BC Hydro

Site C Clean Energy Project – Infrastructure risk and cost management report

13 September 2016

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Jessica McDonald
President & Chief Executive Officer
BC Hydro, 333 Dunsmuir Street
Vancouver, BC, V6B 5R3

6 September 2016

Re: Site C Clean Energy Project – Infrastructure Risk and Cost Management Services

Dear Ms. McDonald:

EY and BTY Consultancy Group Inc. ("BTY") have completed a report as part of the review of the Site C Clean Energy Project ("Site C"). This engagement is being performed in accordance with the signed consulting services agreement dated 15th July 2016 between EY and British Columbia Hydro and Power Authority ("BC Hydro").

The objective of the Engagement is to assess the Site C Project's risk and cost management processes and to identify opportunities to address any material or critical gaps. As requested, this report will assess the practices for cost and schedule forecasting, including risk management and mitigation. This report:

- Evaluates the project management maturity of Site C;
- Identifies current potential risks and issues to the successful completion of Site C on schedule and on budget;
- Provides recommendations to support the achievement of the project's operational and financial targets.

The field work for this report was completed in July and August 2016 and consisted of reviewing project data and documentation, enquiries and discussions with senior management and the project team, and a site visit. The services provided by EY and BTY in this report are advisory in nature.

EY and BTY have not developed their own cost, schedule or risk forecast, but instead have assessed the process undertaken by BC Hydro in preparing these forecasts by reviewing documents provided to us and through information obtained during interviews.

We would like to express our appreciation for the cooperation and assistance provided to us by the Site C Project team and BC Hydro corporate.

Yours sincerely,

Ernst & Young LLP

Ernst & Young LLP

Disclaimer

This report is intended solely for the information and use of British Columbia Hydro and Power Authority and is not intended to be and should not be used by any other parties. In preparing this report, EY and BTY relied upon information provided by their client. EY and BTY have not audited, reviewed or otherwise attempted to verify the accuracy or completeness of such information. This report has not considered issues relevant to third parties and is subject to certain limitations. We shall have no responsibility whatsoever to any third party that obtains a copy of this report. Any use such a third party may choose to make of this report is entirely at its own risk. We disclaim responsibility for loss or damage, if any, suffered by any third party as a result of reliance on, decisions made or actions taken based on this report.

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1. Executive summary

Summary

EY and BTY were engaged by BC Hydro to provide an independent, external review of the Site C Clean Energy Project's ("Site C") business and risk management plans, and a risk analysis of major components of the project budget. Our review focused on four key areas: 1) major contracts (>$50m) awarded to date; 2) risk management plans, processes, and risk registers; 3) cost management plans and processes, with an assessment of overall cost controls; and 4) key cost drivers and indicators compared to the estimate baseline. Over the course of July and August 2016, EY and BTY have reviewed in excess of 100 projects documents, interviewed senior project personnel, and conducted a site visit.

Given Site C's early stage in its lifecycle, our review did not find any evidence to suggest that major project milestones and financial targets will not be met. Overall, the Site C project is both clearly defined and well-planned. BC Hydro employs an industry leading approach to project management via the Project & Portfolio Management system, with practices scaled to both the complexity and size of Site C. While project execution risks do exist, we consider those risks to be well-understood and managed by the project team. A robust process was followed in order to establish the project budget, and extensive due diligence was conducted. Site C also benefits from best-in-class software that BC Hydro has implemented and integrated over the past 5 years, including SAP, P6 (Primavera), HeavyBid, Unifier, and others. Finally, we were strongly encouraged by the level to which Site C has leveraged the depth of knowledge within the broader BC Hydro organization around key areas such as project, contract, and interface management.

Despite strong overall project management practices, our review identifies what we believe to be some key gaps BC Hydro will need to carefully consider in order to meet the projects' financial and schedule targets. Of primary concern, the capacity of both the contractors and project delivery team to manage and monitor the work will be a critical area to watch as the project progresses, particularly given design and construction dependencies across work packages. Managing major work packages in parallel requires significant project resources and close monitoring of interfaces, and will be central to managing and mitigating overall project risks. Good project controls and reporting will also be a fundamental support to the project effort by enabling issue-forecasting and performance monitoring.

Important to addressing these gaps will be the strong culture of continuous improvement we observed when speaking with both senior BC Hydro and project-level leadership. There is also a clear desire within the organization to further mature project execution capabilities and become an industry leader in project management.

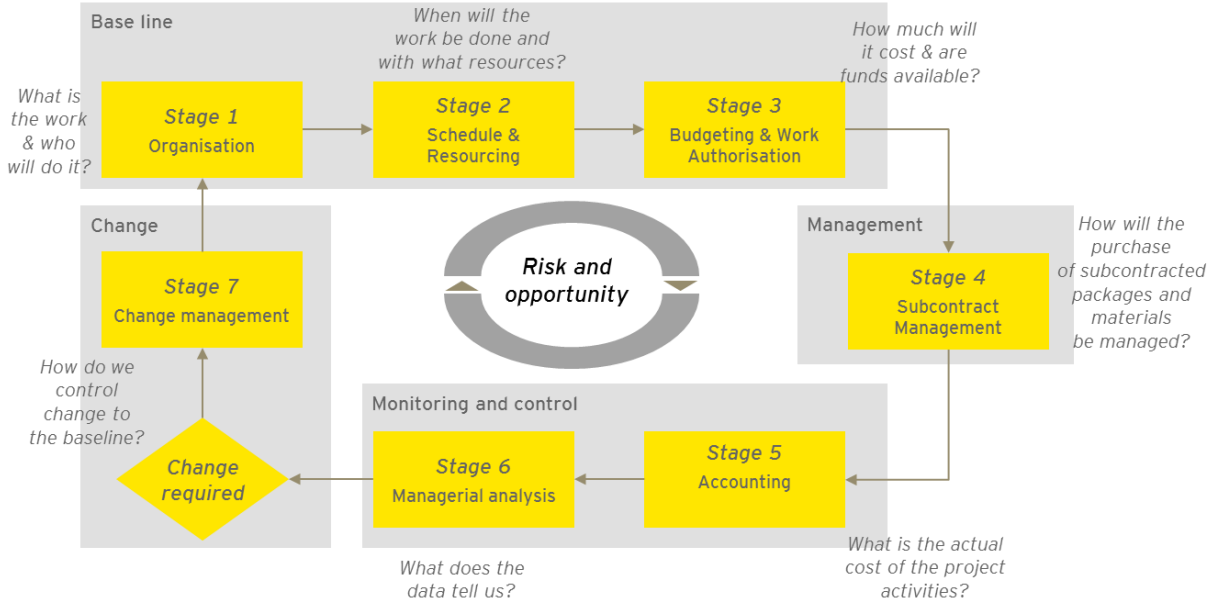
Project management maturity

In 2010, BC Hydro rolled out an integrated project management solution which included such tools and enablers as the Project & Portfolio Management system, P6, and SAP. A maturity assessment measuring the degree of the project delivery maturity in Organizational Project Management (Project Management, Program Management, Portfolio Management and other Organizational Enablers) was performed in both 2010 and again in 2015 using the Project Management Institute's "Organizational

Project Management Maturity Model" (OPM3®). At the beginning of implementation in 2010, BC Hydro received an OPM3® score of 5%, and when reassessed in 2015, received a score of 91%. While we recognize the impressive improvement in overall project management maturity, it is important to note that the OPM3® assessment evaluated project delivery maturity at an organizational level, and not at a project level.

As a result, to support our findings, EY and BTY have used similar industry-recognized Maturity Rating Criteria to measure Site C's maturity on project management practices at a project level. To provide further context to our ratings, Exhibit 1 provides an overview of best-in-class cost and risk management processes for major capital projects.

Exhibit 1: Leading Practice Project Management Process for Major Capital Projects



In Table 1, we provide a high-level overview of the average performance of the Site C project along each of the criteria measured. **We have rated Site C-level practices *only*, and have not provided an assessment of BC Hydro's overall project management maturity**. Our assessment is based upon our observations and analysis of the information provided by BC Hydro over the assessment period. We would not expect, nor require, all projects to be a Level 5 in all areas in order to demonstrate leading practices. Detailed criteria for each rating are provided in Appendix C of this report.

Table 1: Maturity Rating Criteria

Site C score ✓ Expected score based on stage in project lifecycle ●

No.	Observation	Level 1	Level 2	Level 3	Level 4	Level 5
1	Scope definition: how clearly is the scope documented as a baseline for the project				✓ ●	
2	Front end loading (planning) and how well defined is it based on the project scope			●	✓	
3	Capacity of Project & Portfolio Management (PPM) system to meet the project management needs				✓ ●	
4	Procurement strategy and how it addresses the risk of the supply chain				✓ ●	
5	Cost management reporting and how effective it is			✓	●	
6	Project governance as an approval mechanism			✓ ●		

Based on our maturity assessment, Site C follows leading industry practices in key areas that allow effective management of many project risks. While some gaps exist, outlined in further detail below, we recognize the efforts currently underway to build capability in this area.

Summary of key findings/gaps

The main findings in all of the four key areas assessed are summarized in Table 2 below.

