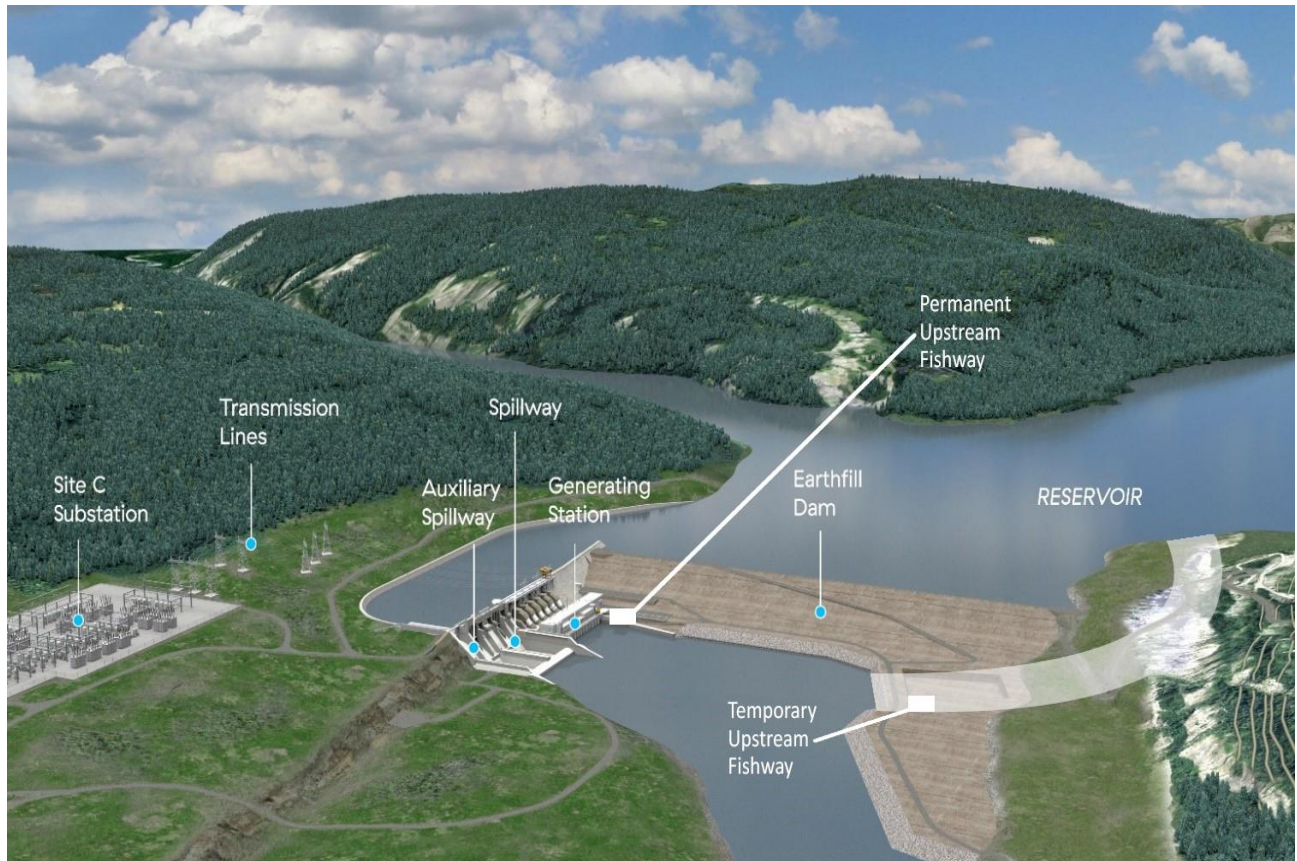


# Site C Project Review



Peter Milburn

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:

On December 12, 2020, I submitted a draft final report of October 10, 2020 for the review of the British Columbia Provincial Government. The report provided a detailed response to the terms of reference assigned on August 1, 2020. This report was not designed to be released to the public as it included Treasury Board and commercial confidential information.

I received a request for a summary report that could outline the observations, conclusions, and recommendations found in the original report. It is my understanding that the Ministers responsible may wish to make this summary available to the public.

Please find the requested summary report attached. This report is consistent with the original report submitted and the terms of reference.

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.

Yours 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 are 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 more than 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**.



Site C Plan View showing features associated with River Diversion.

## **1.0 Terms of Reference**

### **1.1 Terms of Reference (July 31, 2020)**

BC Hydro has experienced significant changes over the last 12 months in relation to identified cost, schedule, procurement, and geotechnical and scope risks associated with the project.

Key drivers of these changes include:

- Impacts of COVID-19 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), wishes 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, as well as 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.

## 2.0 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. Executive Project Director Sea to Sky Highway Improvement Project. Previous Chair of numerous Project Boards, including Surrey Memorial hospital, Interior Heart and Surgical Center, and Transportation Investment Corporation). Thirty-five years of experience in construction, maintenance, and capital projects.

**Rodney Chapman** (Director of Construction and Maintenance for the Ministry of Transportation and Infrastructure). Forty-six 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). Forty years-experience working in the heavy construction industry.

