

Port Mann Bridge / Highway 1 Construction Review

Summary Report

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Prepared for



BRITISH
COLUMBIA

MINISTRY OF FINANCE

by:



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1 PURPOSE, SCOPE AND APPROACH

1.1 Purpose of Summary Report

The purpose of this report is to provide a summary of the Port Mann / Highway 1 Construction Review, prepared by Perrin, Thorau and Associates Ltd. for the British Columbia Ministry of Finance. Perrin, Thorau and Associates Ltd.'s full review is contained in a separate technical report. This summary report is intended to provide an overview of the review, its findings and its recommendations that is accessible to a reader who does not wish to delve into the engineering or construction management of highway construction projects. This summary report therefore uses less technical language than does the technical report.

This summary report is not intended to be a substitute for the technical report. It is not as comprehensive or precise as the technical report nor does it provide the same depth of evidence for the findings of the review. Cross references are provided to guide the reader of the summary report to appropriate sections of the technical report. Where there are differences between the summary report and the technical report, the technical report should be taken as definitive.

1.2 Purpose, Scope and Approach of the Construction Review

The purpose of the review is to examine the functions of the Province and its agencies as they were applied to the Port Mann Bridge/Highway 1 project (PMH1 Project). Those functions include governance, oversight, procurement and construction management. The provincial agencies involved were: the British Columbia Ministry of Transportation and Infrastructure (MOTI), Partnerships BC and the Transportation Investment Corporation (TI Corp).

The Terms of Reference for the review set out six questions to be addressed:

1. Were the governance, oversight, budgetary project control and due diligence processes from project award to project completion timely, effective and consistent with the scope, complexity and objectives identified for the PMH1 Project?
2. Did TI Corp's procurement of owner representation services for the PMH1 Project follow provincial and Crown corporation procurement policies and principles?
3. What led to the decision to accelerate construction of the Project?
4. Was the decision to accelerate construction supported by engineering and/or financial considerations?
5. Was the decision reviewed and approved in accordance with applicable policies and procedures considering the scope, scale, risk and complexity of the Project; and was it consistent with the identified objectives for the Project?
6. Once the decision was made, was the flow of funds to the contractor well-managed?

We examined only the Province's project management practices that had a direct bearing on these questions. When we encountered some other management practices that could be improved upon we made recommendations to do so, but we did not seek out other ways that

management practices could be improved. We did not examine Provincial management of requests for information about PMH1. We did not undertake an audit, but rather allowed Provincial officials to provide us with their stories and sought documents to support those stories. We compared the Province's procedures and processes to good industry practices and performance outcomes to other similar projects throughout North America. We examined a sample of documents prepared by Kiewit/Flatiron General Partnership (Kiewit/Flatiron), the firm that designed and built the PMH1 Project, and by KPMG and other private sector consultants that were retained by the Province to represent its interests in the execution of the project.

In coming to our conclusions, we have both used other sources to support our findings and, in some cases, relied upon our experience with similar projects in North America, explicitly stating when we have done so.

Throughout our review, we had the full cooperation and support of TI Corp, MOTI and Partnerships British Columbia. We thank them for their efforts. While these agencies reviewed drafts of this report, any errors remaining in it are our responsibility alone.

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2 PROJECT HISTORY

The PMH1 Project replaced the Port Mann Bridge, upgraded 37 kilometres of Highway 1 from the Second Narrows Bridge to 216th Street between Langley and Fort Langley and included some ancillary construction components required as a result of the project. It was intended to reduce travel times and congestion along the corridor and improve safety.

The project was announced in January 2006 as part of the Gateway Program, a set of major transportation infrastructure projects. It was, as had been common practice in BC since 2002, expected to be constructed as a public-private partnership. Specifically, it was expected to be a Design-Build-Fund-Operate-Toll-Transfer project, under which a private consortium would design, build and operate the project using private sector financing that would be repaid from toll revenue.

The procurement process to select a private partner began in May 2007 and culminated in the selection of Connect BC in August 2008. Connect BC was a consortium of firms led by Macquarie that included Kiewit/Flatiron. They were authorized in September 2008 to begin design work while the financial details of the partnership agreement were negotiated.

Public-private partnership approaches can result in significant benefits to the Province as a result of transferring most of the risk associated with a project to the private sector and can reduce overall life-cycle costs, for certain projects. However, the private sector has higher borrowing costs than the public sector. Public-private partnerships only make fiscal sense for the Province where the other benefits of the approach outweigh the increased costs of funds faced by the private proponent. In other words, whether or not a deal can be reached with a private consortium that has a net benefit for the Province depends on the size of the difference between the cost of funds for the Province and the Private proponent.

The financial crisis in 2008 significantly increased the private sector cost of funds. That change in circumstances resulted in negotiations with Connect BC being discontinued in February 2009 when it became clear a public-private partnership for the project was no longer financially viable.

The Province decided to retain responsibility for funding the project using government debt and to build the project using a design-build approach. Design-build is an approach to construction under which the contractor is responsible for designing and building the project for a fixed price, given a scope and schedule that is defined in detail. The price is fixed except to the extent that the owner changes the scope or schedule, or that unanticipated events occur that are beyond the control of the contractor which affect the schedule or cost of the project. The details are set out in a design-build agreement.

The public-private partnership that had been under negotiation included design and construction of the project as a significant part of its scope. By early 2009 negotiations of that portion of the agreement had been largely completed, with Kiewit/Flatiron having primary responsibility for design and construction within the Connect BC consortium. As such, a new design-build agreement was concluded with Kiewit/Flatiron in less than a month.



The design-build approach required considerably more involvement by the Province over the course of the design and construction of the project than would have been required under a public-private partnership because of the significant risks retained by the Province. The agencies involved assembled a team comprised of both employees and contractors to fulfill the Provincial responsibilities. A key partner in that effort was KPMG, which fulfilled, among other things, the role of owner's representative.

The approved budget in 2009 for the PMH1 Project was \$3.319 billion comprised of the Design Build Agreement with Kiewit/Flatiron and other costs incurred by the Province in the course of the project. The project was ultimately completed at a total actual cost of \$3.367 billion, an overall increase of \$48 million.

Work on the project began in September 2008 when Connect BC was authorised to begin work on design, surveys and geotechnical tests. Significant milestones in the schedule were:

- substantial completion of the components needed to begin tolling, in particular the Port Mann Bridge itself, by December 1, 2012;
- substantial completion of the portion east of the bridge by December 31, 2012; and
- substantial completion of the portion west of the bridge by December 31, 2013.

Subsequent events related to relocation of utilities in the highway corridor put pressure on the schedule, especially the scheduled start-date for tolling, as discussed in more detail below. Kiewit/Flatiron and the Province ultimately agreed to a payment of \$99 million to bring the project back to the original schedule and the bridge was opened on December 1, 2012, with tolling starting one week later.

The schedule was amended to extend the scheduled completion date for the portion west of the bridge to December 31, 2014. That portion and thus the entire project, was substantially completed in August 2014.

3 PROJECT MANAGEMENT PROCESSES

The first two questions posed in the Terms of Reference are related to the establishment and use of project management processes by the Province from the inception to the completion of the project. Those questions are:

1. Were the governance, oversight, budgetary project control and due diligence processes from project award to project completion timely, effective and consistent with the scope, complexity and objectives identified for the PMH1 Project?
2. Did TI Corp's procurement of owner representation services for the PMH1 Project follow provincial and Crown corporation procurement policies and principles?

Answering these questions required a review of the selection of the delivery method for the project, the provisions of the Design Build Agreement between Kiewit/Flatiron and TI Corp, and the governance and oversight mechanisms that would apply to the project.

3.1 Delivery Method¹

The financial crisis in 2008 eliminated the public-private partnership method as a feasible delivery method for the PMH1 Project, in particular the ability to use private sector funding to finance the project. The public-private partnership approach was originally chosen to transfer as much risk as possible from the Province to a private partner. While it was no longer possible to transfer risks associated with financing and operating the highway assets of the project, transfer of risk associated with designing and building the project was still possible.

There are three common delivery methods for owner-financed construction projects:

Design-bid-build is the traditional method of delivery under which the owning government agency lets separate contracts for managing and approving the completion of each step from preliminary design to detailed design to the construction contract. The owner takes the risk associated with the impact of each step on other steps and is the slowest of the alternatives due to the sequential steps.

Construction manager/general contractor is a delivery method in which the designer and the constructor work together to resolve design issues during project development, but the owner controls the work of each through a direct contractual relationship, as it does in design-bid-build. This method is best used for innovative or unusual designs where not all of the technical and functional requirements are available in advance. This method is not used for highway projects in British Columbia.

Design-build is a method under which a single party, usually a partnership of designers and builders, is responsible for both design and construction. The constructor usually leads these partnerships, with the designer and other development specialties subordinate to them. This method requires that the owning agency clearly articulate, in advance and as part of the contract, the technical and functional requirements of the design. It effectively transfers

¹ See technical report section 4.1

design and construction risks to the contractor and can save time as steps can proceed simultaneously.

The Province's decision to choose design-build was the correct one given the options available given the size and complexity of the project.² Additionally, both of the alternative methods would have been difficult for the Province to use because they require intensive project management from the owner and, in our opinion, the Province has lost the ability to intensively manage the delivery of large and complex surface transportation projects as it has shifted to alternative delivery methods, such as public-private partnerships.

The choice of Kiewit/Flatiron was also the right decision.³ The procurement process used to select Connect BC to undertake the public-private partnership was pronounced fair and open by an independent fairness reviewer and none of other proponents protested the result. Kiewit/Flatiron was the design/construction lead in the Connect BC consortium and had already been assessed to be the most qualified firm to deliver the design and construction of the PMH1 project. When it was impossible to reach a public-private partnership agreement the Province and Kiewit/Flatiron decided to proceed as a design-build agreement, and based on work already done, the agreement was completed in less than a month.

3.2 The Design Build Agreement⁴

The Design Build Agreement was a fixed price contract under which the total amount to be paid to Kiewit/Flatiron is set, provided that the scope and schedule do not change. However, it was inevitable that for a project of the size and complexity of the PMH1 Project there would be changes to both scope and schedule.

The Design Build Agreement followed good industry practices by including provisions to deal with both changes in scope and schedule required by TI Corp in the Province's discretion and changes that arise from events outside the control of the parties. These included:

- Change Certificates – changes to the scope or schedule initiated by TI Corp that, in most cases resulted in a change to the fixed price negotiated between TI Corp and Kiewit/Flatiron;
- Events – changes caused either by the Province not meeting its obligations in a way that changes the scope or schedule, or by circumstances beyond the control of either party. The parties must agree and come to a negotiated settlement related to events or use dispute resolution mechanisms to reach a settlement. If an event causes a delay, the Province can use a change order to accelerate construction to offset the delay.

² See technical report section 4.1

³ See technical report section 4.1

⁴ See technical report section 4.2

3.3 The Project Management Team⁵

Good industry practice requires, among other things, that the owner nominates a project manager with clear authority for management of the project, an owner's representative subordinate to the project manager with a role limited to project control, and a team of qualified checkers to confirm the quality and completeness of work. The TI Corp project management team had all of these elements, plus there was an independent certifier of the completion of work that reported to neither TI Corp nor Kiewit/Flatiron. The Province's project manager was the Vice President, Technical Services of TI Corp: a provincial public servant. The owner's representative, Mr. Gary Webster, was subordinate to the project manager.

The owner's representative plays a special role, acting as a conduit between the owner and the contractor in the administration of the contract. Under good practices, in acting for the owner, the owner's representative has delegated authority to administer the contract as it stands and, in some instances, amend the contract. In this instance, the owner's representative had no unilateral authority to change the scope, schedule or budget of the Design Build Agreement with Kiewit/Flatiron. The owner's representative also had a role in providing expert advice based on their expertise and dealings with the contractor.

The Province's project management team included both employees and contractors. That is not unusual due to the variability in resource requirements associated with major construction projects: project managers are mobile, and they frequently work in different jurisdictions on successive projects. In the case of TI Corp, government's difficulty retaining staff meant even more outside resources with expertise were needed. The Province mitigated the shortage of qualified staff by dispersing MOTI's and TI Corp's public service employees throughout the team as much as possible.

3.4 KPMG Procurement⁶

KPMG was awarded a \$1 million contract to provide business advisory services to the Ministry of Transportation's Gateway Program contract beginning October 2002 with a March 2005 end date. The PMH1 Project was part of the Gateway Program.

The contract was awarded after a two-part procurement process that, first, selected a group of eight qualified business advisory service providers from a group of fourteen firms that were invited to bid, and second, chose KPMG from a subset of three of those from the qualified list who were interviewed.

A chain of amendments and subsequent agreements, all flowing from this initial award and all awarded without competition, increased the value of the work given to KPMG to over \$21 million by May 2015.

⁵ See technical report section 4.3

⁶ See technical report section 4.4

From 2003 to 2009 KPMG was paid an average of \$750,000 per year for business advisory services related to the planning and procurement for the PMH1 Project and the negotiation of the Design Build Agreement with Kiewit/Flatiron.

In late 2009, the individual who was the owner's representative for the PMH1 Project left their previous employer, CH2MHill, and joined KPMG. He was allowed to continue in his role as owner's representative, a good decision because his knowledge of the project and of the contractor could still be brought. However, the transfer of the role from CH2MHill to KPMG was irregular because:

- More than just the owner's representative role was transferred, including field audit and other surveillance responsibilities;
- The CH2MHill contract scope and value were not reduced consistent with the transfer of responsibilities to KPMG; and
- KPMG was not pre-qualified for the same engineering services for which CH2MHill had been qualified, exposing the Province to protest from firms that were prequalified through the procurement process.

There was also a lack of specificity in the deliverables expected from KPMG that limited the Province's ability to control costs under the KPMG contract. While deliverables were reasonably well defined in the original contract, that contract was replaced when it was assigned by MOTI to Partnerships BC in 2004. The replacement contract had, in our opinion, a perfunctory definition of scope and no deliverables.

3.5 Governance and Oversight⁷

Governance and oversight were examined from two perspectives: delegation; and risk.

Delegated authority is the mechanism by which a project is governed and oversight is exercised throughout the management chain, from the ultimate decision-makers of the Treasury Board to the day-to-day management of the project by the management team.

The delegation of authority from Treasury Board and the Minister Responsible to the TI Corp Board of Directors, met or exceeded the Province's requirements in all respects. TI Corp complied with these delegation instruments in almost all respects.⁸

The delegation of authority from the TI Corp Board of Directors to TI Corp staff was clearly articulated, although the comprehensiveness of these delegations evolved over time. In particular, the limits of the Project Director's authority to approve change orders contained a discrepancy until 2013, which resulted in smaller change orders not receiving board approval. This discrepancy mattered more in theory than it did in practice.

⁷ See technical report Section 4.5

⁸ A change in accounting standards during the course of the project resulting in \$39 million in spending associated with bridge decommissioning to be re-categorized from capital expenditure to operating expense, and the delegation instrument which was specific to capital expenditure was not adjusted.

From a risk perspective, we compared the Province's *Capital Asset Management Framework* to the equivalent guidance provided by the US Federal Highway administration. We found that it provided good guidance on controls, approvals and requirements, but relatively little guidance on ongoing project management. Such guidance was not necessary when projects were being delivered through public-private partnerships.

3.6 Project Budget and Cost⁹

As a design-build project, the costs of designing and building the project are all included in the fixed price negotiated with Kiewit/Flatiron. The project budget included those costs of as well as all other costs related to the project:

- Property acquisition, including both the right to use property permanently in the project corridor and temporary use of land during construction;
- Technical services, including professional services used to manage the project, both external and payments made by TI Corp to MOTI and Partnerships BC, and construction project elements that are part of the project scope but not part of the contract with Kiewit/Flatiron;
- Interest during construction on the debt incurred to fund progress payments made during the project term; and
- Other costs such as the infrastructure needed to collect tolls and the stipends paid to bidders under the terms of the procurement process.

⁹ See technical report section 4.6

Figure S1: The PMH1 Project Budget

	<i>2009 Approved Budget</i>	<i>November 2017 Actual</i>	<i>Variance Increase (Decrease)</i>
	<i>\$ millions</i>		
Design Build Agreement: Capitalized			
Design Build Contract	2,398	2,398	-
Management Reserve	64	-	(64)
Additional Scope and Change Orders	28	255	227
	2,490	2,653	163
Other Project Elements: Capitalized			
Property Acquisition	185	140	(46)
Technical Services	110	253	143
Interest During Construction	496	221	(275)
Bridge Decommissioning	-	(39)	(39)
Other	37	92	55
Total Capitalized Expenditures	3,319	3,320	1
Design Build Agreement: Expensed			
Additional Scope and Change Orders	-	8	8
Bridge Decommissioning	-	39	39
Project Cost, per initial budget	3,319	3,367	48

As indicated in Figure S1, the approved budget for the project, as announced in the 2011/12 Provincial budget was \$3.319 billion. The total amount paid on a consistent basis of accounting was \$3.367 billion, an increase of \$48 million.

The original fixed price in the Design Build Agreement was \$2.398 billion and there was \$64 million contingency amount held as a management reserve. After including approved change orders, the authorized expenditure under the Design Build Agreement was \$2.7 billion, of which \$2.691 was ultimately paid out.

The approved change orders included increases to the scope of the Design Build Agreement to include some project elements that the Province originally intended to manage separately, additions to the project scope when it became apparent that it was more efficient to add elements of other Gateway Program projects to the PMH1 Project and a change order to accelerate the schedule, which are discussed further below.

It was possible to accommodate these changes and increases to the cost of technical services within the budgeted amount because of reductions in interest during construction and in land acquisition costs.

During the course of the project, there was a change in accounting standards as the Province moved from Canadian Generally Accepted Accounting Principles (GAAP) to International Financial Reporting Standards (IFRS). Under IFRS, some costs that had been capitalized under GAAP were now considered to be expenses, which reduced net income on TI Corp's financial statements. In particular, the \$39 million cost of decommissioning the original Port Mann Bridge was no longer considered a capital cost. That, together with \$8 million of other scope changes that were also categorized as expenses, account for the \$48 million by which the final project budget, on a consistent basis of accounting, exceeded the original budget.

The only contingency included in the project budget was the \$64 million management reserve associated with the Design Build Agreement. There was no contingency associated with other project costs. That level of contingency was inadequate for the size and complexity of the project. Our experience is that contingency amounts of between 6% and 10% (roughly \$200 – \$300 million in this case) are usually included in the budgets of similar transportation projects. In total this project experienced construction contract costs of \$328 million: \$293 million in the Design Build Agreement and \$35 million in construction contracts with other contractors. Without savings in other cost line items, TI Corp would have had to return to Treasury Board to seek authority to spend more on the PMH1 Project.

3.7 Project Management Process Conclusions

In answer to the first question posed by this report's terms of reference,¹⁰ the development, management and oversight of the PMH1 Project generally followed industry practices and met industry standards.

We conclude that:

- Design-build was the best choice of delivery method for this project.
- The Design Build Agreement, except for some deficiencies that are described in the technical report, was a comprehensive and effective document.
- There were proper separations of authority in the Province's management of the PHM1 project, and the organization of the management team followed good practices.
- The changes in the committees of TI Corp's Board of Directors properly anticipated TI Corp's change from a project management organization into a full-fledged business with responsibilities for collecting revenues storing personal information.
- The budget for the PMH1 Project was set at \$3.319 billion. When stated on the same accounting basis, that figure rose to \$3.367 billion by the end of the project.
- The Design Build Agreement with Kiewit/Flatiron was the largest item in that budget. TI Corp paid Kiewit/Flatiron \$2.691 billion against contract authorities totaling to \$2.700 billion for all authorised expenditures, including both capitalised and operating

¹⁰ "Were the governance, oversight, budgetary, project control and due diligence processes from project award to project completion timely, effective and consistent with the scope, complexity and objectives identified for the PMH1 Project?"

expenditures.

However, the \$64 million contingency in the project's budget was insufficient.¹¹ We therefore recommend:

Risk registers. The Province should, as a major project proceeds through design and construction, revise the risk register and use risk-based schedule and cost management tools to revise contingency funding and manage cost and schedule risks throughout the life of the project.

Contingencies. The Province should publish a policy for the contingency funding of cost increases in surface transportation projects that defines the source of funds available for such contingencies and the optimal distribution of contingency funding within projects and across projects in the Province's surface transportation programs.

In answer to the second question,¹² the procurement and management of contracts with KPMG involved a significant number of amendments and increases to value and scope that were not subject to a competitive process. As a result, the Province lost some opportunities for cost control and was vulnerable to protest from firms that were pre-qualified during the initial selection procurement process for engineering services related to the Gateway Program, of which the PMH1 Project was part.

¹¹ See technical report section 4.6.4 for a full discussion of contingencies.

¹² "Did TI Corp's procurement of owner representation services for the PMH1 Project follow provincial and Crown corporation procurement policies and principles?"

4 THE PROJECT'S EXECUTION

The remaining questions posed in the Terms of Reference relate to specific decisions to approve changes made in the execution of the project:

3. What led to the decision to accelerate construction of the Project?
4. Was the decision to accelerate construction supported by engineering and/or financial considerations?
5. Was the decision reviewed and approved in accordance with applicable policies and procedures considering the scope, scale, risk and complexity of the Project; and was it consistent with the identified objectives for the Project?
6. Once the decision was made, was the flow of funds to the contractor well-managed?

Project management is largely an exercise of the owner and contractor working together to deal with the changes that inevitably are required to complete any construction project, especially one as large and complex as the PMH1 project. The project did experience considerable change. To answer these questions, we reviewed:

- the provisions for change included in the Design Build Agreement,
- significant changes to the scope of the project,
- the events and changes surrounding the decision to accelerate construction of the project, and
- the flow of funds to the contractor in the form of progress payments.

4.1 Provisions for Change¹³

As described in section 3.2 above, the Design Build Agreement included provisions for change through Change Certificates (changes required by the owner) and Events, (changes in circumstances that affect the schedule or cost). These provisions met best practices.

The Agreement defined three types of events, called Supervening Events, that prevented the owner or contractor from fulfilling obligations under the agreement and therefore entitle a party to compensation, an extension of the schedule or termination of the contract. They were:

- Compensation Event, a failure on the part of the Province to deliver unfettered access to the site, such as agreements with utilities, rights-of-way required for the project, environmental clearances or aboriginal claims.
- Relief Event, an intercession into the project that delayed the completion of work but did not necessarily add to cost caused by, for example, emergency services, utilities, or labour disputes affecting other parties. This was the type of event that

¹³ See technical report section 5.1

can be, in some cases, corrected with an acceleration of construction.

- Force Majeure Event, an event not caused by either party that prevented one or both of them from performing under the agreement, such as an earthquake, flood or war.

In the case of a Relief Event, the Agreement provided that the schedule be extended. It also provided that the owner may require the contractor to accelerate construction to avoid or reduce the delay and there were provisions that deal with how that would impact the compensation paid to the contractor, depending on whether a settlement is negotiated between the parties or not.

There were processes in the Design Build Agreement under which the parties could come to an agreement about the course of action as a result of a supervening event. Likewise, change orders required negotiation of the change in compensation and schedule, if any, that were required due to the changes.

Throughout its handling of changes under the Design Build Agreement, we observed that the Province was not able to fully analyse the submissions made by Kiewit/Flatiron or counter with fully developed proposals. The Province's capacity to do this work appears to have waned as design and construction management risks in projects prior to PMH1 were transferred to the private sector through public-private partnerships. We therefore recommend:

Project and Construction Management Capacity. The Province should maintain, at a minimum, the people, business processes and information systems that enable it to create and analyse schedule estimates and cost estimates for transportation infrastructure projects independently of contracted professional services providers and construction contractors.

4.2 Changes in the PMH1 Project¹⁴

There were 59 Change Certificates executed in relation to the PMH1 Project under the Design Build Agreement with a total impact on the cost of the project of \$322 million. That amount represents 13% of the original fixed price of the Agreement. As discussed below, we believe two of these changes, with a total cost of \$108 million, should have been included in the original scope of the Design Build Agreement. Excluding those two changes, the increase in the cost of the Design Build Agreement was 9%.

While a 13% cost increase would be relatively high compared to our sample of other projects in North America, a 9% increase combined with completion of the project on schedule is in line with the outcomes observed in our samples of other projects.

The two changes that we believe should have been in the scope of the project from the beginning are changes related to gravel and construction of the Fraser Wetlands Bridges.

¹⁴ See technical report sections 5.2.1, 5.2.2 and 5.2.4

Another important component of the project added to the scope of the Design Build Agreement was the Carvolth Exchange.

Gravel is an important material in highway contraction, but it is important that the gravel used meets the design specifications associated with each use within the project. As part of the contract negotiations, the Province offered Kiewit/Flatiron access to gravel in several facilities owned by the Province on an “as is, where is” basis at no cost. The PMH1 Project required over 3 million cubic metres (m³) of gravel and the amount available in the offer was between 3.9 and 4.4 million m³. The effect of the offer was that the Province assumed the responsibility for supplying gravel to the project, reducing the project budget by \$50 million to \$75 million.

The Province was unable to supply gravel that met the quality and quantity requirements of the project. A mitigation plan was developed by the Province and TI Corp to ensure that the needed gravel was supplied, and the additional cost was ultimately settled for an amount of \$72 million, not significantly different from what the gravel would have cost if purchased on the market from commercial suppliers. In our view, because of the risks involved with the approach taken and the fact that the approach would have, if successful, understated the actual economic cost of the project and potentially distorted design decisions, the commercial value of the required gravel should have been included in the original scope of the project.

We therefore recommend:

Pricing of Public Inputs. The Province should consider the question of how best to value Crown assets when they are consumed as inputs into its maintenance and construction programs, keeping in mind the opportunity costs of those assets, and establish guidelines for the pricing of these assets as they are consumed.

Two bridges over Fraser Heights wetlands were required to connect the east end of the South Fraser Perimeter Road through to Highway 1 so that road could serve as a toll-free alternative to the Port Mann Bridge. The two bridges required specialized construction techniques due to the sensitive nature of the wetlands that they spanned. These bridges, originally part of the PMH1 project scope, were removed by the Province from that scope during negotiations when Kiewit/Flatiron proposed a fixed price \$31 million for their design and construction. MOTI continued the design of the bridges, but not to completion, and was unable to provide us with any cost estimate that it prepared for the bridges after the project was removed from the scope of the PMH1 project. The wetlands bridges were added back into the PMH1 scope in August 2010 at a price of \$36 million. We believe that this component should have been retained in the initial scope of the project because the Province was unable to develop it and deliver it as a separate design-bid-build project.

The Carvolth Exchange is a transit facility that includes a park-and-ride lot, and was required to be substantially complete by the start of tolling. It was consistent with the objectives of PMH1 Project, and anticipated in the 2006 pre-design concept, but could not be included in the original project scope as the functional requirements for the facility were not known in early 2009. TI Corp’s portion of the Carvolth Exchange was added to the Design Build Agreement in July 2012, once the functional requirements were known, with a change order

for \$61 million.¹⁵ Kiewit/Flatiron sub-contracted the work and difficulties ensued, bringing TI Corp and Kiewit/Flatiron to agree that TI Corp should manage the subcontractor directly. Accordingly, the Change Certificate was set at \$26 million and TI Corp paid the subcontractor directly for the balance of its portion of the work.

Neither of these additions to the scope of the Design Build Agreement were tested for competitive pricing in the construction market. Nor was the Province able to produce independent cost estimates for these components prepared prior to their being directly awarded to Kiewit/Flatiron. The Province might have intended to let these components as separate design-bid-build projects in attempts to secure a lower price, but missing records make that impossible to know. We found that the Province often had difficulties locating documents related to the PMH1 Project and were surprised by the extent to which the Province was unable to recover key documents related to the development of these two components. We therefore recommend:

Project and Construction Management Records. The Province should investigate the benefits and costs of storing documents and records created during major highway project development and construction in a records management system that is designed for project management and, ideally, is compatible with what project management information system the Province considers as it builds up its independent scheduling and costing capabilities.

4.3 Change in Schedule Caused by Utilities¹⁶

For many good reasons, highway corridors are routinely shared with many linear utility structures: sewers, water mains, electrical transmission lines, oil and gas pipelines and railways. These structures also often cross highway corridors. As a result, there are well-established practices and standards to govern the relocation and alteration of utility assets as a result of highway construction projects. In principle:

- Both the highway owner and the utility have a duty to accommodate and work together to solve problems;
- Each party installs, improves and maintains its own assets, e.g. if a BC Hydro line must be moved, the work is done by BC Hydro or its contractors;
- Each party pays all the costs of other parties caused by any disturbance for which it is responsible, e.g. the highway owner must pay to relocate utilities if the highway is moved or widened, but any improvements to the utility done at the same time must be paid for by the utility; and
- Each party absorbs costs to its assets caused by a third party, e.g. if a highway barrier and a electrical pole are both damaged by a motor vehicle accident, both parties are responsible for their own property.

¹⁵ The BC Transportation Financing Authority, Canada's Infrastructure Stimulus Fund, TransLink and the Township of Langley also contributed funds towards this \$132 million project.

¹⁶ See technical report section 5.2.3

It is possible to agree, by contract, to other arrangements when it makes sense for both parties to do so.

The Province began contract negotiations with the utilities that would be affected by the PMH1 Project before the Design Build Agreement was signed. Once signed, all risks and responsibilities related to utilities were transferred to Kiewit/Flatiron under the Agreement. We reviewed the provisions of the Design Build Agreement with respect to utilities and found that they conform to established industry practices.

Construction of a highway project is a complex scheduling exercise, made more so by the need to coordinate the work of affected utilities with the highway construction itself. As the utilities control their own work, it is not uncommon for them to affect the overall project schedule in a way that is beyond the control of the highway construction contractor. In the PMH1 Project three such major delays to the project schedule unfolded in 2010:

- Redesign of the Metro Vancouver Sewage Line. About 1,000 metres of the Coquitlam Interceptor, installed in the 1960s on wooden cradles, had to be relocated. Metro Vancouver rejected Kiewit/Flatiron design proposals and insisted on a more expensive construction technique. Kiewit/Flatiron refused to pay the additional costs required because it was not based on a published Metro Vancouver standard. The cost issue was ultimately resolved by TI Corp providing an additional \$6.68 million through a change order. About 4 months was lost in the design schedule due to the protraction of design reviews with Metro Vancouver, although these delays did not result in significant delays on the project's critical path.
- BC Hydro. BC Hydro fell behind its indicated schedule on the relocation of a complex set of transmission lines. Kiewit/Flatiron had to extend the length of times that it was required to have temporary access and protective works in place that BC Hydro required. In addition, BC Hydro's specifications required more conversions from double-pole to single-pole transmission lines than the Province had initially anticipated, requiring a change order to provide additional \$1.5 million. In all, BC Hydro delayed the project's critical path by about 2 months.
- Recoating of the Kinder Morgan Oil Pipeline. Kinder Morgan decided that, while the PMH1 project was underway, it would excavate and inspect a section of high-pressure pipe, that crossed the highway corridor, which had been installed in the 1960s. The excavation of the pipeline was complex project that involved crash protection and had to occur in three phases to maintain the flow of traffic during construction. It was delayed because, upon excavation and inspection, Kinder Morgan decided to remove the existing protective coat from the pipe's exterior and install a new coat, providing Kiewit/Flatiron and TI Corp with little notice. The recoating process added about 2 months to the projects critical path.

These delays were tracked and reported by Kiewit/Flatiron as they unfolded during 2010. In October 2010 Kiewit/Flatiron reported that the Kinder Morgan delay was a Relief Event. After undertaking due diligence, TI Corp agreed in March 2011 that it was a Relief Event. Under the Design Build Agreement, that would give Kiewit/Flatiron additional time to meet milestones but no additional compensation.

Consistent with industry practice, Kiewit/Flatiron submitted progress update schedules. However, the contract specification did not require these submittals. Best practice includes a specification requirement for these periodic updates, usually monthly. We therefore recommend that:

Schedule specifications in the contract. The Province should specify scheduling and schedule reporting requirements in its contracts for major projects with submission time limits, submission frequency requirements, restrictions on scheduling practices and requirements to resource-load schedules and thus produce a schedule of values. The schedule of values can then be used to determine the amounts of progress payments.

Meeting or exceeding the design and construction schedule was important for the PHM1 project, as it is for any capital asset that is paid for by the revenues it earns when its construction is complete. Given that importance, we expected to find several schedule performance measures. We noted a lack of schedule performance measures in staff reporting to the Board of Directors and found that TI Corp did not have the capability to produce such measures. We therefore recommend:

Schedule performance measures. The Province should measure and analyse schedule performance measures as major highway projects are designed and constructed. Those measures should include variances from a planned value curve and earned value.

The delays shown in the update schedules gave rise to negotiations about the extent to which the Kinder Morgan Relief Event would delay the start of tolling and completion of the project. Kiewit/Flatiron submitted a claim that would have delayed tolling by 313 days to October 2013 and substantial completion by about a year to December 2014. TI Corp countered with a schedule extension to June 2013. Further discussion and concerns about the effect of seasons and weather pushed the Kiewit/Flatiron forecast of when tolling would start as late as September 2014, but the forecast delay later was reduced again to August or September 2013.

The extent of the delay was important because the Design Build Agreement included an early completion bonus of 60% of toll revenue earned during the period between actual and scheduled tolling commencement. A change in the schedule due to a Relief Event would give Kiewit/Flatiron the ability to, at their discretion, spend more to accelerate construction and earn an early completion bonus.

The issue was ultimately resolved by TI Corp using a provision of the Design Build Agreement known as an Authority Change, commonly called a “change directive.” Under this approach Kiewit/Flatiron was directed in December 2011 to achieve the start of tolling by the originally scheduled date of December 2012.

As mentioned above, a change directive was a response to a Relief Event that was anticipated in the Design Build Agreement. The costs of accelerating construction under a change directive would be compensated on a time and materials basis, plus the 15% markup specified in the Agreement, unless otherwise settled with a negotiated change order.

While proceeding on the basis of the directed change, Kiewit/Flatiron proposed a settlement of \$362 million to mitigate utility delays and other outstanding changes, such as those related to gravel. Included in that amount was \$218 million to undertake additional work in 2011 and 2012 to restore the schedule.

TI Corp analyzed its options in the face of the delays caused by utilities, including the additional payments to Kiewit/Flatiron and lost toll revenue. The impact of a delay on users of the highway was also a consideration. They could:

1. Agree to an extension of the schedule with two possible outcomes:
 - (a) tolling commences in mid-2014; or
 - (b) Kiewit/Flatiron accelerates work at its own expense and is thus entitled to an early completion bonus;
2. Pay Kiewit/Flatiron \$218 million to accelerate construction to meet the original schedule;
3. Go to court for a contract dispute; or
4. Issue a change directive and bear the risk of an indeterminate total cost.

Of these options, 3 and 4 were less certain and posed higher risks than the first two options.

TI Corp believed that cost of competing the project within the original schedule under a change directive would be no more than \$125 million, the lowest cost of the four options. We concur with TI Corp's judgement that issuing a change directive to accelerate construction to achieve the original start of tolling in December 2012 and subsequently negotiating a fair and reasonable price, was TI Corp's preferred option.

TI Corp's cost and schedule estimates were produced by contracted consultants as it did not have the internal capacity to produce such estimates. Nor did the Province have the ability to critically analyse Kiewit/Flatiron's project schedules in their native file formats. We therefore recommend:

Independent Costing and Scheduling Capabilities. The Province should maintain, at a minimum, its own capabilities to estimate the cost and schedule of a large highway construction project using best practices and using project management information systems that are compatible with those used by the contractor for the duration of the construction contract.

TI Corp and Kiewit/Flatiron worked together through early 2012 to "crash" the schedule: a construction management practice in which the scope of work is reviewed and sometimes adjusted with the shortening of the schedule in mind. The result was a set of small compromises in scope that helped with the acceleration of work.

As work to restore the schedule was done in the Cape Horn Interchange on a time and materials basis, both TI Corp and Kiewit Flatiron carefully monitored costs and progress, with additional efforts required of the owner's representative and an independent consultant hired to review invoice backup and check it for accuracy. As work proceeded, it became clear that

the actual costs of accelerating the schedule to meet the original tolling start date would be considerably less than the \$299 million that Kiewit/Flatiron had initially offered. As of November 2012, the accepted cost to date of acceleration was \$64 million with two month's work remaining to be billed.

In November 2012 with the start of tolling approaching, consistent with its duty to try its best at all levels to resolve disputes through amicable negotiations, TI Corp and Kiewit/Flatiron went ahead with negotiations to settle the fixed price of acceleration and all other outstanding issues. A total settlement of \$169 million was agreed between the parties, including \$99 million for the schedule acceleration and \$72 million for the gravel issue.

4.4 Progress Payments¹⁷

Almost all highway construction contracts include progress payments: a series of partial payments from the owner to the contractor that grows in line with the proportion of work completed while the work is being performed. Progress payments make good sense because owners – governments in almost all cases except public-private partnerships – usually have a lower cost of borrowing; thus owners can keep project costs down by providing contractors with the working capital they need. Progress payments reduce the amount of borrowing the contractor must do to finance costs as they are paid, the cost of which would be built into the fixed price of the contract if not for progress payments.

The guideline for determining how much to pay the contractor in a progress payment is to keep the proportion of the fixed price paid out close to the proportion of work completed. If progress payments fall too far behind the completion of work then the contractor must borrow working capital and add to the project's cost. If progress payments move too far ahead of work completed then the owner will have insufficient funds in the project budget if the contractor goes bankrupt and another contractor must be brought in to complete the project. It is also good practice to hold back a portion of the fixed price of the contract until the contract is closed out, with all work certified as complete, all defects corrected, and all claims settled. The Design Build Agreement included such provisions.

However, the Design Build Agreement was not without its flaws, notable among them being a lack of specificity about progress payments. Progress payments were not contemplated as part of the original requirements as they are not a feature of a public-private partnership. When the agreement was converted from a public-private partnership to a design-build agreement the terms with respect to progress payments were added quickly and were vague regarding how the amount payable should be calculated.

TI Corp had two options in implementing the Agreement's inexact language.

The approach most often used in fixed price contracts is a proactive approach known as the earned value method. Under this approach, the amount due for each work item in a progress payment is determined by measuring the percent complete for that item and multiplying that

¹⁷ See technical report section 5.3

percentage by the earned value for that item, with the earned value of each item having been agreed between the owner and the contractor in advance of completing work on that item.

$$\text{Amount Due} = \text{Earned Value} = (\text{Value at Completion}) \times (\% \text{ Complete})$$

The sum of the earned values on all items adds up to the fixed price for the contract.

As the project proceeds, field inspectors for both the owner and the contractor estimate, each month, how close to completion each component has progressed in the last month. That estimate, expressed as a percentage up to 100% complete, is then multiplied by the value agreed for that component when it was identified. That amount, less amounts estimated and paid on the same basis for that component in prior months, is the progress payment due in the current month for that component. The sum of the progress payments due in the current month on all components is the amount due to the contractor.

TI Corp and Kiewit/Flatiron defined the components of the project and earned value associated with each, although not to the level of detail that we expected. That did not matter since they did not use earned values to calculate progress payments.

Instead, TI Corp and Kiewit/Flatiron used a more reactive approach: progress payments are based on the contractor's actual expenditures, on a time and materials basis, on each component of the project for which a milestone has been identified. If progress has been made in the completion of a component and all of the costs that the contractor has charged to that component are valid then the payment is approved. To ensure that progress payments do not exceed the fixed price of the contract less the required hold back amount, there are maximum cumulative payment amounts embedded into the contract.

The reactive approach requires close oversight of the costs and activities that are recorded in the contractor's accounting system to ensure that costs are accurately and properly recorded. The oversight of the contractor's accounts requires that those accounts be open for ongoing inspection and supervision by the owner. Kiewit/Flatiron's books were open to the Province throughout the project. TI Corp instructed KPMG to scrutinise Kiewit/Flatiron's entry of their costs into this system and report back to TI Corp quarterly with their analysis of the accounting and payment processes.

The decision to not apply earned value management to the schedule and to not use earned values to determine the amounts of progress payments led to an inability on TI Corp's part to fully assess the implications of the progress payments made to Kiewit/Flatiron related to the schedule delays caused by utilities, discussed above.

Kiewit/Flatiron submitted 80 monthly draws (i.e. invoices for progress payments). In each draw, Kiewit/Flatiron reported its costs incurred to date. The entry of all of these costs into Kiewit/Flatiron's project accounting information was overseen and approved by the Authority's Representative. As the reactive approach to calculating progress payments was applied, no further validation of the amounts requested for payment was required other than the comparison of those amounts to the amounts allowed to be paid under the maximum payment curve.



The amounts reported as spent exceeded the maximum payout amount in most months, suggesting that either the project was ahead of schedule or that this reactive method resulted in higher progress payments than would have been calculated with an earned value method. Use of the earned value method would have been helpful in assessing Kiewit/Flatirons claims about the Relief Event related to utilities delays, since they would have determined the percentage of the project that was complete to a much finer level of detail.

Our examination of the draws revealed no evidence of lax or improper administration of the progress payments. However, we view the experience of the PMH1 Project as evidence that this reactive method of estimating progress payments is, in most ways, inferior to the use of earned values to estimate progress payments. We therefore recommend:

Schedule of Values for Progress Payments. The Province should use, as much as possible, a project's schedule of values and estimates of earned value to determine the amounts of progress payments.

Notwithstanding this comment, the amounts paid in progress payments had no impact on the fixed price of the Design-Build Agreement or the total amount paid to Kiewit/Flatiron.

4.5 Project Execution Conclusions

In answer to the remaining four questions in the terms of reference:¹⁸

- The decision to accelerate construction of the project arose from delays imposed by utility projects beyond the control of Kiewit/Flatiron;
- TI Corp analyzed its options in the face of the delays caused by utilities, including the likelihood of additional payments to Kiewit/Flatiron and lost toll revenue. We concur with TI Corp's judgement that issuing a change directive to accelerate construction to achieve the original start of tolling in December 2012 and subsequently negotiating a fair and reasonable price, was TI Corp's preferred option.
- The decision was made by the TI Corp Board of Directors as was appropriate, based on information and analysis provided by the Project Director and was consistent with the objectives of the project, which included the reduction of travel times and congestion.
- The flow of funds to the contractor for the specific purpose of the acceleration was managed, up to November 2012 on a time and materials basis that was carefully checked. Once the change directive was replaced with a change order, bringing the amount into the fixed price for the Design Build Contract, it was managed in the same way as all other fixed price payments.
- While we believe that progress payments could have been more usefully managed using a proactive rather than reactive approach, that in no way affected the total amount paid to the contractor under the Agreement, which was consistent with the authorizations under the Agreement. Kiewit/Flatiron received \$2.691 billion against contract authorities totaling \$2.700 billion for all authorised expenditures, both capitalised and operating expenditures.

¹⁸ 3. What led to the decision to accelerate construction of the Project?