Table 2: Key findings/gaps

	Key findings/gaps	Action	Priority level [0-3 months – high] [3-6 months – medium] [6-12 months – low]
Review of major contracts (over $50 million) awarded to date			
1.	**The complex nature of the work and contracting strategy exposes the project to risks related to interface management.**	**An interface manager and team should be considered as part of the overall project organization.**	3-6 Months Medium
	Our review noted that BC Hydro has assumed overall responsibility for interface management risk. However, the contracting approach has transferred risk to the extent possible over to the contractors. While the complex nature of these interfaces will put significant pressure on BC Hydro to	A specific interface management plan with clearly defined roles and responsibilities across all contracts should be developed. This would represent a departure from the current view of interfaces at the individual work package level, to an overall integrated and coordinated approach. For instance,	

	Key findings/gaps	Action	Priority level [0-3 months – high] [3-6 months – medium] [6-12 months – low]
	manage and control as multiple contracts run in parallel, we are encouraged by the depth of experience across the organization in managing complex interfaces.	we note that the detailed roles and responsibilities matrix in the Main Civil Works contract is effective, and should be developed across all major contracts.	
2.	**Current contract management needs and reporting requirements are placing significant strain on the capacity of the Site C project team.**	**As the project progresses, Site C would benefit from an independent review of the capacity and capability of the project team to deliver upon evolving project needs.**	3-6 Months Medium
	When the main works contracts are fully executed, there will be a significant volume of information to process, analyze and approve. The contracts have transferred much of risk onto the contractors, however, BC Hydro will still have specific timeframes within which to respond to requests, changes etc.	This review may also be extended to the major contracts to ensure that the team can meet all contract requirements. This will also support any audit of reimbursable elements of contracts. Given the number of current vacancies and potential need for additional resources, a dedicated Human Resources staff should also be employed to the project.	
3.	**The scale and importance of the Main Civil Works package in our view will require additional overview and coordination.**	**The Main Civil Works contractors would benefit from a forward-looking capability and capacity review to help monitor contractor performance against schedule. The implementation of Earned Value Management and Unifier will also support contract management.**	0-3 Months High
	It is clear that a Joint Venture approach for the Main Civil Works work package has clear benefits for executing the nature of the work. This said, given that the parties contracted have not had extensive experience working together on major projects, additional oversight and reporting to ensure cost and schedule targets are met should be considered.	The project team is aware of the risks on the Main Civil Works package and is supporting the contractor in many aspects. Of all the major contracts, it is the one that is most difficult to measure performance on as it is based on a Schedule of Rates and has various 'below ground' risks. The contractor's experience in project controls should be understood before agreeing what level of project controls should be implemented. The planned implementation of Earned Value Management and Unifier will also support performance measurement and	

	Key findings/gaps	Action	Priority level [0-3 months – high] [3-6 months – medium] [6-12 months – low]
		contract management.	
Review of risk management plans, processes, risk registers, and reporting			
4.	**We observed strong schedule development and controls processes, including a challenge function, when reporting schedule against planned. The underlying data feeding the schedule and capability and capacity to manage the project will need to be evaluated throughout the lifecycle.**	**BC Hydro should commission a comprehensive, independent review of the project schedule at a work package-by-work package level in order to both validate schedule content and to identify any schedule risks.**	0-3 Months High
	In particular, the bottom up information and data feeding the contractor's schedule reporting and management into the overall master schedule needs to be independently validated to identify risks areas against the Project Management Baseline.	As mentioned in Key Finding no. 2, an independent review of the capability and capacity of the project team to deliver upon the schedule should also be formally undertaken. The timing of the reviews should be assessed critically in light of major project milestones.	
5.	**The capacity of the project team to keep pace with reporting requirements will be challenged going forward.**	**Reporting requirements should be assessed and streamlined where possible.**	0-3 Months High
	As major contracts start running in parallel, reporting requirements to the various stakeholders will prove overly burdensome with current project resources, and key data and information may be missed.	The project team should seek to streamline reporting across the spectrum of stakeholders where possible. Additionally, while we have seen positive evolution of reporting in terms of both efficacy and efficiency, overall expectations for monthly reporting should not diverge substantially month-on-month.	
6.	**A consolidated view of key forward-looking data analytics and insights would help management level decision-making.**	**Dashboards with key project data should be considered to aid decision-making across the project.**	0-3 Months High
	Positively, we observed many areas of insightful, forward-looking reporting including data and information on schedule, cost, interfaces, etc. Some of these areas include weekly construction reports, Progression Meetings, and the Accountability Report, which provide an important 'look ahead' view for risk	The project team is implementing Earned Value Management to support processes at effectively feeding data into a new managerial analysis/dashboard system. The Tableau dashboard tool is also being rolled out across the organization, and Site C intends to leverage it to enhance	

	Key findings/gaps	Action	Priority level [0-3 months – high] [3-6 months – medium] [6-12 months – low]
	management. However, this reporting could benefit from further refinement into a concise, easily digestible format.	capabilities in this area. The team should also consider the use of Earned Value Types as another reporting tool and project control.	
7.	**Our review has focused on the project team's ability to meet targets, and not on the integrity and accuracy of the data being fed up by the contractors.**	**An audit and people, process, and systems review of the contractors should be considered.**	6-12 Months Low
	This represents a risk as contractor data feeds the master schedule, for which BC Hydro is ultimately accountable. We have seen good practice with quality management and in assuring the schedule integrity, however what isn't clear is the contractors' capability to manage and report on the works accurately. While this area was not the subject of this review, it will be addressed in subsequent reviews.	Particular focus should be on: 1) contractors ability to deliver accurate and timely data; 2) the process and rigor behind the process; and, 3) the accuracy of reporting.	
Review of cost management plans and processes, with an assessment of overall cost controls			
8.	**P6 has limitations as a cost reporting and cash flow tool.**	**BC Hydro should continue supplementing P6 with other tools to address limitations as required.**	3-6 Months Medium
	Project schedulers may be challenged in keeping the project schedule up-to-date as the volume of activities on the project increases given the limitations of the P6 tool. We recognize the integration of Unifier into the suite of project tools will support cost management and contract management on the whole, however, gaps still exist related to cash flow projections.	Another alternative the project team has evaluated is working with P6 vendors to customize the tool for Site C's purposes. The team has rightly only considered this option where benefits can be created for the broader business.	

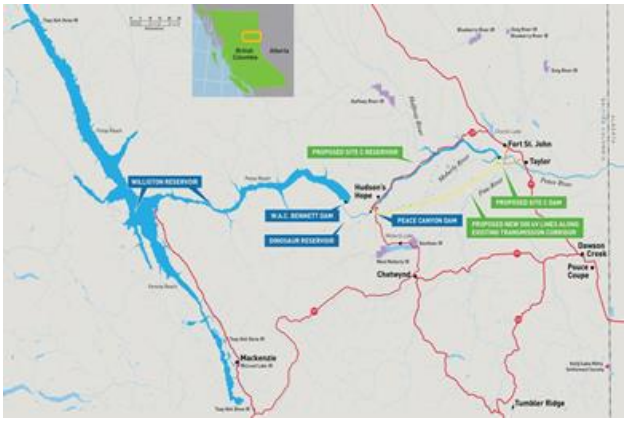
	Key findings/gaps	Action	Priority level [0-3 months – high] [3-6 months – medium] [6-12 months – low]
9.	**Project controls should be a key focus for the project management team going forward.**	**Continue to refine the project controls processes on the project.**	0-3 Months High
	Site C is in the process of implementing Earned Value Management and other project controls on the project. We agree that efforts should be focused in this direction and believe that improvements to the project controls function in terms defining clear responsibilities and processes, as well as how the function reports outward should be a focus. An integrated controls process would allow Cost Performance and Schedule Performance to be combined in a concise report and used as a check on how the construction activity is performing. S-curves are currently only used for engineering but should be embedded in the project for cost, schedule and contingency draw on the project.	Particular emphasis should be placed on the integrated project controls practices across scope, schedule, cost and contingency draw that will provide a full performance report. It would also be valuable to assess gaps in existing Project & Program Management documentation and potentially produce a project control handbook in order to ensure that roles, processes and procedures in this area are clear. Earned Value Management will allow a clear picture of Cost Performance Index and Schedule Performance Index using well established rules of credit.	
Review of key cost drivers and indicators compared to the estimate baseline			
10.	**Most cost drivers have been stable or have seen reductions, with the notable exception of currency exchange rates.**	**Continue proactive management of cost drivers.**	6-12 Months Low
	A notable exception has been currency exchange rates. BC Hydro has effectively mitigated price risk to the extent possible through risk-transfer and risk-sharing with the contractors.	While some market conditions have moved in favour of the project, this could turn at any point, thus ongoing monitoring and mitigation efforts should continue. With the recent award of the Turbines & Generators contract, much of the currency risk on the project has been eliminated.	

In summary, the project scope has been well defined and understood, which has allowed the project to produce a robust risk management plan and strategy. The main gaps identified are the controls for managing performance and reporting against its approved Performance Management Baseline. Actions have been recommended in order to close these gaps.

2. Project background, scope, and approach

2.1 Background

BC Hydro is two years into the development of the Site C Clean Energy Project following Government of British Columbia's Financial Investment Decision in late 2014. The $8.335 billion hydroelectric dam is the largest public infrastructure project in the province's history, and will generate 1,100 megawatts of clean energy on an annual basis once the project is complete in 2024. The project is located on the Peace River in northeast British Columbia.