**Mike Oliver** (Former Chief Geotechnical Engineer for the BC Ministry of Transportation and Infrastructure). More than 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). More than 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, and design-build, 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). More than 27 years of experience as an engineer, lawyer, and consultant in the areas of engineering, construction, project management, construction cost, scheduling, and construction claims.



### 3.0 Approach

The team members conducted the review of the Site C Project through two methods:

- 1) Examination of the records of the BC Hydro, the Project Assurance Board (PAB), Ernst and Young (EY), the Technical Advisory Board (TAB), 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 also created documents to assist us in understanding complex issues.

The interviews conducted included questions on a variety of technical and governance topics. Our team gave the individuals interviewed the opportunity to provide additional information they felt would be relevant to this review. A number of the participants provided advice on documents and other information they felt would be helpful. Our team conducted more than 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 approach taken 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.

## 4.0 Overview and Background

### 4.1 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 a limited level of effort nor poor workmanship. 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, to verify the schedule, or to 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, we reviewed the presentation materials, minutes, and communications.

**Geotechnical issues** – We expended considerable effort to understand the complex geotechnical conditions on this project. The timeframe of observations, assessments, actions, and communications were assessed to understand how geotechnical issues emerged on the project.

**Risk** – The risk system is very complex on this project. We undertook a detailed examination in order to understand and comment on all of its key 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.

### 4.2 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 BC. 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 BC.

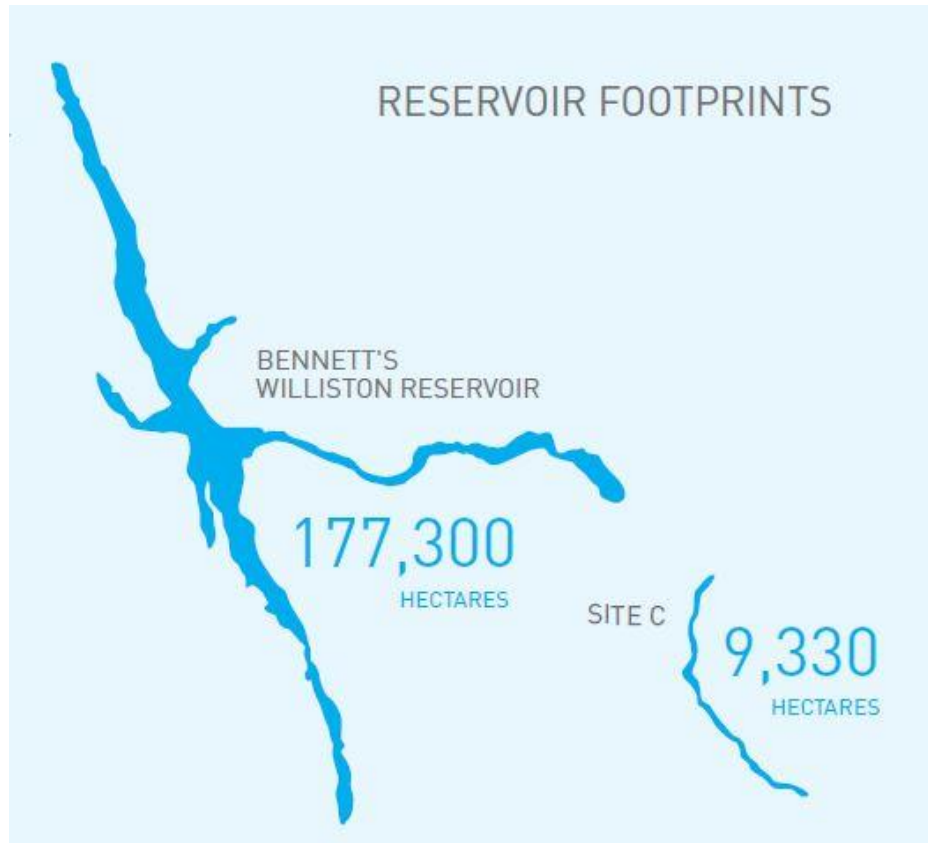


Figure 1 – Reservoir Footprints

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 Site C will generate approximately 35 percent of the energy produced at W.A.C. Bennett Dam, with only five percent of the reservoir area.

In December 2014, the Provincial Government approved the Site C Project to proceed with construction.

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

In the summer of 2017, British Columbia formed a new government. 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.

## 5.0 Project Approval

The Minister Finance and the Minister of Energy, Mines and Low Carbon Innovation (previously Minister of Energy, Mines and Petroleum Resources) commissioned this report to examine the period from January of 2018 until October of 2020.

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) with a project reserve of \$0.440 B to be overseen and controlled by Treasury Board ([info-sheet-site-c-project-budget-april-2018\\_0.pdf](#))

BC Hydro divided the project 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 BC Hydro based most contracts 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). BC Hydro awarded a number of contracts to First Nations.

