expertise of Management and PAB.
- Receives and analyzes monthly, quarterly, annual and ad hoc reports and other information prepared by Management, PAB and the Independent Oversight Advisor.
- A member of the TAB represents the TAB on PAB membership.

Minister of Energy Mines & Petroleum Resources (MEMPR including Staff)

- Receives and analyzes monthly, quarterly, annual and ad hoc reports and other information prepared by Management, PAB and TAB.
- Represents the Minister on PAB membership and participates in all PAB meetings.
- Provides reporting⁶ to the Government Treasury Board on an ongoing basis with support from Management; the BC Hydro Board; the PAB; and the Independent Oversight Advisor, as appropriate.
- Notifies the Government Treasury Board as needed regarding significant changes to Project schedule, budget, risks and risk management plans.
- Makes recommendations to the Government Treasury Board regarding requests to access Project reserve.
- Meets quarterly with Executive Chair of BC Hydro to discuss Project progress within the context of Taxpayer Accountability Principles and input provided by Government.
- Jointly develops Communications Plan with Management.

Treasury Board (full Board or Chair)

- Reviews Annual, Quarterly and Ad Hoc Reports from the BC Hydro Board, Management, PAB and TAB.
- Chair receives monthly reporting from MEMPR on Project status.
- Chair reviews quarterly Project Updates from the Independent Oversight Advisor.
- Provides input and direction, as appropriate, regarding the Project to MEMPR and to BC Hydro.
- Reviews and approves, as appropriate, BC Hydro and MEMPR requests and recommendations in relation to access to the Project reserve.

British Columbia Utilities Commission

- Receives Annual and Quarterly Reports
- Independent regulator of BC Hydro in accordance with the Utilities Commission Act and other applicable legislation

⁵ The TAB TOR's state: There will be approximately two TAB meetings per year. Each meeting will generally be 3 to 5 days in duration at schedules suitable to BC Hydro, the TAB and the Project team...Meetings will generally be held in Vancouver B.C. and/or at the Project site by Fort St. John. TAB meetings will include presentations by the Project team, inspections of constructed works, works under construction, and open discussions. Wherever possible, information packages will be prepared and issued to the TAB in advance of each meeting.

⁶ Including a monthly report to the Chair of Treasury Board following the monthly PAB meeting