Given the scale and complexity of the project, EY and BTY have been engaged by BC Hydro to provide an independent external review of BC Hydro's ability to deliver the project on time and on budget based upon current project management and budgeting processes. While the project is in early stages of implementation, key decisions on procurement strategy, design, and major contracts have been made. The project is being delivered through multiple separate contracts, and several major contracts have been awarded to date, including Early Works, Main Civil Works, Workers Accommodation and Turbines & Generators. The Site C project team supports contract delivery by acting as project and interface manager between proponents. Since the beginning of Site C's development, BC Hydro has employed an integrated design model using SNC Lavalin, Klohn Krippen, and BC Hydro to form the lead engineering team for the project, and established an independent technical advisory board providing oversight. BC Hydro also has a number of best-in-class software tools to support project delivery, including P6, HeavyBid, and SAP.

The project has been through two major cost reforecasting processes over the past six years – one in 2010 at the start of the permitting process and one in 2014 to reflect the new design of the project. As part of the refresh in 2014, BC Hydro prepared an estimate and SNC Lavalin prepared a shadow estimate to provide a cost comparison and test assumptions made by BC Hydro. The current forecasted

cost of $8.335 billion is the result of the final estimate updated in 2014. The project also has access to a $440 million reserve held by the British Columbia Treasury Board.

2.2 Scope

The scope of the engagement, as described in the statement of work, is to provide an independent external review of Site C Project business and risk management plans, a risk analysis of major components of the Site C project budget and recommendations to ensure that approved operational and financial targets and milestones will be met. EY and BTY have not developed their own cost, schedule or risk forecast, but instead have assessed the process undertaken by BC Hydro in preparing these forecasts by reviewing documents provided to us and through information obtained during interviews.

The following project components were reviewed by EY and BTY:

- Review of major contracts (over $50 million) awarded to date
- Review of risk management plans, processes and risk registers
- Review of cost management plans and processes, with an assessment of overall cost controls
- Review of key cost drivers and indicators compared to the estimate baseline

The scope of services does not constitute an audit or review in accordance with generally accepted accounting standards or company law. Nor does it include an assessment of the technical feasibility of the project, nor is it a technical engineering review.

2.3 Approach

EY and BTY have undertaken a number of high profile multi-billion-dollar program reviews over the past ten years, including Muskrat Falls (EY) and the John Hart Generating Station Replacement Project (BTY). This experience has demonstrated that no two programs are alike; the approaches our clients have taken in developing the baselines, interpreting the requirements and modelling costs and risks are necessarily different. As such, the approach we employed during the review provides flexibility to adjust and reflect the manner in which BC Hydro's team has developed the initial data by considering challenges faced, perceived issues, and hard deadlines for delivery the project.

There are four elements that needed to be considered in the review:

- The management of program requirements
- How well defined and understood the scope of works is
- How costs have been estimated and changes are controlled
- How risks have been included, accounted for and modelled

Overall, our framework is designed to evaluate these inputs and provide confidence in each, as well as an overall comparative probabilistic view of the likely outturn cost and schedule. The table below details our step-by-step evaluation process.

Major Capital Projects Program Management Assessment Approach	
Factor	**Factor description and underpinning detail**
A. Contract performance management	**Is there a robust contract performance management process and Critical Performance Indicators?** • Have Critical Performance Indicators been clearly defined • Has a robust performance management process been defined
B. Contract implementation	**Has the contract been implemented to establish the project values, processes and culture?** • Has an implementation workshop been conducted to establish and define the project values, processes & culture • Was a set of contract management controversial scenarios competed to confirm processes • Is a robust contract change process in place along with cost and claims management • Is a risk management process in place and being reviewed regularly
C. Change and cost management	**Is there a robust change and cost management process in place?** • Is there a robust change and cost management process established • Is there a process to identify any forward pipeline of potential changes • Is there a client estimating capability and process to support/manage the change process
D. Risk and issue management	**Is there a robust risk management methodology and active process?** • Is there a clearly defined and managed risk process and a Risk, Actions, Issues, and Decisions Log • Is there a culture of active risk management across the project
E. Governance	**Is there a clear and robust governance process for the project with escalation when appropriate?** • Is there a clear governance process • Are appropriate project contract controls and defined reporting
F. Contract Administration & Management Information System	**Is there an appropriate contract admin support for the project with a robust Management Information System?** • Is there a defined project contract administration function • Is there contract management, documentation and cost management functionality within the project Management Information System
G. Organizational Structure	**Is there an appropriate contract management capability within the client org structure?** • Is there a clearly defined contract management capability with roles, responsibilities and processes • Is there a clearly defined claims, estimating and cost management capability with roles, responsibilities & processes

The approach is predicated on establishing a risk and materiality-based sample of the most critical components of the program which have the greatest impact on delivery confidence. We did this by undertaking an analysis of the baseline models, including project definition, contracting strategy, risk and cost, including vendor performance for major contracts. This approach allowed us to quickly identify the areas of greatest vulnerability and opportunity, the key drivers of success, and elements the baseline is most sensitive to.

Our review does not constitute an audit of the Site C project budget, nor is it an assessment of whether or not the project budget will be achieved. Instead, the outputs of our analysis include:

- identification of areas where leading industry practice has been applied;
- areas of confidence which have been appropriately modelled in the baseline; and
- gaps and variances within the Site C project;
- areas of vulnerability that have the potential to threaten the Site C project's success.

Functionally, EY and BTY's assessment was composed of three main elements: 1) document review; 2) interviews, and 3) site visit. BC Hydro provided access to relevant project documentation such as risk registers, major contracts, procurement strategy, etc., as well as a list of senior management and key members of the project team to be interviewed (for full list of documentation reviewed and interviews conducted see Appendices A and B, respectively). Additional interviews and documentation to be included in the assessment were identified as the review proceeded.

A site visit was also conducted, allowing the reviewers to assess the project from the perspective of those in the field. The site visit provided insights into the robustness of project and cost management processes in action, and helped identify execution gaps that were not evident from exclusively a programmatic perspective.

Our approach carefully considered what we believe is a good balance of the value, cost and risk expectations.

3. Detailed findings and recommendations

3.1 Major contracts (>$50 million) awarded to date

As part of our overall review, we assessed the commercial elements of the four main contracts over $50 million awarded to date. The main areas of consideration included: a) the contract mechanisms for transferring risk and liability to the contractors; b) BC Hydro's responsibilities under the contracts; c) how performance is managed under the contracts; and d) gaps we consider could present future challenges to delivering against contractual requirements and overall project objectives.

Our review does not constitute a legal assessment of the terms and conditions within the contracts, but instead focuses on the processes and controls stated within each of the major contracts.

Findings

3.1.1 Liability transfer

a. For all four major contracts signed to date, BC Hydro has put careful consideration into risk transfer, transferring over significant risk to the contractors under each work package where appropriate;

b. In particular, the Public-Private-Partnership contract with ATCO Two Rivers Partnership outlines clear responsibilities for delivery of work and liability for non-performance;

c. That said, we positively note that BC Hydro recognizes that while liability may have been transferred, they still play an important oversight role in monitoring and supporting the contractor in managing project risks. The work package that will require a high degree of coordination between BC Hydro and the contractors on risk management is Main Civil Works. Although the Main Civil Works contract is clear on scope and responsibilities, the size, complexity, and potential for unknown risks, particularly the geotechnical risks, mean that ongoing, close coordination to manage and mitigate risks will be required.

3.1.2 Contract administration

a. In October 2015, the Site C team implemented an Excel-based Contract Tracker tool to track contracts, schedule, status, changes and change details, costs, variances, etc. This tool allows the team to look forward and identify potential risks or contract changes, and helps avert contractor disputes. Going forward, Site C hopes to transition much of this functionality to Unifier. Unifier will enable the tracking of line item detail at the contract level, and provide portal access for vendors to provide direct progression updates for validation by a BC Hydro representative. Site C has already implemented Unifier with the Main Civil Works and Early Works contracts, and will fully transition away from the Contract Tracker to Unifier once all of the major contracts have been awarded. We believe that this is a step in the right direction for contract management practices on the project, and will significantly enhance schedule reporting and accuracy overall.

b. Despite the mature contract administration tools that are in place, the matrix between BC Hydro and the Site C contractors is complex. While it is clear that BC Hydro assumes ultimate project risk and, therefore, acts as overall contract manager, many of the major contracts have outlined BC Hydro's role as administrator and coordinator. This may lead to some confusion on the part of the contractors as to defined roles, responsibilities, and accountabilities, particularly in both design and construction. Further, BC Hydro has outlined an extensive process for administering the contract on a daily basis. While this may reduce risks, this commitment may prove onerous at current project resources. Clarity on contract administration will be key as scrutiny on the project intensifies, and challenges require more operational oversight and management.

c. Additionally, both the scale of the major contracts and the mature contract administration processes will require significant effort on the part of both the construction and project management teams. For example, the use of a schedule of rates as defined in the contract for measuring and controlling interim payments, scoping and costing change on packages, such as the Main Civil Works, will require significant staff to control effectively.

d. That said, the scope of work for each major contract is well defined, as is the process for managing contract change. Additionally, we are encouraged by the implementation of the Unifier tool, which will further support contract administration, particularly with respect to scheduling. Our primary concern in this area is potential confusion arising from a lack of understanding of which party has ultimate interface responsibility.