After approval, the project experienced a series of challenges. In 2017, BC Hydro encountered major construction issues. These included a major tension crack on the north bank during slope excavation and stabilization activities. BC Hydro determined the river diversion would be delayed to 2020 which used up one year of schedule float. Missing the 2019 river diversion timeline created new pressures on the project's budget and resulted in increases to direct and indirect construction costs, and adjustments to contingency and interest during construction. In addition, the estimated cost of the generating station and spillways civil works contract had increased. This meant additional funding would be required to complete the project.

In 2017 when a new Government was formed in BC, the Premier commissioned an extensive review of the project, as mentioned above, that resulted in the Provincial Government approving the continuation of the project in December 2017.

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

Since the Government of BC made the decision to continue the Site C Project in December 2017, BC Hydro has experienced significant issues related to identified cost, schedule, procurement, geotechnical and scope risks associated with the project, and COVID-19.

These factors created schedule and interface concerns, engineering redesigns, and extensive financial pressure.

The majority of these issues arose within the Main Civil Works contract (MCW).

BC Hydro awarded this contract to Peace River Hydro Partners (PRHP, a joint venture led by Acciona and Samsung 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.

Consistent with the terms of reference, the discussion of these significant issues is divided into four subject areas:

- **Governance**
- **Geotechnical**
- **Risk**
- **Construction and Claims**

## 6.0 Governance

In the fall of 2017, BC Hydro realized they needed to make adjustments to improve the oversight and governance of the project. BC Hydro created a project implementation plan that addressed these improvements. This plan included two specific commitments to improve due diligence and project controls.

- 1 **The first aspect of enhanced due diligence and enhanced oversight was the creation of a Project Assurance Board (PAB)** to provide enhanced oversight to future contract procurement and management, project deliverables, environmental integrity, and quality assurance.
- 2 **The second aspect involved the role of the Independent Oversight Advisor Ernst and Young (EY)** to provide dedicated budget oversight, timeline evaluation, and risk assessment analysis for the duration of the project.

### 6.1 Site C Project Assurance Board

BC Hydro portrayed PAB as an important feature in ensuring the project would be completed successfully. BC Hydro indicated up to five BC Hydro Board members, two external experts with construction experience, the senior member of the Independent Oversight Advisor (EY), and two Government representatives would comprise the PAB.

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.

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:
  - 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 help ensure it is delivered on time and on budget and acts in a role of Site C Project due diligence and oversight.

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

However, BC Hydro has limited PAB’s oversight, and a number of areas for potential improvement exist.

#### **6.1.1 Project Advisory 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 and intentional manner, we have been unable to locate an inventory of skills held by PAB members. Additionally, our team has been unable to find a documented skills matrix.

Through the interviews conducted, we realized some PAB 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.

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

#### **6.1.2 PAB Composition and Independence**

An important feature of providing due diligence is the ability for the group 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.

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. Following this, an official previously responsible for a substantial portion of the project filled the PAB Chair.

Through the interview process, a number of PAB members indicated the BC Hydro Board did not allow the PAB enough opportunity to fully explore the issues and create independent recommendations for the BC Hydro Board. Some PAB members felt frustrated by this process.

Our team recognizes that the strongest and most valuable due diligence often 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.

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.

We also feel there would be a benefit from providing new PAB members with a detailed orientation to the project and the role.

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.

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**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.***

**Recommendation #2**

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

**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.***

**Recommendations #4**

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

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### **6.1.3 Meeting Structure and Time Commitments**

This is one of the most complex projects delivered in recent history in British Columbia. This project 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.

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 sub-committees or working groups focused on high risk topics.

After review of the agendas and interviews with PAB members, it appears that the scope of the topics canvassed for the PAB meetings was limited. The agendas appear to contain many project updates and informational items with few items regarding key project issues or strategic considerations.

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

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#### **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.***

#### **Recommendations #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.***

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### **6.1.4 Independent Oversight (EY)**

BC Hydro in cooperation with the Provincial Government created a material role for EY as independent oversight on the project. BC Hydro hired EY to provide dedicated budget oversight and timeline evaluation, to assist in improving the relationship with the contractor, and to evaluate risk assessment analysis for the duration of the project. EY would provide this service for both BC Hydro and the BC Government.

Specifically:

- BC Hydro would retain EY as a permanent part of the Project Assurance Board;
- EY would assist with a comprehensive reset of Site C's governance structure and project organizational structure;

- EY would assist in a comprehensive reset of project controls and risk management processes; and,
- EY would focus on independent oversight on the MCW contract, including improving the relationship with the MCW contractor.

The role of independent oversight has not been executed consistently with the commitments as briefly described below.

Shortly after the project was approved in January 2018, EY commenced work on an assessment of the current state of project controls and risk systems. EY created a report for the PAB in a report dated May 2018. The report identified many deficiencies in BC Hydro's systems.

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

BC Hydro largely disagreed with EY's report but did adopt some of its recommendations. The report and BC Hydro's response marked a deterioration of the relationship between the two parties.

BC Hydro also stated they felt that EY was not producing enough value for money. Within a few months, BC Hydro notified EY that their contract would be terminated. A short time later, BC Hydro rescoped the contract to lessen the role EY would have in overseeing the project.