4. Was the decision to accelerate construction supported by engineering and/or financial considerations?

5. Was the decision reviewed and approved in accordance with applicable policies and procedures considering the scope, scale, risk and complexity of the Project; and was it consistent with the identified objectives for the Project?

6. Once the decision was made, was the flow of funds to the contractor well-managed?

5 RECOMMENDATIONS

Project and construction management capacity. If the Province believes that it will directly manage the design and construction of major transportation infrastructure projects in the future then it should maintain the people, business processes and information systems that enable it to do so. At a minimum, these capabilities should include:

- **Independent cost and schedule estimation.** The ability to estimate the cost and schedule of a large transportation infrastructure project using best practices and using project management information systems that are compatible with those used by the contractors for the duration of the project.
- **Project, design and construction management records.** The management of records created during project development, design and construction in a records management system that is designed for project management.
- **Risk management.** The Province should, as a major project proceeds through design and construction, revise the risk register and use risk-based schedule and cost management tools to revise contingency funding and manage cost and schedule risks throughout the life of the project.

Contingencies. The Province should publish a policy for the contingency funding of cost increases in surface transportation projects that defines the source of funds available for such contingencies and the optimal distribution of contingency funding within projects and across projects in the Province's surface transportation programs.

Pricing of public inputs. The Province should consider the question of how best to value Crown assets when they are consumed as inputs into its maintenance and construction programs, keeping in mind the opportunity costs of those assets, and establish guidelines for the costing of these assets as they are consumed.

Overhead and profit margins in change orders. In future contracts, the Province should revise its mechanisms for estimating markups in change orders. The mechanism for overhead costs should not necessarily assume that overhead costs are a linear geometric function of direct and indirect costs, and the rate of profit should be commensurate with the risks and the commitment of capital that the change order requires of the contractor.

Schedule specifications in the contract. The Province should specify scheduling and schedule reporting requirements in its contracts for major projects with submission deadlines, submission frequency requirements and requirements to resource-load schedules and thus produce a schedule of values.

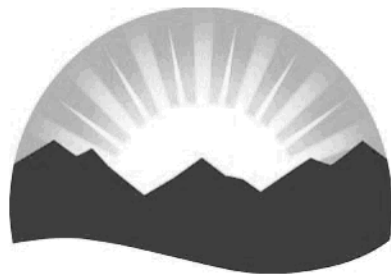
Schedule performance measures. The Province should measure and analyse schedule performance measures as projects are designed and constructed. Those measures should include variances from the planned value curve and earned value.

Schedule of values for progress payments. The Province should use, as much as possible, a project's schedule of values and estimates of earned value to determine the amounts of progress payments.

Port Mann Bridge / Highway 1 Construction Review

February 2018

Prepared for



BRITISH
COLUMBIA

MINISTRY OF FINANCE

by:

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1 EXECUTIVE SUMMARY

Since 2002 the Province has pursued a policy of building capital assets through public-private partnerships, in which private sector consortia do the work of managing design and construction to keep costs down and work on schedule. The financial crisis of 2008 forced a sudden change in the Port Mann Bridge – Highway 1 (PMH1) project from such a partnership to a design-build agreement, in which the Province itself had to manage the project. The Province reacted well to the sudden change and managed this intense and complex project to an on-schedule delivery and almost entirely within the project's initial capital budget of \$3.319 billion. Stated on the same accounting basis, expenditures grew to \$3.367 billion.

Within the PMH1 project budget, the cost of the design-build contract awarded to the Kiewit/Flatiron Partnership (Kiewit/Flatiron) rose from an initial cost of \$2.39 billion to a final cost of \$2.70 billion, an increase of 13%. Since this increase includes \$108 million of added works that, in our opinion, should have been included in the project scope when the contract price was agreed upon, we believe that the other 9% of contract cost growth is what is best compared to contract cost growth in other highway projects. While cost growth of 9% is higher than the average of our experience and our data, the combined contract performance measures for the PMH1 project of 9% growth in cost and 0% growth in schedule is in line with our experience in other well-managed projects.

That said, not everything went well and there is room for improvement. The reliance on public-private partnerships for major projects has left the Province lacking in some of the capabilities and resources that, in our opinion, are needed to ensure the successful delivery of such projects. At least four major transportation projects - Broadway Extension, Surrey Light Rail, Massey Tunnel Replacement and Patullo Bridge - are looming in the Lower Mainland. If the Province is to manage the design and delivery of these projects then the Province should improve its capabilities and resources for the management of design and construction on major transportation projects.

1.1 Formation of a Mega-Project

This was a massive project: not just the Port Mann Bridge but 37 kilometres of Highway 1, almost a dozen major interchanges and extensive transit infrastructure. The combination of its cost and its schedule to toll commencement, 40 months, also made it one of the most intense projects in North America: an average intensity of about \$2 million per working day. Such a high intensity can arise from high productivity or from a high price. Because unit prices and earned values were not calculated and monitored throughout the project, we cannot determine which is the case here.

The Province's officials in charge of the Gateway Program assembled a team of companies and people that they knew and trusted, missing some opportunities along the way to minimise the costs of professional services, and an integrated team of public servants and private sector consultants managed the PHM1 project to a successful conclusion. The roles of the members of the project management team were well-defined and we found no instance when a member of the team over-stepped his or her role.



Public financing was the right way to finance the PMH1 project and design-build was the right way to deliver it.

Transportation Investment Corporation (TI Corp) executed the project within the limits imposed by Treasury Board and, when supervening events suggested that the project might exceed those limits, TI Corp informed its shareholder and sought direction in a proper manner.

1.2 Coping with Change

Change is inevitable in highway construction projects because of unknown conditions and random events. The PMH1 project experienced considerable changes as it proceeded through design and construction. The project controls – the contracts and authorities for approvals – were of good quality and stood up well, even when stressed by the supervening events that were caused by these changes.

While negotiating the design-build contract, Province offered free “as is, where is” gravel to Kiewit/Flatiron and thus reduced the contract cost by about \$50 million. The Province couldn’t deliver enough gravel at the proper specification and, ultimately, paid an additional \$72 million for gravel to offset the shortfall. By pricing gravel into the contract in this manner, the Province assumed a considerable risk and, in an economic sense, did not reflect the true cost of the project.

During pre-contract negotiations with Kiewit/Flatiron, the Province rejected Kiewit/Flatiron’s proposed price of \$31 million for the Fraser Wetlands Bridges and removed them from scope of the PHM1 project. The Ministry of Transportation and Infrastructure (MOTI) did not execute the wetlands bridges as a separate project but put them back into the scope of the PHM1 project one year later for \$36 million.

Problems with utilities introduced an incipient delay of tolling on the Port Mann Bridge of about 4 months. The Province, while assuming significant risk, chose the best of the alternatives available to deal with this incipient delay, eliminating it at an additional cost of \$99 million. Given the prospect of losing about \$75 million of toll revenues and another 4 months of traffic delays during construction, this was a reasonable business decision.

The Province elected to calculate progress payments due to Kiewit/Flatiron by overseeing the entry of Kiewit/Flatiron’s costs into its project accounting system. This approach is, in our opinion, inferior to the more widely practiced alternative of calculating progress payments with a schedule of values. The Province’s method might have resulted in Kiewit/Flatiron receiving some payments sooner than it should but, as the price of the base contract and all change orders was ultimately a fixed price, it did not result in Kiewit/Flatiron being paid more than it was due.

The Design Build Agreement with Kiewit/Flatiron was the largest item in the project’s budget. TI Corp paid Kiewit/Flatiron \$2.882 billion before applying credits of \$191 million for GST and HST that were included in that amount. Once those recoveries were processed, Kiewit/Flatiron received \$2.691 billion against contract



authorities totalling \$2.700 billion for all authorised expenditures, both capitalised and operating expenditures.

1.3 Recommendations

Project and construction management capacity. If the Province believes that it will directly manage the design and construction of major transportation infrastructure projects in the future then it should maintain the people, business processes and information systems that enable it to do so. At a minimum, these capabilities should include:

- **Independent cost and schedule estimation.** The ability to estimate the cost and schedule of a large transportation infrastructure project using best practices and using project management information systems that are compatible with those used by the contractors for the duration of the project.
- **Project, design and construction management records.** The management of records created during project development, design and construction in a records management system that is designed for project management.
- **Risk management.** The Province should, as a major project proceeds through design and construction, revise the risk register and use risk-based schedule and cost management tools to revise contingency funding and manage cost and schedule risks throughout the life of the project.

Contingencies. The Province should publish a policy for the contingency funding of cost increases in surface transportation projects that defines the source of funds available for such contingencies and the optimal distribution of contingency funding within projects and across projects in the Province's surface transportation programs.

Pricing of public inputs. The Province should consider the question of how best to value Crown assets when they are consumed as inputs into its maintenance and construction programs, keeping in mind the opportunity costs of those assets, and establish guidelines for the costing of these assets as they are consumed.

Overhead and profit margins in change orders. In future contracts, the Province should revise its mechanisms for estimating markups in change orders. The mechanism for overhead costs should not necessarily assume that overhead costs are a linear geometric function of direct and indirect costs, and the rate of profit should be commensurate with the risks and the commitment of capital that the change order requires of the contractor.

Schedule specifications in the contract. The Province should specify scheduling and schedule reporting requirements in its contracts for major projects with submission deadlines, submission frequency requirements and requirements to resource-load schedules and thus produce a schedule of values.

Schedule performance measures. The Province should measure and analyse schedule performance measures as projects are designed and constructed. Those measures should include variances from the planned value curve and earned value.



Schedule of values for progress payments. The Province should use, as much as possible, a project's schedule of values and estimates of earned value to determine the amounts of progress payments.



2 PURPOSE, SCOPE AND APPROACH OF THIS REVIEW

Perrin, Thorau and Associates, Ltd. was retained in October 2017 by the British Columbia Ministry of Finance to review the governance, oversight, procurement and construction management functions of the Province as they were applied to the Port Mann Bridge/Highway 1 (PMH1) project by the agencies responsible for its delivery: the British Columbia Ministry of Transportation and Infrastructure (MOTI), Partnerships BC and the Transportation Investment Corporation (TI Corp).

We were directed to review the governance, oversight and management of the PMH1 Project (the Project) by TI Corp and the Ministry of Transportation and Infrastructure with the objective of answering two questions.

1. Were the governance, oversight, budgetary project control and due diligence processes from project award to project completion timely, effective and consistent with the scope, complexity and objectives identified for the PMH1 Project?
2. Did TI Corp's procurement of owner representation services for the PMH1 Project follow provincial and Crown corporation procurement policies and principles?

We were also directed to examine the decision to accelerate construction of the PMH1 Project with the objective of answering the following four questions.

3. What led to the decision to accelerate construction of the Project?
4. Was the decision to accelerate construction supported by engineering and/or financial considerations?
5. Was the decision reviewed and approved in accordance with applicable policies and procedures considering the scope, scale, risk and complexity of the Project; and was it consistent with the identified objectives for the Project?
6. Once the decision was made, was the flow of funds to the contractor well-managed?

We did not examine the Province's project management practices excepting these specific issues that fell within our terms of reference: the procurement of services from KPMG, the role of the Authority's Representative, supervening and relief events, change orders and progress payments.¹ When we encountered project management practices along other dimensions that could be improved, in our opinion, we made recommendations to improve them; however, we did not seek them out.

We did not examine the Province's management of requests for information about the PHM1 project, including requests made under the *Freedom of Information and Protection of Privacy Act* (R.S.B.C.).

As this review was not an audit, we allowed officials of the Province to tell us their stories of the PMH1 Project then reviewed documents to corroborate those stories. In reviewing the Province's conduct of the project during the design and construction

¹ See Section 14 *Glossary of Terms in the Design Build Agreement* for definitions. The role of the Authority's Representative is explained in Section 4.3.2.



phase, we compared the processes and procedures applied by the Province both to their contractual obligations and to good industry practices. We also compared performance measures of project management outcomes for the PMH1 project to the outcomes of other, similar projects throughout North America.

We reviewed a representative sample of the documents produced by Kiewit/Flatiron General Partnership (Kiewit/Flatiron), the firm that designed and built the PMH1 project, and by KPMG and other private sector consultants that were retained by the Province to represent its interests in the execution of the project.

When reaching conclusions about the management of the project, we have referred to other sources where practical but, in some cases, we applied our own experiences with similar projects in North America. We indicate explicitly where we have relied solely on our own experience and are expressing our own views and opinions.

We include a glossary of terms used in the construction of major projects. Where those terms were defined in the Design Build Agreement, we used those definitions and embellished them only for exposition to the lay reader.

When referring to the roles of people, companies and documents of the Province and Kiewit/Flatiron on the PMH1 project, as designated in the Design Build Agreement between them, we employ capitalization. Conversely, lower case is used to identify those roles throughout the industry as a whole. For example, “ Authority’s Representative” refers to a position in the Province’s construction management team for the PHM1 project, while “owner’s representative” refers to that role on any construction management team.

Throughout our review, we had the full cooperation and support of TI Corp, MOTI and Partnerships British Columbia. We thank them for their efforts. While these agencies of the Province reviewed drafts of this report, any errors remaining in it are our responsibility alone.

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3 THE PROJECT

The PMH1 project was executed in 37 kilometres of Highway 1 between its western project boundary at the McGill Street – Highway 1 interchange at kilometre 25, east of Hastings Park and south of the Ironworkers Memorial Second Narrows Crossing (Second Narrows Bridge), and its eastern project boundary close to kilometre 62 at 216 Street between Langley and Fort Langley.

The goals of the project were defined in 2006:

- “Reduce travel times for trips along the [Highway 1] corridor and increase their predictability;
- Reduce congestion at entry and exit points to Highway 1;
- Reduce travel times for trips across the corridor and improve connections within and between communities;
- Improve access to and egress from the corridor for goods movement;
- Facilitate the introduction of transit service along the corridor and the improvement of transit service across the corridor;
- Expand HOV, cycling and pedestrian networks along or in the vicinity of the corridor; and
- Improve safety for vehicle operators and passengers, cyclists and pedestrians.”²

In addition to the design and construction of all of the project’s components, the project also included the dismantling and removal of the original Port Mann Bridge, a single truss arch bridge with a four-lane deck that was completed in 1964.

The scope of the project followed the improvement plan established for the corridor in the program definition report³, but the PHM1 project excluded some components of the corridor plan:

192 Street – Highway 1 interchange and 216 Street – Highway 1 interchange⁴, each of which would increase high-volume traffic access to Langley;

Brunette Avenue – Highway 1 interchange, west of the Cape Horn Interchange, the designs of which are dependent upon the then-incomplete Bus Rapid Transit Plan for the corridor; and

Willingdon Collector/Distributor road system, development of Willingdon Avenue north of the Willingdon – Highway 1 interchange to Highway 7, the Lougheed Highway, and south of the interchange past Canada Way and BCIT’s main campus;

² *Improving Roads and Bridges for people, goods and transit throughout Greater Vancouver: Program Definition Report*. 31 January 2006, Government of British Columbia Gateway Program.

³ *ibid.*

⁴ <https://www2.gov.bc.ca/gov/content/transportation/transportation-infrastructure/projects/highway1-216th>. This was never made part of the PMH1 project and is being executed as a separate project.



These components are named in the concession agreement⁵ as the potential responsibility of TI Corp to execute as projects subsequent to the PMH1 Project. Breaking the development of a corridor into a series of projects⁶ is a common practice in North America, made necessary by the time required to develop the scope of all of the corridor's components and to amass sufficient funding.

3.1 Segments and Sections of the PMH1 Project

A project as large as the PMH1 Project requires subdivisions so that it can be executed effectively. The Province, as it developed the pre-design concept and procured the preferred proponent, divided the project into three segments of Highway 1⁷:

Western Segment the 12 kilometres from the western boundary of the project south of McGill Street in Vancouver to the Galgardi Way interchange at kilometer 37;

Central Segment, the 13 kilometres from the Galgardi Way interchange at kilometer 37 to the 160 Street interchange at kilometer 50; and

Eastern Segment, the 12 kilometres from the 160 Street interchange at kilometer 50 to the eastern boundary of the project west of 216 Street in Langley Township.

These sections were chosen to optimise traffic operations on the PMH1 corridor, set operating requirements for them and applicable penalties for each and over the entire project limits. The PMH1 Design Build Agreement uses these three sections as it defines the rights and responsibilities of TI Corp, as the Owner, and Kiewit/Flatiron, as the Constructor.

As it began the design of the PMH1 project, Kiewit/Flatiron decided – as was its right – that it could most effectively execute the project as four sections, with separate crews assigned to each of:

Section 1, the 15 kilometres from the western boundary of the project to the Brunette Avenue interchange at kilometer 40;

Section 2, the 4 kilometres from Brunette Avenue interchange at kilometer 40 to the northwest abutment of the Port Mann Bridge, comprising the Cape Horn Interchange;

Section 3, the 2 kilometers that is the Port Mann bridge from abutment to abutment; and

Section 4, the 16 kilometres from the southeast abutment of the Port Mann Bridge to the eastern boundary of the project.

⁵ Port Mann Highway 1 Bridge Concession Agreement among the Ministry of Transportation and Infrastructure, the BC Transportation Financing Authority and Transportation Investment Corporation dated 16 March 2010.

⁶ called “phasing” in the United States

⁷ The boundaries of the three segments were shifted somewhat in Change Certificate 0128.



Some of the documents that record the execution of the project refer to the segments; others refer to the sections.

Figure 1: Sections of the PMH1 Project

Copyright

3.2 Components of the Project

The PMH1 Project consists of hundreds of components, of which fifteen of the most significant are described in the pre-design concept published in 2006.⁸ Six of project's components are noted below as they figured prominently in our review.

1. Cape Horn Interchange, on the northwest end of the Port Mann Bridge in Coquitlam, connecting United Boulevard, Highway 7 (the Lougheed Highway), and Highway 7B (the Mary Hill Bypass) with Highway 1. This interchange had a complex design that had to be constructed within tight limits of disturbance.

⁸ *Improving Roads and Bridges for people, goods and transit throughout Greater Vancouver: Program Definition Report*. 31 January 2006, Government of British Columbia Gateway Program.

Figure 2: Cape Horn Interchange, looking West
Copyright

2. CPR Bridge, a component of the Cape Horn Interchange that carries traffic over a Canadian Pacific Railway line. This component is the light grey portion of the roadway in the centre of the picture. Beyond it, looking west, is the Cape Horn abutment on the north side of the highway that was one of the problematic areas in which utilities had to be accommodated.

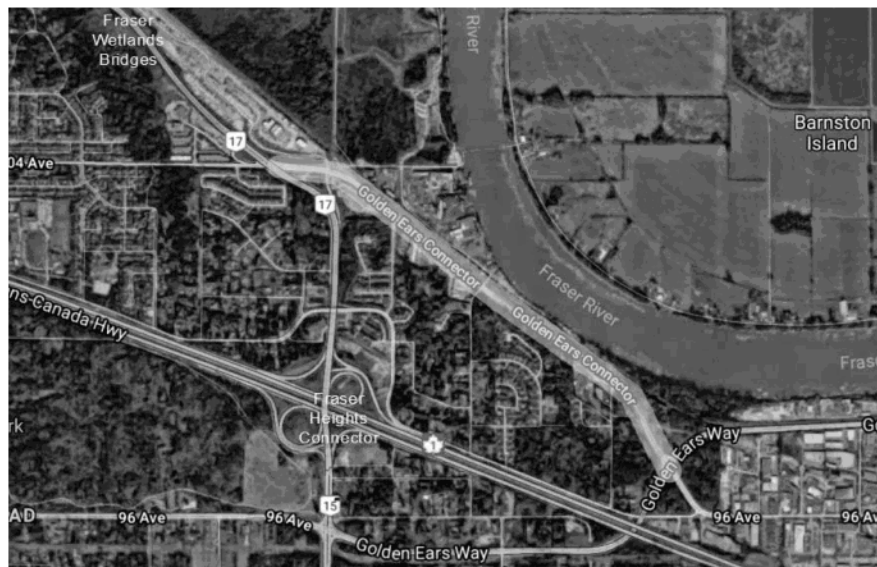
Figure 3: CPR Bridge, looking West
Copyright

3. Fraser Heights Connector, interchange at kilometre 53, connecting Highway 17 (the South Fraser Perimeter Road) – thus providing a toll-free alternative to the Port Mann Bridge crossing – and Highway 15 (the Pacific Highway)/176 Street to Highway 1. Only the interchange is shown in Figure 4 below; the scope of the connector also included that portion of Highway 17 between this intersection and the intersection with the Golden Ears Connector to the north.

Figure 4: Fraser Heights Connector, looking South
Copyright

4. Golden Ears Connector, two kilometres of roadway that connects the South Fraser Perimeter Road to Golden Ears Way, allowing traffic a direct route between Delta in the southwest and Pitt Meadows and Maple Ridge in the northeast. This component is shaded in yellow in Figure 5.

Figure 5: Golden Ears Connector



courtesy Google Maps

5. Fraser Heights Wetlands Bridges, 500 metres of Highway 17 (the South Fraser Perimeter Road) immediately northwest of the Fraser Heights Connector. This segment of the South Fraser Perimeter Road passes through an environmentally sensitive area to the north of 168 Street and southwest of Surrey Bend Regional Park. In order to preserve this area, the segment was designed as a pair of bridge decks and built from those bridge decks, as they progressed, to minimise the impact of construction equipment on the ground. This component was included in the PMH1 Project, rather than the South Fraser Perimeter Road Project, as access to the area was easier from the east than from the west.

Figure 6: Fraser Heights Wetlands Bridges, looking East
Copyright

6. Carvolth Exchange, also referred to as the 202 Street Park-and-Ride, is a surface parking and bus transfer facility on the northwest corner of 86 Avenue and 202 Street in Langley Township. This facility is about 1 kilometre east of exit 59, the 202 Street – Highway 1 Interchange.

Figure 7: Carvolth Exchange, looking North



courtesy of the Ministry of Transportation and Infrastructure



4 THE PROJECT'S FORMATION

*"Someone's sitting in the shade today because someone planted a tree a long time ago."
Warren Buffett⁹*

The Province has been building major transportation infrastructure with public-private partnerships since 2002. The expertise its agencies have accumulated in this alternative delivery method showed to good effect during the formative stages of the PMH1 project.

In this section we review those formative stages, from the selection of the delivery method and definition of the Design Build Agreement, and through the definition of the governance and oversight mechanisms that would apply to the PMH1 project, to answer two questions in our terms of reference:

1. Were the governance, oversight, budgetary, project control and due diligence processes from project award to project completion timely, effective and consistent with the scope, complexity and objectives identified for the PMH1 Project?
2. Did the Province's procurement of owner representation services for the PMH1 Project follow provincial and Crown corporation procurement policies and principles?

We found that, generally, industry practices and standards were followed and met in the development, management, and oversight of the PMH1 project. We concluded that:

- Design-build was the best choice of delivery method for this project.
- The Design Build Agreement, except for some deficiencies that are described in this report, was a comprehensive and effective document.
- There were proper separations of authority in the Province's management of the PHM1 project, and the organization of the management team followed good practices.
- The changes in the committees of TI Corp's Board of Directors properly anticipated TI Corp's change from a project management organization into a full-fledged business with significant assets and liabilities.
- The budget for capitalised expenditures on the PMH1 project was set at \$3.319 billion. Accounting changes required TI Corp to treat \$39 million of this work as an operating expense, which it did, but the budget for capitalised expenditures was not correspondingly reduced. When stated on the same accounting basis, these expenditures rose to \$3.367 billion by the end of the project.
- The Design Build Agreement with Kiewit/Flatiron was the largest item in that budget. TI Corp paid Kiewit/Flatiron \$2.882 billion before applying credits of \$191 million for of GST and HST that were included in that amount. Once

⁹ Stated in January 1991 and quoted in Kilpatrick, A. *Of Permanent Value: The Story of Warren Buffett*. 2007



those recoveries were processed, Kiewit/Flatiron received \$2.691 billion against contract authorities totaling to \$2.700 billion for all authorised expenditures, both capitalised and operating expenditures.

However, we identified a number of areas where, in our assessment, management of PMH1 did not always follow best practices:

- The procurement and management of contracts with KPMG, involving a significant number of direct awards and increases to value and scope, left the Province vulnerable to protest from firms that were pre-qualified during the initial selection process for engineering services.
- The \$64 million contingency in the project's budget was insufficient.

Figure 8: Chronology of the Project's Formation

January 2006	Pre-design concept for the PMH1 project, along with other Gateway Program Projects, is published.
22 May 2007	Request for Qualifications is issued, after considerable advance notice, to execute the PMH1 project as a Design-Build-Fund-Operate-Toll-Transfer (DBFOTT) public-private partnership.
15 June 2007	Request for Qualifications is closed.
August 2007	Short list of three consortia are qualified to proceed to the next steps of procurement. Short-listed consortia are instructed to prepare separate technical (design and construction) and financial (funding and tolling) proposals.
February 2008	Technical submissions are received.
Spring 2008	Final submissions, including technical and financial submissions, are received.
19 August 2008	Connect BC, led by Macquarie and including Kiewit/Flatiron, is chosen as the successful proponent. Negotiations with Connect BC commence.
23 September 2008 ¹⁰	The Province issues a limited Notice to Proceed to Connect BC, authorizing it to begin work on design, surveys and geotechnical tests.
27 February 2009 ¹¹	Connect BC and the Province agree to discontinue negotiations on the financial aspects of the public-private partnership. Macquarie and other members of the consortium withdraw. The Province announces it will proceed with the project under a design-build contract. Negotiations continue with Kiewit/Flatiron to proceed with the project on that basis.

¹⁰ Limited Notice to Proceed (LNTP) Agreement. Amended on 16 October 2009 and on 18 December 2008.

¹¹ <http://www.partnershipsbcc.ca/projects/operational-complete/port-mannhighway-1-improvement-project/>



17 March 2009 Design Build Agreement, effective on this date, is concluded by TI Corp and Kiewit/Flatiron

4.1 Determining the Form of the Project

The Province made two strategic decisions with respect to the form that the PMH1 project would take:

- to retain responsibility for project funding, including the collection of tolls; and
- to execute the project using the design-build delivery method.

We found that the Province's decisions were the correct ones given the options available to it. That said, we doubt that the Province could have delivered the project with either of the other two delivery methods that were feasible for the PMH1 project: both of those methods require close project management from the owner and, in our opinion, the Province has lost the ability to closely manage the delivery of large and complex surface transportation projects.

To determine the method by which the PMH1 project was to be delivered, the Province had to assess the risks that the project faced and decide upon the best distribution of those risks between the Province and the private sector. Risk assessment involves the creation of a risk register: a list of each event that could adversely affect the performance of the project, estimates of the probabilities that each event could occur and of the monetary consequence of that occurrence. In the procurement process, the Province compared its estimate of the risk of each event, i.e. the product of the probability and the monetary value of the consequence, to a price that the private sector proponents demanded to assume responsibility for that event. The Province retained responsibility of those events for which the private sector proponents demanded a price that was higher than the Province's estimate of its risk; otherwise, the Province made payment to the private sector proponent and transferred the responsibility.

From the Province's decision to retain the financial risks of the project and construct it under a design-build agreement implies that: [1] either the private sector's cost of financing or its discount of the toll revenue risk were so high that the Province decided to retain those risks; and [2] the design and construction risks were greater than the additional costs of transferring those risks to the private sector. We examine each of these propositions in turn.

4.1.1 The Elimination of Financing and Operating Provisions

The Province's initial intent was to transfer almost all of the principal project risks to a private sector proponent. To explain these risks we refer to elements of a major project funded with tolls as they are illustrated in Figure 9 below.

Figure 9: Principal Elements of a Tolled Highway Project



The upper part of the diagram shows, in green, the principal engineering phases of a highway project, each with its own set of risks that can adversely affect project's cost, the date on which it is open for service and thus able to earn revenues, the quality and functionality of the highway assets that result, and the costs of maintaining those assets over their life spans. We describe these risks and the Province's disposition of them in the PMH1 project in section 4.1.2 below.

The lower part of the diagram, using red for debits and grey for credits, shows the corresponding financial phases of the project: the build up of debt as the highway is developed and built, the charging of tolls once the highway construction is complete, and the retirement of debt from toll revenues net of operating and maintenance costs. The two principal financial risks that the Province faces as the owner are:

1. The cost of funds used to build the project will be higher if those funds are raised by the private sector proponent than if raised by the Province;
2. The discount of toll revenues that the private sector applies to insulate itself from errors in the project's traffic and revenue forecasts is higher than the Province believes is warranted.

4.1.1.1 The Cost of Funds

The turmoil and uncertainty in financial markets in late 2008 and early 2009 is well known: over 2009, the Dow Jones Corporate Bond Index dropped from over 100 to 85 and the Standard and Poors Index of high yield bond prices dropped from 105 in June 2007 to 55 in January 2009. As Topic Box 1 demonstrates, British Columbia was not the only government that retained financing responsibilities at that time.

**Topic Box 1: The Missouri “Safe and Sound” Bridge Replacement Program**

In September 2006 the Missouri Department of Transportation (MoDOT) announced the program to replace or refurbish 802 structurally deficient bridges across the state.¹² All of the projects, and management of the program itself, would let in a single design-build-finance-maintain (DBFM) contract awarded via competitive bidding to a private consortium. No bridge would be tolled, and MoDOT would make annual availability payments for the 25-year duration of the contract once construction was complete.

Four consortia qualified in the selection round between July 2006 and December 2007.¹³ After six months of subsequent negotiations, MoDOT issued a limited notice to proceed to Missouri Bridge Partners in July 2008.¹⁴ However, that September the financing dimensions of the agreement fell apart after the 2008 global credit crisis caused Missouri Bridge Partners’ financing costs to rise dramatically. MoDOT estimated that, with the growing spread between public and private financing costs, they could save \$300 million to \$500 million by utilizing public borrowing over the 25-year financing period.¹⁵

As it withdrew from negotiations, MoDOT paid stipends of \$2 million to each of Missouri Bridge Partners and Team United, the other proponent that persevered to final selection, so that MoDOT could use their planning and design work.¹⁶

MoDOT elected to proceed with a design-build program, with MoDOT responsible for financing and long-term maintenance. The 802 bridges were divided into two groups: 248 bridges needing rehabilitation were bid out individually or in small batches, and 554 bridges needing replacement were bundled into a single contract.¹⁷

Procurement for the bridge replacement contract began in the fall of 2008 and it was awarded in May 2009 to KTU Construction consisting of: Kiewit, Traylor Bros., United Contractors, HNTB and the LPA Group.¹⁸ The program was funded with state revenue bonds backed by future Federal Aid Highway Bridge Program apportionments.¹⁹ All construction was completed by November 2012.²⁰

¹² http://www.dot.ca.gov/hq/maint/AASHTO/AASHTO_2008_Presentations/Tu7.6-D_Musser-2008AASHTOMtg-07.14.08.pdf

¹³ <https://www.roadsbridges.com/four-teams-short-listed-missouri-bridge-improvement-program>

¹⁴ http://www.dot.ca.gov/hq/maint/AASHTO/AASHTO_2008_Presentations/Tu7.6-D_Musser-2008AASHTOMtg-07.14.08.pdf

¹⁵ <https://www.pmi.org/learning/library/design-process-communication-plans-improvement-4358>

¹⁶ <http://modot.org/expresslane>

¹⁷ https://www.fhwa.dot.gov/ipd/project_profiles/mo_safe_and_sound.aspx

¹⁸ The LPA Group was acquired by Michael Baker International in 2010.

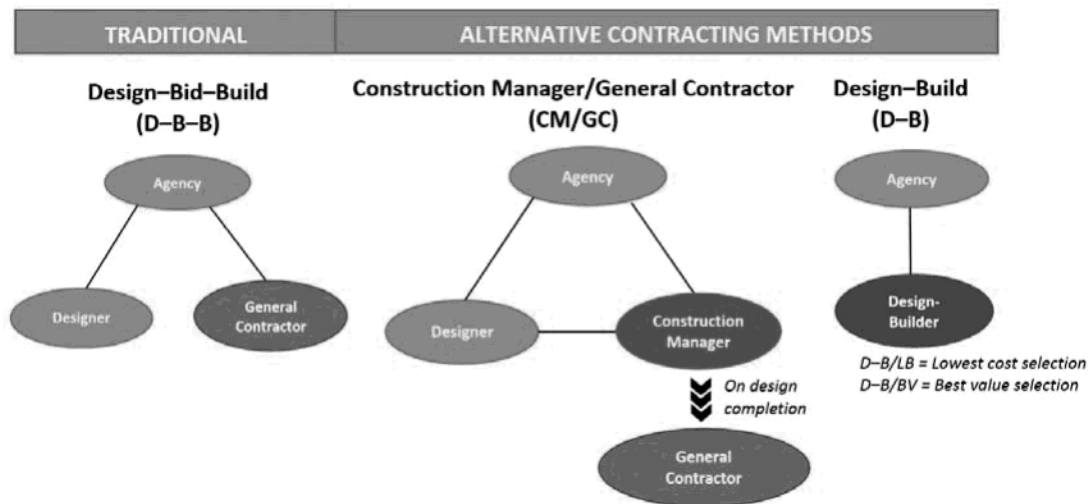
¹⁹ Grant Anticipation Revenue Vehicle (GARVEE) bonds

²⁰ https://www.fhwa.dot.gov/ipd/project_profiles/mo_safe_and_sound.aspx

4.1.2 Design-Build as the Optimal Delivery Method.

The PMH1 project was delivered with the design-build (DB) method, which means that the Province passed over the two alternatives: design-bid-build (DBB) and construction manager – general contractor (CM/GC). The three alternatives are illustrated in Figure 10 below.

Figure 10: Illustration of Design and Construction Delivery Methods²¹



Design-bid-build is the traditional method of delivery that is used in the majority of highway construction projects in North America. Development of the project proceeds through planning and into design with the owning government agency managing and approving the completion of each step: preliminary design, environmental and archaeological assessments, right-of-way acquisition, utility relocation agreements, agreements with municipalities, detailed design, contract and award documents and the construction contract. The outputs of each step are passed to the owning agency, which then takes responsibility for them as they are used in subsequent steps. If, for example, the designer makes a mistake that causes the construction contractor to suffer a loss, the owning agency is responsible for rectifying that loss.

Design-build makes a single party, usually a partnership of designers and builders, responsible for both design and construction. Issues that arise throughout design and the other steps of project development that are described in the paragraph above are the responsibility of the partnership itself to resolve. The constructor usually leads these partnerships, with the designer and other development specialties subordinate to them. This method requires that the owning agency clearly articulate, in advance and as part of the contract, the technical and functional requirements of the design.

²¹ Molenaar, K.R., and Tran, D. *Alternative Contracting Method Performance in US Highway Construction*. Federal Highway Administration, U.S. Department of Transportation. DTFH61-13-R-00019. 2017.

Construction manager/general contractor is a delivery method in which the designer and the constructor work together to resolve design issues during project development, as they do in design-build, but the owner controls the work of each through a direct contractual relationship, as it does in design-bid-build. The construction manager – who is often also the construction contractor – is procured by the owner prior to the beginning of design and consults with both the owner and the designer as the final design is developed. This method is used to its best advantage on projects that require innovative or unusual designs for which the owner cannot articulate all of the technical and functional requirements in advance. This method is not used for highway projects in British Columbia.

The design-build and the construction manager/general contractor delivery methods are advantageous for saving time. Together, Figure 11 and Figure 12 below illustrate how these two methods shorten the time required to complete a project by allowing construction to begin before detailed designs are completed.

Figure 11: Design Bid Build

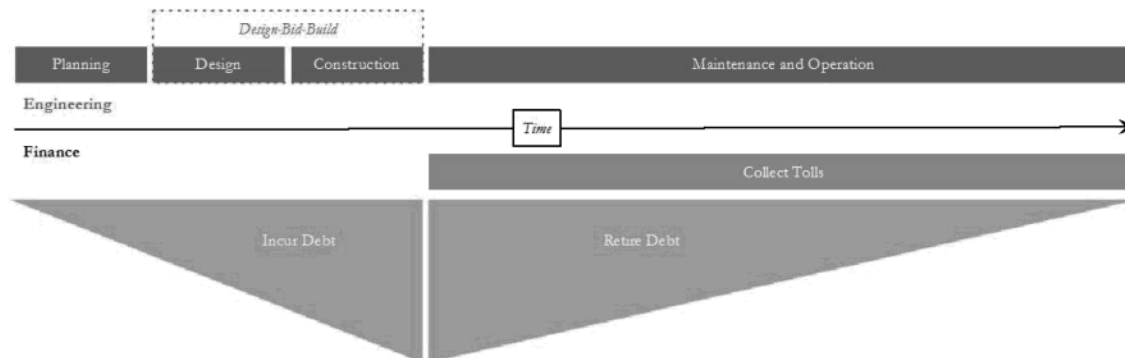
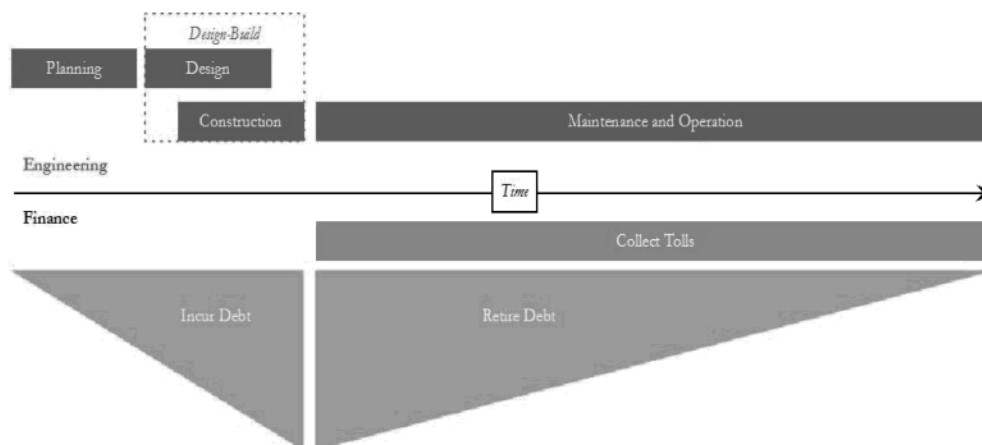


Figure 12: Design Build



With the constructor in direct control of the design, construction can begin as the design is being developed. In design-bid-build delivery, construction cannot begin until detailed designs have been completed (six to twelve months), the designs have been translated into contract documents (three months) and the construction contract procurement process has been completed with a notice to proceed (three months). On a project of the size and complexity of the PMH1 project, a reasonable estimate of



the schedule reduction achieved by the design-build execution of the project is about one year. With calculations in section 5.2.3.4 below, we estimate that a one year reduction in the PMH1 project master schedule, i.e. from the end of planning to substantial completion, was expected to yield an additional \$200 million²² in toll revenues.

The Province offers the following guidance to its agencies as they consider the use of the design-build delivery method.

“The design-build approach can provide design, cost and schedule benefits by allowing greater freedom for private sector innovation. By integrating design and construction, this procurement method can also sometimes facilitate faster delivery. It is appropriate in cases where an agency can clearly articulate its performance requirements and is seeking innovative approaches or solutions.

The primary risk of this approach [relative to a full public-private partnership] is that the private partner has no vested interest in the facility’s long-term performance. Its responsibility expires with the warranty period. Increasing the level of detail in contract specifications may help reduce this risk. However, it can also dilute the method’s potential benefits.”²³

4.1.2.1 *The Colorado Project Delivery Selection Matrix*

The Province’s Capital Assessment Management Framework does not include a differential assessment among the three delivery methods as to which is best suited to a specific project; however such differential analyses are well-established in British Columbia and were applied to the PMH1 project. We used an external tool to assess the choice of delivery method for the PMH1 project: a Project Delivery Selection Matrix for the Colorado Department of Transportation by the University of Colorado - Boulder²⁴ that is widely accepted as best practice across the United States. The summary table from the Colorado tool is shown, completed for the PMH1 project, in Figure 13 below.

²² Throughout this report, all currency is denominated in Canadian Dollars unless stated otherwise.

²³ Province of British Columbia. *Capital Asset Management Framework*. May 2002.

²⁴ <https://www.colorado.edu/tcm/project-delivery-selection-matrix>



Figure 13: Colorado Project Delivery Selection Matrix for the PMH1 Project

PROJECT DELIVERY METHOD OPPORTUNITY/OBSTACLE SUMMARY			
	DBB	DB	CMGC
Primary Selection Factors			
1. Delivery Schedule	--	++	+
2. Project Complexity & Innovation	--	+	+
3. Level of Design	--	+	+
4. Cost	+	--	++
5. Perform Initial Risk Assessment	--	++	+
Secondary Selection Factors			
6. Staff Experience/Availability (Agency)	X	++	+
7. Level of Oversight and Control	--	++	+
8. Competition and Contractor Experience	++	+	+

Rating Key	
++	Most appropriate delivery method
+	Appropriate delivery method
--	Least appropriate delivery method
X	Fatal Flaw (discontinue evaluation of this method)
NA	Factor not applicable or not relevant to the selection

4.1.2.2 Project Intensity

Another dimension of a project to consider when choosing a highway project's delivery method is its intensity, i.e. its mean project cost per working day. More cost per working day generally implies more activity per working day. Projects with high intensities, i.e. high project costs and more activity per working day, benefit more from the design-build and construction manager/general contractor delivery methods

since their more intense levels of activity are more reliably managed with closer ties between design and construction.²⁵

The intensity of the PMH1 Design Build Agreement, under which \$2.702 billion CDN (\$2.6 billion US)²⁶ was spent over about 1400 working days, was almost \$2 million CDN (\$1.9 million US) per day. This very high level of intensity places the PMH1 project among a handful of the largest and most complex highway projects undertaken in North America: it ranks with the Tappan Zee Bridge replacement project as the most intense bridge projects and, among all highway projects, is out-ranked only by the Big Dig and the Alaskan Way Viaduct replacement.

Figure 14: Intensity of Comparable Bridge Projects

<i>Project (State)</i>	<i>Delivery Method</i>	<i>Mean Cost, \$US</i>	<i>Approximate Working Days</i>	<i>Project Intensity \$US/Day</i>
Cooper River (SC)	DB	\$675 million	1000	\$0.675 million
Bay Bridge East Span (CA)	DBB	\$1 billion	1250	\$0.800 million
Veterans Memorial (MO)	DBB	\$229 million	1250	\$0.183 million
Whilamut Passage (OR)	CM/CG	\$204 million	1250	\$0.163 million
High Five Interchange (TX)	DB	\$261 million	1250	\$0.209 million
Tappan Zee (NY)	DB	\$3.98 billion	1750	\$2.27 million
Ohio River, 2 bridges (KY)	DB	\$2.3 billion	1100	\$2.091 million

Figure 15: Intensity of “Mega” Projects

<i>Project (State)</i>	<i>Delivery Method</i>	<i>Mean Cost, \$US</i>	<i>Approximate Working Days</i>	<i>Project Intensity \$US/Day</i>
Big Dig (MA)	DBB	\$15 billion	1500	\$10 million
Alaskan Way Viaduct (WA)	DB/DBB	\$4.25 billion	1000	\$4 million
I-4 Ultimate (FL)	DB	\$2.3 billion	1750	\$1.4 million
T Rex (CO)	DB	\$1.28 billion	1125	\$0.9 million

Having established that the PMH1 project is in the top tier with respect to size and complexity, we turn to the results of research into the choices of different delivery methods for highway projects across the United States that are shown in Figure 16 below. In this sample of 136 projects, the majority which were classed in the “Most Complex” category of the project complexity classification scheme used in the

²⁵ Intensity is frequently used as a performance measure for project execution. For a project of a given cost, a higher intensity indicates that more work was completed more quickly, reducing negative impacts such as traffic diversions within the boundaries of the project. The measure is usefully applied to construction projects within existing rights of way in urban areas.