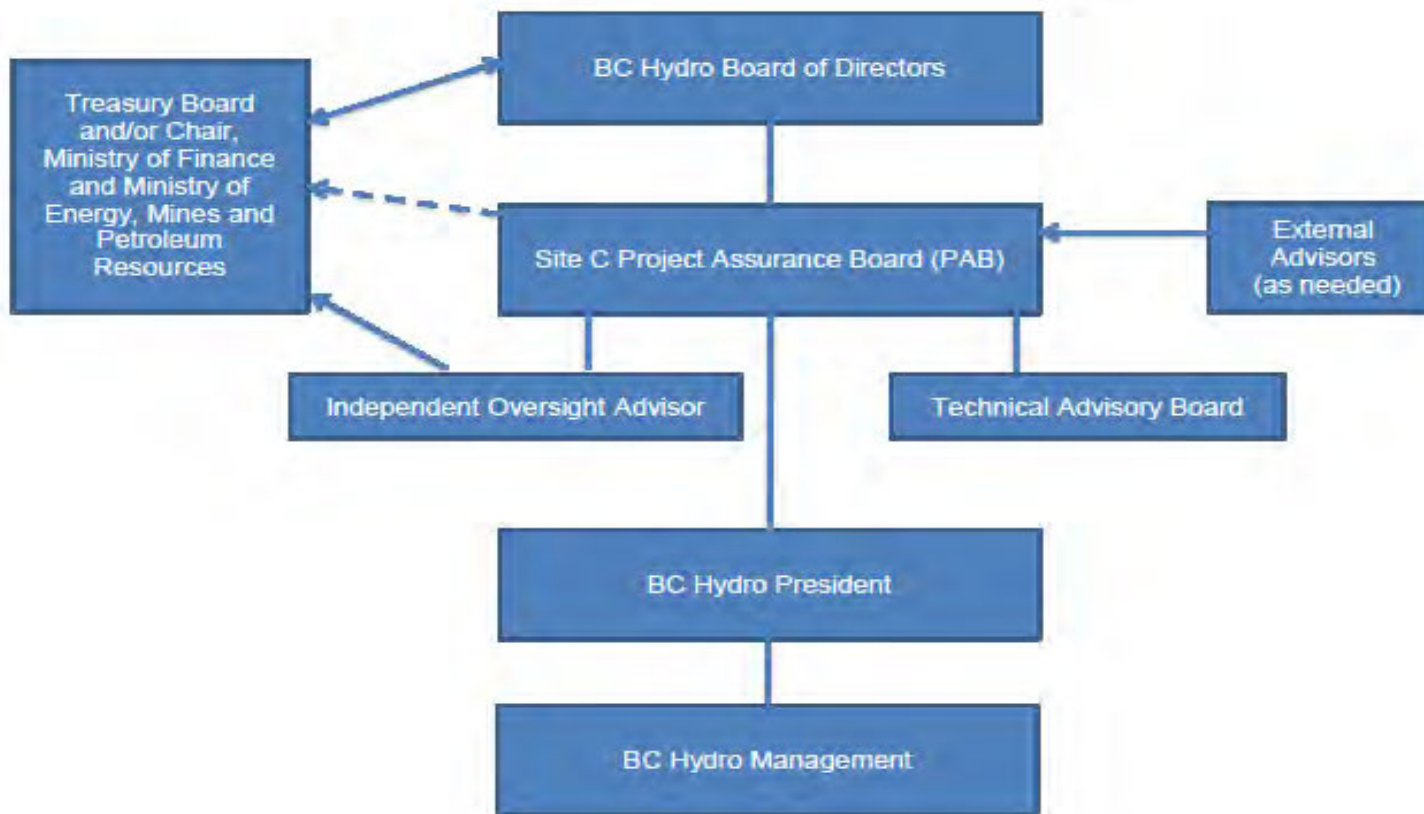


TABLE 2

Site C Reporting Matrix										
	Annual Report ⁷	Quarterly Report	Monthly Project Management Report ⁸	Monthly Report to Chair of Treasury Board ⁹	Comm's Plan	Exception Reporting ¹⁰	Technical Reporting	Contingency Requests	Project Reserve Requests	Independent Oversight Advisor reports
BCH Management	Develop	Develop	Develop & Approve (internal doc)	Assists MEMPR with Report	Develop	Develop & Approve	Review	Develop	Develop	Review
Independent Oversight Advisor	Review	Review	Review	Assists MEMPR with Report		Review	Review	Review	Review	Develop & Approve
Technical Advisory Board¹¹	Review	Review	Review			Review	Develop & Approve			Review
Site C Project Assurance Board	Review	Review	Review		Review	Review	Review	Review & make recco to BCH BOD	Review & make recco to BCH BOD	Review
BCH BOD	Approve	Approve			Approve	Review	Review as needed	Approve	Review and make recco to TB	Review
MEMPR	Review	Review	Review	Develop & Approve	Develop	Review	Review	Review	Develop	Review
TB/TB Chair	Review	Review		Review	Review	Review	Review	Review	Approve	Review
BCUC	Receive	Receive								

⁷ A summary of the TAB reports is to be included in the Annual Report

⁸ BC Hydro develops and approves internal monthly project management reporting and a relevant subset of that information is presented to the Project Assurance Board. The monthly project management reporting provides an update on overall project progress, status and health of the project, material project risks and from time to time results of full risk analysis of major components of project delivery, timelines and project budget. Updates on overall project progress include reporting on physical progress on main construction areas and includes reporting on earned value management metrics and techniques.

⁹ A summary of: (1) materials presented to the Project Assurance Board, (2) subsequent discussion and outcomes of the Project Assurance Board meeting and (3) monthly and quarterly reports from the Independent Assurance Advisor.

¹⁰ BC Hydro develops Exception Reporting for major unanticipated events included significant project-related incidents that may occur between the regular reporting cycles. Exception Reporting includes providing briefing notes, verbal briefing and/or special meetings as required.

¹¹ The Chair of the TAB is a member of the PAB and therefore receives the same reporting any other member of the PAB does.

Appendix 5

EY Statement of Work



Ernst & Young LLP
Pacific Centre
700 West Georgia St
Vancouver BC V7Y 1C7

Tel: 604 891 8200
Fax: 604 643 5422
ey.com

24 October 2018

British Columbia Hydro and Power Authority
333 Dunsmuir Street, Vancouver, BC V6B 5R3
Attn: Mr. John Nunn, Site C Project Assurance Board Committee Chair

Statement of work – Site C: Independent Oversight

Dear Mr. John Nunn,

This Statement of Work, dated 24 October 2018 (this “SOW”), is made by the Canadian firm of Ernst & Young LLP (“we” or “EY”) and British Columbia Hydro and Power Authority (“you” or “Client”) pursuant to Agreement No. 94990, (the “Agreement”), between EY and British Columbia Hydro and Power Authority as amended by the Change Order #2 dated 27 June 2018 (the “Change Order”). This SOW covers the period of 02 June 2018 to 07 September 2018. For work beyond 07 September 2018 a separate SOW will be issued.

Except as otherwise set forth in this SOW, this SOW incorporates by reference, and is deemed to be a part of, the Agreement. The additional terms and conditions of this SOW shall apply only to the advisory Services covered by this SOW (the “SOW Services”) and not to Services covered by any other Statement of Work pursuant to the Agreement. Capitalized terms used, but not otherwise defined, in this SOW shall have the meanings in the Agreement. In the event of conflicts or inconsistencies, if any, between or among the terms and conditions of the Agreement, including the Change Order, and the terms and conditions of this SOW, the terms and conditions in this SOW take precedence and govern over the terms and conditions in the Agreement.

Scope of Services Provided

The following tables describe the services provided for the period of 02 June 2018 to 07 September 2018. Work completed for WS 1&2: Sustainable Workforce Model during 02 – 29 June 2018 will be covered on a separate SOW.