3.1.3 Interface management

a. While the major contracts define the requirements for interface management, we note that it is unclear who will take the lead in proactively identifying and controlling issues and risks;

b. We consider interface risks to be one of the significant areas of exposure for the project, but are encouraged by both the Site C teams' awareness of the risks and proactive efforts to close gaps. BC Hydro also has a long history of successful interface management and deep institutional knowledge of what is required on major projects in this area.

c. Turbines & Generators Contract:

   i. Our general comments on interface management are particularly relevant to the Turbines & Generators contract, where the overall responsible party is not apparent. While the timescales

for issuing information are very clear, how interface management works in practical terms when on site and during the installation phase, including who leads and who manages, has not been fully articulated. Here, a single point of responsibility for interface management may be Site C's best solution. While the construction and contract management team lead has current responsibility for interface management, we believe the interface management complexities on this project require a dedicated role.

ii. Further, the control mechanism to manage the milestones may be rendered ineffective by unclear expectations as to who is responsible and how. In particular, the cause and effect of a delay or event occurring may be difficult to allocate to one particular party. In some cases, it may not present issues, however if certain milestone activities noted in the table are on the critical path, the impact could be significant.

d. With regards to the main civil works there are interface risks that exist as with the other work packages. BC Hydro are responsible for managing the overall interface risks between the work packages, as they identified early on in the project that they are best placed to manage it. We observed significant effort had been made to identify the risks and mitigate them but note that it remains one of the critical risk management items to monitor throughout the project duration.

3.1.4 Warranties, guarantees, and liquidated damages

a. **Turbines & Generators contract:**

i. The specific guarantees BC Hydro has included in the Turbines & Generators contract, including holdbacks, milestone liquidated damages, total completion liquidated damages, Letter of Credit, and Third Party guarantee, places requirements on the contractor to finance guarantees early on in the project. This pressure on the contractor's cash flow should be monitored on an ongoing basis, particularly if the contractor has major projects occurring elsewhere.

ii. The statement that 'liquidated damages set out in the milestone payment table are the amount of damages the parties have agreed to be paid by one party to the other' may be confusing as there is no contractual link between the Generating Station and Spillways (GSS), Turbines & Generators and Completion Contract contracts. How this would work in practice should also be considered.

iii. Positively, the project has a comprehensive insurance strategy, including the purchase of a $1.5 billion construction policy and a $100 million property insurance policy. They are currently in the process of putting in place an owner's protection policy.

3.1.5 Performance monitoring/contractor reporting

a. In general, the reporting requirements outlined in the major contracts, (excluding the ATCO contract), request percentage complete as a method of monitoring progress. Our report highlights the need for improved project controls on the overall Site C project to allow for more accurate checks and balances on progress. From a contractual standpoint, recording percentage complete for all works, checked against planned performance and reported using rules of credit, Earned Value, Schedule Performance Index and Cost Performance Index, would give a more accurate picture of contractor performance (as highlighted in section 3.3.7 of our report).

Recommendations

In summary, our assessment finds that the majority of liability and risk has been transferred to the four current major contractors. However, some significant gaps to consider are:

- The contractual terms for controlling interfaces should be more clearly articulated. In our experience, interface issues in design and execution lead to a significant number of disputes and delays on major projects such as Site C. The Site C team should review the interface requirements on the project and set out an interface plan with defined responsibilities. The interface plan should then be reviewed with contract terms to determine if changes are required or additional management processes should be implemented. A dedicated interface manager should be in place in order to administer and coordinate the interface management plan;
- BC Hydro's capacity to administer the contracts with current resources may be strained as the project ramps up, and particularly during peak periods when major contracts are running in parallel. Given Site C's stage in the project lifecycle, it would be prudent to undertake a capability and capacity review of the project team to ensure that BC Hydro can fulfil their contract requirements;
- The performance reporting outlined in the contracts may need to be adjusted as project controls improves on the project. Specifically, as Earned Value Management is implemented across the project, there will be an improved ability to monitor and manage the performance of the works and contractors;
- In the Turbines & Generators contract, the requirement for guarantees and potential application of liquidated damages may put significant financial pressure on the contractor and will need to be monitored regularly.

3.2 Risk management plans, processes, risk registers, and reporting

Overall, our assessment found that BC Hydro has a disciplined approach to project delivery, which is defined and managed by the ongoing implementation of the Project & Portfolio Management system used across the organization. Site C's Risk Management Plan clearly outlines the risk management process and plan for the project. We found the risk management process to be both robust and fulsome, detailing project-level requirements for risk management planning, risk identification, risk evaluation, risk response, and risk monitoring and control. These processes follow industry best practices set by both the Project Management Institute and the Institution of Civil Engineers Risks Analysis and Management for Projects. Furthermore, accountabilities and responsibilities for managing and mitigating risks for all key project roles are outlined in a clear "Responsible, Accountable, Consulted and Informed" matrix.

Findings

3.2.1 Risk management approach

a. Importantly, risk management on the project is scaled to the project complexity and size. Both the project delivery objectives and BC Hydro's experience delivering other projects form the baseline for

the risk management approach. Additionally, at the outset of the project, risk workshops using historical BC Hydro data were conducted to develop detailed preliminary risk registers, which are now updated on a monthly basis. Cost and environmental factors are evaluated to aid final investment decisions for cost estimates.

b. Any update to cost estimates requires revisions to the Monte Carlo simulations using @RISK software to provide the most accurate data. The software used to assign contingencies is widely recognized as an industry best practice. A P50 Contingency is recommended by BC Hydro and is in line with previous BC Hydro projects, which have generally been completed on budget (of over 653 projects, actual project costs, as compared with approved budgets, are an average of .18% under budget). It should also be noted that while the P50 level is the standard, a range of expected values at different levels of certainty continues to be reviewed as risks progress and unfold. A case in point is the use of a Tornado Chart to present risks associated with the preferred proponent for the Main Civil Works contract during review of their bid with P10, P50 and P90 results for each risk input.

c. The Site C team proactively assesses risk during key procurement phases by reviewing the potential cost variability for contractual risks in the engineer's estimate. Actual contractual risks can then be transferred to the contractor under the award of the work package contract. Changes to the risk allocation from that envisaged in the risk register are then included in the engineer's estimate. The output from the 2014 Monte Carlo model was assessed against the available contingency and determined that no further adjustments to project contingency were required at that time. Contingency is split between the Treasury Board and the Board of Directors. At the Board level, contingency is controlled through six levels of management, which provides strict governance of contingency. Risk assessments of the contingency are undertaken after the preferred proponent has been selected for each contract work package to determine if the budget contingency available is sufficient to address potential contract risks.

3.2.2 Risk control

a. To make the high volume of potential risks on Site C more manageable, and to avoid duplication, risks are categorized as either contractual or strategic before being consolidated into monthly risk reporting. The project risk register is not considered a risk analysis tool, but a repository for the risk analysis results, which are comprised of both key qualitative and quantitative data. Exposure to reputational risk is also considered to provide an overall comprehensive rating. In our view, there exists a relatively high level of buy-in and engagement in the risk identification, management, and mitigation process across the project team. For example, there are currently 2 risk registers with a high level of detail being maintained at the project level. This has largely been the result of a concerted effort to improve proactive risk management given some early adoption challenges, namely capacity of the project team. Going forward, there should be continued emphasis on risk controls as the possibility of high employee turnover and increasing demands of the project have the potential to challenge current resources.

b. We note that the project control for identifying and managing schedule risk is in place, and is used to build float into the schedule where required. The use of milestone reporting was another control mechanism observed, and is managed on a proactive and detailed level. The project control schedule process is under development and, we believe, is a critical overall project control. To

further support this effort, the correct Earned Value Types need to be developed and applied to the relevant elements of the schedule, including in the contractors' own schedules. We note that early start and finish dates are used as scheduled dates, so that milestones are sometimes flagged as missed, even when they still have float available. We are satisfied, however, that procedures are in place to insure that management effort is focused primarily on activities that are critical or near-critical.

3.2.3 Risk evaluation

a. The Risk Management Plan details the risk evaluation process clearly. First, risk evaluation workshops are conducted to consider the treatment, potential probability, consequence and exposure of each specific risk identified. Possible risk "zones" range with colour-coded exposure levels, and are addressed by the respective area lead unless considered critical at which point they are elevated to more senior levels of project management. From our review, it is evident that the project team follows the risk analysis process generally set out in the Risk Management Plan, which is representative of strong industry practice.

b. Schedule risk is well understood and evaluated. Major contracts clearly identify who holds the schedule risk for non-performance. Large projects such as Site C rely on the quality of the contractor's schedules and ability to control and manage activities against the contracted schedule. This then feeds up into the BC Hydro master schedule with risks evaluated throughout the process. The integrity of the data feeding the schedule is central to managing future schedule risks. In summary, the schedule reporting for management purposes is only as good as the information that feeds it.

c. One of the most critical components of monthly reporting is the risk register. There are 2 risk registers that capture and classify all project lists, and a risk 'hotlist' and risk 'heat map' summarizing the top risks for management reporting. The 'hotlist' is generated by assessing factors such as work area, risk event description, risk status, risk and response summary, and residual risk zone. The risk registers include key information on risk details, ownership, planned treatment, and exposure level. Overall, we found that risks are well-articulated and reported in a manner that is in line with leading practices.