²⁶ The Bank of Canada Noon \$US Exchange Rate was an average of \$1.038 CDN over the five years 2009 to 2013. Throughout this report we assume parity, i.e. \$1 CDN = \$1 US unless both \$CDN and \$US figures are provided together as they are in this instance.



United States,²⁷ the projects for which design build with a constructor chosen for best value appear to be, on average, significantly larger than the projects for which other delivery methods were chosen.

Figure 16: Intensity by Delivery Type²⁸

<i>Contract Method</i>	<i>Number of Contracts</i>	<i>Mean Cost, \$US</i>	<i>Mean Project Intensity \$US/Day</i>	<i>Minimum Project Intensity \$US/Day</i>	<i>Maximum Project Intensity \$US/Day</i>
Design-Bid-Build	74	\$21,687,447	\$12,802	\$269	\$123,566
Construction Manager/General Contractor	24	\$41,368,952	\$46,450	\$3,618	\$159,031
Design-Build, Low Bid	18	\$12,249,585	\$12,816	\$894	\$49,892
Design-Build, Best Value	21	\$48,532,458	\$28,527	\$1,930	\$204,341
Total	136	\$28,010,219	\$21,181	\$269	\$204,341

Altogether, it appears that design-build with the construction chosen on the basis of best value, which is the delivery method chosen for the PMH1 project, is the preferred method among the larger and more complex projects throughout the United States. Even among those projects, the PMH1 project stands out as one of the largest and most complex highway projects undertaken in North America over the last decade.

4.1.3 Selection of the Constructor

Kiewit/Flatiron were the engineering, i.e. design and construction, leads in Connect BC, the proponent that the Province selected as the successful consortium from among the four consortia that submitted proposals to execute the PMH1 project as a public private partnership.

The procurement process by which the proposals from the three consortia for the PMH1 project were solicited and evaluated began in early 2007 and culminated in August 2008 with the selection of Connect BC. We judged that process to be open and fair for two reasons: a Fairness Review pronounced the process to be open and fair; and none of the other proponents lodged a protest of the result.

²⁷ National Cooperative Highway Research Program (NCHRP). *Guidance for Cost Estimation and Management for Highway Projects During Planning, Programming, and Preconstruction*. Transportation Research Board, Report 574. 2007

²⁸ Tran, D. *Alternative Contracting Method Performance in US Highway Construction*. Federal Highway Administration, U.S. Department of Transportation. DTFH61-13-R-00019. 2017.



A Fairness Reviewer, an individual with expertise in procurement best practices and whose function it is to critically observe the process, oversaw the PMH1 procurement process and reported as follows:

“... the procurement process has been designed and conducted in a manner that is fair to Proponents, and there has been material compliance with and fair implementation of established procurement and decision processes.”²⁹

After their selection, Connect BC negotiated with the Province to conclude terms on the engineering and the financial aspects of the agreements that would cover the PMH1 public private partnership. They were unable to agree to terms on the financial aspects and mutually agreed³⁰ that the project would proceed under the Design Build Agreement. The engineering aspects having been settled between Connect BC and the Province, it required only about three weeks to amend the draft public-private partnership agreement into the Design Build Agreement.

The Province had the option in the spring of 2009 to discontinue the public-private partnership process entirely and launch a new procurement process for a design-build agreement. The Missouri Department of Transportation elected to take that option, as described in **Topic Box 1** above, and added about nine months to the time required to procure a partner to proceed with their program. We estimate that a nine month delay in the completion of the PMH1 project would have cost the Province about \$150 million in lost toll revenues and, likely, some escalation of costs.

4.2 The Design-Build Agreement

We found the Design-Build Agreement that defined the rights and obligations of Kiewit/Flatiron and TI Corp to be a comprehensive and effective document.

The agreement anticipated and dealt with all of the risks that are identified in the risk assessment table of the Colorado Project Delivery Selection Matrix. The Province, with its relatively long history of executing highway projects in public private partnerships, was able to contain the largest risk: that the functional and technical specifications to which the design must comply are insufficiently defined.

The agreement also stood up to and guided the resolution of the significant adverse events that are described in Section 5.2.2.3 below. All of the issues arising from those events were ultimately resolved within the agreement, and the agreement required no amendment while the PMH1 project was executed.

In this section, we provide explanations of the clauses that figured prominently in events described in Section 5 below.

²⁹ Jane Shackell, Q.C. *Gateway Project – Port Mann/ Highway One Final Report of the Fairness Review*. 26 January 2009.

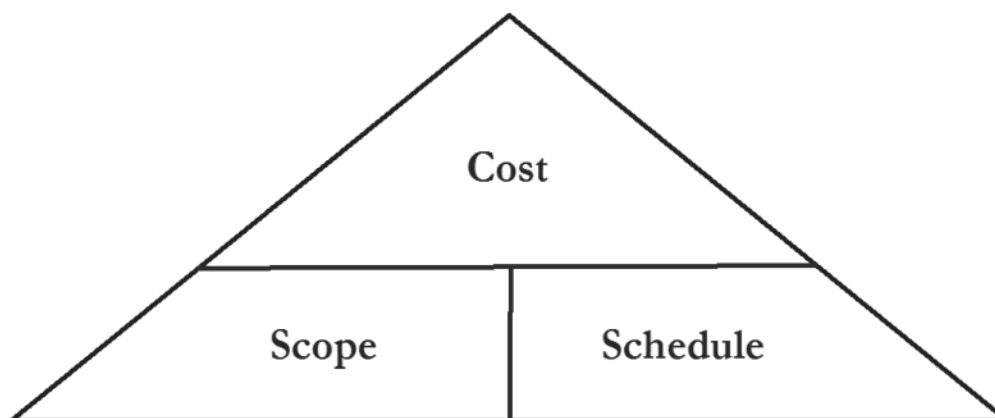
³⁰ Settlement agreement between Connect BC and Partnerships BC, 24 February 2009.

4.2.1 Fixed Price and the Distribution of Risk

The Design Build Agreement was a fixed price agreement, meaning that the price for which Kiewit/Flatiron would fulfill the technical and functional specifications – the scope – and the dates on which they would be fulfilled – the schedule – was fixed in advance. Fixed price is used almost universally in major highway projects over the other two options: time & materials; and cost plus fixed fee. Its application is not as simple as it sounds and needs to be considered in the context of risk.

There is a simple relationship among scope, cost and schedule in any capital project: cost is a function of scope and schedule. The relationship is illustrated in Figure 17 below.

Figure 17: Relationship among Scope, Schedule and Cost



This illustration will appear familiar to some readers as it is used to explain certain relationships in physics: in electric circuits, for example, volts appear in the top of the triangle, amps and resistance appear in the two bottom portions of the triangle. Volts are the product of amps and resistance; amps are volts divided by resistance and resistance is volts divided by amps. In construction, the same relationships exist albeit less exactly:

- Expansions of scope or shortening of schedules will lead to increases in costs; and
- Cost reductions require either smaller scopes or longer schedules.

In a colloquial and more familiar form: the owner can choose any two of scope, schedule and cost; the contractor then sets the third.

The Design Build Agreement contained a variation on the fixed price model: an early completion bonus. Schedule incentives are a common feature of large and complex construction contracts, particularly when the constructed asset will earn revenues when it comes into service. In this agreement, the Early Completion Bonus was 60% of the toll revenue earned between the actual Tolling Commencement Date and the Tolling Commencement Target Date.



Throughout our review of the PMH1 project, we examine its management from the perspective of risk. In a fixed price contract, all three of scope, schedule and cost are locked in at the beginning of the contract. This must be done with imperfect information about site conditions, future prices of inputs and the productivity of design and construction resources. There is a risk in each of the many instances of imperfect information and that risk must be assumed by one of the owner or the contractor. As it should, much of the Design Build Agreement is devoted to defining the risks to the project and which of TI Corp and Kiewit/Flatiron will assume each of those risks. There is no deterministic model for the distribution of risk between the owner and the contractor; this is determined in negotiations between the two parties as they agree upon the scope, schedule and cost of the project. The price of the contract is fixed only to the extent that it need not be changed to deal with new information as that information is revealed throughout the progress of the work.

As it should, the Design Build Agreement anticipates voluntary changes to scope, schedule and cost through Change Certificates; and anticipates involuntary changes made necessary by imperfect information through Events.

4.2.2 Change Certificates

The Design Build Agreement follows good practices in including a mechanism for TI Corp to initiate a Change Certificate. The generic term for Change Certificate is a change order, which neatly describes it as: [1] a change to the scope or schedule of the project; and [2] an initiative controlled by the owner of project. A Change Certificate initiates a negotiation in which the owner defines the desired change and the contractor proposes a change in the fixed price to accommodate the change.

The change order process is universally applied and extensively used in construction management. TI Corp and Kiewit/Flatiron executed about 130 Change Certificates under the Design Build Agreement for the PMH1 project, of which the noteworthy Certificates are assessed in Section 5.2 below.

4.2.3 Events

As the design and construction of a project proceeds, imperfect information will be revealed: some that improve the prospects of the project being completed on time and on budget; some of which are adverse to those prospects. With most of the project risks being asymmetrically distributed – things are more likely to become worse than better – the additional difficulties that arise as those risks unfold combine to build pressure on the project schedule and budget. The Design Build Agreement follows best practice with a mechanism to relieve those increases in pressure: Events.

4.2.3.1 *Types of Events*

The Design Build Agreement classes all permissible Events into one of several categories and specifies procedures for dealing with them. Three noteworthy event classes are:

- A Compensation Event, in this context a failure on the part of the Province to



deliver unfettered access to the site. Examples of areas in which the Province could fail to deliver include utility agreements, right-of-way required for the project, environmental clearances or aboriginal claims.

- A Relief Event, an intercession within the project site by emergency services, utilities, municipalities or other third parties that delays the completion of work but does not necessarily add to project cost.
- A Force Majeure Event, an earthquake, flood, war or other calamity overwhelms the ability of either TI Corp or Kiewit/Flatiron to perform under the agreement.

An event in any one of these classes that has an adverse impact over \$200,000 in costs or over three days' delay to completion dates is also designated as a Supervening Event: an event of sufficient import that the procedures for settling it differ from those put in place for smaller events.

Neither the owner nor the contractor can unilaterally establish an event. The party affected adversely by the event – the contractor in almost every case – must provide notice of the event then provide information in support of its claim. The other party – the owner in almost every case, must either accept or reject the event. Once an event is accepted, settlement processes in the Design Build Agreement come into play.

4.2.3.2 *Settlement of Events*

Two principles govern the settling of events, which the Design Build Agreement requires be done through a process of negotiation:

- Duty to Mitigate. Both parties, but in particular the party that gave notice of the event, must promptly take all reasonable measures to mitigate the adverse effects of the event on schedule and cost.
- Continuation of the Agreement. The aggrieved party is entitled to an extension of schedule or an increase in price but, except in a few specified circumstances, not entitled to terminate the agreement.

Some events, such as unforeseen contamination or other conditions on the site, were considered so likely that the Design Build Agreement defined the compensation required should they occur.

One feature of the settlement process deserves detailed attention here as it played a pivotal role in the events described in Section 5.2.2.3 below: the right of TI Corp to deal with a Supervening Event, which we infer to be a Relief Event, with a change order to accelerate construction.

“Nothing in this Part shall limit the Authority’s right to request an Authority Change [a Change Certificate that is initiated by the owning Authority or the Authority’s Representative] ... in response to a Supervening Event, including an Authority Change to give the Constructor instructions to accelerate construction or take other steps to avoid any delay or impediment, or reduce the period of any future delay or mitigate the effect of any future impediment, resulting from such Supervening Event.... In the event that the Authority requests such an



Authority Change the procedures in respect to such Supervening Event...shall terminate and the matter shall be full determined in accordance with Part 7 [Authority Changes and Constructor Proposals] and Schedule 11 [Changes]....”³¹

During the course of Design-Build Agreement, Kiewit/Flatiron gave notice of about 250 events that were of sufficient magnitude to be considered Supervening Events. Most of these were settled with no increases to the Design Build Agreement Price or increases in the project’s schedule. This volume of notices is in line with our experience in other projects: contractors will, rightly, take every valid opportunity that presents itself to increase the contract price and schedule.

4.3 The Project Management Team

We examined the organization of the PMH1 project management team, constituted under TI Corp’s Vice President Technical Services who was also the Project Director. We compared the organization of the team to good project management practices for large construction projects and found that it followed those good practices.

We believe that some observers of the project confused the separate roles played by the Project Director, the Deputy Project Director and by the Authority’s Representative. We also believe there was some confusion about the roles played by these positions as they ensured that Kiewit/Flatiron properly and fully discharged its responsibilities, and that Kiewit/Flatiron was properly and fully paid for doing so.

We found that there were proper separations of authority across TI Corp’s project management structure, particularly in two respects that are relevant to the observations made:

- The Project Director, who was the highest authority on the PMH1 project management team, was an employee of TI Corp.
- The Authority’s Representative was subordinate to the Project Director and, as is proper, was restricted to the role of project control.
- In addition to Kiewit/Flatiron’s internal quality control and quality assurance measures, there was a team of checkers, qualified people that confirmed the quality and completeness of work, that reported to TI Corp’s project management team and an Independent Certifier who reported to neither party.

We also found that the project management team was composed of a mix of employees of provincial agencies and contractors.

The mixing of employees and contractors in the project management team reflected a problem – the inability of government transportation agencies to retain staff – and a solution to that problem – dispersing employees throughout construction management functions to build their experience and, with hope, maintain their interest in remaining with government.

³¹ Section 8.2(c), Design Build Agreement, 17 March 2009.



4.3.1 Best Practices in Composing the Project Team

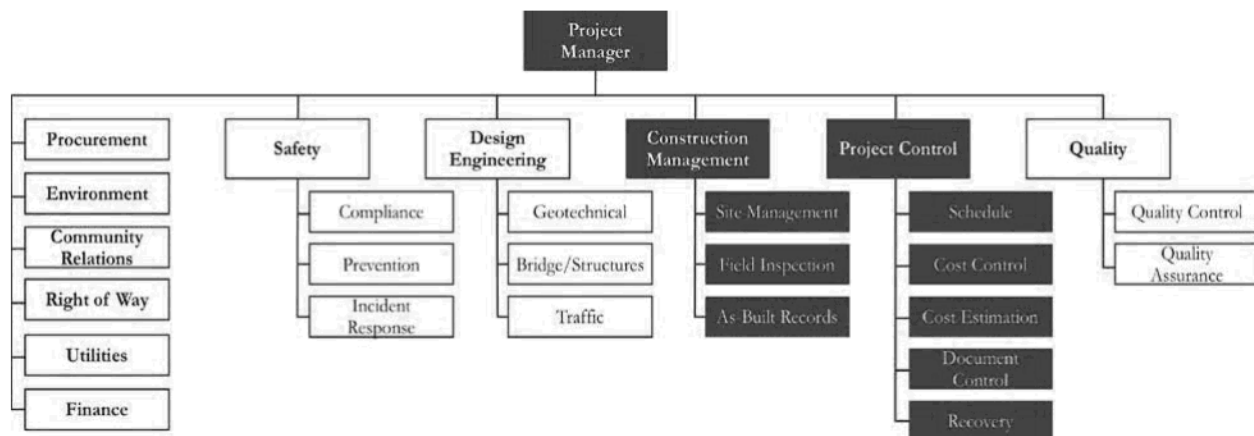
The owner's project manager has five clear and separate responsibilities in the execution of a capital project by design and construction contractors, listed in no particular order here:

1. Health and safety of everyone on the site;
2. Design engineering, culminating in the production of construction drawings that are stamped by a professional engineer and have been subjected to constructability review(s);
3. Project control, meaning the monitoring of costs and schedule to ensure that the contractor completes the work on time and within budget, and recommending or reviewing mitigations to recover the project from schedule slips or cost overruns. More generally, the project control function manages the contract with the constructor.
4. Construction management, including the management of all aspects of construction other than the construction contract itself: the construction site; utilities and other assets within the boundaries of disturbance; the proper completion of work; and, most important, the management of arising issues that might impede either the contractor or the owner in meeting their obligations and completing the project.
5. Quality, ensuring that all works are built to code and to the specifications of the construction drawings.

These five responsibilities are supported by staff functions that are near-universal across highway construction projects and programs. These functions usually require knowledge, skills and abilities that are unique to their fields, and the persons who fulfill these functions are often attached to a specialised staff branch that supports all projects undertaken by a ministry of transportation. The usual staff functions appear in the left side of the organisation chart in Figure 18 below with the five key line functions arrayed to their right. All of these positions report to the individual who has overall responsibility for the project.³²

³² An organization chart of the PMH1 project management team can be found in Figure 21.

Figure 18: A Well-Composed Project Management Team



On smaller projects, two or more of these line and staff functions can be combined into a single position on the project team; on projects as large as the PMH1 project, one or more people are usually responsible for each of these functions.

The dark blue sections of the organisation chart in Figure 18 above show the feature of a well-composed project management team that is relevant to this review: the separation of construction management and project control under project management. That feature of good practice was largely present in the PMH1 management team, shown in Figure 19 below: the construction management and engineering functions reported to the Deputy Project Director and the project control functions reported to the Authority Representative.

4.3.2 The Role of the Authority's Representative

In general terms, the owner's representative is a conduit between the owner of the project and the contractor who is designing and building that project and, depending in which direction the owner's representative is acting, his or her role is different.

The Authority's Representative is empowered to administer the contract but not to amend it: any changes to scope, schedule or cost set out in the agreement must be agreed to by an officer of the Authority. In this sense, and in all others, the Authority's Representative on the PHM1 Project was subordinate to the Project Director.

4.3.2.1 *From the Owner to the Contractor: Delegated Authority*

The owner's representative ensures the contractor's compliance with the contract with the owner's delegated authority. The owner's representative is empowered by the owner to make certain decisions and give certain approvals in the execution of project under the contract. Under good project management practices, this delegated authority is limited in two important ways:

- The authority of the owner's representative is limited to the contract. The owner's representative exercises the owner's rights and obligations under the design and construction contract but has no authority over the contractor in



any matter outside of the contract nor over any other party working on the project.

- The owner's representative is concerned with project control, namely scope and cost. The owner's representative has no authority to change the project scope, schedule or budget as the owner and the contractor have recorded them in the contract.

We found that the role of the Authority's Representative on the PMH1 Project was limited in accordance with these good practices. TI Corp gave direction to the Authority's Representative that was consistent with these good practices:

"The Authority [*sic*] Representative's role is to confirm obligations are met, but under the TI Corp government structure it is only officers of TI Corp who have the authority to authorize and approve changes and invoices for payment."³³

The roles and responsibilities of the Authority's Representative were also made clear in the Design Build Agreement as follows:

Inspecting the completeness of works and plans to determine payments,
including but not limited to:

"2.13 Review, Approval, Inspection and Audit by the Authority."

"4.2 Payments to Contractors." Ensure that Constructor has properly certified that sub-contractors have been paid.

"4.12 Health and Safety Program." Receive the Constructor's written Health and Safety Program and review evidence that the Constructor had implemented the program.

"6.8 Evidence of Insurance" Review insurance certificates for completeness and currency.

Determining the amount of progress payments

The Authority's Representative plays the significant role of checking and approval of progress payments:

"(e) ... inspect the DB Work and attend at the offices of the Constructor such documentation as the Authority's Representative may reasonably request"

"(f) The Constructor shall cooperate with the Authority's Representative to each agreement on a final Draw Request on or before the fifth Business Day of the Draw Request..."

"(g) The Authority's Representative shall identify any deficiencies in the Draw Request and the amount affected thereby within five Business Days of the Draw Request being submitted..."

³³ 9 February 2010 letter from Garry Dawson, Vice President Technical Services, TI Corp to Stephen Beatty, Managing Director, KPMG.



“(h) The Authority’s Representative shall approve the Draw Request as to amounts not in the dispute ... within Five Business Days of the Draw Request being agreed upon...”³⁴

Receiving and giving notices: throughout the Design Build Agreement

Consistent with the good practices of separating the roles of the owner’s representative from that of the construction manager, the Authority’s Representative plays no significant role in any of “Part 7 Authority Changes and Constructor Proposals”, “Part 8 Supervening Events” or “Part 9 Indemnities, Limitations on Liability and Liquidated Damages.” All of these parts of the Design Build Agreement refer to the Authority itself.

4.3.2.2 *From Contractor to Owner: Expert Advice*

The owner’s representative has another role to play: as an advisor to the owner both in the handling of matters arising from the execution of the contract and other matters that might arise within the project. This role is more important in smaller projects, in which the owner might not have the expertise in project management or in construction management that is needed on the project team. In the case of the PMH1 Project, TI Corp had access to ample expertise from among its own staff, other agencies of the Province and contracted third-party professional service providers. On this project, the Authority’s Representative was one of several knowledgeable individuals to whom TI Corp could turn for good advice.

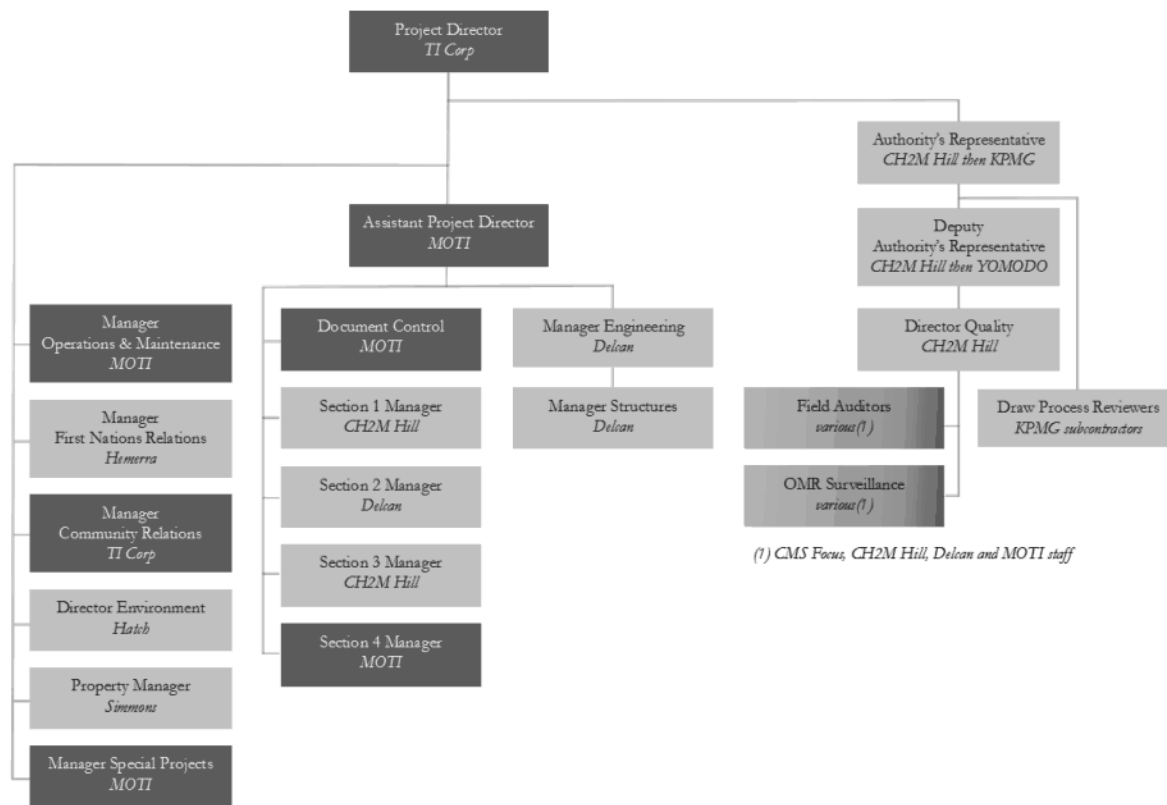
We did not examine the extent to which the Authority’s Representative provided advice to TI Corp as a construction management expert, but we note instances in the minutes of the TI Corp Board of Directors’ meetings in which the Authority’s Representative attended those meetings and provided advice to the Board of Directors.

4.3.3 Integration of Staff and Contractors

The project management team that the Province assembled to execute the PMH1 project followed the form of a well-composed project management team shown in Figure 18 above: the direct reports to the head of the team, the Project Director, followed the proper separation of line and staff functions. Within the line functions there was a proper separation between construction management, managed by the Assistant Project Director, and project control, managed by the Authority’s Representative. These positions, along with some of their direct reports, are shown in Figure 19 below.

³⁴ Design Build Agreement, Part 10: Payments, 10.3A Progress Payments.

Figure 19: Simple Chart of the PMH1 Project Management Team



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All of the key management positions on the PMH1 project management team shown in Figure 19 above are shaded, with the positions filled by employees of the provincial agencies shown in dark green and positions filled by contractors shown in mauve. The distribution of staff and contractors on this team is a good response to the inevitable problem of securing the services of professionals and experts, and it ensured that employees of provincial agencies retained authority over the management of the project.

4.3.3.1 Retaining sufficient staff to manage large projects is close to impossible for the Province.

The problems faced by the Province in recruiting experienced and qualified staff onto its payrolls – and containing its reliance on contracted consultants – are at their most pronounced in the management of large infrastructure projects:³⁶

- Project work implies mobility. The highway program in a typical US state or Canadian province is a mix of many small projects and a few large,

³⁵ “OMR” stands for operations, maintenance and rehabilitation. The OMR surveillance function was to ensure that the existing highway and other structures were being properly maintained during the four years in which the new facilities were designed and built.

³⁶ Cronin, Brian et al. *Attracting, Recruiting, and Retaining Skilled Staff for Transportation System Operations and Management*. National Cooperative Highway Research Program (NCHRP) Report 693. National Academies of Sciences, Engineering, and Medicine. July, 2012.



infrequently occurring projects. Government highway departments have more success in retaining professional staff to execute the smaller projects – safety, rehabilitation, signalization and the like – than for the large projects that occur irregularly. The very nature of the business is that of people who move from one project to the next, taking on a variety of roles for a variety of employers as they do so.

- Highway construction management is a continental market. There is a long history of design engineers and construction managers working internationally and, since the advent of the Canada-US Free Trade Agreement in 1987, project management and construction management professionals have been free to practice in either country.³⁷
- As big as they seem, highway programs are a small segment of the North American heavy construction market. The United States, between its federal and state governments, spends about \$80 billion US per year on highway construction and rehabilitation,³⁸ some twelve times the average of equivalent spending in Canada: \$8 billion CDN.³⁹ These expenditures are but a small portion of the \$1.4 trillion USD of construction output in the United States during 2016⁴⁰ so the need for construction managers in highway programs is subject to labour market forces over which they have little influence.

The high degree of mobility in construction management professions was evident throughout the PMH1 project itself: some key members of project management team changed employers during the execution of the project, causing the sorts of procurement problems for the Province that are discussed in Section 4.4 below. Despite these problems, TI Corp was able to maintain a relatively high degree of continuity in the PMH1 project management team for the duration.

4.3.3.2 *Provincial agency employees were in control of the PMH1 project management team and the project itself.*

The head the PMH1 project management team was the Project Director, to whom the Authority's Representative and all other management positions were subordinate. An employee of TI Corp, the Vice President Technical Services, fulfilled the function of Project Director. The Vice President Technical Services reported to the President of TI Corp who, in turn, reported to the TI Corp's Board of Directors. The Province appointed all of the members of the TI Corp Board of Directors with

³⁷ Under the North American Free Trade Agreement (NAFTA), most of the professions involved in construction management – professional engineers, accountants, project management professionals, economists – are listed in Schedule 2 of NAFTA as “TN Professionals” and are free to hold employment in any of the three signatory countries.

³⁸ <https://www.fhwa.dot.gov/policyinformation/statistics/2015/hf10.cfm>

³⁹ <https://www.tc.gc.ca/eng/policy/anre-menu-3037.htm>

⁴⁰ <https://www.bea.gov/iTable/iTable.cfm?ReqID=51&step=1#reqid=51&step=51&isuri=1&5114=a&5102=15>. Includes residential construction.



Orders in Council,⁴¹ as is customary for appointments to the boards of Crown corporations.

4.3.4 Quality Management

The Design Build Agreement contains a plethora of quality control and quality assurance measures that are applied through the design and construction activities of the PHM1 Project. Most of these measures were the responsibility of Kiewit/Flatiron and, under the Design Build Agreement, Kiewit/Flatiron was required to demonstrate their proper and full use of these measures.

“The Constructor shall... submit Construction Certificates to the Authority’s Representative ...prior to the opening of any Upgraded Infrastructure for use by the public. All Construction Certificates shall be signed by the Design-Build Director, the Designer and the Constructor.”⁴²

In addition, there were quality control and quality assurance measures that were under the control of TI Corp. One of these measures had a direct impact upon the organization of the project management team: construction checks on Category III structures.

The Design Build Agreement stipulates that all structures fall into one of four categories of risk, from Category 0 to Category III. Category III structures are the largest and most complex structures and included the Port Mann Bridge itself. The Agreement stipulates that Category III structures be checked by “... a Checking Team appointed to perform an independent detailed check by experts in Bridge structural analysis and design, and in seismic design by an organization not related to the Designer. The Category III Checking Team shall report directly to the Authority”.⁴³

The design and construction of the Category III structures in the PMH1 Project were checked by HNTB Corporation, an infrastructure engineering firm that is independent of Kiewit/Flatiron and of KPMG.

The final quality assurance measure was independent of both Kiewit/Flatiron and TI Corp: the Independent Certifier. The principal function of the Independent Certifier is to inspect the work to ensure it is complete in all respects required by the Design Build Agreement.⁴⁴ A common good business practice, in North America, for the use of independent certifiers is to use them in only certain components of the

⁴¹ The record of a decision made by the government’s Cabinet under authorities granted to the Cabinet under Acts passed by the Legislature.

⁴² Design Build Agreement, Schedule 4: Design and Construction, Part 3: Design and Certification Procedure, Article 6: Construction Certification.

⁴³ Design Build Agreement, Section 4: Design and Construction, Part 3: Design and Certification Procedure, 3.2 (d).

⁴⁴ Design Build Agreement, Schedule 4: Design and Construction, Part 3: Design and Certification Procedure, Article 6: Construction Certification. The Province hired the Independent Certifier with the clear understanding that the Province was to have no influence over their work.



project that are pre-selected for their risk of defect or difficulty in inspection. TI Corp exceeded this practice by applying independent certification to all components of the PMH1 project.

The Independent Certifier must either issue a Certificate of Completion or issue a notice of its refusal to issue such a certificate that outlines what further work must be done. The certificates required are Certificates of Substantial Completion and Certificates of Total Completion for, separately, the Tolling Components, the Fraser Heights Connector and all other Primary Highway Components and Concession Highway segments.

The Design Build Agreement outlines separate roles for the Authority's Representative and the Independent Certifier in determining the proper completion of work in two respects:

While the Independent Certifier is inspecting work, the Authority's Representative may make submissions to the Independent Certifier that the Independent Certifier must take into account. This implies that the Authority's Representative can make arguments to persuade the Independent Certifier towards or away from issuing a certificate but cannot give the Independent Certifier direction.

If either of the Authority's Representative or the Constructor dispute a decision made by the Independent Certifier, then the Authority's Representative and the Constructor must resolve the dispute with the dispute resolution process in the Design Build Agreement.

The separate roles of the Authority's Representative and the Independent Certifier are recognised also in the contractual requirements placed upon the Independent Certifier, who is required to: "... act fully, impartially, honestly and independently in representing the interests of both Design Build Agreement Parties..."⁴⁵

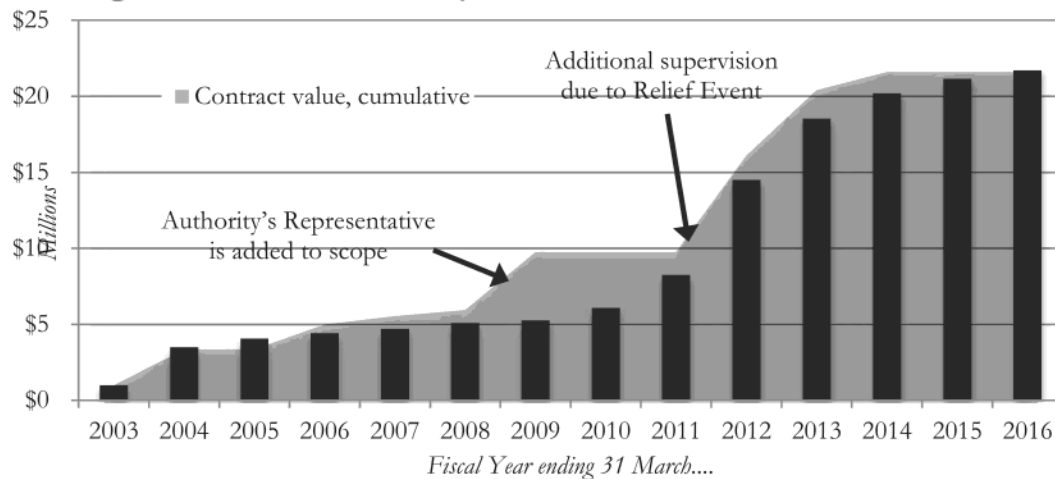
4.4 Procurement of Professional Services from KPMG

The Province retained KPMG to provide business advisory and, later, project management services to the Gateway program, of which the PMH1 project was a component. The Province's procurement and management of its contracts with KPMG did not always follow best practices for public procurement and, as a result, was vulnerable to protests from other firms that the Province had qualified in open procurement processes to provide project management services.

KPMG was awarded a \$1 million contract effective as of October 2002 to provide business advisory services to the Ministry of Transportation's Gateway Program until March 2005. A chain of amendments and subsequent agreements, all flowing from this initial award and all awarded without competition, increased the value of the work given to KPMG to over \$21 million by May 2015. The extraordinary growth of this procurement is illustrated in Figure 20 below.

⁴⁵ Design Build Agreement, Schedule 4 [Design and Construction], Appendix A [Form of Independent Certifier Contract].

Figure 20: KPMG's Gateway and PMH1 Contracts



4.4.1 KPMG's twelve-year contract faced only one competitive procurement.

Competitive procurement is government's principal tool – sometimes its only tool – with which it can contain the costs of the goods and services it purchases from the private sector. When governments do not submit their purchases of goods and services to competitive procurement, they lose opportunities to control the costs of these services and give private sector vendors some latitude to up-sell and cross-sell its services.

A competitive procurement has two key features: [1] it attracts serious proposals from at least three qualified and unrelated vendors; and [2] each of the scope, schedule and cost of the goods and services is prescribed in the vendors' proposals. The Province awarded the initial contract to KPMG in 2002 through a two-stage public procurement process:

1. The Province issued an invitation to submit qualifications to 14 firms, inviting them to describe their qualifications to provide business advisory services and their rates, from which 8 firms were selected as qualified; then
2. Three of the eight qualified firms were invited to an interview.⁴⁶

This process differs from a full request for proposals (RFP), in that a select group of firms was invited to apply and the proponents were not required to commit to scope, schedule and costs.

After the competition for the initial award, there was none in the ensuing 12 years, during which the agreement was renewed 3 times and amended 22 times. The history of these renewals and amendments is appended in Section 8 below.

The cumulative value of KPMG's contracts grew by about \$800,000 per year and payments were about \$750,000 per year, on average, between 2003 and 2009 as

⁴⁶ A November 2009 Gateway Program memorandum from Wayne Locke, Director of Finance and Administration, to Frank Blasetti, Assistant Deputy Minister, states that the initial business advisory services contract was awarded to KPMG "through RFP (Invitation to Submit Qualifications)".



KPMG provided business advisory services during the planning and procurement for the PMH1 project and the negotiation of the design-build agreement with Kiewit/Flatiron. That average level of effort for business advisory services is in line with our experience with other public-private partnerships in North America.

4.4.2 Project management services were transferred from CH2M Hill to KPMG without full controls.

The scope of services that KPMG provided changed fundamentally in late 2009 with the addition of project management services to the contract: the cumulative value of KPMG's contracts almost doubled from \$4.9 million to \$8.7 million with this addition and, thereafter, grew at an average \$2.9 million per year to reach \$21.6 million in early 2015. Payments to KPMG between 2010 and 2016 had an average of about \$2.6 million per year.

The addition of project management services to the KPMG contract was triggered by the departure of Mr. Gary Webster, who filled the role of the Authority's Representative for the PMH1 project, left CH2M Hill in July 2009 to take up a new position at KPMG. The Province had nominated Mr. Webster to be the Authority's Representative and, while Mr. Webster offered to relinquish that role upon his departure from CH2M Hill, the Province wanted to maintain the continuity of Mr. Webster in that role.

The decision to allow Mr. Webster to keep his role as the Authority's Representative as he moved from CH2M Hill to KPMG was, in our opinion, a good one: in major project with a duration measured in years, the Authority's Representative needs good knowledge of the project's history, particularly with respect to events that have transpired to the advantage and the disadvantage of the contractor since the notice to proceed was issued. The notion of public-private partnership is real in this sense: the project management teams of the constructor and the owner on a large and complex project work together closely, and the relationships that they build over time provide good value to both sides. The rate that the Province paid for Mr. Webster's services increased in 2009 from \$260 per hour under the CH2M Hill contract⁴⁷ to \$360 per hour under the KPMG contract⁴⁸ but, even assuming that Mr. Webster would bill as much as 2,000 hours per year, the annual increase in the cost of his services was \$200,000 per year – worthwhile, in our opinion, to maintain continuity in project management.

The execution of the transfer of Mr. Webster's role from CH2M Hill to KPMG was irregular, however, in three respects:

- More project management services than just those provided by Mr. Webster were transferred from CH2M Hill to KPMG. Assuming that Mr. Webster

⁴⁷ MOTI contract 48 CS 6031 with CH2M Hill Canada Limited dated 25 January 2008.

⁴⁸ Letter dated 13 November 2009 from Mr. Stephen Beatty, Managing Director of KPMG, to Mr. Garry Dawson to confirm scope of services and applicable rates. The rate charged by KPMG for Mr. Webster's services would rise to \$390 per hour by 2014.



would bill as much as 2,000 hours per year, the KPMG contract would have to increase by about \$800,000 per year to accommodate Mr. Webster's fees and expenses. The contract increased by an average of about \$2.9 million per year, however, as KPMG also assumed field audit and other surveillance responsibilities on the PHM1 project. KPMG added seven additional people to its roster of consultants for this work at \$318 per hour per person to meet those responsibilities.⁴⁹ We expect that the amounts for these responsibilities would have increased after 2010, as the administration of the Design Build Agreement was intensified to provide additional assurance of Kiewit/Flatiron's draws, and again in 2012 to monitor construction more closely as described in section 5.2.3.6 below. However, the contract with KPMG was not amended to record these changes in the administration of the Design Build Agreement or the additional effort that the changes would require.

- As the Province increased the value of the KPMG contract to absorb the engineering services transferred to KPMG from CH2M Hill, it did not correspondingly reduce the scope or the value of the CH2M Hill engineering services contract. With an original value of \$15 million to provide engineering services from 2008 to 2013, the CH2M Hill agreement was amended three times by the Province in 2010 and 2011 to increase its value to \$33.8 million – all direct awards – and extend its duration into 2014. These increases were intended to fund the additional supervisory workload involved in managing the contract as described and discussed in section 5.2.3.6 below. None of these amendments mentioned any changes to the scope of work.
- KPMG was never pre-qualified in the Gateway Program procurement process to provide project management services. The Gateway Program selected Delcan Corporation to be the program engineer and CH2M Hill to be the technical services advisor through competitive requests for proposals. While the files from these procurements cannot be found, we found no records to show that KPMG submitted proposals under these two RFPs for engineering and project management services. This omission left the Province open to protest from other firms that submitted proposals under the RFP for technical advisory services that they were passed over in favour of a firm that had not submitted a proposal.

4.4.3 The Province missed opportunities to specify deliverables and thus control costs.

Good contracting practices call for the scope, schedule and budget of the work to be performed by suppliers of goods and services to be as specific as is practical and defined as soon as is practical in the relationship between the supplier and the purchaser. These practices, when applied through competitive procurement, tend to maximize the value for money under those contracts. These practices are almost universally applied throughout the procurement and management of design and construction contracts, which produce “hard deliverables” – reports and plans in the design phase and physical assets in the construction phase.

⁴⁹ *ibid.*



When a procurement and subsequent contract calls for “soft deliverables” – advice and guidance – the purchaser faces a challenge to build specific controls into the contract around scope and budget. Engineers in general take a sceptical view of “soft deliverables” and try to avoid them. The business advisory services purchased from KPMG are “soft deliverables” to a large extent and the initial contract between the Province and KPMG⁵⁰ addressed this difficulty: the scope of services ran to some four pages and included both a general description of the nature of the assignment and a specific description of seven summary tasks, each with several sub-tasks, that KPMG was to accomplish.

This specificity was not continued when MOTI assigned the contract to Partnerships British Columbia in 2004. That agency issued a new contract⁵¹ with a scope of services contained in two pages that included a specification of deliverables. Once the contract was transferred, scope descriptions were perfunctory. That contract was replaced by another MOTI contract⁵² in which the scope of services was reduced to less than one page, with no deliverables. When the MOTI agreement was amended to include the responsibilities of the Authority’s Representative, the following was added to the scope of the agreement along with \$3.8 million in additional funding:

“6. Authorities [sic] Representative. Provide contract management advisory services including: contract interpretation, quality management oversight, progress billing, change order negotiations, maintenance contract, toll contract and audit of value assessment.”⁵³

This specification of scope is, in our opinion, perfunctory. As examples, the contract did not include the annual budgets that KPMG proposed for these services over the ensuing four years⁵⁴ and TI Corp wrote a letter, separate from the contract, to provide KPMG with further explanation of the scope of services.⁵⁵ It also includes change order negotiations in the responsibilities of the Authority’s Representative; responsibilities that, as a business advisor, should have been KPMG’s under its original scope and budget.

⁵⁰ MOTI contract 48 CS 1102 with KPMG LLP dated 17 February 2003.

⁵¹ Partnerships British Columbia contract with KPMG Corporate Finance 060020 dated 13 May 2005.

⁵² MOTI contract 48 CS 1102 (A) with KPMG LLP dated 17 November 2006.