WS 3&4: Project Controls & Risk (PCR) wrap-up (02 – 29 June 2018)	
Work Stream Description	WS 3&4: Project Controls & Risk (PCR) EY completed its scope for WS3&4 as contemplated and described below

WS 3&4: Project Controls & Risk (PCR) wrap-up (02 – 29 June 2018)	
Services Provided	<p>Key activities completed during the period include:</p> <ul style="list-style-type: none"> Attend relevant project meetings. WS 3&4: Held future state opportunities review session on 14 June 2018 and 18 June 2018. WS 3&4: Held final Project Controls and risk Steering group on 20 June 2018. WS 3&4: Issued final future state improvement opportunities report on 29 June 2018.
Key Personnel	Caleb Butler (WS3&4) Work Stream Lead

WS 5: Independent Oversight (02 June – 07 September 2018)	
Work Stream Description	EY continued to provide independent oversight activities as described in the Project Assurance Board's terms of reference. In addition, EY continued to produce a Baseline Assessment Report (BAR) in accordance with or previously approved SOW (dated 22 June 2018).
Services Provided	<p>Key activities completed during the period include:</p> <ul style="list-style-type: none"> Attend relevant project meetings. Review project documentation (i.e. Accountability reports, progression reports, Health and Safety statistics, etc.). Produce PAB Correspondence, Presentations and Deliverables Attend PAB meetings Completing the preliminary draft <p>S. 12</p> <ul style="list-style-type: none"> Supported Review of September Treasury Board submission, working with BCH and the Government of BC.
Key Personnel	<p>Michael Kennedy, Partner & Work Stream Lead Tim Philpotts, Partner Brian Campbell, Partner Michael Bae, Manager and Support Sean Stuart, Manager and Support Miranda Wen, Manager and Support</p>

WS 6: Health and Safety Review (02 June – 03 August 2018)	
Work Stream Description	This work stream is focused on enhancing Health & Safety practices for the Site C project.
Services Provided (to 01 June 2018)	Key activities completed during the period include: <ul style="list-style-type: none"> • Attended meetings with key BCH contacts. • Reviewed project documentation. • Conducted a site visit on 13-15 June 2018. • Attended Joint Prime Contractor Safety Steering Committee meetings on 14 June 2018. • Issued a Pilot Fatal Hazzard Activities Assessment (FHAA) Report on 15 June 2018. • Initiated preparation work to begin second FHAA
Key Personnel	Rocco Meraglia, Canadian Senior Resource and Work Stream Lead Sunny Sehgal, Manager and support Lucas Pompeo Paes de Lira, Manager and support

WS 7: Commercial Support and Independent Claims Review (02 June – 03 August 2018)	
Work Stream Description	Commercial support is the process of developing a commercial strategic plan for claims and disputes, analytically supporting negotiating positions, and dispute resolution readiness. Independent claims review consists of an independent review of entitlement, schedule effects and quantum relating to contract claims.
Services Provided	Key activities completed during the period include: <ul style="list-style-type: none"> • An independent review (for entitlement, schedule and quantum) of any provisionally agreed proposal between BC Hydro and PRHP • Analyses to corroborate and quantify the costs claimed by PRHP, per any provisionally agreed upon proposal • Support to BC Hydro on the apportionment of the costs in any proposal to compensable areas of PRHP's claim • Issuing an MCW Settlement Claims opinion report to the client on 29 June 2018. • Supporting WS5 by summarizing and reporting on findings for PAB reporting and TB submission.
Key Personnel	Damian Joy, Partner & Work Stream Lead Walied Abdeldayem, Canadian Senior Resource Tim Stanley, Canadian Senior Resource Terence Crohn, Manager and Support Anthony Hosford, Manager and Support Myles Carlin, Manager and Support Sean Stuart, Manager and Support

WS 8a: Schedule Risk Analysis (SRA) (02 June – 31 August 2018)	
Work Stream Description	EY performed a review of BCH's SRA methodology and SRA model and provided commentary. S. 12
Services Provided	<p>Key activities completed during the period include:</p> <ul style="list-style-type: none"> • Embedded a SMR to work with the BCH team to develop and review the SRA. Activities included: <ul style="list-style-type: none"> • Reviewed of overall SRA approach and examine its consistency with acceptable industry recommendations. • Reviewed the SRA model (structure, activities, logic and main risks) to explore opportunities for enhancing the model and the accuracy of the results. • Reviewed input data sources and review how probabilities for major events were determined. • Provided commentary to BCH of SRA draft and revised versions. • Held meetings to discuss commentary are also expected. • Performed reviews of final version to ensure commentary was addressed • S. 12
Key Personnel	<p>Michael Kennedy, Partner & Work Stream Lead Walied Abdeldayem, Canadian Senior Resource Brian Campbell, Partner Michael Bae, Manager and support</p>

Limitations on scope

We will not identify, address or correct any errors or defects in your computer systems, other devices or components thereof (“Systems”), whether or not due to imprecise or ambiguous entry, storage, interpretation or processing or reporting of data. We will not be responsible for any defect or problem arising out of or related to data processing in any Systems.

We are not responsible for the parallel management of BC Hydro’s in-flight programme improvements.

Specific additional terms and conditions

The SOW Services are advisory in nature. EY will not render an assurance report or opinion under the Agreement, nor will the SOW Services constitute an audit, review, examination, or other form of attestation as those terms are defined by the American Institute of Certified Public Accountants or the Chartered Professional Accountants of Canada. None of the SOW Services or any Reports will constitute any legal opinion or legal advice. We will not conduct a review to detect fraud or illegal acts.