3.2.4 Reporting

a. The implementation of the Project Management Office is a significant transition which has taken place over the past 6 months. It is clear that there is strong technical expertise on the Site C team in the Project & Portfolio Management system, as well as project management practices more broadly, however, as the project ramps up, reporting tools and processes will need to be streamlined in order to keep pace with the volume of information. Our review found that reporting requirements on the project are generally onerous and time-consuming, requiring a considerable level of time and effort on the part of the project team.

b. There are two main sources on ongoing, forward-looking project reporting: 1) Construction Reports; and 2) Progression Meetings. Construction Reports are fed into the Program & Project Management system weekly by the construction managers, and provide a view of progression, areas

of project exposure, safety, drawings, labour statistics, and so forth. These reports are used as the primary way of managing what's happening on the ground, and feed into higher levels of project reporting through the Program & Project Management system, including Progression Meetings. Progression Meetings are conducted with area leads on a 12 day cycle in order to discuss the initial outputs of the Project & Portfolio Management system and refine them based on a look ahead of the schedule.

c. An important practice to add to Progression Meetings is the assessment of how progress is being monitored and reported, so that checks can be developed. For example, the methods of measuring performance against schedule should consider a mix of Level of Effort, discrete activities (end product) including 0/100 milestones, incremental milestones etc., and where possible, should not be percentage complete (which is often used elsewhere for monthly payment and schedule reporting purposes). We recommend that as part of the Earned Value Types evaluation, quantities against which progress is measured should be developed in light of individual work package specificities, particularly where schedules of rates are being used for payment purposes. This is important as the volume of schedule data will be significant and risk exists with inaccurately reported information.

d. Construction Reports and Progression Meetings roll up into the Accountability Report, which is an overall project status summary prepared on a monthly basis. The Accountability Report is presented to the Site C Leadership and Executive during the monthly Accountability Meetings, as per BC Hydro-wide practices for major capital projects. There are a number of key inputs to the Accountability Report, including direct updates provided by each area lead, risk registers, as well as cost and schedule updates from the Progression Meetings. The report is highly detailed and forward-looking in nature and has evolved over time via enhancements from the project team to provide more impactful information for Site C. However, we found that given the comprehensive nature of the report, it may not be in the most digestible format for management decision-making.

e. Given that the objective of the Accountability meeting is to support executive-level decision making, we believe that the meeting would benefit from a more forward-looking discussion of key potential risks. One way to facilitate this might be the implementation of a central dashboard for key data analytics and forward-looking insights, bringing many different elements of project reporting together into a single, concise view. We understand that BC Hydro is in the process of implementing a project dashboard using the Tableau tool for this specific purpose, and believe that this is a good direction for project reporting to go. The implementation of Earned Value Management will help provide some of the inputs for the high-level project dashboard. Project level reporting might also benefit from a brief Executive Summary, which we understand is also being implemented by the project team. To be effective, the Executive Summary should identify key accomplishments, key focus issues, key decisions, contract summary, trending analysis, a 90-day look ahead and construction progress. We also note that the Site C team is developing a project scorecard to provide annual metrics on the program, which we believe will be an important accountability measure as the project progresses.

f. We observed that keeping pace with the volume of weekly and monthly reporting requirements may be a challenge with current resource levels:

i) As mentioned, during Progression Meetings, the initial outputs of the Project & Portfolio Management system are discussed and refined based on a look ahead in order to arrive at a final "snapshot" for the previous month. Quantitative rules set within Project & Portfolio Management determine what issues would require elevation to higher levels of leadership. This reporting cycle involves meetings with each individual area lead and project leadership, and repeats over a 12-day period at the beginning of each month;

ii) Many elements of the Accountability Report are generated outside Project & Portfolio Management using a variety of standard tools such as Word and Excel. These relate to areas such as aboriginal relations, environment, permitting, etc., which have not been treated in the Project & Portfolio Management system but are included in the monthly reporting. Moves are underway to migrate more of the control mechanisms into the Project & Portfolio Management while the project is ramping up.

iii) Major contracts will add to the volume of data and it will become more difficult for the management team to process. Management information needs at each level need to be clearly defined and methods of filtering developed so that all relevant exceptions are identified in the reporting cycle.

g. The Project & Portfolio Management system is not customized for Site C, bringing a beneficial level of understanding and familiarity of the system to the team. However, Site C is the first of its size and complexity at BC Hydro, and the Project & Portfolio Management system is not currently capable of meeting all reporting demands. Further automation of key project data and information should be prioritized, as well as the increased use of quantitative filtering of information. This could alleviate some of the time burden on the reporting cycle and free up meeting time for project delivery.

h. Upcoming, scheduled Project & Portfolio Management system upgrades should be carefully monitored and supported by change management efforts in order to ensure that key project data and information is not lost, and that reporting requirements are met.

Recommendations

Overall, Site C follows a rigorous and effective process for identifying, analyzing, and mitigating risks on the project. To further augment risk management, BC Hydro should consider the following:

- Generally, risk management is scaled to both the size and complexity of the project. The Project & Portfolio Management system supports the risk management process with a robust set of guidelines and tools, and is used effectively by the project team;
- The risk management approach includes employing strict governance over contingency. Proactive assessments are in place to review and evaluate contingency requirements as the project progresses, both in the project budget and during procurement phases. This approach should continue with the same level of rigour as is currently in place;
- A detailed, independent validation of the schedule should be undertaken given the size and complexity of the contracts that have been awarded to date. The review should analyse the contractor's performance and capability to deliver and meet the agreed upon schedule. How contractor performance has been integrated into the overall schedule and then used to monitor performance also needs to be understood in more detail. Only once the project undertakes both a

schedule content and process validation, and a capability and capacity to deliver assessment, will the full picture of schedule risk be clear;

- Given the already substantial effort required to keep pace with weekly and monthly reporting requirements, as the project ramps up and major contracts are running in parallel, the capacity of the project team will be challenged. In particular, it may prove increasingly difficult for current project resources to maintain the volume of data and information feeding into the risk registers, and integrate them with reporting requirements. While initial quantitative filtering of risks is already done prior to selection of the "hot list" for the Accountability Report, further refinement of the quantitative filtering approach taking into account priority, expected value, and cost to date is recommended. This will help to identify which risks are new to a particular reporting cycle, help quantify and track risks, and provide better information for management decision-making. Other opportunities for automating report content, or streamlining reporting across stakeholders, should also be considered where appropriate;
- Further, we recommend an independent capability and capacity review of the project team to determine where gaps in current resources exist in light of future project needs;
- Management and executive decision-making would be supported by the development of a single, concise view of key project metrics, data analytics, and forward-looking insights. The Site C team should continue with the planned development and implementation of a project dashboard, Executive Summary, and annual scorecard as these tools will help draw out the most critical elements of overall project reporting in an easily digestible format;
- A final consideration is both the quantity and quality of data being fed up to the project team by the contractors. While we are aware that there is an onsite quality management program providing oversight to the contractors, the process for validating contractor data and information was not the subject of this review, but will be further evaluated in subsequent reviews.

3.3 Cost management plans, processes, and overall cost controls

The cost management plan and processes provide a thorough approach on how the costs for this project should be managed during the lifecycle of the project, and is aligned with leading practices for a project of this magnitude.

Findings

3.3.1 Cost management plan

a. Having interviewed personnel from the estimating and controls teams, it is clear that the process followed to establish a project budget for Site C was extensive and that the due diligence and approach were solid. There was a major estimate revision in 2010 which was refreshed in 2014 to reflect a re-design of the project. As part of this refresh, the BC Hydro team completed their estimate and SNC Lavalin was asked to prepare a shadow estimate. Both teams used the same Heavy-Bid software to develop the estimates. This software enables the estimates to be resource-based and built from the bottom up by establishing a crew for various work items, number of labour hours per crew, plant, material and overheads.

b. Estimates were developed for a number of work packages such as the clearing, highways and transmission lines by parties that could be considered external to the project, such as the Ministry of Transportation and the BC Hydro Transmission group. In such a situation, there could be scope gaps at the various interfaces between the work packages. The detailed estimates by these parties were thoroughly reviewed and signed off by BC Hydro's lead on the project. The outcome of the estimating process was an amalgamated estimate which was reviewed by an outside, independent team of experienced contractors, and concluded with them testing and approving BC Hydro's estimating methodology and budget.

c. The updating and renewal of the estimate is a continuous process as the procurement process unfolds. As a case in point, the Main Civil Works contract has been bid and awarded at a value of $1.75 billion. BC Hydro's engineer's estimate was a comprehensive update of the 2014 estimate and was 3% lower than the bid price. This is within the benchmark pre-tender estimate range of -5% to +10% expected at this stage of the design for the contract package. The engineer's estimate incorporated a risk transfer amount as the Request for Proposal required the contractor to assume some risk not envisaged at the time of the 2014 estimate. A second major contract, for Turbines and Generators, did require a draw on contingency, but so far the rate of contingency usage from estimate disparity is modest.

d. In summary, we are of the opinion that the due diligence and care taken to establish the budgets for Site C represents good industry practice.