⁵³ Amendment # 6 to MOTI contract 048 CS 1102 (A) dated 11 January 2010.

⁵⁴ \$785,000 in 2009/10, \$945,000 in 2010/11, \$787,500 in 2011/12, \$735,000 in 2012/13 and \$0 in 2013/14. Letter from Mr. Stephen Beatty, Managing Director, KPMG to Mr. Geoff Freer, Director Gateway Program and Mr. Garry Dawson, Vice President Technical Services, TI Corp dated 26 August 2009.

⁵⁵ From Mr. Garry Dawson, Vice President Technical Services, TI Corp to Mr. Stephen Beatty, Managing Director, KPMG dated 9 February 2010.



4.5 Governance and Oversight

We examined the governance and oversight of the PMH1 project through the lens of delegated authority: *ex ante*, how clearly and comprehensively were those delegations articulated; *ex post*, were the conditions of those delegations adhered to?

At the higher level, the delegation of authority from Treasury Board and the Minister Responsible to the TI Corp Board of Directors, we found the instruments of delegation were excellent, meeting or exceeding the Province's requirements in all respects. We found that TI Corp complied with these instruments in all respects except one: a restatement of the project's capital budget that, depending upon some finer points of interpretation, may or may not have omitted \$39 million of project expenditure.

At the lower level, the delegation of authority from the TI Corp Board of Directors to TI Corp staff, we also found that authorities were clearly delegated, although the comprehensiveness of these delegations evolved over time. In particular, the limits on the Vice President, Technical Services' authority to approve change orders were unclear until 2013.

We also examined governance and oversight through the lens of risk. Were governance and oversight aligned to the risks that TI Corp faced as an enterprise?

To see how the Province instructed its agencies in the management of project risks, we compared the Province's *Capital Asset Management Framework* to the equivalent guidance provided by the US Federal Highway Administration (FHWA). Relative to that benchmark, we found the *Capital Asset Management Framework* to be fulsome on controls, approvals and requirements but it provided relatively little guidance on ongoing project management.

Within TI Corp, management and the Board of Directors foresaw the changes in the business risks they would face as TI Corp changed from a project management organization into a full-fledged business, with significant assets and liabilities and with large revenue collection, information systems and customer relations requirements. The changes in the committees of its Board of Directors, and the timing of those changes, properly anticipated these changes in responsibilities.

4.5.1 Delegation of Authority from the Province to TI Corp

As it executed the PMH1 project, TI Corp was spending public funds as it is authorised to do under the *Transportation Investment Act* (R.S.B.C.). TI Corp must manage its funds in accordance with the *Financial Administration Act* (R.S.B.C.), which requires that Treasury Board, a committee of the Executive Council, controls the raising of debt and expenditure of funds. The *Financial Administration Act* (R.S.B.C.) provides for Treasury board to direct⁵⁶ the Minister responsible for TI Corp – the Minister of Transportation and Infrastructure in this instance. The Minister responsible, as the

⁵⁶ Section 4.1 "Management of Capital Expenditures" of the *Financial Administration Act* (R.S.B.C.)



representative of TI Corp's shareholder, provides direction to TI Corp's Board of Directors.

In a well-managed project, we would expect to find a clear trail of delegated authority from Treasury Board, through the Minister Responsible, to the TI Corp Board of Directors. We also expect to find records of TI Corp's use of that authority and its reports back to Treasury Board, through the Minister Responsible, on its use. We found two types of documents with which Treasury Board delegated spending authority to TI Corp: a contract through which the Province granted TI Corp a concession to construct the bridge and, thereafter, charge tolls for crossing it (the Concession Agreement) and Treasury Board approvals for the capital expenditures required to construct the bridge.

4.5.1.1 *The Concession Agreement and Treasury Board's Control Matrix*

The Province and the BC Transportation Financing Authority (BCTFA)⁵⁷ entered into an agreement with TI Corp (the Concession Agreement) in which the Province conferred onto TI Corp the powers to construct the PMH1 project, to operate it and to collect tolls from the owners of vehicles driving over the Port Mann Bridge.

The Concession Agreement is an exhaustive document that delegates to TI Corp the authorities and powers of the Minister Responsible for Transportation and Infrastructure to build the PMH1 project and operate the Port Mann Bridge as a tolled facility. The delegated authorities and powers go well beyond the contracting and spending authorities that are of immediate relevance to this review to include the regulation of some aspects of highway use. The Concession Agreement also conferred onto TI Corp many of the obligations for which the Minister is responsible under the *Transportation Act* (R.S.B.C.) and the *Motor Vehicle Act* (R.S.B.C.) as they would apply to the PMH1 project. The authorities and duties placed upon TI Corp by the Minister under the Concession Agreement, a summary of which is appended in Section 6 below, lead us to conclude that the intent of the Province was a *bona fide* operating and toll concession over 25 years and not some sort of shell game.

Schedule 2 of the Concession Agreement, which is reproduced *verbatim* in Section 6 below, dictates the circumstances when TI Corp must defer to Treasury Board. This schedule represents best practices in two ways: the circumstances are exactly defined with references to the Design Build Agreement and the extent to which TI Corp must defer to Treasury Board is defined in three steps: [1] report and consult; [2] seek approval; and [3] follow direction.

⁵⁷ The BC Transportation Financing Authority is a Crown corporation formed in 1993 under the Build BC Act (R.S.B.C.) That act was repealed in 2004 and, since then, the BCTFA is authorised under the Transportation Act (R.S.B.C.) to form and operate transportation assets in British Columbia for the use and benefit of the general public. BCTFA is the agency that, as the Province's principal accounting entity for financing transportation assets, acquired lands that were required for the completion of the PMH1 project.



4.5.1.2 Treasury Board Approvals of the PMH1 Project

Treasury Board universally requires that, when a Minister responsible for an agency seeks Treasury Board approval, that he or she do so in writing. Such documents, colloquially called Treasury Board submissions, are cabinet documents. Parliamentary tradition demands that cabinet documents are confidential and are not to be viewed by successive governments. Respecting that tradition, we did not examine the Treasury Board submissions through which the Minister Responsible sought Treasury Board approvals and directions for the Gateway Program or the PMH1 project. We assumed that these documents met the test of fully informing Treasury Board of the options and implications for program and project approval.

Pursuant to its directives and practices generally, and the Concession Agreement specifically, Treasury Board's approvals for the PMH1 project are written as letters from the Chair of Treasury Board, who is also the Minister of Finance, to the Minister Responsible. These letters are also confidential, so we did not review them. We did however, review letters in which the Minister Responsible informed TI Corp's Board of Directors of the Province's approvals and conditions. We assume that the Minister Responsible was relaying Treasury Board approvals in these letters that:

- Expressed a "total cost" of \$3.319 billion for the PMH1 project;⁵⁸ and
- Required the Minister Responsible to return to Treasury Board should there be any additions or increases to the risks, either financial or to reputation, that the Province faced in the project.⁵⁹

In our review of the project, we found only one instance when the capital budget was materially threatened: during the relief event and its subsequent resolution that are described in Section 5.2.2.3 below. In this instance, TI Corp reported the event as required under the Concession Agreement, fully described the implications to the Minister Responsible and sought the Minister's approval for its plan to mitigate the event.⁶⁰ As the event was resolved, TI Corp reported that the PMH1 project would be completed within the \$3.319 billion capital budget.

Throughout the execution of the PMH1 project, TI Corp was reporting budgeted and forecasted capital expenditures in its annual service plan submissions to Treasury Board as follows:

⁵⁸ Transportation Investment Corporation. *Service Plan 2011/12-2013/14*. Budget 2011.

⁵⁹ Correspondence between the Hon. Blair Lekstrom and Mr. Grant Main, Chair, TI Corp Board of Directors in December 2011.

⁶⁰ *ibid.*

Figure 21: “Performance Measure 1: Remain within the approved capital budget of \$3,319,000,000”⁶¹

	2013/14	2014/15	2015/16	2016/17	2017/18
Forecast as of ...	3,199,000,000	3,275,000,000	3,300,000,000	3,319,000,000	3,316,000,000
Amount below/(above) cap	120,000,000	44,000,000	19,000,000	0	3,000,000

These reports are correct, given the change in accounting bases described in section 4.6 below. If these results had been reported on the same accounting basis as they were originally budgeted, capital expenditures on the PMH1 project were not \$3.319 billion but \$3.367 billion. Whether TI Corp remained within the “approved capital budget” stipulated in the performance measure depends a fine point of interpretation: whether the term “capital budget” meant capitalised expenditures or spending on a capital project. TI Corp reported upon the change in the accounting treatment and received the Province’s approval of the increase in the overall deficit incurred during construction. The amount of \$39 million was not specifically listed as a component of the approval of the overall debt cap increase.

4.5.1.3 Broader Tests of Good Government Oversight

Treasury Board publishes guidelines and rules with respect to financial management practices and directs ministries and Crown Corporations to comply with them. Treasury Board’s most relevant guidance and requirements with respect to the PMH1 project are found in the *Capital Asset Management Framework*. The framework is almost 15 years old so, to test it for completeness and currency, we compared it to the US Federal Highway Administration’s (FHWA’s) current guidance and requirements for major projects. The FHWA requires that every project with an estimated cost over \$500 million USD that receives Federal Aid Highway Program Funding – which is almost all such projects – maintain a project management plan. FHWA provides a series of questions that serve as a checklist to inform the proper preparation of such plans.⁶²

Compared to the FHWA’s checklist for project oversight, the Province’s *Capital Asset Management Framework* is more of a capital project control framework than an asset management framework. It provides ample instruction on the content of submissions to Treasury Board to initiate projects but provides rather less guidance on the ongoing management of capital programs or projects by the provincial agencies that are charged with executing them. The framework does address asset management as the term is currently applied:

“Transportation asset management is a strategic and systematic process of operating, maintaining, upgrading, and expanding physical assets effectively throughout their lifecycle. It focuses on business and engineering practices for resource allocation and utilization, with the

⁶¹ Transportation Investment Corporation. 2016/17 Service Plan Report.

⁶² 27 June 2017 update. https://www.fhwa.dot.gov/majorprojects/pmp/pmp_guidance_questions.cfm



objective of better decision-making based upon quality information and well defined objectives.”⁶³

The FHWA developed this definition into a set of core principles of asset management for highways:

- “Policy-driven. Resource allocation decisions are based on a well-defined set of policy goals and objectives.
- Performance-based. Policy objectives are translated into system performance measures that are used for both day-to-day and strategic management.
- Analysis of Options and Tradeoffs. Decisions on how to allocate funds within and across different types of investments (e.g., preventive maintenance versus rehabilitation, pavements versus bridges) are based on an analysis of how different allocations will impact achievement of relevant policy objectives.
- Decisions Based on Quality Information. The merits of different options with respect to an agency's policy goals are evaluated using credible and current data.
- Monitoring Provides Clear Accountability and Feedback. Performance results are monitored and reported for both impacts and effectiveness.”⁶⁴

We found that the MOTI and TI Corp applied these principles in the definition of the PMH1 project within the Gateway Program and in its controls over the execution of the project. We also found that the development and management of the PMH1 project met tests of good practice that are implicit in the FHWA guidance items. Our comparison of the *Capital Asset Management Framework* and the management of the PMH1 project to FHWA guidance is appended in section 7 below.

4.5.2 Control of Delegated Authority by the Board of Directors

Within TI Corp, the Board of Directors was required to further delegate the authority it received from Treasury Board and the Minister Responsible to its staff. As in any public or private enterprise, the Board of Directors relies upon internal controls to ensure this authority is not abused. The questions are, therefore: [1] Did TI Corp have adequate internal controls in place as it began the PMH1 project; and [2] did TI Corp use these internal controls as it executed the project?

⁶³ American Association of State Highway and Transportation Officials (AASHTO) Subcommittee on Asset Management. January 2006.
http://www.transportation.org/sites/scoh/docs/Motion_Trans_Asset_Management.doc

⁶⁴ https://www.fhwa.dot.gov/asset/if08008/amo_02.cfm. Adapted from NCHRP Report 551, *Performance Measures and Targets for Transportation Asset Management*, Vol. I, Research Report, 2006





4.5.2.1 *Good Practices for Internal Control*

We took business practices defined by Committee of Sponsoring Organizations of the Treadway Commission (COSO)⁶⁵ as the benchmark for TI Corp to meet in the delegation of authority from the Board of Directors to the TI Corp staff: the President, the Vice President Technical Services and the Chief Financial Officer. COSO bases its recommended business practices on enterprise risk management,⁶⁶ something that is not widely practiced in transportation departments across North America.

Applied to the management the PMH1 project, enterprise risk management would suggest that TI Corp's internal controls – reporting requirements, spending authority thresholds, separation of authorities and information system controls – would be oriented towards the risks inherent to the project itself and towards the people, the business processes and the information systems that support its management. The principal risks in the TI Corp's management of the PMH1 project were that:

- The Board of Directors would not receive warning of emerging threats to project performance in safety, quality, completion, schedule or cost in time to proactively mitigate them; and
- Managers would act outside of their scope of authority and bind TI Corp to contractual commitments that it did not want to assume.

4.5.2.2 *Project Management Reporting*

Project management reporting concerns the flow of information upward from TI Corp staff to the Board of Directors then upwards to the Province. The Province's requirements for project-level reporting are specific. Those relevant to the PMH1 project are, and were at the time:

“A comprehensive report would ... typically include:

- A description of the project's approved scope and objectives, including quantifiable benefits and risks;
- An update on the schedule for each major work package, compared to the approved schedule;
- For each major financial component or work package of the expenditure:

⁶⁵ See Committee of Sponsoring Organizations of the Treadway Commission (COSO) (2004): *Enterprise Risk Management—Integrated Framework*. This authority defines enterprise risk management as “a process, effected by an entity's board of directors, management and other personnel, applied in strategy setting and across the enterprise, designed to identify potential events that may affect the entity, and manage risk to be within its risk appetite, to provide reasonable assurance regarding the achievement of entity objectives.”

⁶⁶ We apply enterprise risk management only as an approach to assess internal controls the highest levels of TI Corp, i.e. the Board of Directors, and as separate from risk management at the project level. We also include some references in the bibliography for the benefit of those who are curious about enterprise risk management across other departments of highways and transportation.

- The budget and forecast financial information by month at the time of approval, including cost at completion financial information;
 - The actual financial information for the month, year to date financial information and forecast financial information by month, including cost at completion financial information;
 - Committed financial information and status of contingency;
 - The forecast financial information at completion, including forecast revenue information at completion; and
- An update on existing or potential risk(s) and proposed mitigation plan(s).⁶⁷

We examined the President's reports to the Board of Directors from 2009 to 2014 and found these reports met the requirements listed above. We also found that these reports improved over time. In the early years, the reporting focus was on activities and the format was primarily narrative, with a basic project schedule dashboard report added in early 2012. From 2013 onwards, the reports appeared to focus more upon performance and expanded their use of dashboard formats. The presentation of financial information was also streamlined in 2013.

From an enterprise risk management perspective, we had a particular interest in the last bullet above: potential risks and their mitigation. We examined the extent to which the Board of Directors was able to see emerging threats to scope, schedule and budget as soon as was possible and certainly soon enough to be able to mitigate them proactively. There is no better example of an emerging threat to the project than the utility delays, described in section 5.2.2.3 below, that came to a head in late 2011. We examined the President's reports to observe how the utility delays were reported to the TI Corp Board of Directors as they were growing in the project and found that the looming utility delay events were reported to the Board of Directors as they arose.

April 2011

"The project remains on target for opening the new Port Mann Bridge by December 1, 2012. Estimated early opening remains at October 2012, although on-going discussions with Kiewit-Flatiron suggest December 2012 is more likely. TI Corp continues to work with K/F regarding potential schedule revisions."⁶⁸

⁶⁷ Province of British Columbia. *Capital Asset Management Framework*. May 2002.

⁶⁸ President's Monthly Summary Report for April 2011.

May 2011

“The project remains on target for opening the new Port Mann Bridge by December 1, 2012. Recent discussions with Kiewit-Flatiron suggest this target may be challenging in light of current construction progress at the Cape Horn interchange. TI Corp continues to work with K/F regarding potential schedule revisions.”⁶⁹

July 2011

“The target for opening the new Port Mann Bridge by December 1, 2012 is unlikely to be realized in light of challenges associated with the construction of the Cape Horn Interchange. TI Corp continues to work with K/F regarding schedule amendments and anticipates adjustments will be determined by September.”⁷⁰

The “Key Project Dates” section of the July 2011 report showed 1 December 2012 for tolling commencement.

August 2011

“Estimated toll commencement date has been revised to reflect Kiewit/Flatiron’s confirmation that December 1, 2012 is no longer feasible. This is primarily attributable to delays associated with utility relocations in Coquitlam affecting completion of some components required for toll commencement. Discussions with K/F are ongoing and a change order formalizing the applicable extension of time attributable to external factors will be concluded in September. It is currently anticipated that toll commencement will be realized in winter/spring 2013.”⁷¹

These reports illustrate the narrative form and the activity-oriented content that we observed throughout the staff reports in the early years. Project schedule reporting did not evolve past dashboard-style reports of qualitative schedule data: ahead, behind, trend improving or trend worsening. The project management team did not have the capability to produce quantitative schedule performance data, a deficiency that we discuss and make recommendations upon in section 5.2 below.

We found that TI Corp staff reported changes to the scope, schedule and cost of the PMH1 project, as they were agreed with Kiewit-Flatiron and recorded in the change certificates stipulated in the Design Build Agreement. Reports as early as 2011 included details of miscellaneous change orders, forecasts of potential future works and breakdowns of project management and property acquisition costs. Less detail was reported from 2012 onward.

⁶⁹ President’s Monthly Summary Report for May 2011.

⁷⁰ President’s Monthly Summary Report for June/July 2011.

⁷¹ President’s Report Monthly Summary Report for August 2011.



4.5.2.3 Delegated Authorities

Reporting is largely a *post facto* internal control and it must be complemented with clear limits and conditions on the authorities that individual members of TI Corp's staff hold to commit TI Corp make expenditures or other obligations. At the corporate level, we looked for spending authorities set by the Board of Directors for TI Corp staff in advance of their use, and a documented business process that showed TI Corp staff complied with those spending authorities.

We found that TI Corp had a matrix of spending authorities and, properly separated from spending authorities, a matrix of payment authorities from its inception in March 2009. The matrix was adjusted throughout 2010 to keep pace with the maturing organization and took on the general form of the matrix shown in Figure 22 below. In its essence, this matrix remained in effect throughout almost all of the construction period until April 2013.

Figure 22: Spending and Payment Authorities, January 2010 to April 2013

<i>Amount</i>	<i>Expenditure</i>	<i>Payment</i>
Over \$3,000,000	Board of Directors	Board Chair
Up to \$3,000,000	Board Chair	President & CEO
Up to \$1,000,000	President & CEO	One of: Chief Financial Officer VP, Technical Services
Up to \$1,000,000	Chief Financial Officer	One of: President & CEO VP, Technical Services
Up to \$1,000,000	VP, Technical Services	One of: President & CEO Chief Financial Officer
Up to \$50,000	Director, Finance	One of: President & CEO Chief Financial Officer VP, Technical Services
Up to \$10,000	Office & HR Manager	One of: President & CEO Chief Financial Officer VP, Technical Services Director, Finance
Design Build Agreement	Vice President Technical Services	President & CEO

In absolute terms, the amounts of spending authority delegated to staff are orders of magnitude higher than is the usual in toll authorities in the United States⁷² but this reflects the microscopic control that American elected officials retain over such

⁷² As examples: the Ohio Turnpike and Infrastructure Commission requires Commission approval of all commitments over \$100,000 US; the Georgia State Toll and Road Authority requires Board of Director approval of all commitments over \$100,000 and the Central Florida Expressway Authority requires commission approval of all Commitments over \$50,000.



authorities. In relative terms, the delegation of spending authorities among TI Corp staff was commensurate with their roles in the organization.

As shown in the last row of Figure 22 above, the spending and payment authorities matrix was customised for the PMHI1 project in that all spending authority for the Design Build Agreement, regardless of the amount, was held by the Vice President Technical Services. This was consistent with the delegation of authority to the Authority's Representative – the Project Director held final approval authority for all change certificates and payments to Kiewit/Flatiron. With no upper limit, however, the authority delegated by the Board of Directors to the Vice President Technical Services meant he could agree to a change order of any amount. The Board of Directors placed a separate control around the Design Build Agreement by creating a management reserve and retaining control over it:

“Upon motion duly made, seconded and carried, the Transportation Investment Corporation Board of Directors:

1. Approved a \$2,398,000,000 fixed price design built contract for the Port Mann/Highway 1 Project between Transportation Investment Corporation and Kiewit [sic]/Flatiron General Partnership, a Joint Venture comprised of Peter Kiewit Sons Co and Flatiron Constructors Canada Limited;
2. Established a \$64,000,000 management reserve to be used only with the approval of the Board...”⁷³

These dual controls may not have functioned as perhaps intended: as the budgets for interest during construction and property acquisition declined in 2009 and 2010, an uncommitted amount of about \$191 million became available within the project's capital budget of \$3.319 billion to fund change orders without resorting to the management reserve. We reviewed the minutes of TI Corp Board of Directors meetings from March 2009 to June 2013, the period in which almost all of the change certificates under the Design Build Agreement were approved by TI Corp. Those minutes record Board approvals of the larger change orders, i.e. those with values greater than \$5 million, but not smaller change orders. The President's Reports to the Board of Directors through 2010 and 2011 reported some change orders but did not seek approval for them.

The Board of Directors noted this discrepancy in early 2012:

“The Board also requested that management develop a Design-Build Agreement change order policy addressing under what circumstances proposed change orders should be brought to the Board for discussion or approval.”⁷⁴

The essence of TI Corp's current matrix of delegated authorities, which it adopted in April 2013, rectified this discrepancy.

⁷³ Transportation Investment Corporation Board of Directors minutes, 13 March 2009.

⁷⁴ Transportation Investment Corporation. Board of Directors meeting 12 January 2012 minutes.

Figure 23: Spending and Payment Authorities since April 2013

<i>Financial Threshold</i>		<i>Expenditure</i>	<i>Contractual Commitment</i>	<i>Invoice Approval</i>
<i>Budgeted</i>	<i>Unbudgeted</i>			
> \$3,000,000	> \$500,000	Board of Directors	CEO	CEO or VP Finance & Corporate Services or VP Technical Services or Director, Finance
Up to \$3,000,000	Up to \$500,000	CEO		
Up to \$1,000,000	Up to \$250,000	VP Finance & Corporate Services or VP Technical Services or Director, Tolling	VP Finance & Corporate Services or VP Technical Services or Director, Tolling	
Up to \$500,000	Up to \$50,000	Director, Finance	Manager, Procurement and Contracts	Any Director
Up to \$500,000	\$0	Any Director		
Up to \$50,000	\$0	Any Manager	Procurement and Contracts Coordinator	Manager of Finance

Design Build Agreement

Change Orders > \$1,000,000	Board of Directors	Authority's Representative and CEO or VP Technical Services	CEO or VP Finance & Corporate Services or VP Technical Services or Director, Finance
Change Orders up to \$1,000,000	CEO		
Change Orders up to \$500,000	VP Technical Services		

4.5.2.4 A Finance and Audit Committee of the Board of Directors

The roles and responsibilities of the TI Corp Board of Directors are defined in section 24.3 of the *Transportation Investment Act* (R.S.B.C.). The Province also provides guidance as to best practices for the boards of Crown corporations, one of which is:

“Best Practices Guideline 3

- a) The board has committees that address the Finance, Governance, Human Resources and Compensation, and Audit functions, as well as any other committees relevant to board operations.
- b) Each board committee has written terms of reference that are available publicly and that outline its composition and responsibilities.

- c) Each committee keeps informed about emerging best practices in corporate governance relevant to its functions.
- d) Every board task force and working group established to address special board needs, has written terms of reference outlining its composition, responsibilities, working procedures and termination date.”⁷⁵

Relative to these best practices, we found that the TI Corp’s Board of Directors formed an Operations Committee in January 2012. The board dissolved that committee and implemented an Audit and Risk Committee in April 2013. We found that this succession of committees in the board’s structure was reasonable given the changing business risks faced by TI Corp: our test of the focus of the board was its orientation towards those risks.

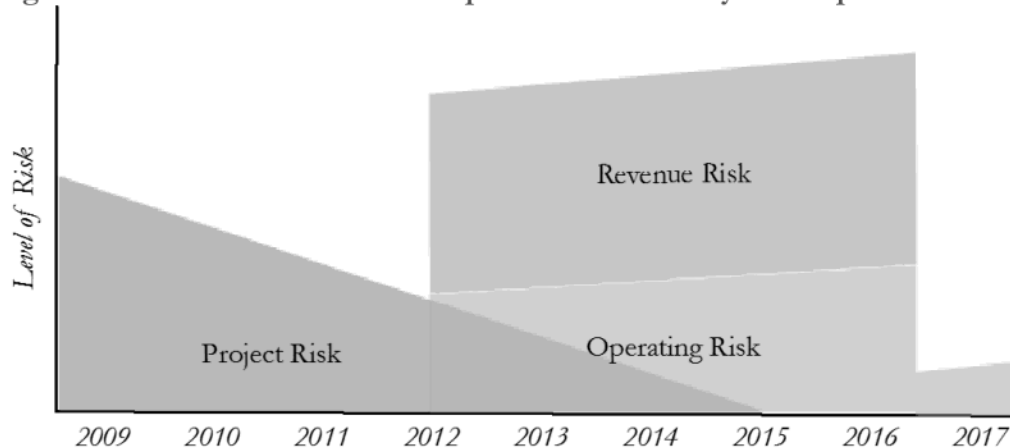
In our opinion, TI Corp has faced three sets of risks since 2009:

- Capital project risks that threatened the cost and delivery date of the assets built under the PMH1 project. These are design and construction risks, primarily, that require engineering and construction management skills to deal with them.
- Operating and maintenance risks, including the cost of debt, that would impact upon the ongoing costs of the assets built under the PMH1 project. TI Corp is maturing from a project management organization into the steward of a significant balance sheet: assets to maintain and debt to manage.
- Revenue collection risks that come with the collection of tolls from the public. When TI Corp began to collect tolls, it faced the risks of a large retailing enterprise: fraud, the compromise of confidential customer data, information systems failures and customer relations risks.

Taken together, these three sets of risks represent the full suite of business risks that any large retail enterprise faces. TI Corp, however faced different risks at different times and never faced them all at once, as illustrated in Figure 24 below.

⁷⁵ Office of the Premier, Province of British Columbia. *Board Resourcing and Development*. February 2005.

Figure 24: Illustration of the Enterprise Risks faced by TI Corp



It was appropriate that the board's initial focus was on project management and the board's membership allowed it to function as a project management oversight committee. The members of the board prepared for the coming changes in the risks TI Corp would face and, in late 2011, retained experts in corporate governance to advise on how the board should mature and diversify as it prepared to oversee management of the more diverse revenue and operating risks. The recommendations of those experts included the formation of an audit and risk committee.⁷⁶

In the narrowest terms, the function of an audit committee is to oversee the preparation and audit of the corporation's financial statements; in part, to oversee the auditors.⁷⁷ That function is not necessary in TI Corp as the Office of the Auditor General audits its financial statements. We assume that the intent of the TI Corp Board of Directors for the audit and risk committee was broader, i.e. the management of debt, the collection of tolls and the use of private information. If this was the case, then we accept that there was no need for an audit and risk committee prior to 2013.

4.6 Project Cost, Project Budget and Debt

The initial construction cost of the fixed price design-build contract was approximately \$2.46 billion, consisting of the initial \$2.398 billion price of the Design Build Agreement plus a \$64 million management reserve. For accounting purposes interest charges, land rights payments and project management costs were also included in the capital budget for the project, resulting in estimated total capital project expenditures of \$3.319 billion. This reflects the Province's budget for the project:

"The total cost of the PMH1 Project, including construction, operations

⁷⁶ Watson Advisors. *Transportation Investment Corporation Governance Review*. January 2012.

⁷⁷ Canadian Public Accountability Board. <http://www.cpab-ccrc.ca/en/topics/RoleAuditCommittee/Pages/default.aspx>



and maintenance, rehabilitation and interest, will be \$3.319 billion.”⁷⁸

Stated on the same basis, the actual cost of the PMH1 project was \$3.367 billion.

Of the \$48 million increase, \$39 million is due to a difference between the approved and actual costs resulting from a change in the accounting basis for capital costs, as the Province shifted from Canadian Generally Accepted Accounting Principles (GAAP) to International Financial Reporting Standards (IFRS) in 2010. The new accounting rules required the amount for the decommissioning of the original Port Mann Bridge to be removed from the capital budget; however, TI Corp spent those funds as an operating expense and incurred additional debt in doing so.⁷⁹

TI Corp paid Kiewit/Flatiron \$2.882 billion before applying credits of \$191 million for of GST and HST that were included in that amount. Once those recoveries were processed, Kiewit/Flatiron received \$2.691 billion against contract authorities totalling to \$2.700 billion for all authorised expenditures, both capitalised and operating expenditures.

The \$64 million management reserve was insufficient. *Ex ante*, it was considerably less than our experience of contingencies between 6% and 10% that are included in the budgets of similar transportation projects. *Ex post*, it was considerably less than the actual increases in the design and construction contract costs of \$328 million: \$293 million in the Design Build Agreement and \$35 million in construction contracts with other contractors. Had interest rates not dropped as they did between 2009 and 2013, TI Corp would have had to return to Treasury Board to seek authority to spend as much as an additional \$260 million on the PMH1 project.

4.6.1 The Basis of the Budget

As the Province and Kiewit/Flatiron negotiated the price of the Design Build Agreement to \$2.398 billion, the Province was also estimating the costs of the other elements of the project that would be included in project’s capital budget. Some of these items might not be self-explanatory to readers who are not acquainted with major infrastructure construction projects:

- Property Acquisition. The rights to use the land required for the project. These were both permanent acquisitions of lands over which the project was built, and temporary acquisitions of sites needed only during construction.
- Technical Services, which combined expenditures on:
 - The professional services needed to manage the project, including payments to Partnerships BC and MOTI for such services; and
 - Elements of the project scope that were better accomplished under separate construction contracts than as part of the Design Build

⁷⁸ Transportation Investment Corporation. *2011/12-2013/14 Service Plan*. Tabled as part of the Province’s 2011 Budget. http://www.bcbudget.gov.bc.ca/2011/crown_toc.htm

⁷⁹ TI Corporation’s total debt as of 31 March 2016 was \$3.579 billion. Transportation Investment Corporation. *Service Plan 2017/18 – 2019/20*.



Agreement with Kiewit/Flatiron. The Golden Ears Connector, at a cost of about \$20 million, was once such element.

- Stipends to Bidders. The Province paid \$2 million to each of the three proponents in the public private partnership procurement that were not selected. This practice, intended both to reduce the barrier to entry for proponents and to allow the Province to use the preliminary engineering work of the proponents, and the amount of \$2 million per proponent, are in line with our experience with other projects in North America.
- Interest During Construction. The Province funded the bulk of the expenditures to execute the PMH1 project with debt that would be retired with toll revenues. As the Province began incurring debt in 2009 and did not begin to collect tolls until 2013, the interest accrued during construction was funded from additional debt. This is the proper accounting practice and is our experience on similar projects.
- Tolling. The infrastructure needed to collect tolls, both on the highway and in administrative information systems.

The evolution of the Province's budget for the PMH1 project is summarised in Figure 25 below.

Figure 25: The PMH1 Project Capital Budget

	<i>2009 Approved Budget</i>	<i>26 May 2010 Update</i>	<i>November 2017 Actual</i>
Design Build Agreement: Capitalized			
Design Build Contract	2,398,000,000	2,398,000,000	2,398,000,000
Scope Reductions			(24,013,000)
Management Reserve	64,000,000	64,000,000	0
Additional Scope and Change Orders	28,200,000	0	278,780,000
	2,490,200,000	2,462,000,000	2,652,767,000
Other Project Elements: Capitalized			
Property Acquisition	185,400,000	195,800,000	139,870,000
Bridge Decommissioning			(38,910,000)
Technical Services: Professional Services	51,027,000	59,027,000	158,564,000
Technical Services: Construction of Other Components	58,773,000	58,773,000	93,978,000
Recovery from the City of Langley			(2,900,000)
Recoveries from Utilities			(470,000)
Insurance	29,000,000	21,500,000	22,754,000
Stipends to Bidders	6,000,000	6,000,000	6,000,000
Issuance and Standby Fees	2,500,000	2,500,000	172,000
Interest During Construction	496,200,000	262,300,000	221,426,000
Tolling		40,000,000	44,707,000
Other		3,400,000	1,800,000
Communications		5,000,000	4,467,000
Uncommitted		191,300,000	0
Winter Access Management			15,122,000
Total Capitalized Expenditures	3,319,000,000	3,307,600,000	3,319,957,000
Design Build Agreement: Expensed (added to Operating Deficit)			
Additional Scope and Change Orders			7,990,000
Bridge Decommissioning			38,910,000
Project Cost, per initial budget	3,319,000,000	3,307,600,000	3,366,847,000

The growth in the cost of the Design Build Agreement, \$287 million, and in the costs of other construction contracts, \$50 million, exceeded the \$64 million management reserve that was budgeted in anticipation of them. The increases in the costs of construction are summarized in Figure 26 below.

Figure 26: Changes in the Costs of Design and Construction Contracts

	<i>2009 Approved Budget</i>	<i>November 2017 Actual</i>	<i>Increases / (Decrease)</i>
Design Build Agreement: Capitalized			
Design Build Contract	2,398,000,000	2,398,000,000	0
Scope Reductions		(24,013,000)	(24,013,000)
Additional Scope and Change Orders	28,200,000	278,780,000	250,580,000
Other Project Elements: Capitalized			
Technical Services: Construction Other Components	58,773,000	93,978,000	35,205,000
Winter Access Management		15,122,000	15,122,000
Design Build Agreement: Expensed			
Additional Scope and Change Orders		7,990,000	7,990,000
Bridge Decommissioning		38,910,000	38,910,000
			323,784,000

This unfavourable variance was largely offset by a \$50 million favourable variance in property acquisition costs and a \$270 million favourable variance in interest costs.

4.6.2 Change in the Accounting Basis

TI Corp was required to change its financial accounting and reporting framework to International Financial Reporting Standards (IFRS).⁸⁰ Under IFRS, TI Corp was required to re-classify the \$39 million cost of demolishing the original Port Mann Bridge as an operating expense rather than as a capitalised expenditure.

The reclassification of this expenditure freed up \$39 million within the capital budget that, over time, was used to fund change orders. There was no revenue available from tolls to pay the additional \$39 million operating expense, so TI Corp's operating deficit – and its debt – increased by this amount. TI Corp stated in its 2011/12-2013/14 Service Plan:

“Except for the injection of \$150 million of Provincial equity, financing for all capital and operating expenditures will be by way of the assumption of debt. All debt assumed as well as operating costs will be repaid over the term of the Concession Agreement from tolls collected from users.”⁸¹

⁸⁰ “The above financial information for 2010/11, including forecast information, was prepared based on current Canadian Generally Accepted Accounting Principles. The budget estimates for the years 2011/12 to 2013/14 were prepared using International Financial Reporting Standards.” Transportation Investment Corporation. *2011/12-2013/14 Service Plan*. Tabled as part of the Province's 2011 Budget. http://www.bcbudget.gov.bc.ca/2011/crown_toc.htm

⁸¹ Transportation Investment Corporation. *Revised Service Plan 2013/14 – 2015/16*.



The direct impact of project spending on debt, as Treasury Board had initially defined it, was not \$3.319 billion but \$3.367 billion: \$3.319 billion for capitalised expenditures that, by 2013, included \$39 million of funds assigned within that budget to other expenditures; plus the expensed expenditure of \$39 million on the demolition of the original Port Mann Bridge and \$8 million of other expensed expenditures that were approved by the TI Corp Board of Directors after the initial budget was established.

TI Corp was always clear about the change in the accounting basis and how it affected its financial statements. For example:

“It should be noted that the old Port Mann Bridge Decommissioning is not part of the Capital Program; however, it is included in the overall Design Build Agreement.”⁸²

4.6.3 Payments to Kiewit/Flatiron

TI Corp paid the amounts shown in Figure 27 below to Kiewit/Flatiron during construction of the PMH1 project.

Figure 27: TI Corp Payments to Kiewit/Flatiron⁸³

	<i>Payments</i>	<i>Authorized Expenditures</i>
2008/09	\$43,000,000	
2009/10	\$480,000,000	
2010/11	\$506,000,000	
2011/12	\$590,000,000	
2012/13	\$618,000,000	
2013/14	\$573,000,000	
2014/15	\$54,000,000	
2015/16	\$18,000,000	
Total including GST and HST paid	\$2,882,000,000	
Recoveries of GST	(\$191,000,000)	
Total	\$2,691,000,000	
Capitalised		\$2,652,767,000
Operating		\$46,900,000
Total		\$2,699,667,000

The Province is exempt from paying the federal Goods and Services Tax (GST) prior to the introduction of the Harmonized Sales Tax (HST) in 2009. In accordance with

⁸² Transportation Investment Corporation. *Budget for Fiscal Years 2014/15 to 2016/17 and Forecast Update to 2013/14*.

⁸³ Transportation Investment Corporation annual reports under the *Financial Information Act* (R.S.B.C.), with amounts rounded to the nearest million.



the terms of the Design Build Agreement, Kiewit/Flatiron: included its payments of GST in the sum of \$191 million in the bases for the progress payments; recouped that amount from Revenue Canada then paid it to TI Corp once recovered. Net of those recoveries, and on a comparable basis to the Province's capital budget for the project, TI Corp paid Kiewit/Flatiron \$2.691 billion for the completion of its parts of the PMH1 project, \$9 million less than the final Design Build Agreement price for capitalized expenditures and the demolition of the original Port Mann Bridge in the 2015 budget shown in Figure 25 above.

4.6.4 Contingency

The contingency in the budget for the Design Build Agreement was \$64 million: 2.7% of the price of that agreement. This contingency was held in the budget as a management reserve under the control of TI Corp's Board of Directors. The contingency within the project budget for the \$829 million of other expenditures was \$0, meaning that the total contingency was 1.9% of the PMH1 project's capital budget. In our opinion, that *ex ante* expectation of growth in cost of the project was too low.

4.6.4.1 *Cost Growth during Preliminary Planning and Design*

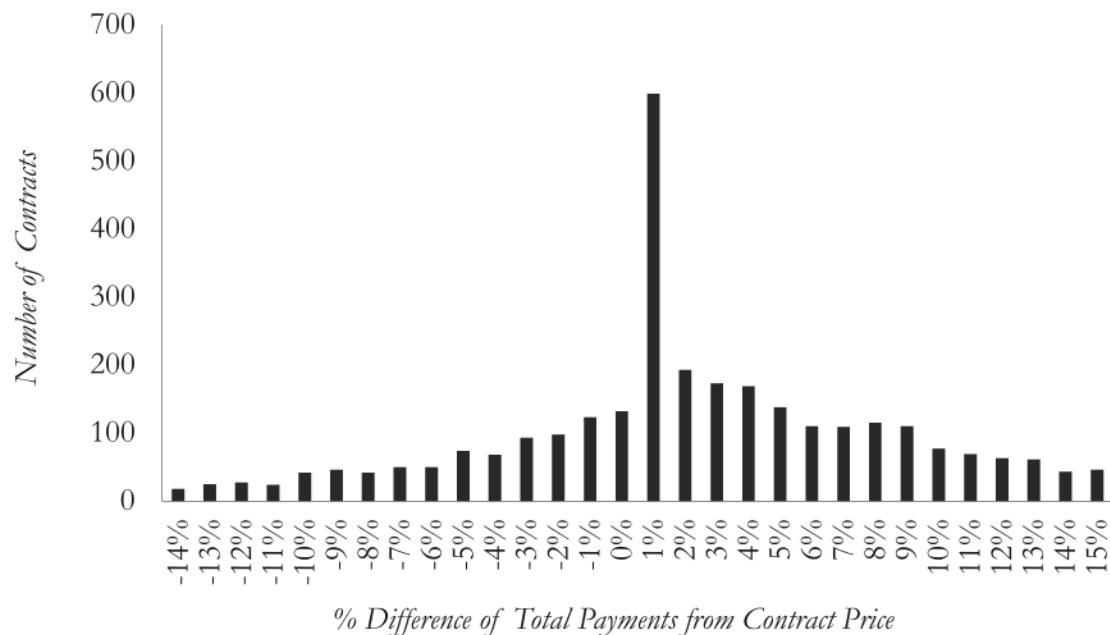
Best practice for the *ex ante* estimation of contingency for a project is to compare the results of the risk analyses for that project to the *ex post* results achieved on other projects. Both *ex ante* and *ex post* contingency estimates are the subjects of considerable academic research. A recent study of major projects in several nations concluded that cost increases from project inception to completion are in the order of 135%, with over 100% due to scope changes in the early planning and design phases of the project.⁸⁴ The experience of the PMH1 project, whose estimated cost increased by 60% from \$1.5 billion in January 2006, when the scope called for a second bridge to act as a twin to the original bridge, to \$2.389 billion in 2012 is better than that average.

4.6.4.2 *Cost Growth During Construction of Design-Bid-Build Projects*

Figure 28 is a histogram of cost changes, each expressed as a percentage of the initial contract price, of 3,618 highway construction contracts that were completed in three US states between 2004 and 2016. The median cost increase, from contract award to contract completion, among these contracts is 2%. Because the data are skewed toward higher cost increases, i.e. cost increases have no limit while cost decreases are limited, the mean increase in cost among these contracts is 6%. Put another way, the most likely cost increase in a highway construction contract is 6% but there is a 50% probability that the cost increase will be no greater than 2%.

⁸⁴ Chong, U. and Hopkins, O. *An international experience on the evolution of road costs during the project life cycle*. Transport Policy, Volume 48. May 2016.

Figure 28: Histogram of Cost Increases in Highway Construction Contracts



4.6.4.3 Design Build Contracts: A Special Case

Over 90% of the contracts in Figure 28 above are design-bid-build contracts. Growth in the costs of highway construction contracts should vary by delivery method, and recent research on the question yielded the results in Figure 29 below.

Figure 29: Contract Cost Growth by Delivery Method⁸⁵

Contract Method	Number of Contracts	Mean	Median	Standard Deviation	Minimum	Maximum
Design-Bid-Build	129	4.1%	2.3%	9.5%	(21.8%)	33.1%
Construction Manager/General Contractor	31	0.9%	0.8%	6.0%	(12.0%)	14.5%
Design-Build, Low Bid	36	2.8%	0.7%	5.7%	(5.6%)	19.0%
Design-Build, Best Value	74	4.0%	1.9%	5.5%	(4.5%)	19.6%
Total	270	3.5%	1.9%	7.8%	(21.8%)	33.1%

The PMH1 project was a design-build project awarded to the proponent that offered the best overall value and is comparable to the data in the fourth row. The mean

⁸⁵ Tran, D. *Alternative Contracting Method Performance in US Highway Construction*. Federal Highway Administration, U.S. Department of Transportation. DTFH61-13-R-00019. 2017.



cost growth among those similar contracts, from contract award to contract completion, was 4%.