Notwithstanding anything to the contrary in the Agreement or this SOW, we do not assume any responsibility for any third-party products, programs or services, their performance or compliance with your specifications or otherwise.

We will base any comments or recommendations as to the functional or technical capabilities of any products in use or being considered by you solely on information provided by your vendors, directly or through you. We are not responsible for the completeness or accuracy of any such information or for confirming any of it.

EY represents and warrants that it has conducted its standard internal conflicts check procedures with respect to identified third parties related to this engagement, including any contractors performing work on the Site C Project who are existing or former EY clients (“EY Clients”) and EY did not identify any conflicts of interest, as such term is defined by applicable professional standards. In reliance on this representation, the Client consents to the performance by EY of current unrelated services for the EY Clients that have been cleared by EY pursuant to its standard internal conflicts check.

If, however, our services for an EY Client or prospective EY client relate or related to this engagement, we will seek the consent of both you and the other client prior to performing any further services.

We have subcontracted portions of the SOW Services to:

- MEM Investments Ltd.
- Intellect Dispute Experts Advisory (IDEA)
- Stratice Consulting Inc.
- Others as required

(collectively, the “EY Subcontractors”)

After the SOW Services have been completed and subject to obtaining the prior written consent of the Client, EY may disclose or present to prospective clients, or otherwise in our marketing materials, that we have performed the SOW Services for you.

Privileged Information

EY and the Client agree and acknowledge that:

- EY has been retained by the Client to perform the SOW Services to support and enhance the delivery of the Site C Project;

- in order for EY to perform the SOW Services, the Client may be asked to share information with EY or EY Subcontractors, whether in written, oral, electronic form or otherwise, which may be subject to Client privilege claims (“Privileged Information”), including but not limited to information that is subject to claims of solicitor-client privilege and/or litigation privilege;
- the provision by the Client to EY or any EY Subcontractor of any access to Privileged Information is done in strict confidence and is subject, as Confidential Information, to the terms of confidentiality set out below;
- for the purpose of delivering the SOW Services, any disclosure or discussion between the Client, EY and EY Subcontractors, whether intentional or inadvertent, of Privileged Information, is not and shall not be interpreted to be, a waiver of privilege, or an intention to waive privilege, over the Privileged Information;
- the Client intends to maintain privilege with respect to any and all Privileged Information provided to or accessed by EY or EY Subcontractors pursuant to the delivery of the SOW Services and continues to assert any and all claims of privilege with respect to such Privileged Information;
- the claims of privilege over the Privileged Information belong solely to the Client and only the Client can waive privilege over the Privileged Information;
- EY, EY Subcontractors and the Client share a common interest in any use made of any Privileged Information shared with EY or EY Subcontractors for the purpose of delivering the SOW Services.

Confidentiality

- EY acknowledges the obligations of confidentiality set out at Section 18 of the Agreement are applicable to the performance of the SOW Services and agrees that EY will require:
- the EY Subcontractors to agree to the same confidentiality terms and obligations that EY has agreed to pursuant to the Agreement and this SOW;
- each of EY’s employees and any EY Subcontractor personnel who will be involved in the delivery of the SOW Services to sign and deliver individual confidentiality acknowledgments to BC Hydro;
- For the purpose of the SOW Services, the definition of “Confidential Information” as that term is defined in the Agreement shall be deemed to include all information, documents and materials, whether in written, oral, electronic form or otherwise, relating in any way to the Project, and includes, all schedules and budgets and other planning information, all reports (including draft reports) and correspondence, all procurement-related materials, all proposals and submissions and tenders from any party relating to the Project, and any information, document or materials produced by EY or EY Subcontractors based on or developed out of any of the information described above.
- EY will only disclose Privileged Information within its organization, in confidence and only as necessary, to perform the SOW Services. EY will only disclose Confidential Information, other than Privileged Information, within its organization, in confidence and only as necessary, to facilitate performance of the SOW Services, to comply with regulatory requirements, to check conflicts, to provide technology or administrative services, or for quality, risk management or financial accounting purposes. EY acknowledges that these confidentiality terms will remain in effect following the conclusion or earlier termination of the SOW Services.

Potential External Reporting

- The Client and EY agree and acknowledge that each may from time to time be asked to provide information or materials prepared or received in relation to the SOW Services to representatives of the Province of British Columbia (the “Province”).
- Prior to disclosing any information or materials to the Province, each party agrees to:
 - notify the other party in advance of disclosing any such information or materials to the Province;
 - consult with the other party regarding the information or materials it intends to disclose to the Province;
 and

- in the case of EY, take steps to identify any information or materials to be disclosed to the Province as “Confidential”, and, where applicable, “Privileged”.
- To the extent any Privileged Information is disclosed to the Province, EY and the Client acknowledge that the provision of such Privileged Information, is not intended to be a waiver of privilege and the Client intends to maintain privilege with respect to such Privileged Information and continues to assert any and all claims of privilege with respect to such Privileged Information.
- The Client asserts that any Privileged Information that may be disclosed to the Province, whether by EY or the Client, is protected by common interest privilege.
- The Client retains the right to disclose any work product produced by EY in the delivery of the SOW Services to the Client’s Board, subcommittees of the Client Board or the Province at the Client’s discretion.