3.3.2 Change control

a. The project change control plan provides a clear description of the change control process for the project. This process is straight-forward and follows a logical sequence, including some key elements we believe are representative of best practices:

    i. The Work Breakdown Structure established to manage the project is effective and provides a clear baseline from which to monitor costs. For example, any claim for change by the contractor that is more technical in nature, might result in a delay, or that cannot be absorbed by the contract budget will be validated by the estimating team. Routine time and materials claims for change are addressed by the contract management team. There is a separate Work Breakdown Structure for contingency draws for the overall project which is controlled by the project's change control plan. Careful management and control of this contingency is instrumental in ensuring the project remains within the budget.

    ii. There is a mechanism for early identification and tracking of anticipated changes through the Site C Contract Tracker tool. This provides a tool for recording areas of concern, planning and, where possible, mitigating any potential issues. When the Unifier tool is implemented across the project it is expected to replace and enhance much of the functionality of the Contract Tracker. Potential cost issues are also tracked manually by Finance, providing an additional early-warning system and allowing timely management action to be taken.

    iii. In order to manage contractor claims, Site C employs a 'one-window' approach. A central point of contact on the BC Hydro side is responsible for receiving and

transmitting all change claims or preliminary change instructions with contractors. This ensures the entire change control process is managed consistently and accurately.

iv. Finally, for major contracts, the details required for submitting a claim are outlined clearly, for example, a contractor must value a change in specified ways, such as lump sum, direct costs, etc. However, flexibility is provided for smaller changes.

3.3.3 Cost, schedule and cash flow interface

a. The concern about the strains on the management structure with an increasing data burden may also be felt by the schedulers, who reside both in Finance and Project Management. (It is difficult to see clear lines of demarcation between the two as the scheduler in Finance recently transferred over from Project Management). Actual costs are ported over from SAP to P6 at the beginning of each month and are reported by activity. There are roughly 6,000 activities in the project schedule. For construction activities, each of these is a summary activity of a series of activities in a contractor schedule after a contract has been awarded for that part of the works. This has the benefit of providing a unified structure for both cost and schedule reporting, avoiding maintaining an interface between cost and schedule "silos". (The Earned Value Management method is another way of doing this, by expressing schedule slippage in dollar terms). The central problem, however, is that P6 was designed as, and remains primarily, a critical-path scheduling program and has limited capability as a cost reporting and cash flow tool. The challenge is further described as follows:

   - P6 has three options for distributing dollars loaded on an activity of doing cash flow analysis: front-loaded, back-loaded, or evenly distributed by month. The front-loaded feature places all the budget in the first month while back-loading places all the dollars in the final month. To overcome this lack of flexibility, the schedulers create dummy activities and load them with the cash flow dollars. This also comes into play on management activities, some of which last for years.
   - While we have not analysed the content of the schedule in detail, there must be a considerable maintenance burden in keeping the summary activities aligned with contractor schedules. This process is assisted considerably by the Acumen Fuse tool, a program that compares versions or updates of a P6 schedule and lists the changes in logic, durations, etc. between them. Nonetheless, there remains the task of mapping the more detailed schedule onto BC Hydro's summary schedule, which is a manual task and requires intensive communication and coordination with the contractors. In addition, to make the logic work, there may be a need for more complex, artificial logic connections, which may compromise the ability to accurately identify the correct critical path and near-critical activities. In summary, a significant amount of checking and fine-tuning is required to accurately report the schedule. There is a concern that, with an increasing data burden, the P6 schedule might deliver an inaccurate view of the project schedule.

b. We understand that P6 has been used at BC Hydro with considerable success on many projects. Given the size and complexity of Site C, BC Hydro should either work with the P6 vendors to overcome its limitations or consider adding other tools to the PPM system augment the limitations of P6. For example, schedule dates could be ported into a separate program and loaded with dollars to do cash flow forecasts, thus avoiding the burden of the summary activities. Or the contractors

could be required to provide their own cash flow forecasts and that data could be collated by BC Hydro.

c. We observed a considerable level of effort expended upon validating and re-validating data. The Project Controls group recently moved under the purview of Finance in order to provide a degree of independence from the Project Management group. While we consider this a positive move, concerns remain as to the clear definition of roles and responsibilities within the Project Controls.

d. Apart from the use of P6 as a cost reporting tool, we note that BC Hydro's general policy regarding reporting of activity dates is to use the early start and finish dates, as opposed to positioning an activity within the range of its float to, for example, level resources. This can lead to some confusion in reporting as activities are reported both as late (behind the early dates), and also on time within the activity's total float. We suggest that this convention be clarified and reporting adjusted accordingly.

3.3.4 Project Controls

a. In moving to a more integrated use of Project & Portfolio Management on the project over the past year, significant improvements to management and controls have been made. Changes are still ongoing, including the recruitment of key project controls positions. Both of these efforts will ultimately enhance performance reporting, and transition current project reporting from backward to more forward-looking with the use of good project analytics techniques.

b. A project of this scale and complexity should use effective project controls and Earned Value Management to support decision making and forecasting. In particular, using cost performance index and schedule performance index will allow the project team to better understand 'value for money' and if the project is achieving the correct ratio of earned value to planned activities. The improvements to project controls will also support improvements to project reporting as it will allow good analytical data to produce S-curves and heat maps for effective management decisions.

3.3.5 Conclusions/recommendations

Overall, Site C's ongoing cost management and process for maintaining cost estimates are what we would expect to see on a major capital project. Some key considerations include:

- The process followed for establishing the project's budget was extensive, and generally representative of good industry practice. The estimating process involved a substantial amount of due diligence and integrity checks, including an outside review by an independent team of experienced contractors who also tested and approved BC Hydro's estimating methodology and budget.
- The process for managing change notices is clear, with key information included for assessing the impact of the change, such as contract sum adjustment, schedule impact, and re-allocation of funds.
- Project schedulers may be challenged in keeping up the project schedule up-to-date as the volume of activities increases. Furthermore, P6 has limitations as a cost reporting and cash flow tool. BC Hydro should consider working with P6 vendors to customize the tool for Site C's purposes, or consider supplementing other tools to the Project & Portfolio Management system.

- Continued implementation of robust project controls on Site C will help support the achievement of both cost and schedule milestones. In particular, Earned Value Management can considerably enhance decision-making and forecasting by better understanding value-for-money and the ratio of earned value to planned activities.

3.4 Key cost drivers and indicators compared to the estimate baseline

We have reviewed the main cost drivers on this project and the extent to which they have changed since the project estimate was prepared in 2014. Most of the cost drivers have been stable or have seen reductions, with the notable exception of currency exchange rates. As identified under Preliminary Risks, Main Civil Works, dated June 2014, specified Key Cost Drivers include the cost of materials, equipment, transport, and electric power.

Findings

The following is a list of Key Cost Drivers we identified during our review:

3.4.1 Geotechnical/soils issues

a. Knowledge of the soil conditions underlying the site is key to successful planning and execution of civil engineering works. As outlined in the Main Civil Packages Preliminary Risk Report, some key risks identified included: rock rebounding and swelling, shears, relaxation joints, bedding planes; and bedrock deterioration.

b. The risk of cost and schedule overruns due to unforeseen ground conditions is generally mitigated by carrying out extensive geotechnical investigations and through careful allocation of risks through contracts. Extensive investigation of the site was undertaken during planning of the project, but it is impossible to understand every nuance of the sub-surface conditions of such a large site. As a result, unforeseen problems have arisen, and will continue to arise, requiring innovative engineering responses to contain cost increases.

c. Contractual responses to risk from sub-surface conditions vary from one contract to the next. BC Hydro's broader strategy is to pass on risk to the contractors if it is appropriate, i.e. a judgement is made as to the cost premium a contractor will charge for assuming a risk, compared with the probable cost to the project should the risk be retained and result in increased cost. In some instances, the risk is transferred completely, with the owner providing all the available documentation to the contractor. In others, (such as for coffer dams) the risk is shared, with the project retaining a portion of the risk. It must be recognized, however, that in cases where there is some transfer, there can still be an adverse effect on the project. We are satisfied from our investigation so far that these calculations are being made in a considered and professional manner.

d. It is worth noting that, when a risk had been assumed to be retained by BC Hydro during budgeting, and is then re-allocated to the contractor at Request For Proposal stage, the value of that risk is included as a line item in the Engineer's (Pre-tender) Estimate.

3.4.2 Design updates

a. This project has a long history with analysis and re-analysis of design options over decades. The 2014 estimate incorporated a re-design of parts of the project, but the design has remained relatively stable since then. We are satisfied that there is a robust system in place for controlling design changes and accounting for their impact on the project.