4.6.4.4 Risk Based Contingency Estimation

The benchmark data for highway construction contracts of all types and, in particular, design-build contracts presented in sections 4.6.4.2 and 4.6.4.3 above suggest that the most likely estimate of contract cost growth in the Design Build Agreement would fall between \$120 million and \$190 million. Best practices for estimating the contingency for a capital project is to base that estimate on the project's risk register: the estimation of each risk that the project faces and the distribution of those risks between the owner and the contractor.⁸⁶ As the design and construction of the project proceeds, best practices suggest that the risk register be periodically updated as some risks recede, and others emerge. Updates of the risk register would be used to revise the amount of contingency funds to which the project should have clear access.

The Province produced a risk register for the PMH1 project and used it throughout the selection of the delivery method and the selection of Connect BC as the public private partner. However, the Province was not able to retrieve from its records a copy of this risk register in which all of the numerical fields of the risk estimates were complete. With most of these fields blank, we were unable to determine whether the Province used the estimates of risk in the risk register to establish that the appropriate contingency was \$64 million at the outset of the PMH1 project.

The Province did not update the risk register as the project proceeded and thus did not apply this valuable tool to manage risks across the execution of the project.

Recommendation: Risk registers. The Province should, as a major project proceeds through design and construction, revise the risk register and use risk-based schedule and cost management tools to revise contingency funding and manage cost and schedule risks throughout the life of the project.

4.6.4.5 Other Project Elements

In the PMH1 capital budget, elements other than the Design Build Agreement itself cost \$829 million, or one quarter of the budget. Each of these elements has its own risks that, in turn, requires its own estimate of contingency funding.

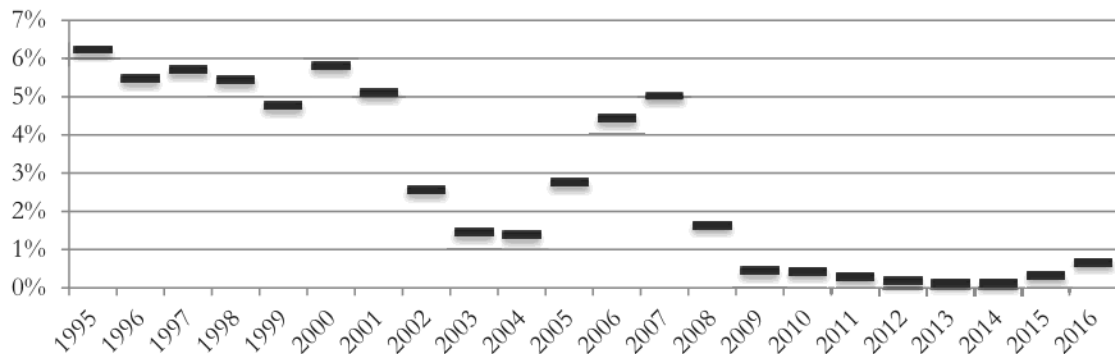
The two largest elements in the initial capital budget were property acquisition, at \$189 million, and interest during construction, at \$496 million. We passed over property acquisition risks in the PMH1

⁸⁶ Diab, M.F. et al. *Modeling the Construction Risk Ratings to Estimate the Contingency in Highway Projects*. Journal of Construction Engineering and Management, 143(8). American Society of Civil Engineers. August 2017.



project as they were dealt with early in the project's life⁸⁷ and, at 5.5% of the project's capital budget, were smaller than is typical for highway construction projects. There are statistical tools available to estimate these risks for projects in which property acquisition stretches well into the design or construction phases or the costs of property acquisition are well over the norm of 10% of the project's budget.

Figure 30: 1 Year US Treasury Interest Rates⁸⁸



Estimating the contingency funding required for variations in interest rates, taking into account the means available for mitigating them, is a subject in which the British Columbia Ministry of Finance is already well-versed. Rather than outline best practices, we merely point out that, given that the history of annual changes in interest rates between 1995 and 2007 was about 0.9%,⁸⁹ as seen in Figure 30 above, that the most likely estimate for changes in interest costs when the PMH1 was at mid-point would have been about \$15 million each year.

4.6.4.6 Project-Level Contingencies and Pooled Contingencies

There is a balance in the funding of contingencies, in a program that is comprised of many projects, between two extremes: each project has its own contingency; and the contingency funds for all projects in a program are pooled. If the contingency funds for all projects are pooled then the sum of contingency funds can be lessened since, by one estimate, the Pearson correlation coefficient of cost overruns among highway construction projects that are being simultaneously executed is at most 0.4.⁹⁰ On the other hand, leaving some of the contingency funds within

⁸⁷ The Texas Department of Transportation is a leader in developing tools for the estimation of risks in property acquisition costs. For example: Xiong, X. and Kockleman, K.R. *The Cost of Right-of-Way Acquisition: Recognizing the Impact of Condemnation via a Switching Regression Model*. Journal of Infrastructure Systems, 20(4). American Society of Civil Engineers. 2014.

⁸⁸ US Federal Reserve Statistical Release H.15(519) "Treasury bills (secondary market)"

⁸⁹ Mean absolute value of year over year changes in US Treasury 1 year rates. US Federal Reserve Statistical Release H.15(519) "Treasury bills (secondary market)"

⁹⁰ Perrin, Thorau & Associates in *Study of NCDOT Cash Management: Report to the North Carolina General Assembly*, March 2001.



projects increases the administrative efficiencies of administering those funds.

Recommendation: Contingencies. The Province should publish a policy for the contingency funding of cost increases in surface transportation projects that defines the source of funds available for such contingencies and the optimal distribution of contingency funding within projects and across projects in the Province's surface transportation programs.



5 THE PROJECT'S EXECUTION

"No plan survives contact with the enemy."

Helmuth Karl Bernhard Graf von Moltke (The Elder)⁹¹

The owner and contractor are allies in an effort to overcome the challenges presented by their major construction project. Their contract is their joint plan of attack. From the moment the first shovel goes into the ground, the owner and the contractor must, together, cope with the surprises that the project has in store for them.

Much of construction management is intended to deal with change. Change is inevitable in highway construction projects because of unknown conditions and random events. The PMH1 project experienced considerable changes as it proceeded through design and construction. Our review of the project's execution focussed on these changes.

In reviewing the history of PMH1's execution and change, we addressed the four questions in our terms of reference:

3. What led to the decision to accelerate construction of the Project?
4. Was the decision to accelerate construction supported by engineering and/or financial considerations?
5. Was the decision reviewed and approved in accordance with applicable policies and procedures considering the scope, scale, risk and complexity of the Project; and was it consistent with the identified objectives for the Project?
6. Once the decision was made, was the flow of funds to the contractor well-managed?

For the most part, we found that the execution of the PMH1, including the management of various changes and events arising over the course of design and construction, was conducted appropriately. We concluded that:

- The Design Build Agreement provided the mechanisms that TI Corp and Kiewit/Flatiron required for managing changes and the two parties used them well to deal with the significant changes that were required in the PMH1 project.
- The addition of the Fraser Wetlands Bridges to the project's scope and the procurement of gravel from more reliable sources than the Province's gravel pits, added \$108 million to the price of the Design Build Agreement. In our opinion, these items should have been included in the scope and base price of the agreement when it was negotiated.
- All other increases in the price of the Design Build Agreement summed to \$214 million, 9% of the \$2.398 million base price. A 9% increase is high, in our experience: at the 75th percentile of the cost increases across the 3,618 highway

⁹¹ Graf von Moltke, Helmuth Karl Bernhard (The Elder) *Über Strategie*. 1871. Translated more closely as: "No plan of operations extends with any certainty beyond the first contact with the main hostile force."



construction projects across North America for which we have that information.

- The PMH1 project was delivered on schedule. There is a tradeoff between cost and schedule in major construction projects, and a combination of a 9% cost increase and a 0% schedule increase is not out of line with our experience on other projects.
- Relocating and renovating the assets of utilities is a frequent source of delays and cost increases in highway construction projects. In the PHM1 project, problems with utilities delayed the commencement of tolling on the Port Mann Bridge by about 4 months. The Province, while assuming significant risk, chose the best of the alternatives available to deal with the delays and eliminated them at an additional cost of \$99 million. Given the prospect of losing about \$75 million of toll revenues and another 4 months of traffic delays during construction, this was a reasonable business decision.

However, we identified areas where, in our assessment, the execution of PMH1 did not always follow best practices:

- During construction, the Province was not able to fully and critically analyse the schedule and cost submissions made by the Constructor as they worked together to resolve problems.
- The Province elected to calculate the progress payments due to Kiewit/Flatiron by overseeing the entry of Kiewit/Flatiron's costs into its project accounting system. This approach is, in our opinion, inferior to the more widely practiced alternative of calculating progress payments with a schedule of values. The method used by the Province might have resulted in Kiewit/Flatiron receiving some payments sooner than it should but, as the price of the base contract and all charge orders was ultimately a fixed price, it did not result in Kiewit/Flatiron being paid more than it was due.

Figure 31: Chronology of the Project's Execution

September 2008 ⁹²	The Province issues a limited Notice to Proceed to Connect BC, the proponent chosen for the public-private partnership, authorizing it to begin work on design, surveys and geotechnical tests.
March 2009	First of several Change Certificates issued with respect to gravel.
December 2009	Colvarth Exchange added to PMH1 project scope.
July 2010	Colvarth Exchange added to Design Build Agreement.
July 2010	Fraser Wetlands Bridges added to Design Build Agreement.
October 2010	Kiewit/Flatiron files notice of a Supervening Event for utility delays.

⁹² Limited Notice to Proceed (LNTP) Agreement. Amended on 16 October 2009 and on 18 December 2008.



- April 2011 Kiewit/Flatiron files claim of a Relief Event for utility delays, saying Toll Completion would be in October 2013. TI Corp accepts the Relief Event but rejects the estimated delay.
- November 2011 TI Corp and Kiewit/Flatiron begin negotiating to settle the claim for the Relief Event and other outstanding issues. Kiewit/Flatiron proposes \$316 million, of which \$218 million is for additional activities required to restore the project schedule to a Toll Commencement Date of 1 December 2012.
- January 2012 Negotiations to settle the Relief Event fail. TI Corp issues a directed change order, telling Kiewit/Flatiron to achieve the original Toll Commencement Date and be paid on a time and materials basis.
- November 2012 TI Corp and Kiewit/Flatiron settle terms on the Relief Event on gravel costs and on other outstanding issues. Kiewit/Flatiron agrees to meeting the original Toll Commencement Date at an additional cost of \$99 million. Substantial Completion Date for the Western Segment, which is not one of the Toll Components, is amended from December 2013 to December 2014.
- 1 December 2012 Scheduled substantial completion of Tolling Components, including Port Mann Bridge.
- December 2012 Port Mann Bridge is opened and tolling begins.
- 31 December 2012 Scheduled substantial completion of East Segment and Fraser Heights Connector.
- 31 December 2014 Scheduled substantial completion of West Segment.
- August 2014 West Segment is substantially completed.

5.1 Provisions for Change in the Design Build Agreement

The Design Build Agreement met best practices with the mechanisms it provided for managing changes as they arose in the PMH1 project: Events and Change Certificates. In Section 5.2 below we describe how TI Corp and Kiewit/Flatiron managed major changes in the PMH1 project and refer frequently to these mechanisms.

5.1.1 Events

The principal mechanism by which changes in the project are introduced into the Design Build Agreement is through Events.⁹³ The agreement recognises, in advance of their occurrence, all of the different kinds of Events, described in the glossary, that might have impacts upon the project's scope, schedule or cost. Three of these kinds of events allow the Constructor to make a claim for losses that exceed \$200,000 in costs or over three days' delay to completion dates:

⁹³ Design Build Agreement dated 17 March 2009. Part 8: Supervening Events.



- Compensation Event, a failure on the part of the Province to deliver unfettered access to the site. Examples of areas in which the Province could fail to deliver include utility agreements, right-of-way required for the project, environmental clearances or aboriginal claims.
- Relief Event, an intercession into the project that delays the completion of work but does not necessarily add to cost. Delays caused by emergency services, utilities, and labour disputes with other parties are cited as examples.
- Force Majeure Event, an event that, through no cause or fault of either TI Corp or Kiewit/Flatiron, prevents one or both of them from performing under the agreement. Earthquakes, floods and wars are examples of force majeure events.

These three kinds of events make up a subset of events called Supervening Events, which are events that: [1] prevent either the Owner or the Constructor from fulfilling its obligations; and [2] entitle that party to compensation, an extension of schedule or termination of the contract. During the course of executing the PMH1 project, Kiewit/Flatiron filed about 250 notices of Supervening Events.

The first duty of both parties after a Supervening Event occurs is to mitigate the adverse impacts of that event on scope, schedule and cost. Both parties then follow processes defined in the Design Build Agreement to decide upon the course of action going forward. Specific to a Relief Event, which triggered the changes outlined in Section 5.2.3 below, the Agreement provides that Target Dates will be postponed, Liquidated Damages abated and Project Schedule amended accordingly.

The Agreement also provides that:

“Nothing in this Part shall limit the Authority’s right to request an Authority Change ... in response to a Supervening Event, including an Authority Change to give the Constructor instructions to accelerate construction [PT&A’s underline added] or take other steps to avoid any delay or impediment, or reduce the period of any future delay or mitigate the effect of any future impediment, resulting from such Supervening Event.... In the event that the Authority requests such an Authority Change the procedures in respect to such Supervening Event...shall terminate and the matter shall be full determined in accordance with Part 7 [Authority Changes and Constructor Proposals] and Schedule 11 [Changes]....”⁹⁴

5.1.2 Scope, Schedule and Cost⁹⁵

Project scope is a broad term, essentially stating what items are to be built through the execution of the project. The statement of scope in the design and construction contract will contain detailed specifics of what items are to be built, including specific engineering criteria for design and construction for those items.

⁹⁴ Design Build Agreement dated 17 March 2009. Part 8: Supervening Events.

⁹⁵ Design Build Agreement dated 17 March 2009. Part 7: Authority Changes and Constructor Proposals.



The scope of a project, along with its schedule and its cost, implies a distribution of project risks among the parties to the agreement. Consequently, the Province must provide sufficient information in the scope that the Constructor can provide the fixed price for that scope of work, including all risks that the Design Build Agreement shifts to the design-builder.

Changes to scope or schedule are then measured from the baseline as written in the executed Design Build Agreement. The contract also sets forth the process for implementing changes to the scope, as described above. The project management team should have a process and criteria for defining, tracking, and controlling contracted scope, including verifying that the considered scope change meets project requirements such as project permits. For PMH1, the final step in the process for managing change was submittal of the Change Certificate to the TI Corp Board of Directors.

The importance of identifying the full scope of work under a design build contract arises because the Province's ability to amend the scope without cost implications is diminished after the agreement is signed. Design will generally be advanced to approximately 25%-35% complete for a design-build procurement and then adapted into a written scope. Schedule 4 of the Design Build Agreement details this scope.

Our review of the scope finds that it is sufficient for its purpose and meets industry best practices. In addition to the lane geometry requirements (number and purpose of lanes through the project limits), the scope provides specific design requirements by municipality through the length of the project. Schedule 4 includes Utility Information Sheets that indicate the extents to which coordination with utilities were completed when the scope was developed. Each division of the work (from geotechnical to tolling) is scoped within Schedule 4 and further specified, as needed, in the MOTI Design Build Standard Specifications for Highway Construction.

Schedule 3 of the Design Build Agreement establishes the dates for the various completion milestones (the Project Schedule), including the Tolling Commencement Date of 1 December 2012. Schedule 3 requires submittal of a detailed schedule (initial Works Schedule) demonstrating the Constructor's plan to meet the milestones. The initial Works Schedule was reviewed and indicates that the Constructor had a proper plan initially set forth to complete the scope of work according to the project milestones.

The principles of costing a construction project element include the quantity of work to be completed, the construction equipment needed to complete the task (means), the method by which the task is completed (includes labour crew size), the output of the selected means and methods, and the time required or available to complete the task. If a construction activity is not constrained for time, the contractor will optimize these principles to result in the lowest total cost.⁹⁶

⁹⁶ One of the most subjective elements of estimating the costs of work is the output rate for the selected means and method. That is, an eight-person crew working a 40-hour week may be estimated to



Generally, owners are setting the contract duration to constrain activities shorter than the lowest-cost duration. Highway owners consider user costs and traffic delays from construction when setting contract durations, and owners will seek to minimize these in the process. This is especially true on large-scale projects, where owners have already set schedules that can be considered fast-track.

From the basis of this scope and schedule, the Constructor then was required, by industry practice and by contract (Section 4.10), to use reasonable efforts to mitigate any time extension or additional cost which may be due because of changes in the scope and schedule. Mitigation methods include rescheduling or resequencing the works, or reallocating resources. A contractor has a duty to mitigate changes that occur which are under his control (internal coordination, material supply chain, etc.) and often must allocate resources or time to known risks for change such as weather. Section 4.10 expands this typical responsibility and contractually requires the Constructor make reasonable efforts to mitigate Supervening Events.

More generally, the Design Build Agreement adheres to the principle that both parties must seek to mitigate the impact of delays and changes to the contract which has been upheld in many various court decisions internationally. The principle is that both parties must take all reasonable steps to mitigate the loss from delays, damages and breaches to the contract. What is reasonable must also be measured at the time decisions or actions are made in the administration of the contract. Also, what is reasonable has not been historically measured by what costs the least.

“It is often easy after an emergency has passed to criticise the steps which have been taken to meet it, but such criticism does not come well from those who themselves created the emergency. The law is satisfied if the party placed in a difficult situation by reason of the breach of a duty owed to him has acted reasonably in the adoption of remedial measures and he will not be held disentitled to recover the cost of such measures merely because the party in breach can suggest that other measures less burdensome to him might have been taken.”⁹⁷

Supervening Events are the component of the Design Build Agreement for any occurrence that prevents the performance of obligations under the contract. They include Force Majeure events: generally, external forces that contractors cannot reasonably plan for, including “Acts of God,” (floods or fire) or human acts (war or strikes).

The Design Build Agreement definition of Supervening Event includes: “the failure by a Utility Supplier to comply with the terms of the applicable Utility Information Sheet.”

construct 100 units. But if the same crew works 48-hours per week, they may be estimated to construct only 115 units.

⁹⁷ *Banco de Portugal v. Waterlow & Sons Ltd* [1932] AC 452 506



The Design Build Agreement was reviewed in context of managing change on the project. The Design Build Agreement provides specific procedures for managing change, including the process for identifying, scoping, pricing, negotiating and authorizing changes. This process, as specified in the agreement, establishes the fair and expeditious process required for processing changes. Without a defined process to manage change, change becomes a risk for the contractor that becomes a contingency priced into their bids for a contract. An owner with a proven record of managing change according to the defined processes and doing so in a fair and expeditious manner will obtain the best pricing for their projects.

The Design Build Agreement provides classifications of changes to the contract: Minor Works, Authority Changes, and Value Engineering Proposals. Minor Works changes must fall below a dollar threshold and not require variation to the design of the project. Authority Changes are the most typical type of change and result in a Change Certificate. The Design Build Agreement establishes a maximum markup (profit) for Authority Changes. Value Engineering Proposals are Constructor initiated changes which do not qualify as changes under the other two definitions, has advantages for the project (constructability, schedule, cost), and may result in shared savings for the project.

The Constructor appropriately used the contract requirement for Notice of Supervening Event to give the Authority knowledge that an event potentially requiring additional time or compensation under the terms of the Design Build Agreement had occurred. And the Constructor and Authority were able to mitigate most of these events. In the instance of the Kinder Morgan facility improvements, the Constructor began demonstrating the impact of the event by placing delay activities into the works schedule. The Authority was able to analyze the schedule impacts and agree that a Supervening Event had occurred. We found evidence that the Constructor had done its duty, presenting the delay data and working to mitigate by resequencing work activities. Likewise, the Authority supported the Constructor in the efforts to mitigate the delay from the Supervening Event.

5.1.3 What “Fixed Price” Means

Fixed price, also known as lump sum, is the preferred method of contracting for design-build infrastructure projects in North America. Fixed price places most of the burden onto the contractor for changes in the cost to deliver the specified scope. This is typically very beneficial to the owner when the contractor is also responsible for the design (design-build). This type of contract is also beneficial to the contractor because it may be possible to deliver the scope of the contract using a material or method which has a lower cost but meets the specifications. As an example, the contractor may choose to design and build more concrete beam spans versus steel girder spans because of the cost differential. Both would meet the specified scope under a standard design-build agreement. Some of the risks that are transferred to a design-builder within a fixed price include plan accuracy, constructability of design, relocation of utilities and railroad coordination, among other things.



Unit price contracts (measurement contracts) are often used when the design is completed under a separate contract, known as design-bid-build. Unit price contracts provide the owner with flexibility during the construction phase to adjust the scope without having to execute a contract amendment. As an example, an additional sidewalk to connect to a side road may be added to the originally contemplated work.

Cost plus contracts are not typical to the transportation construction industry. Under this contract form, a contractor is paid for his actual costs of time and material to deliver the scope, plus a fixed markup or fee for administration and profit. A cost-plus contract place all of the risks and benefits associated with changes in material and labour costs upon the owner. It also adds risk to the owner for the contractor's inefficiencies.

While not often used, both fixed price and unit price contracts for transportation construction will contain a provision for a construction change directive. When the contractor and owner are unable to agree on a price or time extension for the change, the owner can direct the contractor to perform the work. The contractor is then paid on a time & material basis for the change in scope. Sometimes called a force account, a construction change directive can require substantial additional effort on the part of the owner, as they most often will need additional site representation to observe and, more importantly, document the additional work efforts.

5.2 Scope, Schedule and Cost Changes in the PMH1 Project

The Design Build Agreement is a typical design and construction contract in that the Authority provided scope, schedule and specifications for the project, and the Constructor agreed to build the project for a stated price. However, it is rare that any project is completed without changes, and implausible that a project of this size could be completed without changes. Changes arise during the course of a construction project under three general reasons: the scope and specifications prove to be incomplete or inconsistent; the owner wants to add/delete certain items; or existing conditions prove to be different than those expected when the contract was concluded. Design and construction contracts address these situations through change orders.

The Design Build Agreement included procedures for requesting and issuing Change Certificates: timing, notifications, and dealing with the common situation of disagreement between the contractor and owner as to value of the changed work.⁹⁸

All changes in the scope, schedule and cost of the Design Build Agreement were executed through 59 Change Certificates, summarized in Figure 32 below and appended in Section 11 below.

⁹⁸ Design Build Agreement dated 17 March 2009, Schedule 11: Changes.

**Figure 32: Summary of DBA Change Certificates, Net and Final Basis**

Fraser Heights Wetlands Bridges	\$36,000,000
Carvolth Exchange (202 Street Park & Ride)	\$26,000,000
Gravel	\$72,000,000
Central Segment Acceleration	\$99,000,000
Miscellaneous change orders	\$18,000,000
Other change orders settled before the May 2013 settlement	\$43,000,000
Other change orders settled after the May 2013 settlement	\$11,000,000
Minor works	\$2,000,000
PST/HST recoveries on change order payments	(\$20,000,000)
Sub-Total, Managed by Kiewit/Flatiron	\$287,000,000
Carvolth Exchange after Kiewit/Flatiron withdrawal	\$35,000,000
	<u>\$322,000,000</u>

Change Orders as % of total Design Build Agreement cost

Including Fraser Heights Wetland Bridges and Gravel	13%
Excluding Fraser Heights Wetland Bridges and Gravel	9%

Relative to the cost growth experienced in other jurisdictions, as described in section 4.6.4 above, a growth rate of 13% is high at the 85th percentile of the 3,618 projects in that sample. However, we are of the opinion that the scopes and the amounts authorised in Change Certificates for gravel and for the Fraser Heights Wetlands Bridges, totalling to \$108 million, should have been included in the project budget when the Design Build Agreement was concluded in March 2009. Had they been included in the budget, cost growth would have been 9%, at the 75th percentile, rather than 13%. There were no schedule delays, which is a better-than-average performance for highway construction projects generally and for large projects in particular. The combination of cost and schedule outcomes for the PHM1 project, 9% growth in costs and 0% growth in schedule, were in line with the outcomes observed in our samples of other projects.

That is not to say that the scope, schedule and cost performance outcomes were satisfactory across the board in the PMH1 project. In two instances – the supply of gravel and the Fraser Wetland Bridges – the Province assumed significant risks in the project that, in hindsight, it would have been better had they not assumed them. In another instance – schedule delays caused by utilities – the Province assumed significant risks as it chose the best of the alternatives available to deal with the delays. All of these instances required extensive management on the part of the Province, through the issuance and revision of Change Certificates, to contain costs and ensure timely completion of the project.

Throughout its handling of these changes, we observed that the Province was not able to analyse the schedule and cost submissions made by Kiewit/Flatiron to their full depth, nor were they able to counter Kiewit/Flatiron's proposals with cost proposals of their own that were sufficiently fulsome to be worthy of Kiewit/Flatiron's attention. The Province's capacity to make its own schedule and cost estimates has waned over the years as the Province pursued a strategy of transferring design and construction management risks to the private sector through public-private partnerships. The conversion of the PMH1 project from a public-private partnership to a design-

build delivery in 2008 made it the first of what might be several major transportation projects in the lower mainland for which the Province will require more capacity to manage schedule and cost than it currently has.

Recommendation: Project and Construction Management Capacity.

The Province should maintain, at a minimum, the people, business processes and information systems that enable it to create and analyse schedule estimates and cost estimates for transportation infrastructure projects independently of contracted professional services providers and construction contractors.

5.2.1 Schedule and Cost Performance Outcomes

Cost growth of 9% is roughly one standard deviation above the mean of the projects in the samples used in section 4.6.4 above, meaning that about 75% of the contracts in those samples experienced a lower rate of growth in costs than did the PMH1 project.

The PMH1 project was completed on schedule, based on the completion of the Tolling Components in December 2012. The schedule outcome is relatively good when compared to a sample of other large highway projects throughout North America, as summarised in Figure 33 below. In that sample, projects of all delivery methods were completed, on average, 11% behind schedule and design build projects with the proponent chosen through best value criteria (the delivery method of the PMH1 project) were completed, on average, 15% behind schedule.

Figure 33: Schedule Growth in Highway Construction Contracts⁹⁹

<i>Contract Method</i>	<i>Number of Contracts</i>	<i>Mean</i>	<i>Median</i>	<i>Standard Deviation</i>	<i>Minimum</i>	<i>Maximum</i>
Design-Bid-Build	63	(10%)	0%	38%	(65%)	118%
Construction Manager/General Contractor	13	31%	0%	76%	(30%)	199%
Design-Build, Low Bid	20	(11%)	(6%)	18%	(44%)	19%
Design-Build, Best Value	50	15%	7%	31%	(71%)	81%
Total	146	11%	0%	40%	(71%)	199% ¹⁰⁰

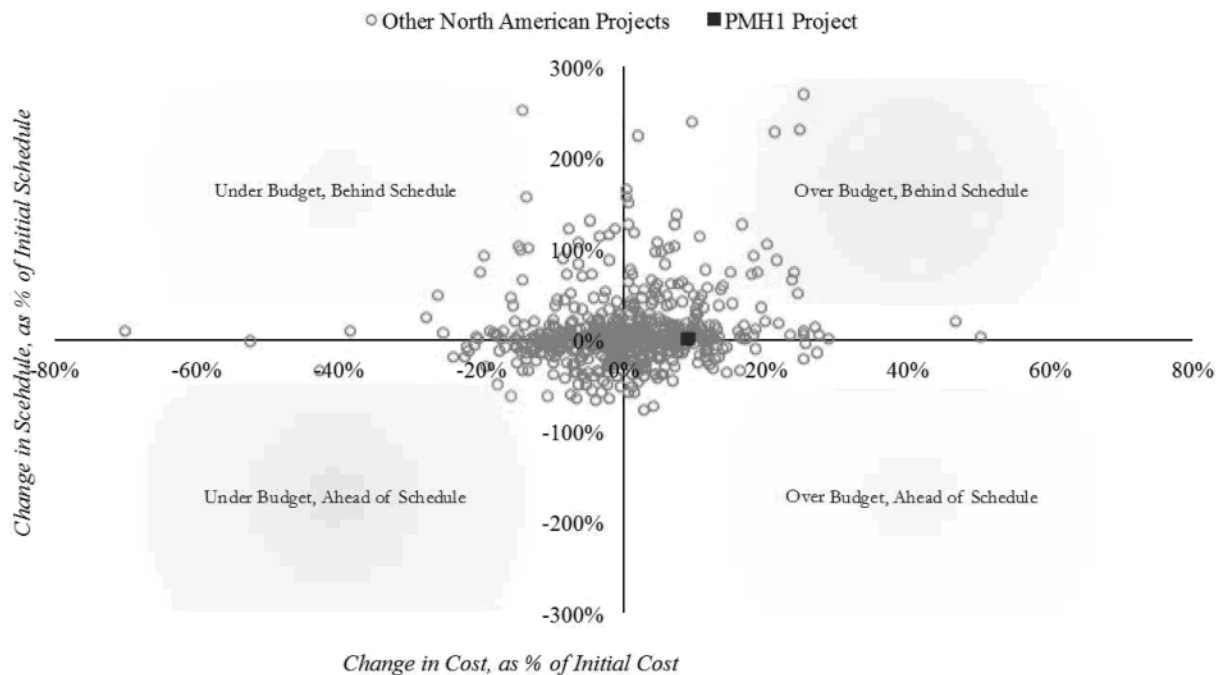
Figure 34 below shows these two measures of construction management outcomes for the PMH1 project, 0% growth in schedule and 9% growth in cost, along with the same measures¹⁰⁰ for 630 other completed highway construction projects in the

⁹⁹ Tran, D. *Alternative Contracting Method Performance in US Highway Construction*. Federal Highway Administration, U.S. Department of Transportation. DTFH61-13-R-00019. 2017.

¹⁰⁰ Definitions of both measures are appended, along with other project performance measures, in Section 10 below.

United States. Each project is plotted with its change in cost on the horizontal axis and its change in schedule on the vertical axis. Projects that vary from their initial costs and schedules will fall into one of four quadrants in the graph. Each quadrant is labelled and shaded to indicate what the combined outcomes for projects in that quadrant.

Figure 34: Cost and Schedule Performance in Highway Construction



The distribution of the 631 projects in this sample, including the PMH1 project, along the two axes of cost growth and schedule growth illustrate two patterns in the data:

- Projects are more likely to be late than they are to be over budget. The variance of schedule changes is much higher than the variance of cost changes. This can also be seen in the high standard deviations in schedule reported in Figure 33 above and the lower standard deviations in cost reported in Figure 29 above.

This provides some context for the schedule delays on the PMH1 project that are described in Section 5.2.2.3 below: such delays are common in highway construction projects.

- There is no statistically significant relationship between changes in schedule and changes in cost. The intuition of construction managers is that there are trade-offs between schedule and cost along the lines of the relationships among scope, schedule and cost as described in Section 4.2.1 above. Specifically, that any action taken to shorten a schedule will incur additional cost. We know this to be the case in the PMH1 project: a \$99 million change order increased the cost of the project by about 3% and eliminated an 8% delay in the schedule.¹⁰¹

¹⁰¹ In the original project schedule, 50 months elapsed from the limited Notice to Proceed in August 2008 and the Substantial Completion of Tolling Components in December 2013. Our assessment of the utility-induced delay, in Section 5.2.3 below, is 4 months.



This trade-off between cost and schedule does not appear in our sample of 630 projects, however. With a Pearson correlation coefficient of only -0.15, the relationship is so weak that it must be assumed to be not significantly different than zero.

In the sub-sections below, we examine the principal Change Certificates according to their impacts on the cost, schedule and scope of the PMH1 project.

5.2.2 Gravel: A Change in Cost

Gravel is a ubiquitous material in highway construction. Free-flowing in transport and deposit, it conforms to the uneven surfaces of ground upon which it is deposited to provide a flat surface on which asphalt driving surfaces and other structures can be erected. Incompressible, it is able to carry significant loads without significant creep or deflection; porous, it drains water readily and maintains its load-bearing abilities during periods of heavy rains and floods. Built as it was in the soft alluvial soils of the Fraser delta, the PMH1 project required over 3 million cubic metres (m³) of gravel to provide the sub-surface base on which the project rests.

Other heavy construction projects, be they highways, industrial facilities or high-density residential and commercial buildings, similarly require gravel. Most of the naturally occurring gravel in the Georgia Basin is in riverbeds and the mining of it is contentious.¹⁰² Demand for construction grades of gravel in the metropolitan Vancouver area, about 15 million m³ annually, exceeds the local supply in the Fraser Valley and much of the lower mainland's gravel requirements are met with manufactured gravel from adjacent areas: one the largest suppliers, for example, is a quarry and mine tailings dump on Texada Island. There is an established market for construction gravel in the lower mainland in which gravel producers, like the suppliers of other construction materials, offer their products at known prices and specifications.¹⁰³ As with most suppliers of construction materials, if the quality or the volume of their delivered gravel fails to meet the specification in the purchase contract then that contract generally provides remedies for the purchaser to refuse the material, pay less for it or demand that it be remediated at the supplier's expense. In short, the gravel supplier bears the risk of supplying the proper quantity and quality of gravel and prices that risk into the commercial rate it charges.

In our experience, government agencies, as the owner of roads and highways, almost always transfer the risks around the quantity and quality of gravel to the private sector: first to the construction contractor, who agrees with the owner on a contract price that includes the gravel required. More often than not, the construction contractor transfers that risk in turn to the gravel supplier with the market mechanism described in the paragraph above. In the Design Build Agreement, the Province took an altogether different approach:

¹⁰² BC Business Magazine. *Gravel Battle in the Fraser River*. 7 July 2010.

¹⁰³ British Columbia Ministry of Transportation and Infrastructure. *Standard Specifications for Highway Construction. Table 202-C*. November 2017.



“The Constructor may execute a gravel licence with the Province to extract material from any of eight provincial gravel pits for use in the PMHI Project only. All costs and regulatory obligations in the extraction of material from these pits are the Constructor’s responsibility. The price paid to the Province for such material is \$0 if used before the Total Completion Date and \$3.75/m³ after the Total Completion Date until the Termination Date. The Authority gives no warranty of the quality of material and the Constructor must ensure that gravel from the provincial pits and other pits meets the project requirements.

<i>Gravel Pit</i>	<i>Potential Available Volume, m³</i>
Strong	750,000
Haney	1,500,000
Sieferd	30,000
Brown Road	500,000
Mary Hill Land Development	600,000
Quarry Road Prospect (potential site)	500,000 to 1,000,000
	3,880,000 to 4,380,000” ¹⁰⁴

In short, the Province offered to supply the gravel required for the PMH1 project from its own gravel pits, “as is”, and delivered free *in situ* at those pits. In doing so, the Province:

- Assumed the responsibility to provide gravel, in sufficient quantity and quality, for the PMH1 project. To an extent, the Province became a participating supplier in the lower mainland’s commercial gravel market.
- Reduced the cost estimates for the project by an amount between \$50 million and \$75 million.

The Province was not prepared to assume these risks: it neither established a contingency against the risk in the project budget, nor properly assessed the readiness of its pits to meet the requirement.

The strategy failed, in that the Province was unable to supply the quality and quantity of gravel that it hoped that it could. TI Corp and Kiewit/Flatiron executed a mitigation plan such that, in the end, the cost of gravel to the project was not significantly different than it would have been had the Province followed the more usual course of leaving Kiewit/Flatiron to obtain gravel from commercial suppliers.

5.2.2.1 Management of Gravel Risks

MOTI has owned gravel pits for many years to ensure it had sufficient sand and gravel for road maintenance. Even when road maintenance was transferred to the

¹⁰⁴ Design Build Agreement, 17 March 2009. Schedule 8, Lands; Section 4.5, Gravel Pits.



private sector in the 1980s, MOTI retained control of the gravel pits, as is explained in **Topic Box 2** below.

Topic Box 2: Gravel Pits and Private Sector Highway Maintenance

In October 1987, the Province announced the privatization of road and bridge maintenance on all provincial roads and highways. With no county roads in the province, that represented almost all highways and all roads that lay outside municipal boundaries: about 95,000 lane-kilometers and 2,650 bridges.

The salient points of the privatization policy were:

- Maintenance would be managed by government under performance-based contracts, with the Ministry of Transportation making field inspections of highway conditions to enforce the contracts.
- Several risks were to be transferred to the private sector, principally the effects of weather.
- To create competitive market structure, a separate contract would be let for each of the 28 highway districts in the province. No one contractor could hold a contract in more than three districts, and no person or corporation could have an ownership interest in more than three contractors.
- To prevent successful bidders from building barriers to the entry of new competitors into the market, the Province would retain ownership of highway maintenance yards and government gravel pits, leasing these assets to successful bidders for the duration of their contracts.
- No employees would be laid off or terminated. The Province's highway maintenance workers were given the choices of: [1] accepting employment with the selected contractor in their district; [2] remaining in government, providing they would accept an equivalent position anywhere in the province; [3] taking early retirement (if qualified); or [4] resigning with no severance.¹⁰⁵

The government of the day relied upon the mayors of municipalities throughout the province for their support, thus the government wanted to minimize disruptive impacts on the communities in which highway maintenance workers lived and worked. For this reason, and to ensure that former employees could work for the contractor selected in their district, the government put certain conditions upon the first round of contracts (1988-1991). The successful bidder would:

- Be a successor employer of the bargaining unit that had been employed by the government to maintain roads, thus would have to accept that bargaining unit for its employees and all of the terms and conditions of the collective agreement between the government and British Columbia Government Employees' Union (BCGEU), the union that represented the bargaining unit, for the duration of that agreement.

¹⁰⁵ Lund, E.A. *Privatization of Road and Bridge Maintenance in British Columbia*. World Bank Management Training Seminar, 18 December 1996.



- Be a company owned by the government's former highway maintenance employees in that district if those employees had formed such a company;
- An employee-owned company in another district if no employee-owned company had been formed in that district; or
- If no employee-owned companies were formed, any qualified company.

Prior to the first round of contracts being let, the government provided management counselling and assistance to any group of employees that wished to form a highway maintenance company. The government also set preferred rates at which its 5,500 pieces of mobile and stationary equipment would be transferred to these companies. Over 25 employee groups attempted to form companies, and 11 employee-owned companies bid on contracts in the first round.

In the first round 11 contracts were awarded to 10 employee-owned companies and 17 contracts were awarded to companies owned by other parties. By 1990 all of the former government highway maintenance employees had been placed: 2,280 employees accepted positions with the companies that won the maintenance contracts, about 200 took early retirement and about 20 moved to other jobs in public service.

The government continued its favoured selection of employee-owned companies in the second round of contracts (1992-1996) but allowed those companies to compete against each other in all 28 districts. In the second round, 11 employee-owned companies won the majority of the 28 districts. In the third round (1997-2006), competition was opened to all bidders and employee-owned companies won the contracts in 16 of the 28 districts.

Throughout the first four rounds, i.e. from 1988 to 2016, the government never relaxed the requirement that the successful bidders take on the successor rights of the bargaining units, and to bargain with the BCGEU. This requirement was dropped in the fifth round, commencing in 2017.

The limit on the number of districts that could be serviced by one contractor was increased from 3 to 4 in the second round. This limit was discontinued in the fifth round.

Over the years, one employee-owned company has failed, and four contractors have defaulted on their contracts.

Before committing itself to a large contract for the supply of gravel, a prudent gravel producer will ensure itself of three things with respect to its gravel pits:

1. Permits are in hand. The Province regulates gravel pits under the *Mines Act* (R.S.B.C.), which places many requirements upon gravel pit operators.¹⁰⁶ The Province enforces these requirements by requiring gravel pit operators to demonstrate their compliance with them as part of obtaining a permit,

¹⁰⁶ British Columbia Ministry of Energy, Mines and Petroleum Resources. *Guide to Preparing Mine Permit Applications for Aggregate Pits and Quarries in British Columbia*. February 2010.

without which they cannot operate their pits. MOTI must comply with these requirements for its pits.

2. Development is complete. Once the mining permits are in hand, the gravel pit operator must ensure that the road into the pit, the supply of electrical power into the pit, drainage, noise abatement and dust control are all developed to the satisfaction of adjacent residents and municipal governments.
3. Material is tested. The quantity and the quality of the material in the pit is affirmed by sound geotechnical sampling methods.

As facts around its pits unfolded, it became clear that the Province did not assure itself of these things before it committed itself to supplying the PMH1 project's gravel.

- The Strong Pit. Expected to supply up to one-quarter of the material required, this pit had permits in place and was fully developed. It is located in west Abbotsford, near the intersection of King Road and Bradner Road and to the east of the Huntingdon pit, a large commercial gravel pit then owned by LaFarge Cement.¹⁰⁷ Ultimately the material from the Strong Pit was found to contain too high a proportion of "fines", meaning that while suitable for maintenance in the summer it could not be used for construction in the wet winter weather. Also, because of unsuitable drainage, Kiewit/Flatiron was unable to place in the Strong Pit the volume of wet soils that were being excavated from PMH1 worksites that it planned to place. Ultimately, additional costs were paid for LaFarge Cement to accept the excavated soils into its adjacent pit.
- The Haney Pit. The largest of the prospects, it was expected to supply nearly one-half of the total gravel requirements of the PHM1 project. Located near the Fraser Regional Correctional Centre, the Province had permits in place but had undertaken no development or consultation. Material extracted from this pit would have been hauled south on 256 Street to Webster's Corners then west on the Dewdney Trunk Road into Maple Ridge. The residents along this route demanded road upgrades worth about \$20 million to accommodate the increase in heavy vehicle traffic. That additional cost made the material from this pit uneconomic.
- The Siefert Pit. A small pit in Langley that was expected to supply 10% at most of the PMH1 project's requirements. The pit had permits in place, was developed and the material was well-known. The pit was close to depletion and it was not worth the costs of setting up equipment at the site to extract such a small amount of material.
- The Brown Road Pit. Initially expected to provide about 15% of the total material requirement, Kiewit/Flatiron planned to rely heavily on this pit because its location, near 240 Street and 68 Avenue in Langley Township and

¹⁰⁷ Now owned by Target Products Ltd.



close to the Highway 1 corridor, would minimise transport costs. The Province operated a small gravel pit on the site in the 1960s and 1970s, then closed and partially reclaimed the site. In consultations during early 2009, the property owners in the Langely area demonstrated that they relied upon the Hopington Aquifer for water to supply their domestic and agricultural operations. The township and its residents energetically raised their concerns about the disturbances that the pit might make in the quality of water available from that aquifer.¹⁰⁸ In the summer of 2009, the Province withdrew its plans for developing the Brown Road pit.