Ultimately, BC Hydro determined the amount and type of oversight they would receive from EY. This appears inconsistent with the concept of independent oversight and with BC Hydro's commitments to government.

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

## 6.2 Observations

The commitments BC Hydro made to improving independent project oversight with the assistance of EY have not been fully achieved. The comprehensive reset of project controls and risk management processes has not occurred. BC Hydro greatly diminished the role of EY in providing independent oversight on the MCW contract, including improving the relationship with the MCW contractor, through the exclusion of those provisions in EY's amended contract.

Please note, our team has found EY's advice and reports to be of good quality and valuable to the project. However, BC Hydro may not have used these reports to their full potential. This is discussed further in the Risk section of this summary report.

In summary, BC Hydro engaged EY to perform Independent Oversight, with a focus on organization, project controls, and risk; however, since the delivery of the assessment EY produced in May 2018, BC Hydro reduced EY's role as Independent Oversight, resulting in a diminished Independent Oversight function that does not appear to be operating in the manner initially intended or envisioned.

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### **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.***

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## 7.0 Site C Geotechnical Review

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 understand and design the soil and rock foundations. Geotechnical engineering is a specialty discipline of civil engineering concerning the behaviour and structural interconnected properties of geologic materials and groundwater. Geologic materials include natural soil and rock, but also include human-made materials such as compacted soil fill, crushed stone, concrete, and manufactured stones.

The study of the geological material properties on a construction site is critical in the 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 investigations to analyze them generally only give the engineer a small piece of the whole story. Often, the only time the engineer understands the full picture is when one excavates for the foundation or starts work on site.

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

Due to the challenging foundation geology, BC Hydro conducted a significant amount of investigation over a 40-year period. These investigations focused on characterizing the shear strength, groundwater, and other aspects of the foundation that could influence the project design.

Despite these investigations, a number of unexpected geotechnical conditions have created significant pressures on the project.

As of September 2020, BC Hydro has paid very large sums to the Main Civil Works contractor for geotechnical issues through Amending Agreements, Change Orders, and Direct Work Orders, in addition to granting a one-year time extension. The majority of these payments relate to tension cracks in the left bank encountered in 2017. These cracks resulted in BC Hydro redesigning the slopes and increasing excavation volumes, which consumed a one-year float in the project schedule. Additionally, geotechnical issues arose 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 relates 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. BC Hydro was not aware of the presence and continuity of bedding planes below the Roller Compacted Concrete (RCC) buttress during the design of the dam. Previously, reports considered the rock stable, and the design relied on this assumption.

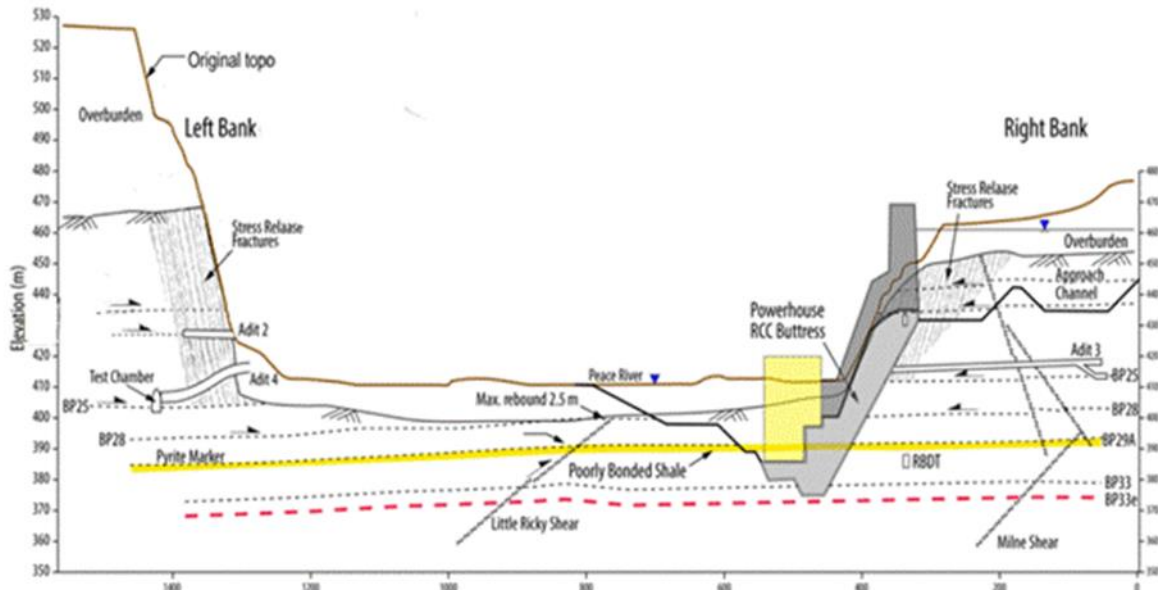
### **Bedding Plane Movement Below Dam Structures**

In mid-August of 2018, BC Hydro became aware of 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.”*

*“Therefore, a substantial investigation is warranted to validate the extent of this plane of weakness, improve its strength characterization, and evaluate mitigation measures, if they prove necessary. There is some urgency associated with this undertaking since mitigation, if needed, may be costly and might impact schedule associated with spillway construction.”*

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 project schedule could be significant.