Timetable

Unless otherwise agreed, and subject to the General Terms and Conditions of the Agreement, cover the period from 02 June 2018 to 07 September 2018.

EY Relationships

The Client is advised that Groupe SNC-Lavalin Inc., ATCO Energy Solutions Ltd., Aecon Group Inc., ACS, Actividades de Construccion Y Servicios, SA, EBC Inc, Samsung C&T Corporation, Acciona, SA, Klohn Crippen Consultants Ltd, Tetra Tech Canada Holding Corporation, and Voith Canada Inc (“the Group”) has previously engaged EY to perform services. The Client confirms that it (1) is aware that EY has performed the professional services for the Group (the “Services”); and (2) has had the opportunity to discuss the scope of the Services with EY. The Client further confirms that it will not make a claim against EY that these circumstances present a conflict of interest, real or perceived.

EY confirms that the members of its engagement teams serving the Client will not perform services in connection with the work described above for the Client without both their prior written consent. EY further confirms that, except as otherwise agreed in writing by the Client and the Group, confidential or privileged information in the possession of an engagement team will remain confidential to the client served by that engagement team in accordance with applicable professional standards. The Client waives any claim it may have against EY based on any inability to obtain access to the confidential information of the other in the possession of EY.

Contacts

You have identified **S. 19**, as your contact with whom we should communicate about these Services. Your contact at EY for these Services will be Michael Kennedy, Partner.

Fees

The General Terms and Conditions of the Agreement address our fees and expenses generally. Client shall pay EY’s fees for the Services based on time spent by the relevant professionals in performing the Services, at hourly rates ranging from **S. 21**, as adjusted periodically in accordance with the terms and conditions described in Agreement No. 94990 // the following hourly rates:

Canadian Resources:

Senior Resource or Partner
Manager and Support

S. 21

S. 21

Global Resources:

Global Partner	S. 21
Global Senior Manager	S. 21
Global Manager	S. 21
Global Senior Consultant	S. 21

Other Subject Matter Experts (SMR) (as required):

Global SMR	S. 21
SMR	S. 21

Our fees for the Services as incurred by all work streams, summarized in the table below, is **\$1,002,503** in labour fees and **\$118,000** in expenses, excluding any applicable taxes. We request a change order (#3) be issued and approved to include the total labour fees and expenses incurred between 02 June 2018 to 07 September 2018.

Work stream	Fee
02 – 29 June 2018 Labour Fees Incurred for WS 3&4, 5, 6, and 7	\$ 510,550*
30 June – 03 August 2018 Labour Incurred Fees for WS 5, 6, 7 and 8a	\$ 271,768
04 – 31 August 2018 Labour Fees Incurred for WS5 and 8a	\$ 195,595
01 - 07 September 2018 Labour Fees Incurred for WS5	\$ 24,590
Total Labour Fees incurred between 02 June 2018 to 07 September 2018	\$ 1,002,503

* WS 1&2: Sustainable Workforce Model labour and expenses incurred during 02 – 29 June 2018 will be covered on a separate SOW.

All travel and out of pocket expenses will be billed in addition to fees in accordance with the Client's policies. For this SOW, we estimate the expenses to be **\$118,000**.

EY's fees and expenses and any applicable taxes have been invoiced separately monthly as time and expenses are incurred. Payment of EY's invoices is due upon receipt. Interest on overdue accounts accrues at 12% per annum starting 30 days following the date of our invoice.

Please indicate your agreement with the terms of this engagement by executing this SOW in the space provided below and returning it to Michael Kennedy.

Yours very truly,

A handwritten signature in black ink that reads "Ernest + Young LLP". The signature is written in a cursive, flowing style.

per **Michael Kennedy**

Agreed:

British Columbia Hydro and Power Authority

per _____
Name:
Title:

Appendix 7

BC Hydro Letter Disagreeing with conclusions
reached by EY

June 1, 2018

Project Assurance Board Members,

I am writing to express my disagreement with the findings of EV's Current State Assessment of BC Hydro Site C Project Controls & Risk.

Project controls and risk are important elements of the Site C project, and BC Hydro welcomes feedback that enables us to continue to improve these functions. However, feedback that lacks rigour and fails to reflect the breadth of our approach across the project can prove to have a detrimental effect. I am concerned that EV's Current State Assessment unfairly characterizes BC Hydro's current approach to risk project controls. Moreover, this report is a stark departure from the 2016 EV assessment that provided reassurance to BC Hydro management that, "Overall, Site C follows a rigorous and effective process for identifying, analyzing, and mitigating risks on the project¹."

I have three main concerns with the report:

- 1) The assessment makes broad claims about risk management and controls across the project, despite considering only the Main Civil Works (MCW) contract during a period we lacked a valid performance measurement baseline (PMB).
- 2) A philosophical difference in approach to risk management and accountability appears to bias the scoring criteria.
- 3) The differences between the 2016 and 2018 EV assessments appear to be irreconcilable.

1) Extrapolating from the MCW Contract

EV's assessment was conducted through the lens of the MCW contract during a period (January - March 2018) without a contractual schedule in place. Having recently missed the 2019 diversion window, in January and February we lacked a contractual schedule and valid PMB against which to track contractor progress. By March, we had inputted our "without prejudice" schedule as an interim PMB.