- The Mary Hill Land Development. Expected to provide about 20% of the material needed by the project, this site sits on Pitt River Road within one kilometer of the Cape Horn Interchange. The pit is located on the Coquitlam #2 Indian Reserve, bounded by the Coquitlam River to the west, Natch Park to the east and the Chelsea Estates residential development to the north. As of 2009, the Province had no permits in hand, had undertaken no consultations with the Kwikwetlem First Nation or other stakeholders, and had done no development or material testing. Kiewit/Flatiron and TI Corp concluded that this pit could not be developed in time to be of use to the PMH1 project.
- The Quarry Road Prospect. Thought capable of supplying between 15% and 25% of the project's requirements, this site is on the west side of Widgeon Creek, and north of a commercial quarry on the Pitt River. The Province had some of the permits required to develop the site but had done no development work and had conducted no consultations. Kiewit/Flatiron and TI Corp concluded that this quarry could not be developed in time to be of use to the PMH1 project.

As discussed in section 4.6.4 above, the Province did not take these risks into account when establishing its contingency funding for the PMH1 project. While the Province left Kiewit/Flatiron with the risks in respect to the quality and quantities of materials from the Province's pits, this was a transfer of risk on the face of the agreement only; ultimately, TI Corp had to accept additional costs of using more distant provincial pits and obtaining commercial gravel to fill the needs that the initially-nominated provincial gravel pits could not meet. Those costs are discussed in section 5.2.2.3 below.

5.2.2.2 Reduction of the Project Cost

In a gravel market that offered prices between \$20/m³ and \$30/m³ for material delivered to the PMH1 site, the Province offered its material at no cost other than what Kiewit/Flatiron would itself have to pay to extract the material from the pits and transport it – a cost well under \$10/m³. The Province subsidized the cost of gravel in the PMH1 project, which poses two questions for economists:

1. Does subsidising the cost of inputs distort design decisions about the use of

¹⁰⁸ The Globe and Mail. *Langley Boiling Over about Gravel Mining Plan.* 26 March 2009.

those inputs? When a consumer faces a choice among substitutes – two or more goods or services of which any one can fulfill the consumer's needs – then the relative costs of those substitutes influences the consumer's choice among them. Subsidising the cost of one good or service, relative to its substitutes will, *centris paribus*, cause consumers to use more the subsidized good or service. Society applies this effect to compensate for externalities; subsidizing transit use relative to private vehicle use, for example. No such externalities exist in highway construction, however, when engineers make choices between inputs.

Gravel and geogrids are an example of a pair of substitute inputs in highway construction: geogrids, such as the one shown in Figure 35 below, add tensile strength across two dimensions to gravels or other materials in repose. The additional tensile strength allows for thinner bases under driving surfaces and steeper slopes on berms and shoulders. In other words, adding geogrids can reduce the amount of gravel required to meet a design specification.

Figure 35: A Geogrid used in a Highway Base

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To achieve a specification, the design engineer can trade off gravel for geogrids since, to an extent, more geogrid means less gravel. A cost-minimising engineer will choose the least-cost combination of gravel and geogrid. When gravel is free, that engineer will use more gravel and less geogrid than he or she would if both those inputs were available at their market cost.



2. Is the Province stating the true cost of the project? The question of a highway project's true cost in British Columbia arose out of the Coquihalla Inquiry in 1987, in which that Commission found:

“The current method of reporting highway capital spending...has served to disguise the true cost of major projects.”¹⁰⁹

This finding was made in the context of Province's financial statements and its public reports of the Coquihalla project's financial costs. We are happy to report that the governance and financial control of the PMH1 project, as we examined them in Sections 4.5 and 4.6 above, give rise to no such finding here: the financial costs of the PMH1 project were properly and fully reported.

We raise the question in an economic perspective, rather than a financial one, in the instances where Crown assets that are provided to highway construction projects. Should the true cost of a project be only the expenditure of funds, or should it also include the opportunity cost¹¹⁰ of utilising Crown assets? We believe it should include opportunity cost as, in our opinion it would better represent the true cost of a project.

Land illustrates the conundrum more clearly than does gravel. If a highway project requires a parcel of private land, then the Province must pay fair market value to acquire that land. The market value of the land should equal its opportunity cost so, when the financial cost is included in the project's expenses its opportunity cost is captured in the project's cost. Had that parcel of land been Crown land, it might have been given to the project at no financial cost. The value of that parcel of land is the same, regardless of whether it is Crown land or private land, yet the cost of committing that land to the project is its financial cost, not the opportunity cost that is reflected in the land's value. In the example of this parcel of land, its cost to the project differs depending on who owned it rather than its value in its next-best use.

In the case of the Province's gravel, giving it to the PMH1 project engenders questions about the opportunity cost of that gravel. Does the gravel have no value in terms of its opportunity cost? It would if the Province had a near-infinite supply of gravel sufficient to supply all of its maintenance and construction requirements. If not, then how does the Province decide the best use of its free gravel, knowing that other gravel must be purchased at market prices to meet all of its needs? If that is the case, then do the different costs of gravel – free or market cost – affect management's

¹⁰⁹ MacKay, D.L. *British Columbia Commissioner Inquiry into the Coquihalla and Related Highway Projects*. Queen's Printer, 1987. This Commission also found that 38% of the total value of construction contracts in the Coquihalla project was awarded through change orders that were determined on a cost-plus basis or on negotiated unit prices. On the PMH1 project, such change orders amounted to 13% of the project's contract cost, and they were supplanted with fixed prices in the Settlement Agreement.

¹¹⁰ The value of the benefit that is foregone when a resource is consumed in one application and is thus no longer available to be consumed in another application.





decisions about the use of gravel throughout its maintenance and construction programs?

Recommendation: Pricing of Public Inputs. The Province should consider the question of how best to value Crown assets when they are consumed as inputs into its maintenance and construction programs, keeping in mind the opportunity costs of those assets, and establish guidelines for the pricing of these assets as they are consumed.

5.2.2.3 *Determining the Amount of the Change Order*

The Design Build Agreement places two requirements on Kiewit/Flatiron in presenting its case for an increase in cost, as it had to do in this instance. First, Kiewit/Flatiron must take all reasonable steps to mitigate the cost increase – as must TI Corp as the owner. Second, Kiewit/Flatiron must record and present the actual costs incurred. We found that Kiewit/Flatiron met both of these requirements with respect to gravel costs.

Kiewit/Flatiron presented a cost estimate of \$88.6 million. While work proceeded on a time and materials basis, TI Corp reviewed the details of the estimate and verified that some of the costs were consistent with the contract while others were not. In ensuing negotiations, and as part of the Settlement Agreement, the parties agreed to an increase of the fixed price of \$72 million.

We noted that the Design Build Agreement allowed Kiewit/Flatiron to include a 15% markup for overhead costs and for profit. We question whether it is sound policy to allow a contractor a profit on a change order that was, at least initially, managed on a time and materials basis: in such a change order, a contractor is neither taking risks or committing capital – the two reasons to allow a profit. With the ultimate reduction of this change order's cost and its conversion to a fixed price, the question is moot for this change order.

Kiewit/Flatiron's initial gravel plan is compared in Figure 36 below to the mitigation plan that was devised jointly by the Province and Kiewit/Flatiron.

Figure 36: Kiewit/Flatiron Baseline Plan and Mitigation for Gravel¹¹¹

Gravel Pit	Placed Volume, m ³		
	Baseline Plan	Mitigation Plan, as Executed	change
Brown Road	1,319,411	0	
Strong	822,601	1,175,679	
Jackson	0	33,300	
Huntingdon	0	99,955	
Nursery	91,790	148,698	
	2,233,802	1,457,632	(776,170)
Commercial	744,716	1,654,207	909,491
	2,978,518	3,111,839	133,321

To contribute to the mitigation effort, the Province offered up gravel from three of its pits that were not in the Design Build Agreement: the Nursery pit in Surrey, Huntingdon pit in Abbotsford and the Jackson pit in Coquitlam. Each of these pits were farther from the PMH1 project site and thus involved higher haulage costs.

Kiewit/Flatiron more than doubled its purchases of commercial gravel to compensate for the 776,170 m³ that could not be extracted from the Province's pits. Also, Kiewit/Flatiron had to increase the total amount of gravel used in the PMH1 project by 133,321 m³ due to "mass flow impact": longer cycle times required to move gravel and native soil required Kiewit/Flatiron to make slightly larger excavations than were initially planned in some locations.¹¹²

In its initial plan, Kiewit/Flatiron also intended to haul about 1,653,000 m³ of excavated soils from the PMH1 work site as waste fill back to the Brown Road Pit. Ultimately 1,221,739 m³ of waste material was deposited in LaFarge Cement's pit adjacent to the Strong Pit and 431,261 m³ was placed in other commercial dumping sites.

Kiewit/Flatiron recorded its costs as it executed the mitigation plan as debits and the costs from its original gravel plan that it avoided as credits. Kiewit/Flatiron's estimates of these debits and credits were reported in 242 cost items submitted in support of Change Certificate (CC) 0132B – the last and most all-encompassing of a series of Change Certificates relating to gravel.¹¹³ These items are summed into 37

¹¹¹ Change Certificate CC-0132B Material Flow Diagram, Reference # 11.

¹¹² Change Certificate CC-0132B Baseline Estimate vs. Impacted Quantity Summary, Reference # 5.

¹¹³ Change Certificates CC-0028, CC-0053, CC-0060, CC-0077, CC-0078, CC-0107 and CC-0129. This series of change orders served a purposed analogous to progress payments: to provide an interim payment to Kiewit/Flatiron to lessen its use of its own working capital.

activity groups or cost centres that Kiewit/Flatiron and TI Corp defined for the accounting of these debits and credits. Those sums are appended in Section 12 below. We simplified the summation of those 242 cost items into six categories, representing the basic activities of gravel management in a highway construction project:

- Mobilising equipment and personnel onto the gravel pit sites;
- Developing the pit until it is ready to produce gravel by stripping away overlying soil, building an access road into the pit, setting up drainage systems and preparing sites where native soils excavated from the pits themselves and from the PMH1 work site can be deposited.
- Managing the pit while it is producing, with drainage, power, security, traffic control, quality control and safety functions.
- Excavating native soils from the PMH1 worksite where finished materials, i.e. sands and gravels, will be placed.
- Hauling excavated native soils from the PMH1 worksite to the pits and finished material from the pits to the PMH1 worksite.
- Processing materials, usually by crushing or screening, so that the mixture of coarse and fine material is correct for its intended purpose.

Kiewit/Flatiron's initial estimates of costs for the gravel change certificates are summed by basic gravel management activities in Figure 37 below.

Figure 37: Summary Costs of Gravel Change Certificates¹¹⁴

<i>Activity</i>	<i>Credits</i>	<i>Debits</i>	<i>Net Increase</i>
mobilise		\$349,784	\$349,784
develop pit	(\$7,246,340)	\$7,307,648	\$61,308
manage pit		\$5,556,245	\$5,556,245
excavate native soil	(\$7,526,802)	\$6,184,169	(\$1,342,633)
haul native soil	(\$15,598,111)	\$32,928,670	\$17,330,559
dump native soil		\$103,747	\$103,747
relocate material		\$2,800,119	\$2,800,119
process material	(\$1,174,636)	\$4,272,151	\$3,097,515
haul material	(\$41,997,190)	\$49,889,890	\$7,892,700
purchase material	(\$614,503)	\$23,735,726	\$23,121,223
place material		\$2,359,866	\$2,359,866
price increase	(\$341,844)	\$6,220,798	\$5,878,954
overhead		\$24,494,091	\$24,494,091
contingencies	(\$2,954,343)		(\$2,954,343)
	(\$77,453,769)	\$166,202,904	\$88,749,135

¹¹⁴ Change Report CC-0132B: Gravel Premium to Total Completion.



TI Corp reviewed these costs, accepting some and rejecting others, and arrived in the negotiation of the Settlement Agreement at a fixed price of \$72 million for the gravel change orders. The \$88.7 million paid to Kiewit/Flatiron on a time and material basis were treated as progress payments against this fixed price of \$72 million, with the difference applied as a credit to subsequent progress payments for work done under the base price of \$2.398 billion.

Among supporting and indirect costs there is one that is cause for concern: a 15% markup on all direct and supporting costs to provide additional profit and overhead costs. In Kiewit/Flatiron's initial estimates for this change order, that amounted to \$11.5 million. This calculation, which was defined in the Design Build Agreement, combines overhead costs and profit into a single geometric increase. This implies that each of overhead costs and profit should increase as a linear function of direct costs and support costs. We disagree with a universal application of such a linear function for two reasons.

- Overhead costs do not grow in proportion to direct costs in an incremental change order. Overhead costs, by their nature as fixed costs, generally increase at a lower rate than direct costs, which are variable costs. It is appropriate to use percentages to distribute overhead costs into accounting cost centres to estimate the total costs of activities but not appropriate to assume those overhead costs grow in proportion with variable costs.¹¹⁵
- The Constructor's profit should not increase when the incremental additions to the price of the Design Build Agreement are determined on a time and materials basis. The addition to the price that was agreed in Change Certificate-0132B and its predecessors was determined in the same way that the price of contract is determined under the cost-plus-fixed-fee delivery method. The amount of profit that Kiewit/Flatiron receives under the Design Build Agreement is not reduced by a change order and, given that CC-0132B did not require Kiewit/Flatiron to commit its capital or to take risks, an increase in its profit is not warranted.

Recommendation: Overhead and profit margins in change orders. In future contracts, the Province should specify separate mechanisms for estimating markups in change orders. The mechanism for overhead costs should not necessarily assume that overhead costs are a linear geometric function of direct and indirect costs, and the rate of profit should be commensurate with the risks and the commitment of capital that the change order requires of the contractor.

5.2.3 Utilities: A Change in Schedule

Highways are not the only assets that require corridors of land. Railways, electrical power, telecommunications, and oil and gas also require corridors in which their assets can be placed. History and the high opportunity cost of land have resulted in these different utilities sharing corridors and assets. Telecommunications utilities use the

¹¹⁵ See, for example: *Pricing of Construction Contract Change Order Documentation*. Case Western Reserve University. 00410, revised May 2014





poles of electricity providers, who place their poles adjacent to highways and railways. Oil and gas pipelines, while they try to avoid proximity to roads, are often forced to run alongside or under roads and highways. Ditches, canals and flood control mechanisms are invariably located close to rivers and other bodies of water, as are highways. The very nature of potable water distribution and sewage collection require mainlines for those facilities to run under roads that are also provincial highways. On any given highway in any jurisdiction, more often than not, utilities are running alongside highways (longitudinal utilities) and crossing over or under highways (transverse utilities).

Public utilities providing consumer service connections (distribution) are allowed to occupy the rights of way for highways as a near-universal public policy because it is in the public interest and reduces total impacts from infrastructure.¹¹⁶ More significant utilities (transmission) more frequently occupy their own right of way. This creates the conflicts that must be resolved during reconstruction of highways.

With its large size and the critical location, the corridor of the PMH1 project is significantly intermingled with up to 22 utilities,¹¹⁷ including:

- The Canadian Pacific Railway (CPR). A connecting line between CPR's main yard in Port Coquitlam and the Canadian National Railway bridge across the Fraser River in New Westminster runs along the south side of the Lougheed Highway, underneath the Cape Horn Interchange and along the south side of Highway 1 between that interchange and the Brunette Avenue Interchange to the west of it.
- BC Hydro and Power Authority (BC Hydro). Two 230kV lines, 2L 22 and 2L 39, and a 69kV line, 60 L 17, run through the Cape Horn Interchange. Further west a third 230kV line, 2L 50, runs adjacent to Highway 1 into the City of Vancouver as shown in Figure 38 below.

¹¹⁶ Ministry of Transportation Utility Policy Manual
<http://www.th.gov.bc.ca/permits/Utility%20Permit%20Manual.pdf>

¹¹⁷ Design Build Agreement, 17 March 2009. Schedule 4: Design and Construction, Appendix C: Utility Agreements, Part 1: List of Utility Agreements.

Figure 38: BC Hydro Main Lines in the Proximity of the PMH1 Project
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- Metro Vancouver, formerly Greater Vancouver Regional District (GVRD) water mains cross Highway 1 in eight places within the PMH1 project, as shown in Figure 39. The eastern-most of these eight water mains is the Port Mann Main, which connects the Cape Horn Reservoir and pump stations in the north to the Whalley Reservoir in the south. In 2011, Metro Vancouver began construction of a water supply tunnel that increased its capacity in the Port Mann main by about 250%.¹¹⁸ This expansion was completed in 2017.

¹¹⁸ Metro Vancouver. *Port Mann Water Supply Tunnel Now in Service*. Media Release, 20 February 2017.

Figure 39: Metro Vancouver Water Mains under the PMH1 Project
Copyright

Metro Vancouver also has sewage main lines shown in Figure 40 below within the PMH1 project right-of-way, the eastern-most of which is the 90 cm diameter Coquitlam Interceptor that runs along the north side of the Lougheed Highway, underneath the Cape Horn Interchange then along the south side of Highway 1 west to the Sapperton Pump Station.

Figure 40: Metro Vancouver Sewer Mains in the Cape Horn Area
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- Kinder Morgan. Kinder Morgan's existing Trans Mountain Pipeline crosses Highway 1 under the Cape Horn Interchange, between Schooner Street on the south side and Coleman Avenue on the north side. Kinder Morgan has included this crossing in the alternate route for the second pipeline that it proposed as part of the Trans Mountain Pipeline Expansion Project.

For PMH1 at the Cape Horn interchange, the corridor widening was constrained between the bluff to the north and the Canadian Pacific Railway to the south. The corridor needed to be widened for both the Highway 1 and the Lougheed Highway in this section. Parallel to the CPR was a shared utility right of way for BC Hydro transmission lines and a GVWR sewer main.

As Highway 1 was to be widened and re-aligned in the PMH1 project, the design included the relocation of some of these utilities and their placement into a narrower cross-section of the available corridor. The cross sections of the general design scheme, before and after the PMH1 project, are shown in Figure 41 below.

Figure 41: Conceptual Cross Sections of Utility Relocations

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The narrower cross section for utilities was largely achieved by having BC Hydro convert from a tri-pole transmission line to a single-pole transmission line, the likes of which are shown in Figure 42 below. While re-locating their tracks, the CPR spur line was also pushed into a narrower cross-section. Note that Metro Vancouver's sewer main was accommodated within BC Hydro's easement.

**Figure 42: BC Hydro Single Pole and Multi-Pole Transmission Lines**

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BC Hydro single pole transmission lines to the left, multi-pole transmission lines to the right.

The Constructor was required to select an option during the procurement process of either widening to the north or widening to the south. Widening to the north would require substantial geotechnical solutions to cut into the bluff (excavation, retaining walls, and slope stabilizations). Widening to the south would require relocation of the railway and the two major utilities. It is in this same location that the Kinder Morgan facility crosses the corridor. Requiring the Constructor to select the direction for widening would be considered a best practice for vesting the Constructor into monitoring, controlling, and mitigating the design and construction process during the project.

5.2.3.1 *Managing Utilities*

Over a long history of cohabitation of corridors, some general principles have evolved to govern relationships between highway departments and utilities:

- A duty to accommodate. It is in the public interest to minimize the use of land and to maximize the use of corridors, so highway departments and utilities work together to solve whatever problems might prevent them from cohabiting in a corridor.
- Each party installs, improves and maintains its own assets. The highway department, for example, has a responsibility to notify the utility of any deficiencies that it observes in utilities' assets but has no obligation to repair those deficiencies.
- Each party pays all of the costs of its interventions. When one party needs to disturb the assets of the other parties to work on its assets, that party will pay all parties' related costs.
- Each party absorbs costs caused by third parties. For example, when a vehicular accident on a highway damages the highway and a utility pole, the highway department repairs the highway and the utility company repairs the pole, each at their own expense.



These general principles are reflected in MOTI's utility management procedures¹¹⁹ which, while rather dated, generally conforms to the utility management standards that are applied throughout North America.^{120,121}

The duties listed in Figure 43 below arise from these principles when a highway department wishes to improve its highway in a corridor.

Figure 43: Duties with Respect to Utility Relocations

<i>Duties of the Highway Owner</i>	<i>Duties of the Utility Owner</i>
To notify.	To respond.
To accommodate the utility design and construction standards in the highway design.	To accommodate the relocation requirement, i.e. move to place designated in the highway design.
To pay the utility's costs of utility relocation and, otherwise, not touch the utility's assets.	To relocate the utility promptly and according to highway construction scheduling.
To allow the utility the opportunity to improve their assets.	To pay the costs of betterment if utility chooses to improve its assets.

The Province began discussions with the various utilities affected by the PMH1 project in 2007, while the project was still in the planning stages. In May 2008, these discussions culminated in contracts with the utilities that governed the relocations that were part of the PMH1 project. The contracts with some utilities differed from the duties outlined in Figure 43 above in that the Province agreed to pay all of the utilities' costs, including betterment costs that the Province found to be reasonable, in return for those utilities providing guarantees that they would complete their work within the times allotted to them in the Master Works Schedule.

Some of the relocation agreements with the utilities were signed and some were not when they were assigned to Kiewit/Flatiron under the Design Build Agreement in March 2009. Thereafter, Kiewit/Flatiron assumed the rights and responsibilities, along with the risks, of utility relocation agreements.¹²² We reviewed the provisions of the Design Build Agreement with respect to utilities and found that they conform to established industry practices.

The Utility Information Sheets provided in the Design Build Agreement indicate that betterment opportunities for Metro Vancouver to increase pipe size in areas of which sections of sewer or water mains were required would be considered. Because they

¹¹⁹ British Columbia Ministry of Transportation and Infrastructure. *Utility Policy Manual*. 1998.

¹²⁰ U.S. Federal Highway Administration. *Program Guide: Utility Relocation and Accommodation on Federal Highway Projects*. January 2003.

¹²¹ American Association of State Highway and Transportation Officials (AASHTO). *Accommodating Utilities within Highway Right-of-Way*. October 2005.

¹²² Design Build Agreement, 17 March 2009. Schedule 4: Design and Construction, Part 1: General Provisions, Article 5: Utilities. The terms agreed with each utility by the Province were included in the Agreement in the form of Utility Information Sheets.



are relevant to the major utility delays suffered by the PMH1 project, we provide the following summaries of three utility relocation agreements.

- Metro Vancouver. GVRD standards and specifications would apply. Those specifications were available to Kiewit/Flatiron. Kiewit/Flatiron would design and build according to GVRD's approvals. Kiewit/Flatiron would pay all costs, provided that plans were reviewed within 28 days. No water shut-downs between 1 May and 1 October. No sewer diversions between 1 October and 1 May. A final utility agreement was not signed with Metro Vancouver prior to concluding the Design Build Agreement.
- BC Hydro.¹²³ BC Hydro to assist with design and approve the result. BC Hydro contractor to perform the work. No guarantees of schedule. All costs to be borne by Kiewit/Flatiron. Restrictions on outages during heavy load periods in winter. BC Hydro responsible for any required permits.
- Kinder Morgan. Highway designs that affect the pipeline under the highway to be approved by the National Energy Board.¹²⁴ Highway construction that affects the pipeline is subject to Kinder Morgan inspection and approval. All work on the pipeline to be conducted by Kinder Morgan or its contractors. Kinder Morgan to set schedule for all work, inspections and approvals on the pipeline itself. Kiewit/Flatiron is responsible for direct costs of relocation and like-to-like¹²⁵ alterations and Kinder Morgan pays for all betterments. Cost sharing arrangements are subject to the approval of the National Energy Board.

5.2.3.2 *Schedule Delays Caused by Utilities*

Utilities are the cause of many delays in the completion of highway construction projects. Utilities are, in the main, willing and responsive partners but advance information about the location and the nature the utilities in the right-of-way is commonly incomplete or inaccurate.¹²⁶ There were such instances in the PMH1 project but, in the case of the three major utility delays suffered by the project, the delays were caused by inexact advance knowledge of what the utilities' requirements would be. The three major delays in the PMH1 project schedule were:

- Redesign of the Metro Vancouver Sewage Line. About 1,000 metres of the Coquitlam Interceptor, installed in the 1960s on wooden cradles, had to be relocated. Kiewit/Flatiron submitted a like-to-like design. Metro Vancouver

¹²³ This pertains to the utility information sheet for the BC Transmission Corporation, which was merged into BC Hydro in July 2010. There is another utility information sheet in the Design Build Agreement with BC Hydro itself that pertains to utility poles and other works used for retail delivery of electricity.

¹²⁴ Oil pipelines are federally regulated.

¹²⁵ The new asset is designed and built to current standards; otherwise, it provides the same functions and capacities of the old asset that it is replacing.

¹²⁶ Quiroga, C. et al. *Identification of Utility Conflicts and Solutions*. U.S. Strategic Highway Research Program (SHRP 2) Report S2-R15B-RW-1. 2012

rejected that design, calling for the pipeline to be supported on piles rather than wooden cradles. Kiewit/Flatiron submitted a second design that proposed friction piles.¹²⁷ This design was also rejected, and in ensuing discussions, it became clear that Metro Vancouver did not have published design standards; it was approving designs at its own discretion. Metro Vancouver insisted on a design in which the pipe was supported on concrete piles driven to refusal.¹²⁸ Kiewit/Flatiron refused to pay the additional costs required and, to resolve the deadlock, TI Corp issued CC-129 with an additional \$6.68 million to fund what it considered to be betterments for Metro Vancouver. About 4 months was lost in the design schedule due to the protraction of design reviews with Metro Vancouver, although these delays did not result in significant delays on the project's critical path.

Figure 44: Sewage Main on Cradles
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- BC Hydro. BC Hydro fell behind its indicated schedule on the relocation of a complex set of transmission lines and stations in the area of the Cape Horn Interchange: along King Edward Street, about 300 metres west of Schoolhouse Street. Kiewit/Flatiron had to extend the length of times that it was required to have temporary access and protective works in place that BC Hydro required. In addition, BC Hydro's specifications required more conversions from double-pole to single-pole transmission lines than the Province had initially anticipated. To expedite BC Hydro's and Kiewit/Flatiron's completion of this work, TI Corp issued CC-021 with an additional \$1.5 million to fund more steel single-pole installations. In all,

¹²⁷ Piles driven down into soft ground only as far as is required for the friction between the surface of piles and surrounding soil can bear the loads put upon them. Friction piles usually have corrugated surfaces to increase their coefficients of friction.

¹²⁸ Piles driven down into soft ground until repeated hammering will not drive the piles any further.



BC Hydro delayed Kiewit/Flatiron's construction of the King Edward Street Bridge, which was on the critical path of the master Works Schedule, by about 2 months.

- Recoating of the Kinder Morgan Oil Pipeline. Kinder Morgan decided that, while the PMH1 project was underway, it would excavate and inspect this section of high-pressure pipe, which had been installed in the 1960s. The excavation of the pipeline had to occur in three phases, such that only one-third of the Highway 1 cross section was not available to carry traffic at any one time. In addition, Kiewit/Flatiron had to provide crash protection measures in each phase while the pipe was excavated. It was complex work but anticipated by all of the parties at the beginning of the project. Upon excavation and inspection, Kinder Morgan decided to remove the existing protective coat from the pipe's exterior and install a new coat, providing Kiewit/Flatiron and TI Corp little advance notice of its decision to do so. The recoating process added at least two weeks to each of the three phases for a total of about six weeks. These additional six weeks threw the construction of the CPR bridge, about 500 metres to the east, out of sequence and added about 2 months to the schedule for that critical component.

Figure 45: Coating an Oil Pipeline

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As these delays unfolded during 2010, Kiewit/Flatiron took steps to mitigate their effects, in particular rescheduling construction activities to work around Metro Vancouver's intransigence with respect to the design of its sewage main. During the summer of 2010, Kiewit/Flatiron's monthly updates of the progress schedule showed that they were tracking 45 days behind schedule for the Tolling Commencement Date. This would not be out of the norm for projects like PMH1. At this point in the project, when design build work was 43% complete,¹²⁹ it would be reasonable to accept that the Constructor could make up the 45 days as there were 750 calendar

¹²⁹ Draw Request 20, 21 August 2010.



days remaining before the milestone for the Substantial Completion of Tolling Components, 1 December 2012.

Kiewit/Flatiron's mitigation efforts were overwhelmed by the delays in the construction of the CPR bridge caused by the Kinder Morgan pipe recoating work, however, and Kiewit/Flatiron reported a Supervening Event in October 2010.¹³⁰

After completing their due diligence, TI Corp agreed in March 2011 that the Supervening Event, triggered by the additional work performed by Kinder Morgan within the rights of way of the project, was a Relief Event.¹³¹ A Relief Event would grant the Constructor additional time to meet milestones, but the Constructor would not have cause to seek additional compensation if granted full relief from the milestones.

The Kiewit/Flatiron's request for relief in April 2011, summarised in Figure 46 below included an additional 313 calendar days to the Tolling Commencement Date, i.e. a change in that date from 1 December 2012 to 10 October 2013.

Figure 46: Relief Event Schedule Changes Claimed by Kiewit/Flatiron¹³²

	<i>Tolling Commencement</i>	<i>Substantial Completion</i>	<i>Total Completion</i>
Design Build Agreement	1 December 2012	31 December 2013	30 November 2014
Revise for Relief Event	10 October 2013	23 December 2014	23 December 2014
Additional Calendar Days	313	357	23

TI Corp considered the time extension request as an outermost negotiating position by Kiewit/Flatiron and all indications to them were that the actual delay would be much less. While the additional work performed by Kinder Morgan would extend the time between each shift of traffic on Highway 1 and Lougheed Highway, TI Corp's analysis of the Relief Event impact did not add up to a 313-day delay.

In subsequent discussions, Kiewit/Flatiron submitted that the relief period should be lengthened to take proper account of the restrictions that seasons and weather placed upon paving and upon all activities that might affect the migration of fish along the Fraser River. Taking these restrictions into account would, in Kiewit/Flatiron's view, further extend the Toll Commencement Date into 2014, as it reported in the series of Work Schedule Updates that it submitted to TI Corp from April 2011 onwards. These successive forecasts of the Tolling Commencement Date for Segment 2, i.e. the Cape Horn Interchange, are shown in Figure 47 below.

¹³⁰ Letter from Frank Margitan, Kiewit/Flatiron Project Director, to Gary Webster, Authority's Representative, 1 October 2010.

¹³¹ Letter from Gary Webster, Authority's Representative to Frank Margitan, Kiewit/Flatiron Project Director, 29 March 2011.

¹³² Letter from Frank Margitan, Kiewit/Flatiron Project Director, to Gary Webster, Authority's Representative, 5 April 2011.

Figure 47: Forecasts of the Toll Commencement Date by Kiewit/Flatiron¹³³

Kiewit/Flatiron Work Schedule Updates issued in...	<i>Tolling Commencement Segment 2</i>
April 2011	1 December 2012
July 2011	9 April 2014
August 2011	26 September 2014
September 2011	26 September 2014
October 2011	26 September 2014
December 2011	26 September 2014
January 2012	26 September 2014
March 2012	30 August 2013
April 2012	30 August 2013
May 2012	30 August 2013
June 2012	30 August 2013
July 2012	28 August 2013
August 2012	12 August 2013
September 2012	17 September 2013
November 2012	1 December 2012

Observing this range of forecasts, we elected to analyse the options available to both parties to resolve the delay with a working date of 30 June 2014 to represent Kiewit/Flatiron's likely claim for relief through late 2011 and into early 2012.

Once TI Corp confirmed that a Relief Event had occurred, the Constructor's progress schedule began to include more detailed reporting of tasks. This allowed both sides to more specifically identify the measures that have to be taken mitigate the delay.

From April 2011 to November 2011, TI Corp observed the Constructors work and they could see the Tolling Commencement Date delay decreasing. However, this is another area where the contract could have been improved by more complete specifications for critical path scheduling. We observed that Progress Schedules were submitted approximately three months after the 'data date' (or 'as-of' date). A delay like this in receiving the current schedule documentation can make it more difficult for an owner to manage and mitigate delays on the project.

In TI Corp board briefings in the fall of 2011, the President and staff reported that the Constructor, in their judgement, was not delayed to the extent of the 313 days claimed for the relief event. The estimate of delay was 60 to 120 days, meaning a tolling commencement date in the winter or spring of 2013.

¹³³ Letter from Frank Margitan, Kiewit/Flatiron Project Director, to Gary Webster, Authority's Representative, 5 April 2011.



5.2.3.3 *Deficiencies in the Works Schedule*

Our assessment of the information that was available to TI Corp in January 2012 is that the most likely forecast of the Toll Commencement Date was March 2013, or about 4 months behind schedule. Our assessment was somewhat limited by deficiencies in the Work Schedule.

A construction contract for public works will customarily include a requirement for the contractor to submit a planned schedule for completing the work within the contract schedule. That requirement was included in the Design Build Agreement and achieved by the Constructor on the PMH1 project. And the baseline schedule (i.e. the first version of the planned schedule from which TI Corp and Kiewit/Flatiron would measure all subsequent revisions to the schedule) that Kiewit/Flatiron submitted was adequate to represent the Constructors plan to complete the work.

We noted that the baseline schedule (initial Works Schedule) was not required by the Design Build Agreement until 180 days after the effective date of the Design Build Agreement. This is longer than typical for submittal of a detailed schedule, as a significant portion of the design would have been completed in that time. Second, the specifications for the Works Schedule primarily stated that the schedule would be “in accordance with Good Industry Practice.” While this may have worked out acceptably on the PMH1 project, these specifications are less than best practices: receipt of a baseline schedule within 90 days of Notice to Proceed and updates no more than 30 days past the end of each work period.

We also noted that the baseline schedule (initial Works Schedule) is dated 19 June 2009, or three months after the effective date of the Design Build Agreement and 173 days after the Limited Notice to Proceed. The detail of the baseline schedule was found to be commensurate with a project of this size and complexity. Offsite activities such as design, procurement, acquisition, and coordination are appropriately shown. The schedule provides design, protection and relocation activities for utilities in each segment. The baseline schedule does not show any maintenance or betterment activities by Kinder Morgan. No impact to Kinder Morgan facilities under Highway 1 was projected at the establishment of baseline schedule.

Consistent with industry practice, the Constructor submitted progress update schedules. However, the contract specification did not require these submittals. Best practice includes a specification requirement for these periodic updates, usually monthly. The progress schedules reveal the impact of the Supervening Event on the timely completion of the project.

Design and construction contracts include specific requirements for work schedules to improve the owner’s ability to monitor the contractor’s performance and to forecast the likelihood of the contractor achieving the completion milestones, i.e. completing significant segments of the work, on schedule. For instance, activities and tasks must be broken down to level of detail at which no task or activity has a duration that is longer than one reporting period. All tasks at the lowest level of detail must thus be started and finished across one or two reporting periods. Measuring progress across



two periods is more exact than measuring progress across many periods. Resource levelling is often prohibited.¹³⁴ External constraints are often prohibited unless they are contractually required, such as access to acquired property; they are not allowed in the instance of a limit on the availability of resources external to the contractor. Progress schedules (interim schedules) are required to be submitted in time for the owner to review and measure progress before the next period completes.

Recommendation: Schedule specifications in the contract. The Province should specify scheduling and schedule reporting requirements in its contracts for major projects with submission time limits, submission frequency requirements, restrictions on scheduling practices and requirements to resource-load schedules and thus produce a schedule of values, and the use of the schedule of value to determine the amounts of progress payments.

Meeting or exceeding the design and construction schedule was important for the PHM1 project, as it is for any capital asset that is paid for by the revenues it earns when its construction is complete. Given that importance, we expected to find several schedule performance measures. We noted a lack of schedule performance measures in staff reporting to the Board of Directors and found that TI Corp did not have the capability to produce such measures.

Schedule performance metrics would measure variance from the contractor's original plan by both time and value:

- Differences in time, measured in days, are schedule variance: for any given milestone, the difference between the current forecast of that milestone's date and the date for that milestone in the baseline schedule.
- Measuring value begins by requiring a planned value curve (PV): the baseline schedule cost-loaded to match the schedule of values used for payment. The value earned (EV) in a period is actual percent complete multiplied by the cost to complete. The value variance is EV minus PV and the schedule performance index is EV divided by PV.

It is important to note that these metrics should be measured and monitored both for falling out of a certain range and for trends across multiple reporting periods. This sampling of metrics would have provided the Board with better insight into the contractor's performance month-to-month.

¹³⁴ Resource levelling is a project management practice in which the contractor rearranges the schedule to optimise the assignment of resources to tasks. A contractor may use resource levelling to lower total labour or equipment cost, but this does not represent a contract requirement and may result in a different critical path.



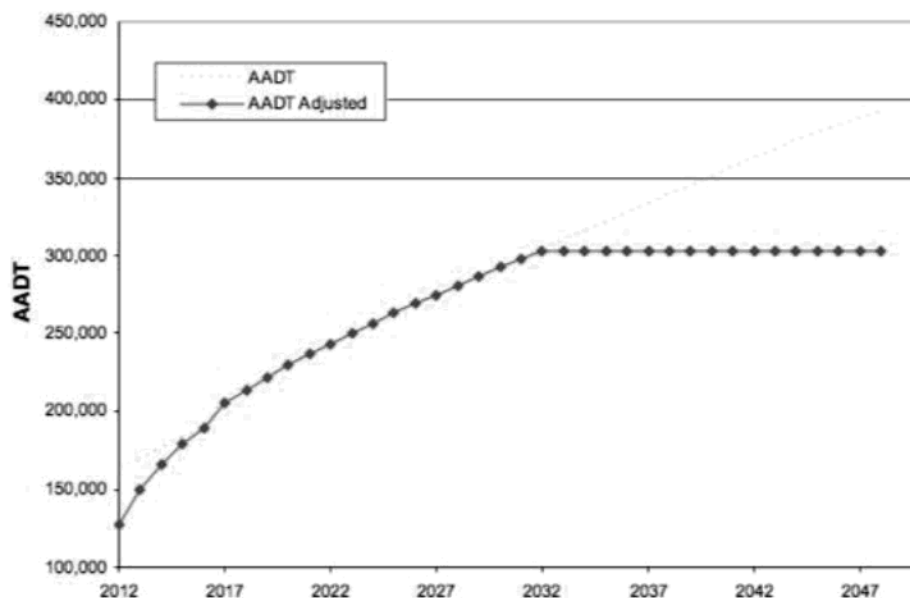
Recommendation: Schedule performance measures. The Province should measure and analyse schedule performance measures as major highway projects are designed and constructed. Those measures should include variances from a planned value curve and earned value.

5.2.3.4 The Business Case for Acceleration

The decision to restore the PMH1 schedule to its originally planned Toll Commencement Date of 1 December 2012 is best analysed as a benefit-cost decision. The benefit, according to the toll and traffic projections that TI Corp had in hand, was about \$18 million per month in tolls collected. If our estimate of the project delay being about 4 months is correct, then the delay would have cost TI Corp about \$75 million in lost toll revenue.

The working traffic forecast that TI Corp held in early 2012 is illustrated in Figure 48 below. The forecast for the first year of operations after a ramp-up period of two years was about 130,000 vehicles per day in both directions, stated as average annualized daily traffic (AADT).

Figure 48: Traffic Projections for the Port Mann Bridge¹³⁵

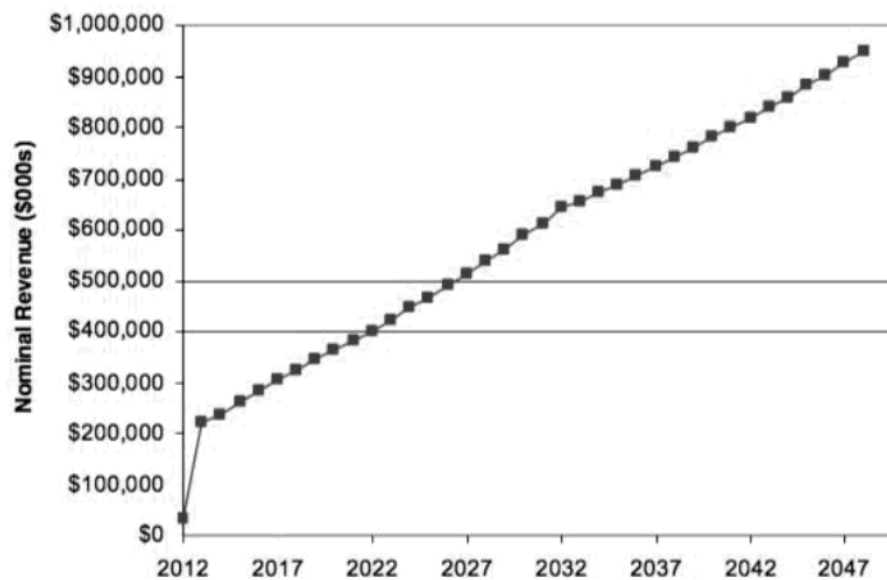


The less conservative forecast¹³⁶ called for about 160,000 AADT in the first year after traffic ramp-up, generating annual revenues of \$220 million. Revenue projections are shown in Figure 49 below.

¹³⁵ MVA Asia Limited. *Port Mann/Highway 1 Project: Review of Traffic Forecasts on behalf of Lenders to Connect BC*. November 2008.

¹³⁶ iTRANS. *Port Mann Bridge Highway 1 (PMH1) Traffic Forecast*. July 2008.

Figure 49: Revenue Projections for the Port Mann Bridge¹³⁷



The toll rates that, in early 2012, TI Corp would have expected to apply to the PMH1 project are shown in Figure 50 below.

Figure 50: Toll Rates

	Cars	Small Trucks	Large Trucks	Motorcycles
Maximum Designated Toll Rates, 2010¹³⁸				
Base Toll, Paid with Toll Device or Prepay	\$2.85	\$5.70	\$8.55	\$1.45
Video Processing Surcharge	\$2.30	\$2.30	\$2.30	\$2.30
Toll Rates for First Year after Introductory Period¹³⁹				
Base Toll, Paid with Toll Device or Prepay	\$3.00	\$6.00	\$9.45	\$1.50
Video Processing Surcharge	\$2.60	\$2.60	\$2.60	\$2.60

Monthly pass for unlimited crossings of a pre-registered car:

Dec. 1, 2012 – Nov. 30, 2013	\$75 per month per car
Dec. 1, 2013 – Nov. 30, 2014	\$150 per month per car

¹³⁷ MVA Asia Limited. *Port Mann/Highway 1 Project: Review of Traffic Forecasts on behalf of Lenders to Connect BC*. November 2008.

¹³⁸ Port Mann Highway 1 Bridge Concession Agreement, 10 March 2010. Schedule 2. Amounts are in 2009 dollars and subject to inflationary increases in subsequent years.