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

In the same October report, the TAB recommended to the Engineering Design Team (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, televiewer 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 year, the EDT and the TAB worked on these recommendations and additional engineering studies including deepening the shear key to more fully assess the bedding plane strength and slip resistance. The TAB and EDT anticipated 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.

During this period of time, the PAB had a limited role in the review of this issue.

By January 2020, the EDT realized that grouting and improved drainage would not be sufficient and that more robust structural mitigation were likely required. Between January and March, engineers completed further engineering analyses of the possible mitigation measures. 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.

*The Project first observed this geotechnical issue in August of 2018, and the EDT and TAB reported the issue to the PAB in October of 2018. Yet PAB members expressed “surprise” in early 2020 when BC Hydro informed them that the problem required robust mitigation.*

From a governance and oversight perspective, our team feels that the PAB should have been actively involved in the review of mitigation measures. One of the primary roles of PAB is to review risk issues and provide strategic advice on mitigation.

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

As the PAB were not actively engaged in this issue, they were not in a position to alert the Provincial Government to this potentially significant cost risk at an earlier date. It is possible that if the PAB had more members with specific expertise, they would have taken a more active role.

## **7.1 Summary and Observations**

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 all the geotechnical issues is significant. At the time of writing, the final cost is unknown. However the October 2020 cost estimates are 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. Despite decades of research, BC Hydro did not understand how these issues would manifest themselves in the design.

This review has 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.

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

**“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”.**

**Our review team believes BC Hydro followed a reasonable process to assume the bedding planes below the RCC Buttress would not be subject to movement.**

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

BC Hydro's presentations emphasized the significant amount of engineering study 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 misplaced 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 BC Hydro miscalculated the potential impact of the geotechnical issues. Given BC Hydro's adoption of the Observational Method, which means that the design may need to be modified depending on the field conditions encountered, it appears reasonable 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.**

Our assignment did not include a review of the proposed mitigation measures to address the movement in the bedding planes. We understand an external review is currently underway.

On this project, it may be beneficial to carry out Value Engineering at an early stage of mitigation development. 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. A skilled facilitator leads the multidisciplinary



team, which is generally independent of the project's management or design staff. This allows the team to perform an objective, critical review of cost, value, and constructability. Finally, we find it important to note the risk of additional geotechnical issues on this project continues at the time of writing.

As of October 9, 2020, the most substantive geotechnical risk identified is the potential instability of the earth fill dam due to potential bedding planes with lower shear strength than assumed in the design.

The design team has indicated the shell profile of the dam can be modified, and the construction staged, if additional changes are required.

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**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.***

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## 8.0 Risk Management

The Special Advisor's mandate specifically requested 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.

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 influence project outcomes and goals. When risks are effectively managed, their overall impact to project outcomes and goals, can be reduced.

While there are a 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.

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.).

An actively updated document that sets out the Risk Management Plan governs the Site C risk management. The latest version is dated June 5, 2020.

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.

While the plan aligns with industry standards, our team has 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 and the BC Government.

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. EY's May 2018 report also identified the limited size of the risk management organization and recommended additional resources.

The sections below will discuss the three main components of the risk management plan. The **risk register**, the **cost risk analysis (CRA)**, and the **schedule risk analysis (SRA)**.

## 8.1 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 BC Hydro provides a description of all open risks in the Risk Register 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.**

Each risk in the Risk Register identifies a risk owner. This responsible owner is 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 responsible risk owner or a delegate is to prepare and manage the treatment plan.

The Risk Register assesses each risk in two areas, probability of occurrence and consequence of severity if the risk should be realized. This qualitative assessment prioritizes the project risks based on the sum (addition) of probability and consequence. This provides each risk with a numerical value (<13.5) which is used as the foundation for risk reporting which will be discussed below.

The following gaps were noted in the Risk Register:

- The Risk Register focuses on qualitative assessment of risk, while focused quantitative 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 in the 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 BC Hydro refers to them, 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 plan; 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.

Limitations in the information provided in the Risk Register, include:

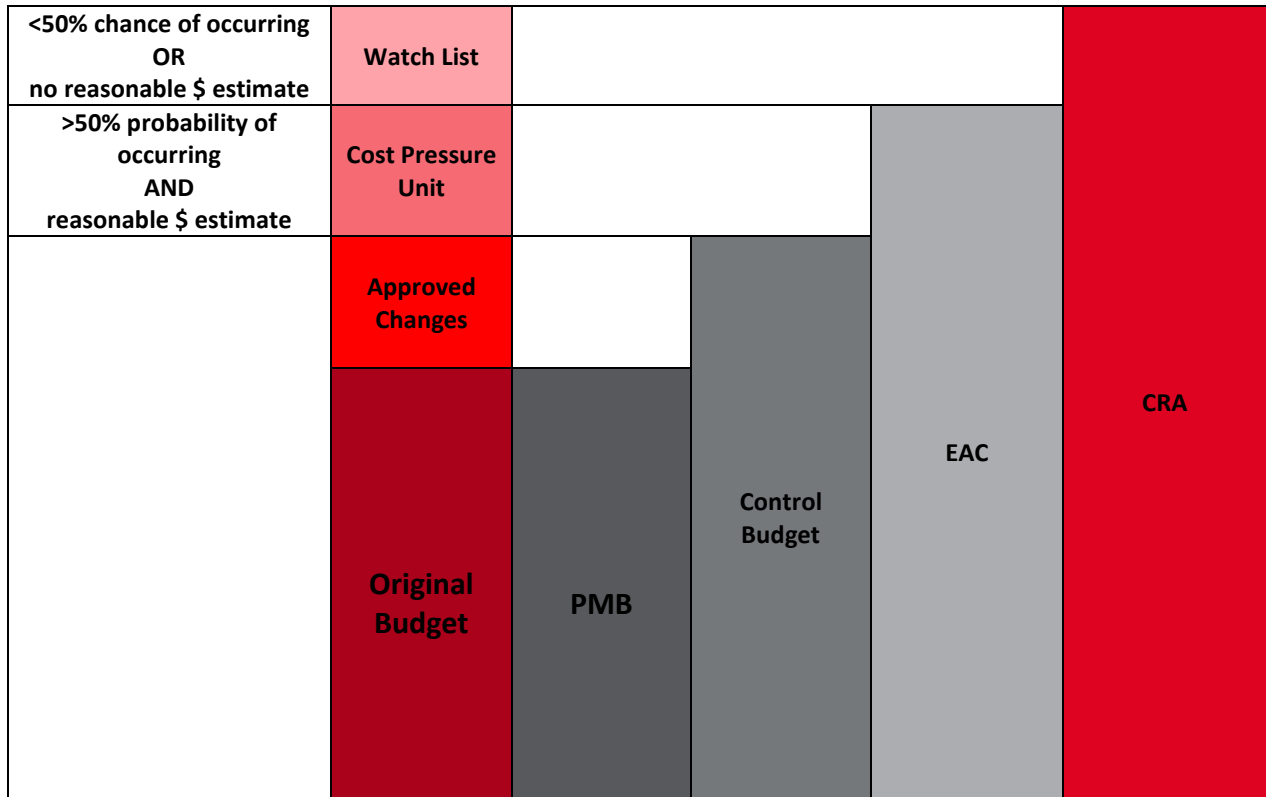
- Not all closed risks on the Risk Register have a clear explanation of whether the risk has expired, been realized, replaced, or omitted.
- Risks continue to be modified on the Risk Register after the risk has been closed.
- The highest probability of consequence in the Risk Matrix is >60%.
- Many risks on the register overlap, meaning 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.

Based on review of the documentation provided and the interviews performed, the Independent Advisor, EY shares these concerns and has identified a number of similar areas of potential improvement in the Site C risk management processes.

## **8.2 Cost Risk Analysis**

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.

On Site C, four key components comprise 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 Management** (Source: Site C Risk Management and Cost Management) EAC = Estimate at completion

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.
- Where a risk is located depends not only on probability of occurrence and probability of contingency use, but also on a difficult to define quality of estimate.
- Watch List items below 30% probability of consequence are not generally considered in the CRA.
- Watch List items 3-point estimates may be subject to adjustment based on an undefined assessment of probability of consequences.
- Watch List items between 30% and 60% probability of consequence are all forecast to occur (i.e., have a probability of 100%) on every Monte Carlo analysis (simulation).
- It is unclear how consistency in the preparation of the various lists is maintained.
- 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.

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

If the system was complex but was accurate and well understood by team members and the PAB it would be more acceptable. However, it appears to be neither accurate nor well understood based on information provided by participants in interviews.

Built-in assumptions limit the scope of the CRA. Particularly, the schedule assumptions around river diversion and first power being met could have a profound effect on cost. These are not low probability events -- in the last Schedule Risk Analysis, the probability of missing the in-service date was 35% -- yet the CRA did not capture the financial impact of this.

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

- The CRA is not an accurate predictor of potential total project costs; the level of confidence that the project should have in the CRA 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 the 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 the CRA 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 as to 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 be an effective tool to evaluate project risk.

### **8.3 Schedule Risk Analysis (SRA)**

The other primary risk tool used in the risk management system is the SRA. The SRA is a tool that creates a probability distribution of key project milestones, such as river diversion, or critical path events. Like the CRA, it uses a Monte Carlo Analysis.

BC Hydro developed the SRA and the CRA independently from each other. BC Hydro attempted 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.

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.

#### **8.4 Reporting of Risks**

As part of its regular updates to PAB and the BC Government, BC Hydro reported on project risks. As mentioned above, each risk on the Risk Register is given a numerical value that indicated the sum of the probability of the risk occurring and the consequence if the risk comes to fruition. This results in risks valued between 0 and 13.5. BC Hydro would report those risks with a value of greater than 10.5 to the PAB on a monthly basis.

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.