Since we lacked a valid PMB for MCW, many of the control systems and processes we normally rely on were compromised. For example, the SI Key Finding states that "The level of progress achieved relative to the project baseline is not clear from the data presented in Management Information ². Although this was true for MCW at

the time, this information was available to management on all other awarded contracts at that time and is unfairly characterized by EV as a broader issue.

While the absence of a contractual MCW schedule has been a significant challenge for the project, we have been transparent about the situation and are working hard to rectify it through our proposed settlement with the contractor. It is inappropriate and unfair to assess our broader capabilities using this particular contract at a time when it has been severely compromised. I do not have an explanation for EV's claim that they were "advised by BCH Leadership to focus ... through the lens of the Main Civil Works contract³". as neither I nor my management team provided such advice.

2) Biased Scoring Criteria

While the criteria in the EV assessment are proprietary and not transparent to BC Hydro, their philosophy appears to presume that successful risk management requires a large, distinct risk management team.

¹ EY- "Site C Clean Energy Project- Infrastructure risk and cost management report." September 13, 2016, pg. 18.

² EY - "Current state assessment- BC Hydro Site C Project Controls & Risk." May 2018, pg. 8.

³ EY- "Current state assessment- BC Hydro Site C Project Controls & Risk." May 2018, Letter to Ken Peterson.

In contrast, BC Hydro holds the Project Manager accountable for risk management and corresponding activities, such as risk identification and regular reviews to ensure they are current and accurate. Project team members take responsibility for carrying out risk management activities, and have been located at site since construction commenced.

EY appears to favour a more centrally managed approach to risk management & controls. While this would make risk management and controls more apparent on an organizational chart, it could also lead to a diffusion of accountability compared to BC Hydro's current approach.

3) 2016 vs. 2018 EY Reports

Commenting specifically on Project Controls and Risk Management, EY's 2018 report states that "...current practice does not reflect what would normally be expected on a project of this scale⁴." This finding is completely different from what EY advised us in its 2016 report, which stated, "We found the risk management process to be both robust and fulsome, detailing project-level requirements for risk management planning, risk identification, risk evaluation, risk response, and risk monitoring and control. These processes follow industry best practices set by both the Project Management Institute and the Institution of Civil Engineers Risks Analysis and Management for Projects⁵."

As the executive responsible for Site C, I personally relied on the findings of the 2016 report. Needless to say, I find it difficult to reconcile two opposing views on the project that have been prepared by the same consulting firm.

The maturity assessment included in the EY 2018 report rates BC Hydro at the "basic" or "developing" level in every category (i.e. 1 or 2 on a five-point scale). The 2016 assessment rated BC Hydro as a 3 or 4 on a similar five-point maturity scale. Although the categories do not map directly, there are clear contradictions between the two. For example, in 2016 BC Hydro scored a 3 overall on "Project governance as an approval mechanism," with a score of 4 or 5 on every subcomponent listed under project governance. In contrast, the 2018 report gave "Governance: Fact based decision making" a score of "Basic" (1)⁶.

A number of comments and findings from the 2016 report speak directly to BC Hydro's performance on risk management and controls for Site C. The following highlight the confidence EY provided to BC Hydro at that time:

- Page 14- "Site C's Risk Management Plan clearly outlines the risk management process and plan for the project. **We found the risk management process to be both robust and fulsome**, detailing project-level requirements for risk management planning, risk identification, risk evaluation, risk response, and risk monitoring and control. **These processes follow industry best practices** set by both the Project Management Institute and the Institution of Civil Engineers Risk Analysis and Management for Projects. Furthermore, accountabilities and responsibilities for managing and mitigating risks for all key project roles are outlined in a clear 'Responsible, Accountable, Consulted and Informed' matrix."
- Page 16 - "From our review, it is evident that the project team follows the risk analysis process generally set out in the Risk Management Plan, which is **representative of a strong industry practice**".
- Page 16 - "Overall, we found that risks are well-articulated and **reported in a manner that is in line with leading practices**"
- Page 18 - "**Overall, Site C follows a rigorous and effective process** for identifying, analyzing, and mitigating risks on the project".
- Page 19 - "The cost management plan and processes provide a thorough approach to how the costs for this project should be managed during the lifecycle of the project, and is **aligned with leading practices for a project of this magnitude**"

⁴ EY - "Current state assessment - BC Hydro Site C Project Controls & Risk." May 2018, pg. 8.

⁵ EY- "Site C Clean Energy Project - Infrastructure risk and cost management report." September 13, 2016, pg. 14.

⁶ EY - "Current state assessment - BC Hydro Site C Project Controls & Risk." May 2018, pg. 27.

- Page 22 - "Overall, Site C's ongoing **cost management and process for maintaining cost estimates are what we would expect to see on a major capital project.**"
- Page 26 - "Overall our review finds that the project is well defined and that **the processes for managing risks and costs are largely representative of leading practices**"

In summary, I find it difficult to reconcile two opposing views of the project from the same consultancy. While the project has experienced challenges with budget and schedule, these did not result from failures of risk management and control.