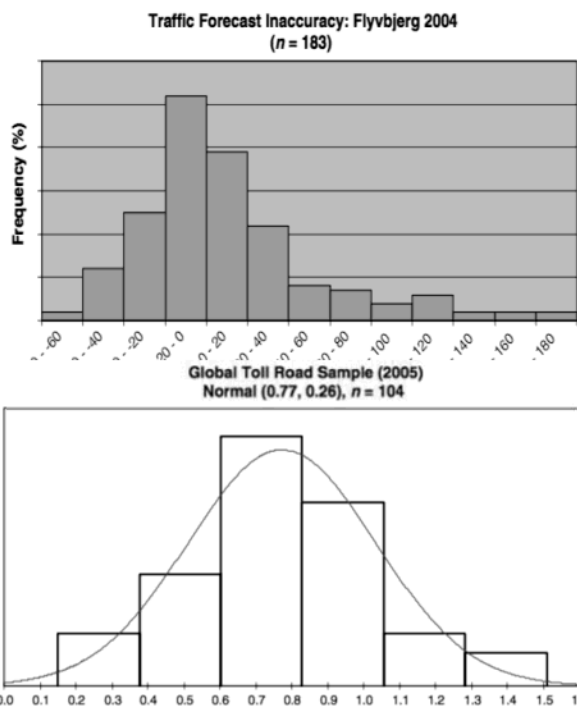
¹³⁹ TI Corp Board of Directors minutes, 23 July 2012.

Annual revenues of \$220 million from tolled traffic of 160,000 AADT implies an average toll yield of about \$3.75 per vehicle, which falls within the bounds of the toll schedule shown in Figure 50 above.

Topic Box 3: Errors in Traffic and Revenue Forecasts

Predicting traffic volumes requires assumptions about several causal variables: land-use patterns, operating and capital costs of vehicles and, when tolls are involved, the willingness of drivers to pay them. Each of these causal variables can be estimated, but only with low levels of confidence over payback periods that can be 30 or more years. A forecast of the dependent variable – traffic volume – inherits uncertainty from the causal variables, to produce margins of error that can be observed when comparing past forecasts with post-construction traffic volumes.

The accepted norms for the margins of error in traffic and revenue forecasts were unsettled somewhat in 2006 with the release of two reviews, the results of which are illustrated and described below:



Flyvbjerg's review of 183 road projects that found forecasting errors resulted in one half of the forecasts being wrong by more than $\pm 20\%$. Worse, the errors were asymmetrically distributed, with positive errors – forecast traffic was higher than the actual traffic – being larger than negative errors.¹⁴⁰

Bain's study of 104 toll-road projects found forecast errors were normally distributed around a mean 23% under-estimation of demand, with a standard deviation of 26%.¹⁴¹

These studies, along with some cases of failed forecasts that spectacularly over-estimated toll revenues at the time,¹⁴² has created an uneasiness about traffic and revenue forecasts.

¹⁴⁰ Flyvbjerg, B., Skamris Holm, M. K., & Buhl, S. L. *Inaccuracy in Traffic Forecasts*. Transport Reviews, 26(1). 2006.

¹⁴¹ Bain, R., & Polakovic, L. (2005). "Traffic forecasting risk study update 2005: through ramp-up and beyond." *Standard and Poor's Rating Direct on the Global Credit Portal*, 25.

¹⁴² One example being the Central Texas Tollway, which opened in 2006 to carry traffic that was only 30% of the forecast. The tollway was bankrupt by 2009.



Both the Province and Kiewit/Flatiron's were mindful of the negative impacts of a longer construction period, both in terms of lost toll revenues and extended disruptions of traffic on Highway 1. Kiewit/Flatiron proposed the following increases to Price of the Design Build Agreement in the fall of 2011.¹⁴³

Figure 51: Cost Changes Proposed by Kiewit/Flatiron

	<i>\$ millions</i>
Additional costs to mitigate utility delays, already incurred	81
Forecast costs to mitigate utility delays, forecast to completion	218
Total costs to mitigate utility delays to schedule	299
Offer to settle all other outstanding changes, e.g. gravel	63
Total offer	362

The Province considered the \$362 million cost proposed by Kiewit/Flatiron to be unreasonable. The Province rejected the claims of additional costs already incurred as the Design Build Agreement required Kiewit/Flatiron to bear these costs under its duty to mitigate. TI Corp treated the other outstanding changes as separate issues and focussed upon Kiewit/Flatiron's estimate of \$218 million to restore the schedule as of the spring of 2011, which TI Corp believed to be no more than \$125 million.

The Design Build Agreement allowed Kiewit/Flatiron an early completion bonus: should the Toll Components be substantially completed ahead of their scheduled completion of 1 December 2012 then Kiewit/Flatiron would be paid 60% of the toll revenues collected in advance of 1 December 2012. Assuming that TI Corp would ultimately have to accept a Substantial Completion of Tolling Components date as late as 30 June 2014, that date would then become the date from which an early completion bonus would be calculated. For example: had the Relief Event moved the Substantial Completion of Tolling Components date to 30 June 2014 and Kiewit/Flatiron subsequently shortened the schedule at its own cost such that tolling could begin on 1 December 2012 then, based on the traffic and revenue forecasts available at the time, their early completion bonus would have been about \$146 million.¹⁴⁴

Having submitted a schedule for Substantial Completion of the Tolling Elements in the summer of 2014 due to a Relief Event, Kiewit/Flatiron would have been entitled to an early completion bonus of about \$146 million¹⁴⁵ had it substantially completed the Tolling Components in December 2012.

There were four options available to TI Corp once it accepted the Relief Event in March 2012.

¹⁴³ CC-0128B Change Report 9 January 2012.

¹⁴⁴ As the tolled traffic was forecasted to be ramping up from about 62% to about 90% in the first 12 months, expected tolls in the first 12 months were about \$165 million. Tolls in the 13th to 18th months would have been about \$110 million. 60% of the sum of those revenues is \$146 million.

1. Accept the Relief Event and agree to an extension of the schedule with two possible outcomes:
 - (a) tolling commences in mid-2014; or
 - (b) Kiewit/Flatiron accelerates work at its own expense, achieves a Toll Commencement Date of 1 December 2012 and is thus entitled to the early completion bonus;
2. Pay Kiewit/Flatiron \$218 million to achieve a Toll Commencement Date of 1 December 2012;
3. Rescind the acceptance of the relief event and, likely, go to court for a contract dispute; or
4. Issue a change directive and bear the risk of an indeterminate total cost.

Our estimates of the fiscal implications for each of TI Corp and Kiewit/Flatiron are summarised in Figure 52 below.

Figure 52: Summary of TI Corp's and Kiewit/Flatiron's Options

		<i>Additional Payments from TI Corp to KF</i>		<i>Lost Toll Revenue</i>	<i>Net Loss to TI Corp</i>	<i>Additional Amounts Paid to KF</i>
		<i>Schedule Restoration Costs</i>	<i>Early Completion Bonus</i>			
<i>\$ millions</i>						
1(a)	Do nothing. KF substantially completes tolling components by June 2014.	0	0	243	243	0
1(b)	Do nothing. KF substantially completes toll components by December 2012 and earns the early completion bonus.	0	146		146	146
2	Accept KF's estimated cost to restore the project to original schedule.	218			218	218
3	Resort to the courts.	150			150	150
4	Directed change, paid by time and materials.	125			125	125

The outcomes for options 3 and 4 are less certain and thus pose higher risks than options 1 and 2.



TI Corp staff took a similar analysis to their Board of Directors in September 2011¹⁴⁶ that included estimates of these fiscal costs. We concur with TI Corp's judgement that option 4, negotiating a fair and reasonable price to mitigate the Relief Event while requiring a Substantial Completion Date for Toll Components of 1 December 2012, was TI Corp's preferred option.

An analysis of using an Authority Change, in which the Province would instruct Kiewit/Flatiron to continue to work towards the original completion dates but be paid additional funds with a modified "force account" method,¹⁴⁷ was reviewed with the TI Corp Board of Directors in the fall of 2011. One consideration for using an Authority Change was that only auditable actual costs from the date of the directive forward would be eligible for reimbursement, plus the 15% markup specified in the Design Build Agreement. This was an important consideration as it provided mutual control of the additional activities that would be part of the acceleration effort. TI Corp could help verify individually that additional work activities, additional equipment and additional staffing were direct costs to the acceleration before the work was performed.

Additional direct costs included additional staffing on the construction management team to document Kiewit/Flatiron's acceleration work (force account and actual cost records) and potential effort spent preparing to defend potential Constructor claims.

Another risk was that these efforts would not actually achieve the desired result of a December 2012 tolling commencement. One risk of force account work is that the contractor will work at lower than usual production rates – being reimbursed on a time and materials basis, the more time the contractor takes the more the contractor will collect in payment. TI Corp was aware of this risk as it considered the directed change and managed it by requiring Kiewit/Flatiron to meet the original completion dates.

TI Corp's goal did remain to commence tolling by the original date if the costs could be kept manageable. A directed change was a reasonable course of action given these criteria.

In December 2011, TI Corp provided Kiewit/Flatiron with an Authority Change to execute option 4.¹⁴⁸

The proper management of option 4 required TI Corp to set two initiatives in motion.

- (1) TI Corp had to direct Kiewit/Flatiron to continue work on a time and materials basis; in turn this required both parties to work together on mitigation measures and to more closely supervise the progress of work.

¹⁴⁶ Transportation Investment Corporation Briefing Note. 27 September 2011.

¹⁴⁷ An industry term for the separate accounts that are kept to track the costs of time and materials as they are incurred.

¹⁴⁸ CC-0129A, 8 December 2011.

- (2) TI Corp and Kiewit/Flatiron would, eventually, have to reach an agreement to settle all outstanding claims and differences.

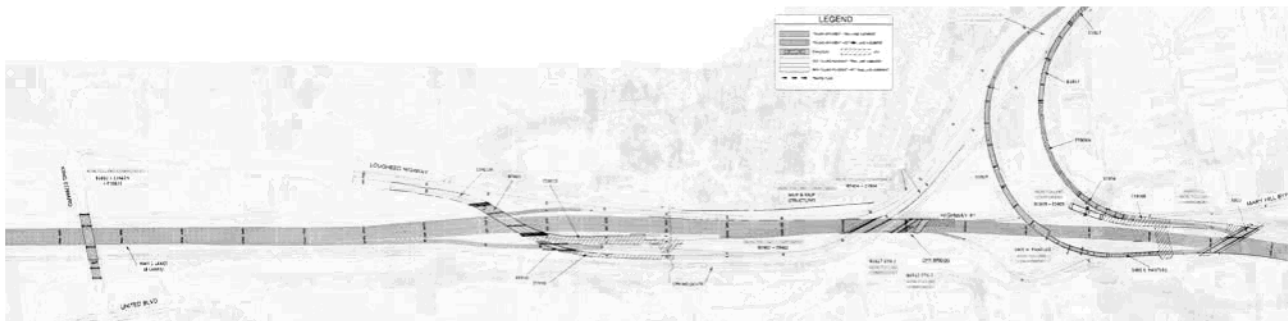
5.2.3.5 Managing the Directed Change: Crashing the Schedule

The general principle of mitigating the impacts of a Supervening Event apply both ways: TI Corp is obliged to do what it can reasonably do to restore the schedule.

Delays in the order of 90 to 120 calendar days could be mitigated over a period as long as 730 calendar days by “crashing the schedule”, an industry moniker for considering every method available to shorten the path to the end milestone.

Generally, all of the methods available to shorten or crash a schedule were considered and applied by TI Corp and Kiewit/Flatiron on PMH1. These include applying additional labour and equipment to activities on the critical schedule path, revising lane-closure restrictions and other schedule specifications to allow more work, and revising material specifications which restrict work such as allowing winter paving with asphalt heaters. Significantly, the parties also revised the minimum requirements of the traffic capacity to be in place along Highway 1 before tolling commenced, meaning that some elements of the PMH1 project were no longer among the Tolling Components. This, in turn, allowed some revisions to the design itself, the plan for which is shown in Figure 53 below with the revisions of the non-tolled components in orange.

Figure 53: Revised Capacity Requirements for Toll Commencement¹⁴⁹



5.2.3.6 Managing the Directed Change: Costs and Payments

TI Corp would expect increases in cost to result from crashing the schedule; only some of the methods used to shorten the schedule would not result in additional costs to Kiewit/Flatiron. A lump sum change order to implement the crashed schedule would require an agreement in advance on the price to be paid the shortened schedule. TI Corp and Kiewit/Flatiron were unable to agree on the price in advance, so they followed industry best practices in such a circumstance: TI Corp directed Kiewit/Flatiron to shorten the schedule to meet the Toll Commencement Date in December 2012 and be paid additional amounts for doing so on a force account basis.

¹⁴⁹ CC-0128B Change Report 9 January 2012.



When a portion of a project is executed on a force account basis, the costs of the work are not agreed in advance; rather, the owner and the contractor agree that “what will be, will be” and pay the contractor for time and materials expended to complete that portion of the project. A time and materials payment mechanism requires both parties to monitor the work done much more closely than a fixed price contract requires, and the costs of each party’s management efforts increase for that portion of the work completed on a force account basis. If the two parties have not agreed upon a fixed price for that portion of the work before it is completed, then the price of that work is the amounts due to force accounts that were created to keep track of the time and materials expended.

As a first step in this process, TI Corp and Kiewit/Flatiron developed lists of acceleration items and mutually agreed that these items were directly related to the acceleration. These approved acceleration lists formed the first basis of making progress payments to Kiewit/Flatiron. Kiewit/Flatiron would then allocate and record costs for these acceleration activities separately in its accounting system by applying activity codes to labour, equipment and material usage directly associated with these activities.

Since progress payments for the acceleration were based on actual costs, Kiewit/Flatiron needed to record the actual costs properly within their accounting system. This meant that TI Corp was able to examine Kiewit/Flatiron’s accounting records for actual costs incurred. TI Corp engaged Deloitte to check invoices presented by Kiewit/Flatiron against data in its accounting system to prevent overpayment or duplicate payment.

The works schedule updates with critical path analyses continued to be produced monthly by Kiewit/Flatiron. During the period of acceleration under the change directive, Kiewit/Flatiron submitted works schedules that identified and included the measures from the approved acceleration lists. The works schedule gave greater certainty that the selected measures for acceleration (working overtime on certain activities, etc.) were effective in shortening the schedule paths to tolling commencement. Likewise, it helped to make sure that acceleration measures were not being expended on activities that were not under a delay.

Invoices included detailed backup of actual costs incurred using the basis of the lists of approved acceleration activities. Kiewit/Flatiron, as part of the invoice submission, certified the actual costs. The Authority’s Representative and an independent consultant, Deloitte Inc., reviewed the invoice backup and tested it for accuracy.

Ultimately, Kiewit/Flatiron and TI Corp agreed upon fixed prices for the measures taken to restore the schedule and the measures taken to ensure that gravel of sufficient quantity and quality were available to the project. Thus, the force account payments that TI Corp had made under all of the relevant change orders were rendered *post facto* into progress payments: interim payments that were subject to the agreed price.



As is described in Section 5.3.3 below, the monthly progress payments due to Kiewit/Flatiron each month for work done within the base contract price of \$2.398 billion were estimated using the actual costs incurred by Kiewit/Flatiron. As a result, those monthly progress payments were calculated in the same manner as the time-and-materials payments made into force accounts. While the two streams of payments were different, they looked very much the same: for example, the same cost items often appeared in both the base contract progress payment calculations and in the force account calculations. With their calculations laid out side-by-side in Kiewit/Flatiron's monthly draws, the base contract calculations and the force account could easily be confused with each other.

5.2.3.7 *Negotiations of the Final Fixed Price*

After several months of proceeding on a time and materials basis with the additional work required to restore the schedule, TI Corp and Kiewit/Flatiron ultimately agreed upon a fixed price of \$99 million, additional to the contract price of \$2.398 billion, to achieve a Toll Commencement Date of 1 December 2012, versus the \$218 million initially proposed by Kiewit/Flatiron. The amounts paid to Kiewit/Flatiron on a time and material basis were treated as progress payments against this fixed price of \$99 million.

TI Corp's initial position for negotiation in September 2011 was to informally counter with an offer to extend the tolling milestone to June 1, 2013. As of November 2011, TI Corp considered the cost of an Authority Change issued to hold the tolling milestone to be approximately \$100 million. So the Board approved TI Corp to issue an Authority Change and appointed a representative to conduct negotiations. In response to the Authority Change, Kiewit/Flatiron proposed an additional cost of \$362 million to eliminate the delay in the schedule, which included \$60 million for settling other outstanding unresolved, disputed changes and \$90 million of past delay costs. Kiewit/Flatiron's proposal is shown in Figure 51 above.

By late January 2012, TI Corp and Kiewit/Flatiron negotiations had stalled. Neither side was prepared to accept the cost estimates that were presented by the other. The negotiations ultimately succeeded later in the execution of the restored schedule, when the force account amounts clearly indicated that the actual costs of the additional activities required would be nowhere near the \$218 million initially proposed by Kiewit/Flatiron. Our review of the negotiation process revealed that, in this matter, the Province had to rely upon contracted consultants to produce its cost estimates. For a project the size and complexity of PMH1, an estimating resource who could independently develop bottom-up contractor-style estimates would have been appropriate. A contractor-style estimate is built up using planned crew sizes, equipment, and material and then factors in production rates. This is different from unit price estimating used by most engineers, where average unit prices are based on historical data instead of built up from planned equipment and crew sizes.



Recommendation: Independent Costing and Scheduling Capabilities. The Province should maintain, at a minimum, its own capabilities to estimate the cost and schedule of a large highway construction project using best practices and using project management information systems that are compatible with those used by the contractor for the duration of the construction contract.

Confronted with various unsettled changes, delays and disputes, TI Corp went forward in November 2012 to settle the acceleration and other matters with Kiewit/Flatiron. TI Corp, as they approached the Tolling Commencement Date, still had the option to convert the directed change to a negotiated change. This was to their advantage as it is generally to both parties benefit if changes are settled at the project level. Taking a dispute to a court proceeding or alternative resolution is an expensive and time-consuming process. TI Corp was acting as directed in the contract. The Design Build Agreement states that TI Corp was to “make bona fide efforts to resolve by amicable negotiations” and to “exhaust all efforts to resolve at all levels of management.”

For both of these changes, TI Corp had been making progress payments and it is unlikely in the reviewer’s determination that the changes could have been settled for less than the progress payments to date. At the time of the negotiation, progress payments on the acceleration directive totalled \$64 million with another two months of costs due to be paid to Kiewit/Flatiron above that number. With TI Corp pre-approving the activities which were needed to accelerate the work, Kiewit/Flatiron submitting actual costs associated with those activities, and Deloitte providing another review of the costs, it is not realistic that TI Corp could have negotiated a significantly lower cost than they did once prior approved payments and unpaid months are considered.

The total settlement was \$169 million and included two significant changes. The acceleration costs were settled for \$99 million and the gravel issue for \$72 million.

5.2.4 Fraser Heights Wetlands Bridges and the Carvolth Exchange: Changes in Scope

The Province added two components to the scope of the PMH1 project in July 2010, 15 months after the Design Build Agreement was concluded: the Fraser Heights Wetlands Bridges and the Carvolth Exchange. Both of these additions to scope were consistent with the objectives of the PMH1 project; indeed, they were included or anticipated in the pre-design concept for the project that was defined in 2006.

The delay in making these additions created difficulties in the project schedule as both components were Tolling Components and thus had to be substantially complete by December 2012. The compressed schedule requirements added 18% to the cost of the Fraser Heights Wetlands Bridges and 23% to the cost of the Carvolth Exchange. MOTI did not develop these projects to the point that they were ready to advertise as stand-alone design-bid-build projects, or even produce its own cost estimates for the components, during the 15 months that they were under MOTI management. That likely contributed to these unsatisfactory outcomes.



The Province might have intended to let these components as separate design-bid-build projects in attempts to secure a lower price, but missing records make that impossible to know. We found that the Province often had difficulties locating documents related to the PMH1 project and were surprised by the extent to which the Province was unable to recover key documents related to the development of these two components. In our experience, generic records management systems such as the Province's Total Records Information Management (TRIM)¹⁵⁰ System are not well-suited to the unusual requirements of construction management. Other jurisdictions in which we have worked tend to use off-the-shelf records management programs that are designed for construction management and are compatible with project management information systems.

Recommendation: Project and Construction Management Records. The Province should investigate the benefits and costs of storing documents and records created during major highway project development and construction in a records management system that is designed for project management and, ideally, is compatible with what project management information system the Province considers as it builds up its independent scheduling and costing capabilities.

5.2.4.1 Fraser Heights Wetlands Bridges

The wetlands bridges were included in the initial scope of the PMH1 project that was provided to Connect BC and other public-private partnership proponents in 2008. As it was negotiating the scope, schedule and cost of the Design Build Agreement the Province requested a separate price for this component of the project, and Kiewit/Flatiron proposed a price of \$31 million. The Province rejected that price and the two parties agreed that this component would be excluded from the scope of the Design Build Agreement. Once the Design Build Agreement was concluded in March 2009, the Fraser Heights Wetlands Bridges became a separate project in the hands of MOTI to execute.

There was no question that the wetlands bridges had to be built by the Toll Commencement Date of 1 December 2012: Highway 17, of which they are a part, was the toll-free alternative to Highway 1 across the Port Mann Bridge for travel from Tsawwassen, White Rock and Delta into the interior.

“The pre-design concept calls for significant redesign and reconstruction of the [176 Street] interchange to address forecast changes in travel patterns and provide for connections for new road networks created by the South Fraser Perimeter Road (SFPR) and Golden Ears Bridge. Improvements will include replacement of the overpass to meet new clearance standards and increase cross-highway capacity....”¹⁵¹

¹⁵⁰ Not to be confused with the Province's Terrain Resource Information Mapping (TRIM) System.

¹⁵¹ Province of British Columbia Gateway Program. *Improving Roads and Bridges for people, goods and transit throughout Greater Vancouver: Program Definition Report*. 31 January 2006,





Nor was there much question of the scope and construction method. The bridges pass over a wetlands area that is sensitive to any intrusion and were built with a special technique in which all of the heavy equipment needed is kept on the bridge decks itself, rather than on the ground below them.

The only question was whether the wetlands bridges would be built as part of the SFPR project, as part of the PMH1 project or as a separate project. It had been included in the PMH1 project up to March 2009 to capture some advantages in construction:

“There are significant benefits to having the PMH1 contractor responsible for this section, including:

- Construction and design efficiency due to proximity to the Highway 1/176th Street Interchange [the Fraser Heights Connector];
- Bridge design expertise – the same contractor that will build the new Port Mann Bridge will be responsible for design and construction of an approximately 450-metre long bridge over the wetland area adjacent to the Fraser Heights Area.”¹⁵²

The Province added the wetlands bridges to the scope of the SFPR project in March 2009¹⁵³, but removed them two months later, on 7 May 2009, intending to execute them as a separate project. The Province began acquiring the rights-of-way needed for the wetlands bridge project in June 2009. Thereafter, missing records make it difficult to determine fully what MOTI did to advance the project during the following year. In July 2010, a MOTI working group reported that design was about 50% complete and construction was scheduled to begin in September 2010.¹⁵⁴ Any project cost estimates that MOTI developed during that year have been lost.

In August 2010, MOTI transferred the wetlands bridges project to TI Corp for inclusion in the scope of the PMH1 Project¹⁵⁵ and TI Corp issued a Change Certificate directing Kiewit/Flatiron to execute the wetlands bridges project for \$31 million, the price proposed by Kiewit/Flatiron in early 2009.¹⁵⁶ Kiewit/Flatiron accepted the direction to commence work but reserved the right to revise the cost, given the one-year delay in commencing work. In November 2010, after discussions and compromises on the construction method, TI Corp accepted Kiewit/Flatiron’s estimate of \$36.5 million to execute the wetlands bridges by 1 December 2012.¹⁵⁷

¹⁵² Province of British Columbia Gateway Program. *Questions and Answers*, April 2008.

¹⁵³ Resolution of the Gateway Program Executive Board, 13 March 2009.

¹⁵⁴ E-mail from Kevin Baskin, MOTI, to Neil Valsangker, MOTI, 28 July 2010.

¹⁵⁵ Letter from Wayne Locke, Gateway Program, to Frank Blasetti, MOTI, 30 August 2010.

¹⁵⁶ CC-0027 27 August 2010.

¹⁵⁷ TI Corp Board of Directors Executive Summary, 26 October 2011



The Province is unable to produce documents that record why the wetlands bridges were transferred from the PMH1 project to the SFPR project in 2009, only to reverse the transfer one year later with an uncertain amount of work done during that year to advance the project. If the intention was to secure a lower price for executing the project then the attempt was doomed to fail: the Province removed the wetlands bridges from the SFPR project before any of the proponents shortlisted there could propose a price; the project was never advertised for award as a design-bid-build project and – most disturbing of all – there is no record of the Province preparing its own detailed cost estimate for the construction of the wetlands bridges.

The haphazard management of the Fraser Heights Wetlands Bridges is reflected in a poor cost performance outcome for this project: a cost increase of 18%, which is worse than the rest of the PMH1 project and at the 85th percentile of construction cost increases in our sample of 3,618 highway construction in North America, summarized in Section 4.6.4.2 above.

5.2.4.2 Carvolth Exchange

TI Corp and the Transit Branch of MOTI executed an agreement¹⁵⁸ under which MOTI would design and build the Carvolth Exchange between 29 July 2009 and 31 March 2012. Assigning the responsibility for funding and executing this exchange to TI Corp was consistent with the more general assignment of responsibilities to TI Corp in the Concession Agreement:

“The TI Corp covenants and agrees with the Province that it will, at the cost of the TI Corp, construct the Rapid Bus Eastern Connection and Transit Exchange [in the 202 Street area, Langley], in accordance with the Highway 1 Bus Rapid Transit Service MOU [between the Ministry of Transportation and TransLink dated 12 September 2007], to the reasonable satisfaction of the Province, as required by the Province and upon such terms, at such time and to such standard and specification as the Province shall determine and notify the TI Corp in writing.”¹⁵⁹

The scope of the Exchange provided for 1,000 parking places, bus-only access to and egress from Highway 1, an extension of 202 Street under Highway 1 and a storm water retention pond that would serve the surrounding community. This scope was generally consistent with the pre-design concepts for the PMH1 project, which anticipated park-and-ride facilities as necessary adjuncts to the HOV lanes and bus-only queue-jumping ramps that were key features of the project:

“... several opportunities for other transit priority measures have been identified along the [Highway 1] corridor. These include:

- Park-and-Ride lots at key interchanges in Surrey and Langley to

¹⁵⁸ British Columbia Ministry of Transportation and Infrastructure. *Project Funding Agreement between Transit Branch and Transportation Investment Corporation respecting Project No. 04822: 202nd Street Park-n-Ride Project*. Executed 6 January 2010.

¹⁵⁹ Concession Agreement dated 10 March 2010, Schedule 3: Additional Project Work.



enhance ridership for transit services being considered for this segment of the corridor; and

- Priority bus access to the highway corridor from the various Park-and-Ride lots”¹⁶⁰

The location and the scope of the exchange were also affirmed in a more specific business case analysis.¹⁶¹

We conclude that the inclusion of the Carvolth Exchange in the PMH1 project was proper, in that it had been anticipated in the conceptual specification of the project as early as 2006. The Province’s participation in the funding of park-and-ride facility was not unusual, given the different arrangements used to fund other park-and-ride facilities in the lower mainland, some examples of which are described in Topic Box below. It was also reasonable that the exchange was excluded from the scope of work defined in the Design Build Agreement in early 2009 as the design and location details had not emerged from the regional bus rapid transit plan at that time.

¹⁶⁰ Province of British Columbia Gateway Program. *Improving Roads and Bridges for people, goods and transit throughout Greater Vancouver: Program Definition Report*. 31 January 2006, Province of British Columbia Gateway Program.

¹⁶¹ Delcan Corporation. *202 Street RapidBus BC Transit Exchange, Ramps and Park-n-Ride Project*. 2008.

**Topic Box 4: Funding of Park and Rides in the Lower Mainland**

TransLink, when describing the mass transit services available in its service area, includes 20 park and ride facilities¹⁶² of which eight are owned and managed by TransLink directly and 12 are managed by municipal governments, other government agencies or private operators.

Over the past two decades, as many of these park and ride facilities were commissioned, there appears to have been no uniform formula to determine funding for their construction or operation. Decisions as to who would cover capital and operating costs appear to have been determined on a case-by-case basis. Three recent examples illustrate this conclusion:

South Surrey Park and Ride. Opened in 1991 and operated directly by TransLink, the South Surrey Park and Ride was relocated in 2006. The new site, on provincial Crown land, was leased to TransLink which then paid all construction and operating costs.¹⁶³ However, when the facility was expanded in 2012 construction costs were paid for by MOTI.¹⁶⁴ TransLink continues to operate the site.

Bridgeport Station Park and Ride. Bridgeport Station Park and Ride is housed within the River Rock Casino's parkade. Built as part of an agreement with TransLink regarding the development of Bridgeport Station, the Great Canadian Casino Corporation provided land, paid for construction, and currently operates the facility.^{165,166}

Coquitlam/Port Moody Park and Rides. Three park and ride facilities were constructed or expanded in the Cities of Coquitlam and Port Moody to support the Evergreen SkyTrain Extension. The original project scope contemplated 500 new park and ride facilities along the alignment. They were funded as part of the project, through a cost sharing arrangement between the Federal Government, Provincial Government and TransLink. Two park and ride facilities (an expansion at Moody Centre and new spaces adjacent to Coquitlam Central Station) were built by the Ministry of Transportation-led project team, and are operated by TransLink. It later became apparent that there would be benefit in providing additional park and ride spaces at the terminus station, Lafarge Lake Douglas Station. This additional capacity was funded through the project's contingency fund, and was delivered and is operated by the City of Coquitlam. In all, 704 new park and ride spaces were provided as part of the project.¹⁶⁷

¹⁶² TransLink. Park and Ride. Retrieved November 8, 2017 from

<https://www.translink.ca/en/Getting-Around/Driving/Park-and-Ride.aspx>

¹⁶³ Staff Report to GVTA (Greater Vancouver Transit Authority, TransLink) Board of Directors. South Surrey Park & Ride - Specific Project Approval. May 20, 2005 Board Meeting, Agenda Item 4.6.

¹⁶⁴ Ministry of Transportation and Infrastructure Press Release, October 12, 2012. *\$60.5 million for highway improvements*. <https://news.gov.bc.ca/stories/605-million-for-highway-improvements>

¹⁶⁵ Great Canadian Gaming Corporation. Legacy Projects - Richmond.

<https://gcgaming.com/legacy-projects/#1470682078218-8f72df36-91a4>

¹⁶⁶ Staff Report to City of Richmond Council (2007). Zoning Amendment Bylaw 8212 (RZ 07-359525). May 22, 2007 Regular Council Meeting, Agenda Item 11.

¹⁶⁷ Amanda Farrell, Partnerships BC, February 6, 2018.



The agreement between TI Corp and MOTI defined the delivery method as design-bid-build and set the schedule and budget shown in Figure 54 and Figure 55 for the components of the project that TI Corp was expected to fund and execute: the HOV lanes and other structures within the Highway 1 right-of-way.

Figure 54: Carvolth Exchange Project Schedule¹⁶⁸

Early November 2009	Start of rezoning process with Township of Langley
December 2009	50% detailed design
March 2010	Design completion and tender package
April 2010	Start of construction
31 March 2011	Substantial completion
31 March 2012	Completion

Figure 55: TI Corp's Share of Carvolth Exchange Project Funding, 2009

Total Project Costs	\$53,266,000
Less Recoveries	
Federal	(\$17,816,000)
TransLink	(\$2,750,000)
BC Transit	(\$0)
Municipal	(\$0)
Net Project Budget	\$32,700,000

The execution of the project differed significantly from these provisions. Rather than completing the project design between November 2009 and April 2010 as agreed with MOTI, TI Corp completed preliminary designs and provided them to Kiewit/Flatiron for pricing. In July 2010, TI Corp gave the design¹⁶⁹ and construction work to Kiewit/Flatiron within the PMH1 Design Build Agreement in a direct award.¹⁷⁰ The pursuant change certificate was in the nature of a limited notice to proceed, in that it specified a maximum amount of \$3 million and did not specify scope or schedule. The change certificate was increased to \$10 million in September 2010.

Given that the Design Build Agreement was a fixed price contract, good construction management practices suggest that Kiewit/Flatiron would agree upon the price for the

¹⁶⁸ British Columbia Ministry of Transportation and Infrastructure. *Project Funding Agreement between Transit Branch and Transportation Investment Corporation respecting Project No. 04822: 202nd Street Park-n-Ride Project*. Executed 6 January 2010.

¹⁶⁹ Kiewit/Flatiron noted that the preliminary design did not take into account significant additional construction costs for temporary works to construct the overpasses. TI Corp directed Kiewit/Flatiron to redesign the structures on Highway 1 to provide continuous connectivity for 202 Street during construction. Kiewit/Flatiron used other components of preliminary design for the park and ride itself.

¹⁷⁰ CC-0076 for \$3 million dated 7 July 2010.



exchange in the fall of 2010. Instead, they altered the delivery method in December 2010 to a time and materials basis, i.e. with no fixed price, “until the cost to completion is agreed, at which point the Authority Change will be amended.”¹⁷¹ TI Corp wrote to Kiewit/Flatiron in January 2011 to specify the scope of the exchange, the work to include all outstanding design work and all construction, and a substantial completion date of 1 December 2012, i.e. the substantial completion date for the Toll Components. Kiewit/Flatiron was to continue working on a time and materials basis and expect an amending change order in February 2011;¹⁷² however, that amending change order was never issued.

As design and construction proceeded throughout 2011, TI Corp and Kiewit/Flatiron had desultory discussions about the cost of the exchange: TI Corp requested cost estimates but was unable to put forward cost estimates of its own in sufficient detail to serve as the basis for a fixed price; Kiewit/Flatiron reiterated that the work was directed by TI Corp to be done on a time and materials basis.¹⁷³ TI Corp subsequently terminated the change certificate and directed Kiewit/Flatiron to discontinue in its role of prime contractor for the Carvolth Exchange as of 31 March 2012.¹⁷⁴ The exchange was completed by the sub-contractors assigned to the work and opened on schedule in December 2012.¹⁷⁵

Ultimately, the full project was executed at a cost of \$132 million, as shown in the sources and uses of funds shown in Figure 56 below.

¹⁷¹ CC-0076 Revision B dated 17 December 2010.

¹⁷² Letter from Gary Webster, Authority’s Representative to Frank Margitan, Kiewit/Flatiron dated 21 January 2011.

¹⁷³ Letter from Gary Webster, Authority’s Representative to William Murphy, Kiewit/Flatiron dated 16 December 2011 and letter from William Murphy, Kiewit/Flatiron to Gary Webster, Authority’s Representative dated 22 December 2011.

¹⁷⁴ Letter from William Murphy, Kiewit/Flatiron to Gary Webster, Authority’s Representative dated 4 May 2012.

¹⁷⁵ “Transit exchange a boon for Fraser Valley communities, says City of Langley mayor.” Langley Times, 19 November 2012.

Figure 56: Carvolth Exchange, Sources and Uses of Funds, 2013¹⁷⁶

	<i>MOTI</i>	<i>TI Corp</i>	<i>Total</i>
Sources of Funds			
PMH1 project budget		\$58,118,000	\$58,118,000
Transportation Finance Authority	\$52,770,062		\$52,770,062
TransLink	\$2,750,000		\$2,750,000
Canada: Infrastructure Stimulus Fund	\$15,158,638		\$15,158,638
Township of Langley Development Works Agreement		\$2,900,000	\$2,900,000
Total Sources	\$70,678,700	\$61,018,000	\$131,696,700
Uses of Funds			
Highway 1 at 200 Street			
Detours during construction	\$9,198,000	\$0	\$9,198,000
Eastbound HOV through lanes	\$0	\$26,635,000	\$26,635,000
200 Street Eastbound on-ramp	\$0	\$223,000	\$223,000
Eastbound HOV off-ramp	\$6,334,000	\$0	\$6,334,000
Eastbound HOV on-ramp	\$3,800,000	\$0	\$3,800,000
Westbound HOV on-ramp	\$6,334,000	\$0	\$6,334,000
Westbound HOV off-ramp	\$3,800,000	\$0	\$3,800,000
202 Street modifications under Highway 1	\$459,700	\$0	\$459,700
Westbound HOV through lanes	\$0	\$26,834,000	\$26,834,000
Westbound general traffic off-ramp	\$0	\$1,102,000	\$1,102,000
Highway 1 flyover 202 Street	\$3,324,000	\$3,324,000	\$6,648,000
Township of Langley development works		\$2,900,000	\$2,900,000
Subtotal	\$33,249,700	\$61,018,000	\$94,267,700
Carvolth Transit Exchange			
Design, Construction, Management:	\$20,989,000		\$20,989,000
Properties:	\$16,440,000		\$16,440,000
Subtotal	\$37,429,000	\$0	\$37,429,000
Total Uses	\$70,678,700	\$61,018,000	\$131,696,700
Reconciliation to TI Corp Budget			
TI Corp spending per table above		\$61,018,000	
CC-076, i.e. paid to KF ¹⁷⁷		(\$25,902,275)	
MOTI Tech Projects, i.e. paid to sub-contractor difference		(\$35,205,084)	
		<u>(\$89,359)</u>	

Construction management performance outcomes for TI Corp's portion of the project, summarized in Figure 57 below, were poor relative to the rest of the PMH1 project and relative to our experience with similar projects across North America.

¹⁷⁶ TI Corp: TI Corp and BCMoT cost Comparison by scope, total project, 21 February 2013

¹⁷⁷ The amount of CC 076 was budgeted at \$65 million at the time that Kiewit/Flatiron was dismissed.

Figure 57: Delivery of the Carvolth Exchange Project

	<i>Initial Specification</i>	<i>As Delivered.</i>	<i>% Change</i>
Scope, # of parking stalls	1,000	670 ¹⁷⁸	(33%)
Schedule, substantial completion date	1 December 2012	1 December 2012	0%
Cost	\$53 million	\$61 million	15%

We believe that these relatively poor construction management performance outcomes were due, at least in part, to the Province's lack of clear direction subsequent to its decision to manage this project using the design-bid-build delivery method, as was contemplated for it in the agreement between MOTI's Transit Branch and TI Corp.

5.3 Progress Payments

Almost all highway construction contracts, and all of the approximately 4,000 contracts that we used for the analyses in Section 4.6.4 above, include progress payments from the owner to the contractor: interim payments that the owner makes to the contractor while the work is being performed.

The rapid conversion of the delivery method from public-private partnership to design-build caught the parties flat-footed in some respects; nowhere else as much as with respect to progress payments. Public-private partnerships do not have them and the Province, after decades of reliance on public-private partnerships to deliver major projects, may have become unaccustomed to the administration of progress payments.

It might have been the sudden appearance of a need for progress payments that caused the Province to deviate away from the best practice of developing a full schedule of values and determine progress payments by estimating earned value as the project was executed. While TI Corp and Kiewit/Flatiron continued to develop the schedule of values, it was never used to determine the amounts payable in progress payments. Instead, the Province and Kiewit/Flatiron agreed to use a more reactive approach and use the costs entered into Kiewit/Flatiron's project cost accounting information system for the PMH1 project. The result in this case was that the amounts calculated for progress payments gave potentially misleading signals that either the project was further ahead of schedule than it actually was or that more costs had been included in the calculation than should have been. Either way, the maximum payout curve was required to restrict the amounts payable under progress payments more often than we expected it would.

We examined the calculations and invoicing of each progress payment and found that they had been properly estimated and paid out according to the method chosen to calculate them. However, we believe that the method chosen, the reactive method that

¹⁷⁸ Partly due to an enlargement of the area required for the detention pond and other conditions imposed in the Langley Township's approval of the development.



relied upon costs paid by Kiewit/Flatiron, is inferior to the alternative of using a full schedule of values.

5.3.1 The Rationale for Progress Payments

The purpose of progress payments is to minimise the cost of cash during construction, a cost that ultimately falls to the owner. If the owner makes no progress payments and makes only one payment at the completion of the project, then the contractor must secure the funds required to pay all of its costs during design and construction: materials, equipment, energy and labour. Usually, and in the case of the PMH1 project, the contractor's cost of funds is higher than that of the owner government. Since the contractor will factor its cost of funds into the fixed price of the contract, the owning government has an incentive to pay the contractor in such a way that the contractor draws on its own funds as little as is practical.

The amount to be paid in progress payments is at the equilibrium of two risks:

- If payments exceed the value of the work actually completed during the course of construction, any sudden insolvency of the contractor would leave the owner with less money in the project budget than it must pay to have another party complete the work; and
- If payments are much less than what the contractor has paid out, the advantage of government's lower cost of capital is lost.

Progress payments, whether paid on a monthly schedule or at the accomplishment of project milestones,¹⁷⁹ are designed to be close to project disbursements or earned value.

5.3.2 Progress Payments in a Fixed Price Contract

The amounts paid in progress payments have no impact on the total amount paid to the contractor. The sum of all payments is always the contract price, adjusted for change orders and event settlements. The final payment made to the contractor is that adjusted price less the sum of all progress payments.

How best practices fit progress payments into the overall payment arrangements of highway construction contracts is illustrated in Figure 58 below. The fixed price is shown by the thick red line at the top of the figure, unaffected by the payments shown in blue below it. Highway construction contracts typically hold back, or retain, a portion of the price that is paid out only after the close-out of the contract: all work is certified as complete, all defects are corrected and all claims settled.¹⁸⁰ From the beginning of the contract, the sum of progress payments will never be

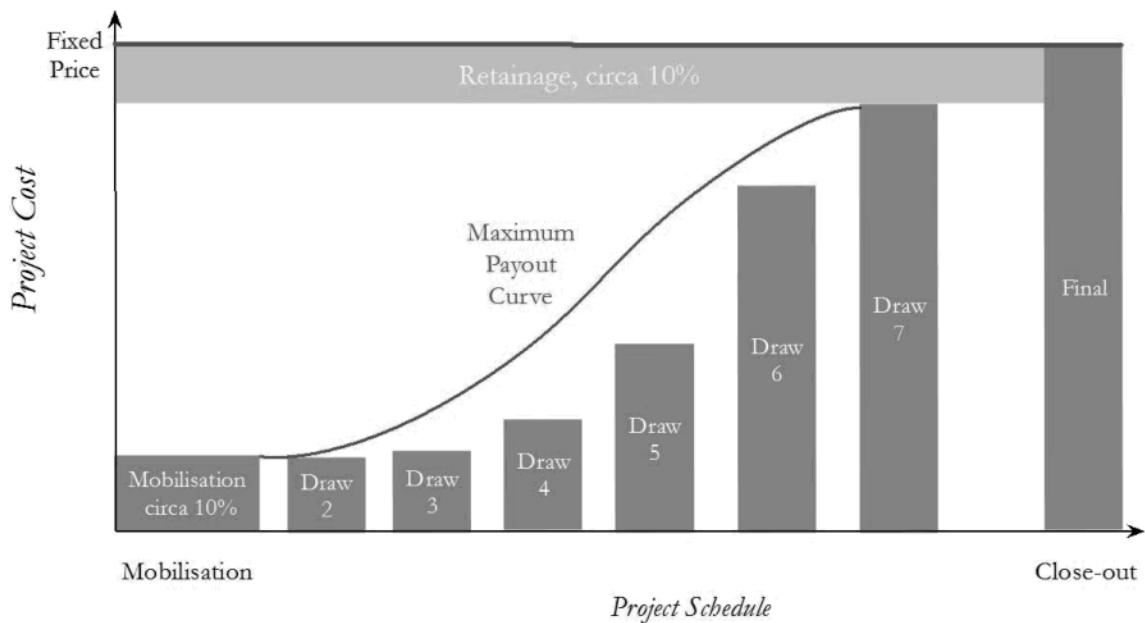
¹⁷⁹ In project management, a milestone is a marker in the works schedule of a significant event; in this case, the completion of a set of tasks. Unlike tasks, which have durations and efforts. Milestones have durations and efforts of zero.