In this review, our team tracked risks as they occurred and were reassessed since January 2018. In February 2018, the 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. This appears strange as the MCW was experiencing significant geotechnical issues in 2017, and those issues have regularly continued to this date (October 2020).

However, the February 2018 Risk Register did contain other 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)*. BC Hydro assigned these items residual risk ratings of 10, 10, 9 and 9, respectively, and they were not reportable to the PAB on a regular basis.

The result of this is that only one of five Geotechnical risks met the PAB reporting threshold.

When the EDT observed movement in bedding planes (including BP33e) in mid-August 2018, a new risk (814) was created – “*Geotechnical issues on work fronts other than the Left Bank Diversion Tunnel*” 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, EDT created Risk 874 – “Additional MCW work needed to meet RCC buttress requirements.” This risk had a residual risk rating of 10, and so was not reportable to the PAB.

Two years later in October 2020, the Risk Register shows eight significant geotechnical risks associated with the MCW contract but only two, Risks 874 and 927 – *Unstable Earthfilled Dam*, are reportable to the PAB.

As demonstrated, 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 is that original risks may fall below the PAB reporting threshold.

***This process may have resulted in the full extent of MCW geotechnical issues not being fully transparent to members of the PAB.***

***It would seem reasonable that given the magnitude of project geotechnical risks they should be a subject of review at almost every meeting with full disclosure and examination of all potential risks.***

## **8.5 Reporting to the BC Provincial Government**

Our team also reviewed whether the information provided to the Provincial Government was consistent with that provided to PAB and reported on a timely basis.

Our review shows that the specific risk information prepared for the BC Government appears to be generally consistent with similar material tabled at the PAB and is provided in a similar timeframe. As such, the concerns identified in the review of the PAB reporting apply equally to reporting to the BC Government.

## **8.6 Risk Management Reset**

As detailed in the Governance section of this report, the Government of BC anticipated that BC Hydro and its Independent Advisor, EY, would be working on a “Comprehensive reset of BC Hydro project controls and risk management functions and associated reporting.”

Since May 2018 EY has consistently identified a number of areas in the risk management process that would benefit from improvement. It is worth noting that some of the substantive recommendations have not yet been addressed.

The most recent example occurred 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.



The slide identified key focus areas for review and discussion including:

“All identified risks include the following data.

- Pre-mitigation & post-mitigation cost and schedule impacts
- Pre-mitigation & post-mitigation probability of occurrence
- Robust basis of estimate for all probabilities and impacts

All risks that include a mitigation strategy must have an associated plan that includes costs, responsibilities, and monitoring mechanisms.

- All project and subprojects interfaces are fully addressed and accounted for.
- Conformity with contractors ongoing and most recent plans to ensure consistency between risk modelling and site performance.
- Enhanced visibility and transparency in gathering information and developing models.
- Models will be based on the risk register rather than the cost pressure and watch list process inputs”.

The meeting ended without EY being allowed to present the slide.

While it is apparent some progress has been and continues to be made, it does not appear to amount to the “joint comprehensive reset of risk management” that BC Hydro committed to undertake.

Since January 2018, BC Hydro could have done a much better job of anticipating risks, quantifying the range of risks, tracking the effectiveness of risk mitigation, or communicating risks to the PAB and the Provincial Government.

In our view the likely reasons include the limitations of the systems used, the data input, and the low staffing level associated with project risk management. Given the size and complexity of this project, the level of resources dedicated to risk management appears very inadequate.

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**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.***

**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.***

**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.***

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## **8.7 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 going to occur 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, BC Hydro had not yet allowed EY to become involved in or any portion of the baseline work.

While this may have been subsequently remedied, such an approach is not consistent with the intention to have independent oversight be fully involved in all aspects of the budgeting process.

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.

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**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.***
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## 9.0 Construction and Claims Management

The construction of the Site C dam is one of 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 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.

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 experienced personnel, and the relationship with the contractors is generally good. However, the relationship between BC Hydro and the MCW contractor could benefit from improvement.

## 9.1 Main Civil Works Contract

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 Project (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.

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

The apparent lack of a 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.

However, based on discussions and the information provided, we understand the contractor has generally produced quality results.

### BC Hydro MCW Field Supervision

The performance of the BC Hydro field supervision 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, some of the people on the ground working for BC Hydro appear to lack the requisite experience to handle a large contract of this nature.

During the interviews with construction advisors, comments were stated regarding 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.

Having experienced and effective field supervision will be the key to success on the Main Dam. Several potential risks 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.

Based on information gathered during this review, it is our opinion that currently there are an insufficient number of experienced personnel within BC Hydro at the time of writing of this report. Construction advisors also hold this view.

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**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.***

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## **9.2 Schedule**

BC Hydro has had difficulty in securing a timely work schedule from PRHP. Extended periods of time have passed where, due to ongoing negotiations to resolve claims, PRHP has been unable to provide an accepted specification schedule. During these periods interim updates have usually been provided on the basis of a “without prejudice” schedule. This has been identified as a key issue by all of the construction advisors.