3.4.3 Labour resources

a. Based on Statistics Canada data, labour availability in the Peace River Region has increased since 2014, due to decreased investment in the oil and gas sector. This is likely to drive down construction cost to some extent. The extent to which this takes place is dependent on contractors' perceptions of future labour trends over the course of long-term contracts.

b. The Peace River region's labour supply is heavily reliant on the adjacent, Alberta market. Based on recent Statistics Canada data for July 2016, the unemployment rate in Alberta has risen to 8.6%. In the event labour resources from outside BC are required, accommodation would not be an issue as BC Hydro already has site accommodation in place.

c. On the management side, staff with specialist expertise or those on the leadership team are experiencing greater demands on their time as the project ramps up. There appears to be a high level of confidence, however, that the right staff can be found to fill vacant positions, often from within BC Hydro itself.

3.4.4 Plant and machinery

a. As with labour availability and pricing, the turn-down in the oil and gas sector has reduced pressure on the project in terms of possible shortages of plant and equipment required as part of the construction process. While this could change with an upturn in the fortunes of the oil and gas industry, many of these costs are being locked in as major contracts are let. More broadly, based on American Rental Association data, there has been from 7% to 9% annual growth in rental revenues from 2014 to 2016. Total rental revenue in Canada is expected to grow at a compound annual growth rate of 4.2 percent over the 2016 to 2020 period.

3.4.5 Currency exchange rates

a. The currency exchange rate between the Canadian and U.S. dollars represents the one cost driver among those reviewed that presents a cost challenge to the project. The 2014 average exchange rate was approximately 90 cents and it is currently 76 cents. This can have a major impact on purchases of any commodity purchased outside Canada, and might be felt particularly strongly when purchasing major equipment priced in U.S. dollars. Movement in the relative value of the Canadian and the Euro has been significantly more modest over the 2-year period.

b. The Turbine and Generator Design-Bid-Build package was awarded in April 2016 for $470 million. Given market conditions, the currency risk/impact at the time of award of this contract was negligible.

c. With the award of the Turbines & Generators contract, the currency risk on the project has been largely extinguished. We also understand that BC Hydro also has long-term contracts with some suppliers, which may have additional price stabilisation mechanisms.

3.4.6 Interest rates

a. We continue to see low interest rates, a considerable boon for a project of this size and duration. The Bank of Canada overnight interest rate has dropped a further 0.5% since 2014, resulting in a reduced estimate for interest during construction. It appears likely that this situation will persist for the foreseeable future.

3.4.7 Land costs

a. We understand that the purchase of lands for the reservoir is imminent. We have not been able to discern trends in land prices in the Peace River Region and understand that this is a delicate process, especially when compulsory purchase is involved. A detailed study was carried out in January 2002 to determine the potential impact of the dam construction on land values in or near the Peace River Region.

3.4.8 Permits

a. The permitting process for Site C is necessarily complex and time-consuming. Responding to information requests and managing to government conditions have the potential to result in unforeseen cost and schedule changes. We observed an effective process for managing all components of the permitting process, including proactive stakeholder management, comprehensive mitigation programs, and ongoing monitoring.

3.4.9 Material Prices

a. Two types of requirements for materials have been identified for the project. The first is specialised in nature, and in some cases one-off orders. Items such as turbines, major butterfly valves, steel lining and transformers will most likely not be available locally and will require special order from various locations worldwide. Transportation for these items will mainly be by air and road, and the project also has rail transportation available as an option.

b. The second type of materials/equipment includes commonly used construction materials, such as concrete, reinforcing steel, structural steel, and gravel. In comparison with the 2014 baseline, most of the commodity prices have been decreasing. Copper dropped approximately 10%, structural steel and rebar dropped about 5%. Concrete, aggregate, fly ash and timber are expected to see cost reductions from the 2014 baseline. Cement/fly ash manufacturing would be a benefit in this project.

3.4.10 Fuel/diesel

a. Oil prices dropped almost 50% since 2014, therefore it is expected to see a cost reduction on fuel costs for plants and machinery. The drop in price at the pump has not been as great as the drop in the price of crude oil.

3.4.11 Taxes

a. There has been no change in the rate of GST & PST since 2014. The 2014 estimate incorporated an increase of $200 million to account for the re-instatement of the PST.

3.4.12 Conclusions/recommendations

In summary, most of the major cost drivers for Site C have moved in favour of the project, with the exception of the exchange rate with the U.S. dollar. Most of the major equipment purchases are now under contract, however, so this risk has been largely contained. BC Hydro should continue their ongoing monitoring and proactive management of cost drivers in order to capitalize on favourable market conditions where possible.

4. Conclusion and next steps

Overall, our review finds that the project is well defined and that the processes for managing risks and costs are largely representative of leading practices. Execution of the major work packages are clearly scoped and supported by both a robust set of project management practices and tools, as well as by a team with deep experience on delivering major projects for BC Hydro. The Site C team follows a continuous process for updating and renewing cost estimates, which we found to support the integrity of the overall budget. Furthermore, the project has been aided by general stability or reductions in most of the cost drivers.

Going forward, it will be critical for BC Hydro to place strong emphasis on project controls and resources to support the achievement of both the project's financial and operational milestones. The processes under BC Hydro's Project & Portfolio Management system bring clear benefits to project execution, such as bottom-up approvals, all-encompassing change management procedures, and the ability to bring in team members from the BC Hydro organization with deep institutional knowledge of the system and a portfolio-perspective. As the project ramps up, the volume of work to be coordinated and data to be consumed will mean that the project needs to re-evaluate how it uses the processes as defined under Project & Portfolio Management. Additionally, clear resource gaps should be carefully evaluated in light of future project needs. The ongoing development and implementation of effective project controls to produce forward-looking insights for management decision-making should be a key focus area in the coming months.

Next steps to consider are:

i) The managerial information and reporting from Project & Portfolio Management should be reviewed in further detail to determine if there are further improvement areas, and if so, a plan to design and deliver the improvements should be developed.

ii) The ongoing changes in project controls should be accelerated as the use of fully integrated Earned Value Management will provide more meaningful project in monitoring and reporting. (See Appendix D for details).

iii) BC Hydro should undertake a detailed, independent validation of the schedule to analyze the contractors performance and capability to deliver and meet the agreed upon schedule.

iv) As the project progresses, the capability and capacity of the project team should be assessed in order to ensure that future project needs at the various stages will be met. We recommend an independent party performs the assessment.

v) A forward-looking review of the major contractor's capability and capacity should also be performed in order to monitor the work performed against schedule. This would be particularly useful when considering the gaps in Earned Value Management, overall capability and capacity constraints on the project, and the contractor performance challenges identified.

vi) Project roles and responsibilities should be reviewed and updated to ensure both the contractors and project team are clear on their roles within the project. This will need to be updated as the project progresses and new contractors and team members are added.

5. Appendix

5.1 Appendix A: Documents reviewed

We have reviewed in excess of 100 documents during the period of July 11th – August 15th.

- Cost Budget Management Reporting
  - Monte Carlo
- KPIs
- Procurement Management
  - Board Materials
  - Material Contracts
  - Payment Schedules and Documentation
  - Procurement options, approach, and plan
  - Contract roles
- Program Information
  - Construction Management, Contract Management, and Cost Management Plans
  - Financial models
  - Monthly progress reports
  - PPM System
  - Project Board & Board or Directors Reports
- Risk Management documentation
  - Risk Analysis and Reports; Risk Registers
  - Risk Management Plan
- Scope Management Change Control
- Technical Advisory Board Reports
- Time Schedule Management Reporting

5.2 Appendix B: Interview list

Organization	Interviewee	Date
BC Hydro	Manager, Supply Chain Infrastructure Projects	July-14-16
BC Hydro	Vice President, Project Delivery (retired)	July-15-16
BC Hydro	Manager, Business Planning, Scheduling & Reporting	July-18-16
BC Hydro	Commercial & Risk Manager	July-18-16
BC Hydro	Principal Engineer Contracts, Procurement and Market Specialist	July-18-16
SNC Lavalin	Design Manager	July-19-16
BC Hydro	Project Manager, Early Works	July-19-16
BC Hydro	Director, Legal Services	July-19-16
BC Hydro	Director, Supply Chain Infrastructure Projects	July-19-16
BC Hydro	Director, Environment, Aboriginal Relations & Public Affairs	July-19-16
BC Hydro	Project Manager & Director of Operations	July-19-16
BC Hydro	Engineering Division Manager	July-20-16
BC Hydro	Scheduler	July-20-16
BC Hydro	Finance Manager, Business Services	July-20-16
BC Hydro	Project Manager, Main Civil Works	July-21-16
BC Hydro	Vice President & Project Director	July-21-16
BC Hydro	Estimating & Contract Scheduling Team Lead	July-22-16
BC Hydro	Director, Finance	July-22-16
BC Hydro	Deputy CEO & Capital Infrastructure Project Delivery Management Team	August-03-16
BC Hydro	Vice President, Project Delivery	August-24-16
BC Hydro	Contracts, Document Control & Submittals Manager	August-24-16
BC Hydro	Senior Manager, Contract Services Capital Infrastructure Project Delivery	August-29-16

5.3 Appendix C: Maturity rating criteria

EY and BTY have used industry-recognized Maturity Rating Criteria to measure Site C's maturity on project management practices for major capital projects. The tables below represent our assessment based upon the information and data provided by the Site C project team. It should be emphasized that we have rated project-level practices only, and have not provided an assessment of BC Hydro's overall project management maturity. Additionally, we would not expect, or require that all projects be a Level 5 in all areas to be representative of leading practices.