Chris

Chris O'Riley
President and Chief Operating Officer

Appendix 8
EY Report on Risk

EY Report detailing areas in the Risk Management Process that would benefit from improvement

PPM Practice	Modified Practice Applied on Site C	Site C Improvement Opportunity	Key Finding	Updated Commentary
<ul style="list-style-type: none"> ▶ Project risk is entered into the Risk Register on PPM Workspace in SharePoint. 	<ul style="list-style-type: none"> ▶ The Project Risk register resides on the PPM workspace, but due to differences in the Risk register template, the CIPD SAP Business Warehouse reporting functionality is not usable. 	<ul style="list-style-type: none"> ▶ Implement automated reporting and data analytics tool to understand and present risk trends and an overview of the risk profile. 	R2	BCH have used tableau to provide additional trending information. However, gap still remains. With 2 risk professionals on a project of this magnitude, Risk Management software may be required.
<ul style="list-style-type: none"> ▶ The PM is accountable for Project Risk Management. The Project Delivery Director is accountable for escalating risks. ▶ There is no specific Risk Management function identified in the PPM RACI, in addition to Project Manager, WPM / Project Team Member, Functional Managers and Portfolio Delivery Manager roles. 	<p>In addition to the roles specified in PPM, there is one Risk Manager on Site C responsible for the overall Site C risk management program and supporting all risk management activities.</p> <ul style="list-style-type: none"> ▶ A 'Risk Professional' and 'Risk Analyst' are identified roles in the RACI in the draft Risk Management Plan (RMP) to support the PMs, but are not in place. ▶ A Risk Manager is identified on the GSS Civil Works Contract Management Plan as supporting the Hydro Rep to track the monthly Contract Risk register. This process is not in the draft RMP. 	<ul style="list-style-type: none"> ▶ Increase the size and on site presence of the risk function to facilitate the PM's ability to manage the growing risk profile 	R1 R2	Gap remains, as discussed above. Currently the project employs a Risk Manager and a risk analyst which, in EY's opinion, is insufficient for a project of this size
<ul style="list-style-type: none"> ▶ Identified risks are evaluated using the Project delivery matrix to determine the Risk Zone applicable to each risk. 	<ul style="list-style-type: none"> ▶ Consequence severity thresholds are further broken down in the Risk Register between S5 and S6, but not in the Project delivery matrix documented in the draft RMP. 	<ul style="list-style-type: none"> ▶ Communicate the updated and agreed risk management practice to all Risk Owners. 	R1 R2	This action was completed. However, given the extremely wide bands within the matrix site c should consider augmenting the matrix further to accommodate the higher risk impacts associated with Site C. New team members also need to be onboarded as required

PPM Practice	Modified Practice Applied on Site C	Site C Improvement Opportunity	Key Finding	Updated Commentary
<ul style="list-style-type: none"> ▶ Executive Risks are communicated to Board level 	<p>The key Project risks, known as Hot List risks, as opposed to all Executive risks are escalated to Leadership in the monthly PAB and Accountability reports.</p> <ul style="list-style-type: none"> ▶ Risk roll-up categories are reported to the Board in the Site C Quarterly report. No unique risk identifiers are shown. 	<p>Present the aggregate risk exposure of the Hot List risks and also the wider exposure of Executive risks to Board level to inform decision-making.</p> <ul style="list-style-type: none"> ▶ Include a quarterly review of all Executive risks recorded in the Risk register. ▶ Develop alternate criteria to select risks based on objective criteria for escalation 	R2	Gap remains. BCH present only "PAB level" risks to the Project Assurance Board based solely on the risk rating established by the matrix. Generally this will be around 20 risks. Whilst these risks may be the highest ranked, due mostly to the financial impact, they are not necessarily the most relevant risks at that time. e.g., Workers Accommodation was a PAB level risk despite additional funding being approved to address the risk. This remained a PAB risk for many months following this approval, despite having little relevance to the project at that time. The detail noted on the risk e.g., mitigation strategy etc. is not sufficient for decision making unless specifically discussed
<ul style="list-style-type: none"> ▶ Schedule delay is considered as a driver for consequence types, but not as a consequence type itself 	<ul style="list-style-type: none"> ▶ It is intended to include Milestones from the P6 work breakdown structure (WBS) within the Risk Register to link to schedule risk. 	<p>Include 'Start/Stop' dates for Schedule risks to inform treatment plans, monitor trends and understand mitigation timeframe.</p> <ul style="list-style-type: none"> ▶ Include the initial impact of a risk in addition to the residual impact to inform management of the risks considered unacceptable and therefore requiring a treatment plan. 	R2	Gap partial remains. Start/stop dates are captured within the risk register. However, schedule risk exposure is not captured within the BCH risk register
<p>The estimating team may be engaged to conduct a QRA to estimate required contingency for key risks with a severity ranking greater than \$100million (m) at the Sub-Project or contract level.</p> <ul style="list-style-type: none"> ▶ The accountable role to request a QRA is not specified in PPM. 	<p>The Risk Register shows 15 risks ranking greater than \$100m (21 February 2018). It is not clear whether a QRA is undertaken in accordance with PPM criteria to reforecast contingency.</p> <ul style="list-style-type: none"> ▶ The Project Director role is shown as accountable for the QRA process in the draft RMP. 	<p>Conduct QRA's on a periodic basis to reflect the maturing risk profile against the PMB of the project and Sub-Projects and meet the Government request of quarterly updates.</p> <ul style="list-style-type: none"> ▶ Document the decision criteria for a Project Director to undertake a QRA. 	R2	CRA/SRAs are run periodically on the project but have not followed the 1/4ly commitment based on BCH deferring CRA/SRA.