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**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.***

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## **9.3 Generating Station and Spillways (GSS)**

The GSS contract is a form of civil construction that BC Hydro is very familiar with and has experienced field personnel to handle. 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

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

projects. In addition, a number of the managers have experience on several projects with BC Hydro.

Through the interview process, our team learned employees believe the contractor supervision team 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, our team received positive comments related to the quality, productivity, and safety of the craft labour.

The BC Hydro team is also experienced and includes people with 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.

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 and full cooperation are evident between the two parties. The BC Hydro team understands the work and is quick to recognize and make decisions. Our team has noted that BC Hydro personnel are actively involved in the work and engaged in jointly solving issues.

#### **9.4 Turbine and Generator (T&G)**

BC Hydro awarded the Turbine and Generator contract in 2016 at \$464 million to Voith.

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.

Voith laboratory in Lausanne, Switzerland completed testing. 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.

#### **9.5 Balance of Plant (BOP)**

The Balance of Plant contract is in the procurement stage. Our team notes 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. BC Hydro issued these supply contracts through separate procurement processes, and these contracts 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.

For the Balance of Plant procurement, the bids came back with a low bid that was more than the BC Hydro estimate.

Currently, the Balance of Plant procurement is being re-planned to break it into 6 packages, each of which is to be bid separately, starting in January 2021. This approach has its own risks as it introduces more contractors and the schedule and interface issues that brings.

## **9.6 Claims Administration**

The comments on claims administration 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.

### **Contractual**

With reference to contractual entitlement, we found the work of the BC Hydro team to be of high caliber. 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.

### **Commercial**

**This section is highly abbreviated to not compromise BC Hydro's negotiating position moving forward.**

BC Hydro's commercial approach to claims was complex. It required them to have a good understanding of the additional costs and impacts of schedule slippage.

Unfortunately, the materials prepared for the PAB to analyze these points were difficult to understand and lacked complete information. This was particularly true as it pertained to the cost associated with critical milestones. We expect the PAB members also experienced this difficulty. This was confirmed by some PAB members through the interview process.



Our team notes that an opportunity for improvement exists as it relates to the accuracy and quality of cost and schedule information presented to the PAB.

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**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.***

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## **9.7 Claims Management Process**

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, and that the delay in responding to an early claim may have contributed to the apparently strained relationship between BC Hydro and PRHP.

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.

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.

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**Recommendation 16:**

*It is recommended that BC Hydro give consideration to 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.*

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## 10. 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.

### 10.1 Summary of Recommendations

Recommendation #	Recommendation
<b>Recommendation 1</b> 6.1.1 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.
<b>Recommendation 2</b> 6.1.2 PAB Composition	It is recommended that consideration be given to having more external, independent, and skill specific membership on the PAB.
<b>Recommendation 3</b> 6.1.2 PAB Composition	Due Diligence and oversight require independent consideration. The current process appears to truncate the opportunity to properly explore problems and potential

Recommendation #	Recommendation
	solutions. BC Hydro should consider providing PAB with more autonomy and opportunity for independent due diligence and deliberations.
<b>Recommendation 4</b> 6.1.2 PAB Composition	It is recommended that the orientation process is formalized and includes formal feedback on content, quality and methodology.
<b>Recommendation 5</b> 6.1.3 Meeting Structure and 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.
<b>Recommendation 6</b> 6.1.3 Meeting Structure and Time Commitments	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.
<b>Recommendation 7</b> 6.2 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.
<b>Recommendation 8</b> 7.1 Summary and Observations	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.
<b>Recommendation 9</b> 9.0 Risk Register	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.
<b>Recommendation 10</b> 8.1.2 Cost Risk Analysis	<ol style="list-style-type: none"> <li>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.</li> <li>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.</li> </ol>
<b>Recommendation 11</b> 8.1.4 Risk Reporting	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><b>Recommendation 12</b> 8.1.6 Re-Baseline</p>	<p>The Rebaselining exercise should include the following:</p> <ul style="list-style-type: none"> <li>• Cost impacts of all the elements that were presented as key risks in the July update.</li> <li>• 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.</li> <li>• The cost pressures and watch list items should also include schedule related cost impacts (based on the SRA's anticipated completion date).</li> <li>• The Independent Advisor, EY, would have access to and oversight of the entire process.</li> </ul>
<p><b>Recommendation 13</b> 9.1 Main Civil Works Contract</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><b>Recommendation 14</b> 9.2 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><b>Recommendation 15</b> 9.6 Claims Administration</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><b>Recommendation 16</b> 9.6 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"> <li>1. A senior executive whose primary duty is claims negotiations.</li> <li>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.</li> <li>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</li> </ol>

Recommendation #	Recommendation
	<p>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"> <li>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.</li> <li>5. An external experienced forensic engineering and claims specialist, to assist with strategy development and claim preparation.</li> <li>6. Trained personnel whose duties include recording information and preparing meeting minutes, signing off on contractor work, and responding to contractor correspondence and claims.</li> </ol>
<p><b>Recommendation 17</b> 9.7 Claims Process</p>	<p>BC Hydro should consider a formalized claims management plan and program to react, counter, and where possible proactively respond to claims.</p>