BC Hydro Score as at August 2016

Scope definition					
Sub-Process	**Level 1**	**Level 2**	**Level 3**	**Level 4**	**Level 5**
Baseline scope development	Ill-defined scope, with little or no stakeholder involvement. No formal process.	Project requirements fare documented after solicitation from stakeholders. A basic process is in place to define a high-level WBS.	The baseline scope is included in project approval document. A detailed WBS is created that is used as the basis for determining project tasks.	Corporate-level technical requirements are fully integrated in the scope baseline. The WBS is closely aligned with all project deliverables.	Quality assurance techniques are included as well as review of historical requirement definitions. Process is sustained and improved upon.
Baseline scope verification	Verification in the field, but limited documentation.	Verification against set of requirements, but not consistent across projects.	Documented baseline verification, following scope management plan.	Verification is integrated with schedule and cost tracking systems.	Largely automated and available for real-time analysis.
Scope change identification, analysis, and approval	Ill-defined scope does not allow for the identification of changes. No scope management plan.	Change identification is not systematic. Analysis and approval processes defined, but informal.	Formal process for identification, analysis and approval. Written scope management plan.	Changes identified and analyzed quantitatively. Approval with most stakeholders' involvement.	Proposed scope changes measure value in addition to cost and schedule impacts.
Scope change monitoring and control	Changes are communicated in an ad hoc manner. Updated scope not completely tracked and documented.	There are defined tracking parameters and a formal process used on large highly visible projects.	Detailed scope change control system, reporting, and analysis processes are defined and adhered to by all project teams.	The scope control system is integrated with corporate control systems, monitoring program, and risk management processes.	Changes are implemented and monitored for effectiveness. Lessons learned are documented and shared.

Front end loading

Sub-Process	Level 1	Level 2	Level 3	Level 4	Level 5
Schedule development	No activity definition, sequencing, or duration estimating process. Durations between milestones are usually rough guesses.	Basic guidelines exist which outline schedule development, but not always used. No detailed WBS or network diagram.	All projects have schedules that are detailed and resource loaded. Baseline schedules are developed.	Earned value management capabilities are developed for some projects. Schedule decisions are largely data driven.	Project as-built schedules are captured and maintained in a database to improve the process.
Schedule analysis	Schedule does not allow for analysis.	Schedule analysis is largely qualitative, no formal float or delay quantification process in place.	Schedule analysis performed at regular intervals. Standard CPM techniques used.	Schedule analysis based on simulation, resource levelling. Interdependencies regularly used in decision making.	Schedule analysis is contemporaneous with project decisions. Process is continuously improved.

Front end loading (cont'd)

Sub-Process	Level 1	Level 2	Level 3	Level 4	Level 5
Schedule monitoring and control	Schedule control is left to each project team. Milestone changes are managed inconsistently and often are not monitored.	A formal process is developed including for schedule change control. Process is not consistently followed across projects.	A developed schedule change control and reporting process have been implemented on all projects. Cost and schedule systems are linked.	Schedule assessments are used to determine project efficiency. Earned value management in place at some projects.	Earned value trends monitored and corrective actions tracked on all projects. Historic performance trends stored in a project database.

Procurement strategy

Sub-Process	Level 1	Level 2	Level 3	Level 4	Level 5
Project delivery and contract strategy	There is no formal procurement planning process. Basic requirements only.	The project manager plans high level contract strategy and how scope is bought.	A formal plan is prepared, including a full buyout log with a schedule and proposed contract strategies.	The procurement plan is coordinated with other projects and corporate buying activities for potential benefits.	Alternative project delivery models are evaluated on a periodic basis for improvement opportunities.
Bid and award	There is no standard for pre-qualifying vendors, requesting proposals, or evaluating bids.	Corporate procurement policy drives solicitation and award with little project team input.	Project-based bid evaluation and award processes are documented and followed.	Processes are part of formal procurement plan, integrated with corporate policy.	Project requisition and contract award are functions of the enterprise purchasing system.
Supply chain integration	Purchasing good s and services as needed.	Discounts negotiated on case-by-case basis.	Comprehensive list of preferred vendors maintained.	Long-term master agreements in place.	Strategic alliances considered.

Contract administration	Contracts are loosely managed with minimal reporting required in the contract.	Vendor's processes used for change management. Invoices reviewed by accounts payable department only.	Vendor and project change processes are integrated. Project team involved in invoice review and contract compliance.	Project vendors use standard templates to provide regular status updates. These templates are included as contract exhibits.	Contract management processes are continually evaluated and improved.
Contract closeout **[not assessed]**	Closeout is initiated after contract's end date with little to no data retention.	The closeout process follows the vendor's typical procedures.	Closeout process is driven by owner requirements and associated plan.	Closeout process is documented and integrated with other processes.	Closeout process provides continuous feedback to future procurement.

Cost management reporting

Sub-Process	Level 1	Level 2	Level 3	Level 4	Level 5
Cost estimating	Estimates are ad hoc and may miss some costs. Basis for estimate documentation is inadequate.	Cost estimates tied to a simple WBS. Cost estimating template used and basis of estimates documented.	Formal estimating standard and a cost management plan. Historical database and alternatives analyses used.	Integrated with finance and accounting systems. Discipline-specific cost standards developed.	Lessons learned are used to improve the estimate quality. Historical database maintained in corporate systems.
Cost budgeting	Processes are not standardized and not all projects may baseline costs.	Baselining on all large projects. Process is formal, but not implemented consistently.	All projects develop cost baselines at the lowest reasonable level per formal standards.	Fully integrated with project scheduling, corporate finance, and strategic planning.	Cost baselines are continuously evaluated for improvement on future projects.
Cost forecasting	Basic forecasting performed once budget is exceeded.	Cost forecasting on large projects upon manager's request.	Forecast performed and documented at regular intervals.	Forecast integrated with a quantitative risk assessment.	Forecast and related assumptions can be updated in real time.
Cost monitoring and reporting	Individual teams apply their own approach. Cost reports are provided only if requested.	Periodic reports by projects team, not fully reconciled to accounting system.	Cost change control, cost reporting, and cost performance analysis is performed regularly.	Cost reports are integrated with schedule, technical status and activity reporting.	Cost assessments for management decisions and for continuous improvement.
Payment application review	Invoices reviewed only by company accounts payable.	Project team involvement on large contracts.	Thorough, but manual review per contract terms.	Audit-level contract compliance review and cost evaluation.	Statistical methods used for sampling and tracking trends.
Cash flow projections	Budget is not integrated with schedule.	Inferred from cost curves provided by vendors.	Projections developed from master schedule.	Detailed resource-loaded schedule provides projections.	Increasing accuracy through analysis of previous spend.

Capacity of PPM to support project management needs

Sub-Area	Level 1	Level 2	Level 3	Level 4	Level 5
Project – specific tools and systems	Standard performance metrics are developed and used to evaluate the performance of individual projects.	There are simple systems that the PM can utilize across the project such as a shared drive or a centralized reporting system. Custom tools used by each project manager.	There is a central project system that contains project information tools, processes, and procedures. Not all team members are taking full advantage of functionality.	Project systems and tools are standardized across projects and used by all project team members.	Earned value management systems are in place to evaluate project efficiency and effectiveness. Lessons learned are used to make project management system improvements.
Capital program support by corporate-wide systems	No support to project management from corporate systems.	Enterprise systems have some project management functionality, but used at the PMs discretion.	Enterprise systems offer standard reports that can be exported and further customized by project management.	Enterprise and project management systems are integrated and standardized reports can be produced at regular intervals.	Enterprise system offers real-time automated reporting for project management.

Project governance

Area	Level 1	Level 2	Level 3	Level 4	Level 5
Project initiation and authorization	Projects are initiated informally with limited or no documentation of approval.	There is a defined process for creating project charters, scope statements, but the project scope definitions are broad and difficult to track against.	Work does not begin for any project without a written authorization, including clearly defined scope and objectives.	The project charter process is highly developed and repeatable. Scope, assumptions, and constraints are documented and monitored.	Data from previous projects are consistently utilized to refine scope, define requirements and improve upon project management processes.
Progress monitoring	The project manager provides informal updates to management.	Consistent use of industry metrics to measure progress, but no formalized process.	Standard metrics are developed and used to evaluate the performance of individual projects.	Tracking and reporting at regular intervals against a detailed baseline across all projects.	Project progress tracked and updates available in real time. All projects report earned value.
Oversight organization	No oversight requirements on project delivery.	Executive committees briefed on large projects.	Program level oversight organizational structure.	Oversight structure is fully integrated with any and all capital spend.	Oversight structure is part of a project-based company organization.
Approval processes	No project approval hierarchy.	Large projects follow corporate approvals.	Approval authority is consistent across capital program.	Integrated project and operations approvals.	Continuously evaluated against oversight processes.
Decision – making	Decisions are made as issues arise and no formal process in place	Decision-Making process is defined but not supported by analysis tools.	Decision-Making process defined and supported by quantitative analysis.	Formal process in place for Decision-Making with evaluation criteria and methods for evaluation.	Process is managed and linked with progress monitoring to allow foresight.

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