Appendix 22
Frank Margitan Report

CONSTRUCTION - APPENDIX #22

1. Construction

The construction of the Site C dam is one of the largest and most complex projects in the Province's history. The project has many components that make up the dam. Below is a listing of the key components:

1. Access roads in the vicinity of the site and a temporary construction access bridge across the Peace River at the dam site.
2. Construction of two temporary cofferdams across the main river channel to allow for construction of the earth fill dam.
3. Worker accommodation at the dam site, with other workers being housed off site and in the region.
4. The realignment of six segments of Highway 29 over a total distance of 30 kilometres.
5. Shoreline protection at Hudson's Hope.
6. Two new 500 kilovolt AC transmission lines that will connect the Site C facilities to the existing Peace Canyon Substation, along an existing right-of-way.
7. An 800-metre roller-compacted-concrete buttress to enhance seismic protection.
8. An earth fill dam, approximately 1,050 metres long and 60 metres high above the riverbed.
9. A generating station with six 183 MW generating units.
10. An 83-kilometre-long reservoir that will be, on average, two to three times the width of the current river.

BC Hydro divided the project into approximately 30 contracts. These include onsite contracts for Main Civil Works (MCW), Generating Stations and Spillways (GSS), Turbines and Generators (T&G), Balance of Plant (BoP) and worker accommodation, as well as contracts for clearing, transmission lines and highway construction.

While most contracts are based on the traditional Design-Bid-Build model, a few departed from this approach. These include the contracts for Turbines and Generators (Design-Build) and worker accommodation (Design-Build-Operate with partial financing). Some contracts were direct awards to First Nations.

The two largest contracts (Main Civil Works and Generating Stations and Spillways) went through a Request for Qualifications and Request for Proposals procurement process based on BC Hydro's design. These contracts entered into with the successful proponents provide for payment on a unit price basis, with some work paid on a lump sum basis based on the Design-Bid-Build model. In this model, the majority of the cost risk stays with the owner (BC Hydro).

The Site C BC Hydro projects has 5 main on site projects.

1.1 Main Civil Works (MCW)

The scope of the main civil works contract includes the construction of the following major components:

- Diversion works, including two concrete-lined, 10.8 metre diameter tunnels. Tunnel No. 1 is 700 metres in length and Tunnel No. 2 is 790 metres in length;
- Diversion tunnel inlet and outlet portals, and approach channels;
- Excavation and bank stabilization;
- Relocation of surplus excavated material (including management of discharges);
- Dams and cofferdams (including a zoned earth embankment dam 1,050 metres long and 60 metres above the present riverbed, and stage 1 and 2 cofferdams);
- Roller-compacted concrete (including a buttress approximately 800 metres long made up of approximately 1.7 million cubic metres of concrete); and
- Haul roads.

1.2. Generating Station and Spillways (GSS)

The generating station and spillways scope of work includes the construction of the following major components:

Generating station and spillways civil works, including:

- Powerhouse: Concrete placements, installation of structural steel, and installing hydraulic gates;
- Inlet headworks: Concrete placements, construction of the penstocks, and installing hydraulic gates; and
- Spillways: Concrete placements and installing hydraulic gates.
- Cranes, which includes the supply and commissioning the powerhouse cranes, tailrace gantry crane, and headworks gantry crane; and
- Hydromechanical equipment, including the supply of all gates.

1.3. Turbines and Generators (T&G)

The scope of work for turbines and generators includes the complete design, supply, installation, testing and commissioning of six turbines, generators, governors, and exciters.

1.4. Balance of Plant (BOP)

The Balance of Plant contract scope includes everything required to complete the construction of the generating station and spillways that is not included in the scope of work of the generating station and spillways civil works contract and the turbine and generator contract, including:

- a) Installation of mechanical and electrical water-to-wires equipment supplied by others.
- b) Provision of mechanical and electrical systems.
- c) Installation of protection, control, telecom, security and similar systems. Provision of miscellaneous items and structures, including the permanent fish passage facility.
- d) Provision of building systems, such as fire detection and protection; heating, ventilation, and air conditioning (HVAC); domestic water; etc.
- e) Completion of interiors to the finished state.

- f) Temporary construction, decommissioning and site clean-up.

The Balance of Plant contract includes design-bid-build, design-build, and supply-install components. BC Hydro has specified its requirements by providing performance specifications, reference drawings, and interface requirements, and the contractor will be responsible for designing and supplying the equipment in accordance with these requirements.

1.5. Worker Accommodation

The Site C worker accommodation camp was originally designed to house 1,600 workers with services and utilities to accommodate a total capacity of 2,200, should the need arise over the duration of the Project.

In 2018, various scenarios were modelled to forecast required bed nights, and these indicated peaks in camp capacity greater than 1,600 beds occurring in 2020, 2021 and 2022 based on forecasted work volumes. As a result, in 2019 the first phase of a two-phase expansion was completed which added 150 beds. Phase 2, which will add a further 450 beds, is planned for construction. The camp is functioning well.

2. Individual Contract Analysis

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