¹⁸⁰ The close-out often takes months after the project is substantially complete, i.e. accepted for service.

more than the contract price less the amount retained, shown as the bottom of the pale red rectangle. The Design Build Agreement has such a retainage scheme.

In contracts with an early completion bonus, the contractor may decide to accelerate work to capture that bonus. Whether or not this adds to the contractor's overall costs, it would add to the amounts payable in the progress payments. So that the owner does not fund the contractor's decision to accelerate design and construction, the contract's payment scheme usually includes a moving cap, called a maximum payout curve, above which the sum of contract payments cannot rise regardless of how far ahead of schedule the contractor has achieved key milestones. The maximum payout curve is shown as a curved red line in the figure below. The Design Build Agreement had such a maximum payout curve.

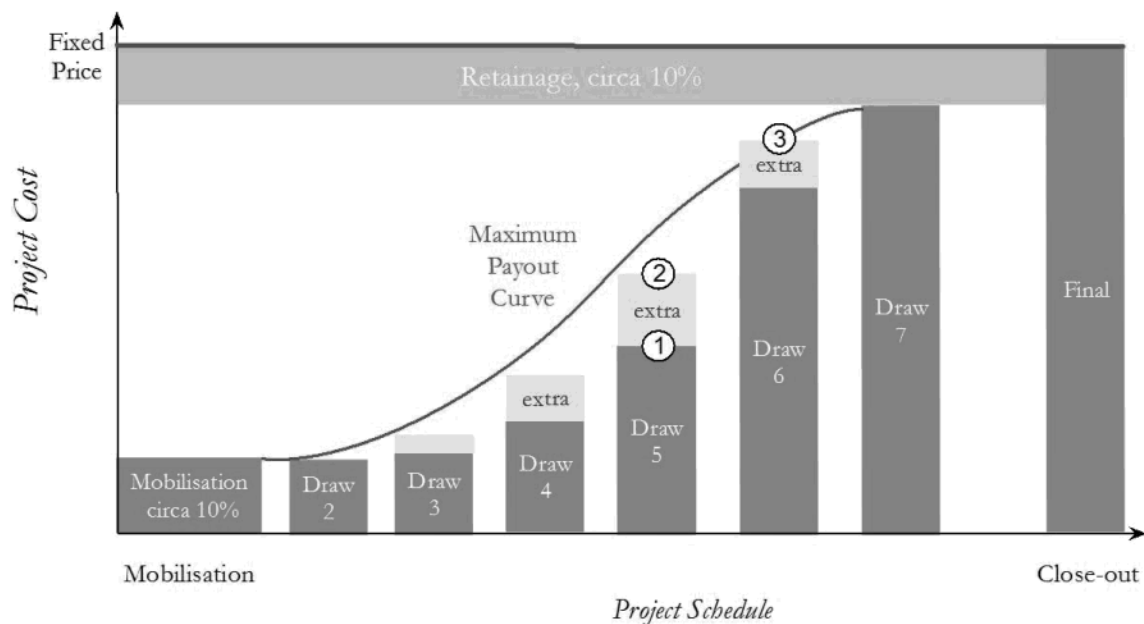
Figure 58: Prices and Payments



Progress payments are illustrated as blue-coloured Draws in the figure above. The earliest costs incurred in a highway construction contract do not materially advance the project's earned value. These are mobilisation costs: the costs of moving people and equipment into position on or near the site. Mobilisation costs can be, typically, about 10% of the total cost of the project so best practices are to define the first draw as a mobilisation payment of a fixed amount, to be paid when mobilisation is complete. The Design Build Agreement did not provide for a mobilisation payment, which contributed to the difficulties described in Section 5.2.3.6 above.

To amplify the point that the amounts paid in progress payments do not affect the total amount paid to the contractor, we modified Figure 58 above to show the unusual case of progress payments being higher than they should be, for one reason or another, in Figure 59 below. For the purposes of this illustration, we imagine that progress payments were incorrectly calculated, starting in Draw 3, and show the incorrect additions as pale blue rectangles.

Figure 59: Extra Progress Payments



The incorrect calculation adds to the progress payment up to Draw 5, in which the amount paid has incorrectly increased from (1) to (2). By Draw 6, however, the progress payment has encountered the maximum payout curve and is capped by the curve at (3). By Draw 7, the amounts paid by the incorrect calculation have been squeezed out entirely. In summary, the effect of an incorrectly calculated progress payment is not to pay too much, but to pay too early.

5.3.3 The Calculation of Progress Payments

The Design Build Agreement was not without its flaws, notable among them being a lack of specificity about progress payments. Progress payments were not contemplated as part of the requirements; they are not a feature of a public-private partnership. When financial negotiations between Connect BC and the Province failed, the agreement was converted from a public-private partnership to a design-build agreement in the space of about three weeks. The terms with respect to progress payments were added in that short period of time. Notwithstanding, the amounts paid in progress payments, including what items might have been included in the calculations of the amounts due, had no impact on the fixed price of the Design-Build Agreement.

The Design Build Agreement provided that:

“The Draw Request shall

- i. show the percentage completion of each item of [Design Build] work, including separately itemized construction costs (including stockpiled materials, soft costs, fee and applicable taxes); and



- ii. set forth the amount payable.”¹⁸¹

This inexact specification left TI Corp to choose between two approaches when calculating the amounts of progress payments.

5.3.3.1 *The Proactive Approach: the Schedule of Values*

In this method, the owner and the contractor insert milestones throughout the project schedule to mark the substantial completion of significant items of the design and construction work. They assign, only for the purposes of measuring progress and making progress payments, a portion of the contract price to each item. The amount assigned to each item is that item’s earned value. The list of items, each with its earned value, is a schedule of values: a list of the amounts that should be paid to the contractor in progress payments once the items are 100% substantially complete, subject to the maximum payout curve and subject to the fixed price of the contract. The sum of the earned values for all of the milestones in the schedule of values is equal to the contract price.

“The key to writing a successful lump sum payment provision is to request a payment schedule, or schedule of values, (from the contractor) that protects the agency for paying too much before work is complete and also does not create undue burden for administering the payments.”¹⁸²

Also known as the “percent complete” method, this proactive approach is the approach used most often in fixed price contracts.¹⁸³ The amount due for each work item in a progress payment at the end of each month is determined by measuring the % complete for that item and multiplying that percentage by the earned value for that item.

Amount Due = Earned Value = (Value at Completion) X (% Complete)

As the project proceeds, field inspectors for both the owner and the contractor estimate, each month, how close to completion each component has progressed in the last month. That estimate, expressed as a percentage up to 100% complete, is then multiplied by the value agreed for that component when it was identified. That amount, less amounts estimated and paid on the same basis for that component in prior months, is the progress payment due in the current month for that component. The sum of the progress payments due in the current month on all components is the amount due to the contractor.

TI Corp and Kiewit/Flatiron agreed upon an initial schedule of values for the 19 items of DB Work shown in Figure 60 below.

¹⁸¹ Design Build Agreement, 17 March 2009, Clause 10.3A Progress Payments.

¹⁸² Molenaar, et al. *Recommended AASHTO Design-Build Procurement Guide*. Project No. 20-7/Task 172, August 2005

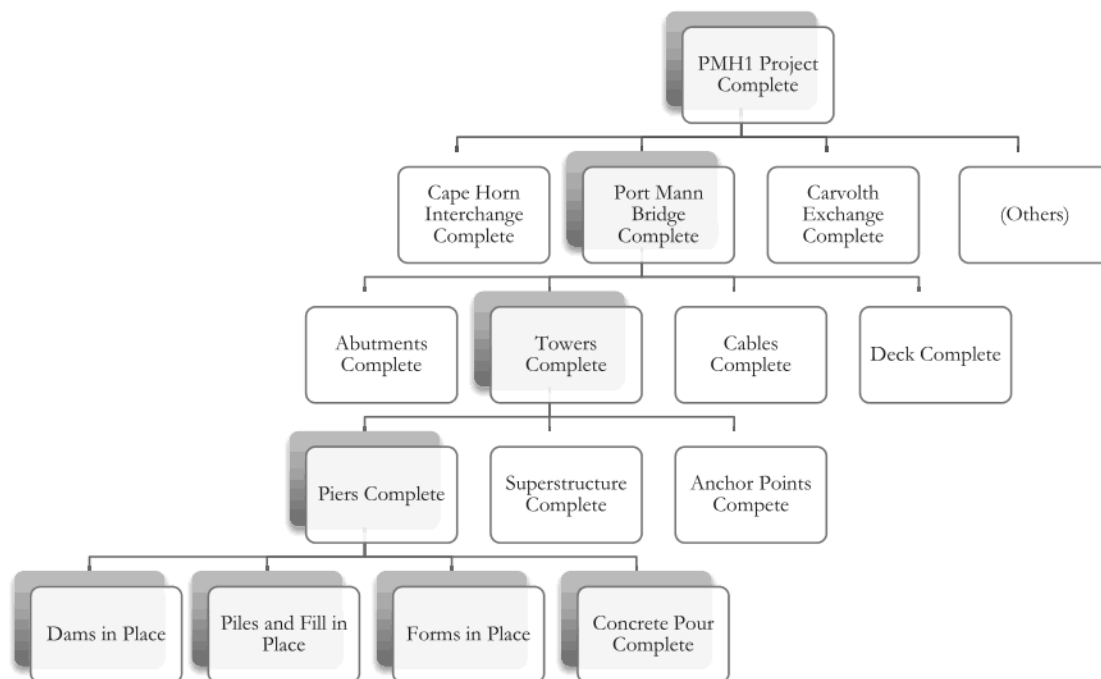
¹⁸³ Some design-bid-build projects use unit price payment methods.

**Figure 60: Initial Schedule of Values**

<i>Item #</i>	<i>Items of DB Work</i>	<i>Earned Value</i>
1.0	Hub and segment office mobilisation and demobilisation	\$145,840,000
2.0	Detailed design and construction support	\$236,673,000
3.0	Traffic control, traffic devices and detours	\$66,177,000
4.0	Demolition and removal of bridge, walls, buildings, culverts and barriers	\$19,850,000
5.0	Excavation and embankment of native soils	\$154,202,000
6.0	Walls	\$88,749,000
7.0	Environmental controls	\$20,012,000
8.0	Drainage: culverts, catch basins, water and sewer	\$97,985,000
9.0	Utility protection and relocation	\$59,431,000
10.0	Gravel and sand pit development and processing	\$34,226,000
11.0	Onshore foundations, sub-structures and superstructures	\$331,132,000
12.0	Base preparation and paving	\$105,531,000
13.0	Landscaping, lights, barriers, painting, traffic control systems	\$164,232,000
14.0	Quality control and survey	\$53,954,000
15.0	Port Mann Bridge foundations	\$268,704,000
16.0	Port Mann Bridge substructure	\$107,926,000
17.0	Port Mann Bridge superstructure	\$306,547,000
18.0	Port Mann Bridge dredging, docks, tugs and barges	\$97,920,000
19.0	Port Mann Bridge demolition	\$38,909,000
		<hr/> \$2,398,000,000

When a project is delivered with the design-build method, the milestones at the lower levels of the hierarchy may not be known when the contract is signed since detailed designs are not available. It is good practice to continue to develop the schedule of values as the design and construction of a project proceeds and details of the project become clear. On a complex project, a schedule of values has milestones arranged in a hierarchy in which milestones grouped underneath a high-level milestone represent the completion of smaller components within a larger component. Figure 61 below illustrates such a hierarchy, in a simplified form, for the piers of the Port Mann bridge.

Figure 61: Hierarchy of Milestones in a Schedule of Values



The proactive method of estimating progress payments require TI Corp and Kiewit/Flatiron to continue to develop the schedule of values into a hierarchy, in which more earned values were agreed for additional, more detailed, items. The objective of this continued development is a schedule of values for a large number of items whose completion is easy to determine and for which the earned values are small relative to the contract price. We illustrate with the example of the Cooper River Bridge design-build project, with a contract cost of \$675 million US and a final schedule of values of about 520 items, which administered its progress payments with an average earned value of about \$1.3 million US per item.

When using a schedule of values to determine progress payments, the process of estimating the percent complete towards hundreds of milestones is a more-or-less continuous process, in which field inspectors for the owner and the contractor are making estimates every day, negotiating towards their agreed values and recording these in daily and weekly field inspection reports. The estimation of the progress payment due each month is merely summation of progress and value estimates previously agreed. The verification of the progress payment invoice itself is a simple affair that takes only a few days; the five days allowed to TI Corp in the Design Build Agreement is consistent with this practice.

TI Corp and Kiewit/Flatiron ultimately defined 260 items of DB work in a hierarchy under the 19 items in Figure 60 above which, once they defined earned values for these items, resulted in an average earned value of about \$9 million CDN per item. This is a higher average earned value than we would recommend for good earned value management or for the administration of progress payments. Put another way, the schedule of values was not resolved down to the level of detail that we expected



to find in the PMH1 project. Such an observation is moot, however, because TI Corp and Kiewit/Flatiron used the earned values for neither schedule management nor to determine the amounts of progress payments. Instead TI Corp and Kiewit/Flatiron elected to use the reactive approach in the PMH1 project

5.3.3.2 *The Reactive Approach: Reviewing the Accounting System*

In the reactive approach, progress payments are based on the contractor's actual expenditures, on a time and materials basis, on each component of the project for which a milestone has been identified. If progress has been made in the completion of a component and all of the costs that the contractor has charged to that component are valid then the payment is approved. In the language of project management, progress payments are tied to effort, not to earned value.

The reactive approach requires close oversight of the costs and activities that are recorded in the contractor's accounting system to ensure, among other things:

- Only expenses that have been actually paid out are included in the progress payments, i.e. there are no accruals;
- No costs have been double-counted, e.g. overhead and indirect costs are properly allocated;
- Payments to sub-contractors, suppliers and utilities have been made in accordance with the governing agreements; and
- All liquidated damages and other hold-backs are properly recorded and included in the calculations of amounts to be paid.

In short, this is a cost accounting approach. The focus of the owner's oversight is on the contractor's accounts, not on their progress towards completion in the field. This method is almost always used in the cases of time and materials contracts, i.e. cost plus fixed fee contracts, in which the final cost of the project is not known and, therefore, a schedule of values cannot be calculated.

In the determination of the progress payments in the PMH1 project, for which earned values had been agreed for about 260 items of DB Work, those values at completion were used to estimate a percent complete of each line item.

$$\% \text{ Complete} = \frac{\text{Costs Incurred}}{\text{Value at Completion}}$$

This calculation does not yield a true measure of percent complete since the actual costs incurred are not necessarily the same as the earned value. Indeed, a significant performance measure in cost and schedule management is the difference between costs and incurred and value earned.

The oversight of the contractor's accounts requires that those accounts be open for ongoing inspection and supervision by the owner. Kiewit/Flatiron's books were open to the Province throughout the Project. TI Corp instructed KPMG to



supervise Kiewit/Flatiron as they entered activities and their costs into this system and report back to TI Corp quarterly with reviews of the accounting and payment processes:

“The payment quarterly process...is not a review of the Authority Representative himself but is intended for TI Corp to undertake appropriate reviews of the Design Build Contractor. Services include review of the billing processes and procedures used by Kiewit/Flatiron in order to understand the underlying processes being employed and the controls to assess the associated inherent risks that TI Corp may be exposed to. It was always understood by TI Corp that this would involve two steps, the first being to assess the process and then following TI Corp’s review of any findings to help arrange testing of the process.”¹⁸⁴

TI Corp went on to define the role of the schedule of values in determining the amounts of progress payments.

“I would also like to confirm that the original schedule of values does not form part of the Design Build contract. Its purpose is purely to act as a “proxy” and can be amended at any time as designs and priorities change consistent in a design build contract process. The schedule of values of is currently being updated to reflect changes in design, work sequencing, and material ordering as a result of one year’s progress.”¹⁸⁵

The decision to not apply earned value management to the schedule and to not use earned values to determine the amounts of progress payments led to an inability on TI Corp’s part to fully assess the implications of the progress payments made to Kiewit/Flatiron as is described in Section 5.2.3 above and in Section 5.3.4 below.

5.3.4 Payment History

Kiewit/Flatiron submitted 80 draws, i.e. invoices for progress payments, over the course of the PMH1 project’s design and construction at the rate of about 1 draw per month. In each draw, Kiewit/Flatiron reported its costs incurred to date in the design and the construction of the 19 items in the initial schedule of values. The entry of all of these costs into Kiewit/Flatiron’s project accounting information was overseen and approved by the Authority’s Representative. As the reactive approach to calculating progress payments was applied, no further validation of the amounts requested for payment was required other than the comparison of those amounts to the amounts allowed to be paid under the maximum payment curve.

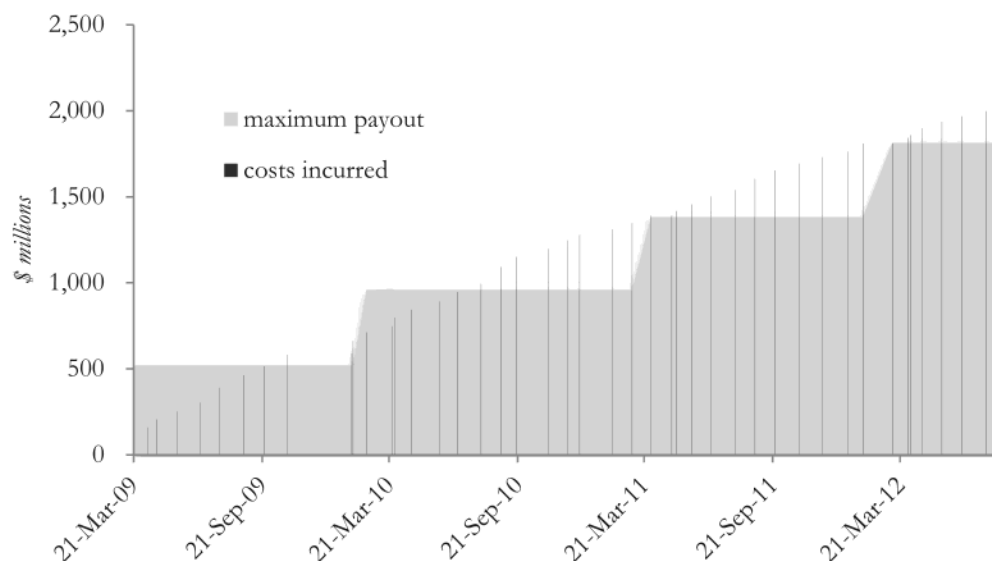
¹⁸⁴ 9 February 2010 letter from Garry Dawson, Vice President Technical Services, TI Corp to Stephen Beatty, Managing Director, KPMG.

¹⁸⁵ 9 February 2010 letter from Garry Dawson, Vice President Technical Services, TI Corp to Stephen Beatty, Managing Director, KPMG.

TI Corp and Kiewit/Flatiron applied the test of maximum payouts separately to amounts due under the base contract price of \$2.398 billion and to the sum of all Change Certificates. The Design Build Agreement directly specified the maximum payout curve for the base contract price. It also specified that the maximum payout in each month for Change Certificates would be the sum of all Change Certificates for which a fixed price was agreed plus the costs incurred under all Change Certificates that were issued on a time and materials basis.

We examined the first 47 of these 80 draws as they represented the seminal period in which payment procedures were first applied, and the periods in which design and construction activities were at their most intense. These draws spanned the period from March 2009, when the contract was signed, to September 2012.

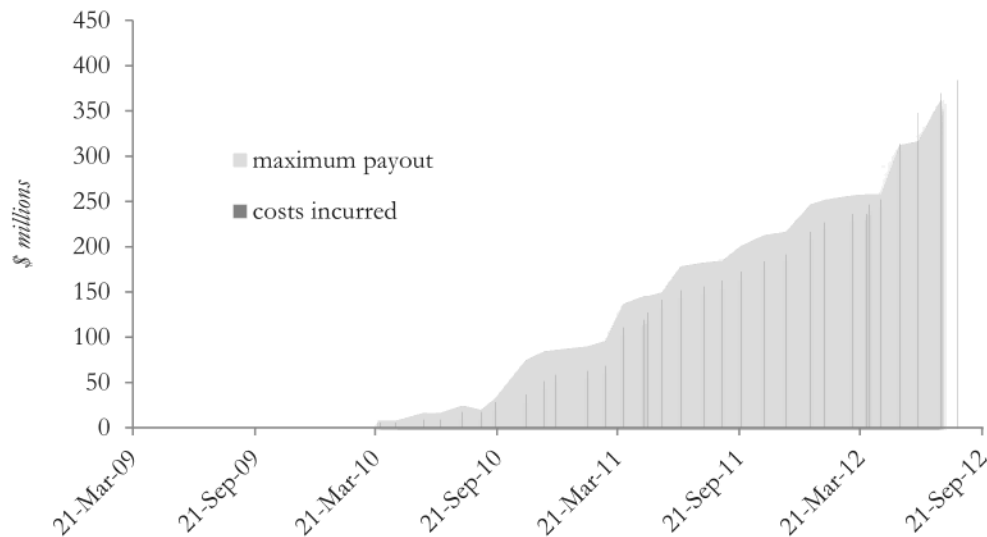
Figure 62: Maximum Payouts and Costs Incurred, Base Contract



We found that the maximum payout curve for the base contract price was less than the costs incurred up to that month only six of the first 18 draws but, thereafter, in all of but 1 of the 29 subsequent draws. This result leads to a significant conclusion: either the PMH1 project was consistently ahead of schedule between March 2009 and September 2012 or the reactive approach has calculated higher progress payments than would the proactive approach. If the PMH1 project were as consistently ahead of schedule as the progress payment suggested, then an observer would be sceptical of Kiewit/Flatiron's claim that the delays outlined in Section 5.2.3 above were a valid basis of a Relief Event. High progress payments determined under the reactive approach could lead an observer to question the costs that had been included in the calculation of those payments. Unfortunately, the lack of an independent determination of % complete and earned value leaves us unable to test which of these two possible explanations is the true one.

On the other hand, costs incurred under Change Certificates exceed the maximum payouts allowed for those change orders in only one of the 48 draws that we examined.

Figure 63: Maximum Payouts and Costs Incurred, Change Certificates



Our examination of the draws revealed no evidence of lax or improper administration of the progress payments. However, we view the experience of the PMH1 project as evidence that the reactive method of estimating progress payments is, in most ways, inferior to the proactive method of using earned values to estimate progress payments.

Recommendation: Schedule of Values for Progress Payments. The Province should use, as much as possible, a project's schedule of values and estimates of earned value to determine the amounts of progress payments.

**6 APPENDIX: CONTROL MATRIX IN THE CONCESSION AGREEMENT**

<i>Subject Matter or Section of Design Build Agreement (if applicable) or other Subject Matter</i>	<i>Consultation with Province Required?</i>	<i>Written Approval of Province Required?</i>	<i>TI Corp Required to Follow Direction of Province?</i>
Section 7.1 Approval of Constructor Proposals	Yes if TI Corp not capable of fully funding the Constructor Proposal or if there would, as a result of the Constructor Proposal, be a material change either to the risk profile or the liability exposure of the Province.		No.
Section 8.3 Determination of Constructor's entitlements for Compensation Event (unless such determination is expressly dealt with otherwise herein).	Yes if TI Corp not capable of fully funding the resulting Direct Losses (as defined in the Design Build Agreement) for which the TI Corp is responsible without materially changing either to the risk profile or the liability exposure of the Province.		No.
Section 8.6(a) Termination by TI Corp for Force Majeure Event	Yes.		No.
Section 8.6(a) Rejection of Constructor's for Force Majeure Event	Yes.	Yes if TI Corp not capable of fully funding the resulting Direct Losses (as defined in the Design Build Agreement) for which TI Corp is responsible without materially changing either to the risk profile or the liability exposure of the Province.	No.



<i>Subject Matter or Section of Design Build Agreement (if applicable) or other Subject Matter</i>	<i>Consultation with Province Required?</i>	<i>Written Approval of Province Required?</i>	<i>TI Corp Required to Follow Direction of Province?</i>
Section 8.7(a)(iii) or (iv) Termination by TI Corp for Damage or Destruction	Yes.		
Section 8.7(b)(i) or (ii) Election of TI Corp to terminate if Seismic Event over \$5 million	Yes.		
Section 8.10 Determination of Constructor's Entitlements for sharing of Increased Capital Expenditures	Yes if TI Corp not capable of fully funding the Constructor's resulting Capital Expenditures (as defined in the Design Build Agreement) without materially changing either the risk profile or liability exposure of the Province.		No.
Section 9.5, Section 9.6 Agreement to or settlement of any claim for indemnification by TI Corp.	Yes if TI Corp not capable of fully funding the payment of the resulting indemnity or if there would be as a result of the agreement to or settlement of any claim be a material change either to the risk profile or liability exposure of the Province.	No.	
Section 11.4 Exercise of TI Corp's Emergency Rights	No.		



<i>Subject Matter or Section of Design Build Agreement (if applicable) or other Subject Matter</i>	<i>Consultation with Province Required?</i>	<i>Written Approval of Province Required?</i>	<i>TI Corp Required to Follow Direction of Province?</i>
Section 12.3, 12.4 Exercise of TI Corp's remedies for Constructor Default.	Yes for proposed termination of Design Build Agreement.		No.
Section 14.2 Termination for Convenience	Yes.		
Section 16.4 Assignment by the TI Corp.	Yes.		

7 APPENDIX: CHECKLIST OF PROJECT MANAGEMENT PLAN GUIDANCE QUESTIONS¹⁸⁶

<i>US Federal Highway Administration Guidance (2017)</i>	<i>In CAMF (2002)?</i>	<i>As applied in the PMH1 Project</i>
What is the purpose of the project?	Yes	
What have been the historical commitments?	Yes	
Planning and environmental phases?	Yes	Defined in the 2006 Gateway Program Definition Report.
A clear description of what is to be accomplished?	Yes	
Scope, commitments, and public expectations?	Yes	
Social and community objectives?	Yes	Alternative transport modes and aboriginal rights explicitly considered. Aboriginal program objectives established for the project.
A clear, consistent definition of success?	Yes	TI Corp service plans had a full set of performance measures by 2013, of which three were directly related to the project goals: travel time savings, safety improvement and project cost.
Public trust and confidence?	Yes	
Cost estimate?	Yes	
Schedule?	Yes	
General public agreement?	No	Beyond the scope of this review.
A clear understanding of the project execution strategy?	Yes	The choice of delivery method was supported by comprehensive and risk-based analysis.
Has risk been assessed?	Yes	
Are there contingencies and a strategy to manage them?	Yes	Contingency funding was insufficient.
How will the contingencies be managed?	Yes	Insufficient contingency funding resulted in TI Corp finding relief from cost pressures via a change in the basis of accounting.

¹⁸⁶ 27 June 2017 update.https://www.fhwa.dot.gov/majorprojects/pmp/pmp_guidance_questions.cfm

<i>US Federal Highway Administration Guidance (2017)</i>	<i>In CAMF (2002)?</i>	<i>As applied in the PMH1 Project</i>
Can the strategy adapt to scope change?	No	Yes, and did so through the execution of the project.
Can the strategy adapt to technological change?	No	n/a
An acquisition strategy for right of way?	n/a	Yes
An acquisition strategy for design and construction?	Yes	Yes
An acquisition strategy for labour?	No	Some issues found in the procurement of technical services.
General liability insurance?	Yes	Insurance requirements fully stipulated in the Design Build Agreement.
A clear dispute resolution mechanism?	No	Fully stipulated in the Design Build Agreement. All issues were resolved by negotiations between TI Corp and Kiewit/Flatiron.
Will impacts on traffic and commerce be mitigated?	n/a	Yes: fully stipulated in the Design Build Agreement.
Is the management organization appropriate?	Yes	Yes
Are roles and responsibilities clearly delineated?	Yes	Yes, in particular the role of the Authority's Representative was properly defined.
Are authority thresholds clear and reasonable?	No	Set out clearly in TI Corp's spending authority policies.
Private sector roles are properly controlled?	No	Private sector personnel on the project management team were under a project director who was an employee of a provincial agency.
Does it facilitate timely decision-making?	No	Yes
Is project funding sufficient?	Yes	Contingencies within the project were insufficient.



<i>US Federal Highway Administration Guidance (2017)</i>	<i>In CAMF (2002)?</i>	<i>As applied in the PMH1 Project</i>
Is there a financial plan?	Yes	The project's budget for capitalised expenditures was not reduced by \$39 million when that amount for bridge decommissioning was reclassified from capitalized expenditures to operating expenditures.
Are the controls adequate on cost, schedule, scope, quality, safety, and security, for management to make decisions?	Yes	Project controls on scope and schedule met industry good practices. Quality controls exceeded good practices. Cost controls evolved into good practices after the change from a PPP to a design-build required progress payments to be made.
Value engineering?	No	Beyond the scope of this review.
Content, frequency, and distribution of reports?	Yes	Project reporting improved in 2013.
Claims and change management?	Yes	Well executed under difficult circumstances.
Is there an oversight plan that provides management with an objective, separate, and periodic review of project progress?	Yes	The project management team did not have the ability to conduct independent analyses of the project schedule on an ongoing basis.
Are adequate checks and balances in place?	Yes	Reporting requirements ensured timely information and separations of authority were complied with.
A communications plan to keep public and stakeholder awareness and expectations current and accurate?	Yes	Beyond the scope of this review.
A transition plan to move the project from construction to operations?	No	Included in TI Corp's service planning.
Is there a signed agreement among principals?	Yes	Both the Concession Agreement and the Design Build Agreement were well formed.



<i>US Federal Highway Administration Guidance (2017)</i>	<i>In CAMF (2002)?</i>	<i>As applied in the PMH1 Project</i>
Multistate/jurisdictional	No	Municipal approvals and co-operative project planning and funding with TransLink indicate the proper degree of municipal involvement.
Elected and other public officials	Yes	n/a



8 APPENDIX: HISTORY OF THE KPMG AGREEMENT

<i>Contract Owner</i>	<i>Contract #</i>	<i>Execution Date</i>	<i>Effective / Commencement Date</i>	<i>Completion Date</i>	<i>Scope</i>	<i>Comments</i>	<i>Addition to Contract</i>
MOT	048 CS 1102	17-Feb-03	1-Oct-02	31-Mar-05	Business Advisor for the Gateway Program, from program planning to transaction completion & performance monitoring. Some program development duties are shared with the Financial Advisor and the Owner's Engineer.	42 consultants with rates ranging from \$180/hour to \$295/hour.	\$1,000,000
	Amendment 1	20-Aug-03	1-Mar-03	31-Mar-05	No change in scope or duration.	An additional 14 Consultants with rates ranging from \$180/hour to \$295/hour.	\$2,340,000
PBC	04-057				Assigned to PBC under # 04-057		
PBC	05-003	1-Jun-04	1-Apr-04	31-Mar-05	Work Tasks for 2004/2005: project planning, development, implementation and approvals; business model and business plan; risk management with risk allocation matrix and Monte Carlo analyses; tolling; procurement; due diligence	PBC issues new Agt	
	Amendment 1	1-Sep-04	1-Jun-04		Per diem rates amended.		\$0
PBC	06-020	13-May-05	1-Apr-05	31-Mar-06	Scope of the Business Advisory Services for 2005/2006 are project planning and process management, relationship review during procurement, complete risk management analysis that was started in 2004/05, procurement process and tolling.	PBC issues new Agt	\$625,000
	Amendment 1	9-Dec-05	1-Dec-05		Approved contractors and fees amended		\$0
MOTI					Assigned to MOTI under 048 CS 1102 (A)		

<i>Contract Owner</i>	<i>Contract #</i>	<i>Execution Date</i>	<i>Effective / Commencement Date</i>	<i>Completion Date</i>	<i>Scope</i>	<i>Comments</i>	<i>Addition to Contract</i>
MOTI	048 CS 1102 (A)	17-Nov-06	1-Apr-06	31-Dec-09	Services to be provided: procurement advice and input; peer review [i.e proponent selection]; contract preparation; negotiation support; relationship review. No deliverables specified for the first time.		\$550,000
	Amendment 5	1-Feb-08	1-Aug-07		Increase in funding only		\$405,000
	KPMG letter		26-Aug-09		KPMG commits services from Gary Webster for PMH1, including Authority Representative, for \$2.869 million and SFPR for \$383,000.		
	Amendment 6	11-Jan-10	1-Sep-09	31-Mar-14	Authorities' Representative added to scope. Risk management dropped from scope. No deliverables specified. Tolling reappears as a separate item in scope.		\$3,800,000
	Amendment 7	25-Feb-10	1-Sep-09		Payment schedule amended changing individuals.		\$0
	Amendment 8	9-Jun-10	1-Apr-10		Payment schedule amended changing individuals.		\$0
	Amendment 9	11-Aug-10	1-Jul-10		Payment schedule amended changing individuals.		\$0

<i>Contract Owner</i>	<i>Contract #</i>	<i>Execution Date</i>	<i>Effective / Commencement Date</i>	<i>Completion Date</i>	<i>Scope</i>	<i>Comments</i>	<i>Addition to Contract</i>
TI Corp	11CB039	1-Sep-10	1-Sep-10	31-Mar-14	Assigns contract 048 CS 1102 (A) to TI Corp under 11CB039		
	Amendment 1	10-Mar-11	1-Mar-11		Additional individuals, including Mike Proudfoot as sub-contractor. For 2010/11: \$425,000 for YOMODO Systems Inc.; \$360,000 for Momentum Consultancy Group.		\$785,000
	Amendment 2	17-Jun-11	1-May-11		Allowed for changes to contractor's employee resources through email.		\$0
	Amendment 3	17-Jun-11	1-Apr-11		Added Glenn Chow of GreyBurg Consulting Ltd. as a sub-contractor		\$312,000
	Amendment 4	17-Jun-11	1-Apr-11		Added Tony Fong of BearCat Consulting Ltd. as a sub-contractor		\$312,000
	Amendment 5	23-Jun-11	1-Apr-11		For 2011/12: \$600,000 for YOMODO Systems Inc.; \$350,000 for Momentum Consultancy Group.		\$950,000
	Amendment 6	8-Sep-11	1-Aug-11		Additional individuals and an additional \$100,000 up to 30 June 2012 for Jacobs Canada Inc.		\$100,000
	Amendment 7	24-Aug-11	1-Jan-11		Amended rates for YOMODO Systems Inc. and Momentum Consultancy Group.		\$0
	Amendment 8	24-Oct-11	1-Aug-11		Amended limitation of KPMG's liability downward to \$500,000.		\$0



<i>Contract Owner</i>	<i>Contract #</i>	<i>Execution Date</i>	<i>Effective / Commencement Date</i>	<i>Completion Date</i>	<i>Scope</i>	<i>Comments</i>	<i>Addition to Contract</i>
TI Corp	Amendment 9	30-Nov-11	1-Sep-11		Increase in funds for continuation of services for the PMH1 project.		\$3,900,000
	Amendment 10	15-May-12	1-Apr-12		Increase in funds for continuation of services for the PMH1 project.		\$4,300,000
	Amendment 11	19-Sep-13	1-Apr-13		Increase in funds for continuation of services for the PMH1 project.		\$1,000,000
	Amendment 12	30-Mar-14	30-Mar-14	31-Mar-15	Increase in funds and extended the end date by one year.		\$1,200,000
	Amendment 13	24-Feb-15	24-Feb-15	31-May-15	Extended the end date by two months.		\$0
	Amendment 14	1-May-15	1-May-15	31-May-16	Extended the end date by one year for those services related to the Design Build Agreement.		\$0
							\$21,579,00

9 APPENDIX: BEST PRACTICES ASSESSMENT

The list below includes all of the steps in our best practices assessment template. We did not assess the PMH1 project at all of these steps; only those steps for which evaluation tables appear in this appendix. The full list serves as a checklist on the formation and execution of projects.

- 1.1 Pre-Project Planning and Completion
 - 1.1.1 Define measurable project objectives
 - 1.1.2 Consider alternatives for achieving project objectives
 - 2.1.3 Identify and enumerate investment risks
- 1.2 Project Definition
 - 1.2.1 Define scope and schedule used to achieve project objectives
 - 1.2.2 Approve sufficient funding in a time frame that allows the scope and schedule to be accomplished
 - 1.2.3 Enumerate project risks and the contingency funds to deal with project risks
 - 1.2.4 Define the budget, including contingency
- 1.3 Project Development
 - 1.3.1 Identify the party best able to control each of the project risks
 - 1.3.2 Select the project delivery method
 - 1.3.3 Select the pricing method
 - 1.3.4 Progress payments and retainage terms
 - 1.3.5 Fair and transparent project procurement procedures that provide open competition for qualified contractors
 - 1.3.6 Select designer and constructor of the project
 - 1.3.7 Plan to mitigate and manage each of the project risks
 - 1.3.8 Define the project performance metrics
- 1.4 Contract Development
 - 1.4.1 Contractual agreement for design and construction projects
 - 1.4.2 Specify scope of work, schedule, and cost
 - 1.4.3 Controls on scope and the change management process
 - 1.4.4 Processes for dealing with unexpected events
 - 1.4.5 Sequencing of work
 - 1.4.6 Dispute resolution process
 - 1.4.7 Quality control and quality assurance procedures

- 1.4.8 Safety procedures
- 1.4.9 Start-up and/or commissioning procedures
- 1.5 Project Management Development
 - 1.5.1 Project governance to align agency, owner's representative, and contractor
 - 1.5.2 Roles and responsibilities of owner's representative and other major functions
 - 1.5.3 Procuring owner's representative services according to agency and government policies and regulations
 - 1.5.4 Project cost control methods
 - 1.5.5 Project schedule control methods
 - 1.5.6 Project quality control methods
 - 1.5.7 Procedures for assessing the costs and benefits of events and change orders
 - 1.5.8 Approval authorities for events, change orders and payments
 - 1.5.9 Management of contingency allocation and approval of use
 - 1.5.10 Foster a positive working relationship throughout the design and construction process
 - 1.5.11 Seek to prevent disputes proactively and have a plan to expedite resolution when disputes occur
- 1.6 Construction Management and Project Control
 - 1.6.1 Analysis and management of the master schedule
 - 1.6.2 Utilize formal work scheduling methods and maintain an up-to-date progress schedule
 - 1.6.3 Changes and delays due to third-parties
 - 1.6.4 Performance reporting on project performance metrics
 - 1.6.5 Verifying construction percent complete and milestone reporting using field management
 - 1.6.6 Ongoing risk assessment and mitigation management
 - 1.6.7 Evaluation of events and mitigation measures
 - 1.6.8 Evaluation of change order requests
 - 1.6.9 Accelerating construction due to schedule delays
 - 1.6.10 Managing work performed on contractor force account or time and material type payment method

1.3 Project Development

1.3.1 Identify the party best able to control each of the project risks

Overall, and in the evaluator's opinion, was this best practice properly applied in this project?		Yes.
Policies and Procedures		
Did the owner clearly define the roles, responsibilities, and apportionment risk for the owner and contractor?	Yes, both in the initial risk register and in the terms of the contract. The risk register was developed with the Constructor during the public-private partnership procurement phase.	
Execution Practice		
Describe how key project risk allocation elements were defined in the contract.	Responsibilities for scope, schedule and cost elements were clearly defined and explicit provisions were made for unknown conditions and other changes.	
Describe any specific opportunities for communications/discussions of risk allocation between the owner and the contractor.	Constructor was involved in the creation and evaluation of the risk register during the P3 procurement phase.	
Example Indicators of Use		
Did the owner maintain a risk register during the planning and execution of the contract?	Only until the Design Build Agreement was concluded.	
Did the owner, or legal representative, develop a risk allocation matrix when authoring the contract?	There was a clear distribution of risk between TI Corp and its shareholder, the Province.	
How were these roles and responsibilities mapped to the appropriate project risks?	Both in the Design Build Agreement and in the Concession Agreement between the Province and TI Corp.	
Subjective Evaluation of Practices:		
Allocation of risks was clear and, with the one exception of gravel, appropriately distributed among the parties. The Province did not update the project risk register as the project was executed , but all parties were aware of risks at the time that the contact was signed.		

- AACE International Recommended Practice: *67R-11 Contract Risk Allocation – As Applied in Engineering, Procurement, and Construction*
- Construction Industry Institute Knowledge Base: *RT-210 Contracting to Appropriately Allocate Risk*
- Construction Management Association of America – Construction Management Standard of Practice: *Risk Management*
- Guide to Risk Assessment and Allocation for Highway Construction Management, *Report # FHWA-PL-06-032, Federal Highway Administration*
- Project Management Institute – Project Management Book of Knowledge: *Project Risk Management*

1.3.4 Progress payments and retainage terms

Overall, and in the evaluator's opinion, was this best practice properly applied in this project?		No.
Policies and Procedures Were the terms of payment to the contractor reasonable for the project?		Yes, with the exception of insufficient clarity in the beginning as to how progress payments should be calculated.
Execution Practice Explain the payment system used for the project. Describe any incentives included in the contract.		Progress payments based on % complete of 18 project elements, subject to a maximum payout curve. Retainage for incomplete items was calculated as the project proceeded and paid out at Total Completion. Fixed price, less progress payments, paid upon completion. Schedule bonus equal to 60% of toll revenue earned on tolls collected in advance of Toll Completion Date specified in the agreement.
Example Indicators of Use Was the progress payment contractual arrangement appropriate for this project? Were the incentives in the contract applied appropriately? Who were the proper authoritative parties to approve progress payments? Were proper approvals of progress payments made?		It was initially flawed in that it did not specify a schedule of values, i.e. how % complete would be calculated for each draw. n/a The Authority's Representative held this responsibility but had to seek the approval of the TI Corp's Vice President of Technical Services for all payments. Yes.
Subjective Evaluation of Practices: The basic payment structure was sound. There was insufficient detail in the Design Build Agreement as to how progress payments were to be calculated. This was rectified early in the project's execution but the section managers never had a detailed schedule of values with which to make their own estimates of % complete. In the absence of such a detailed schedule of values, the Constructor was paid for partially completed work according to what it had spent on the work.		
<ul style="list-style-type: none"> Alternative Payment and Progress Reporting Methods, Report to the <i>U.S. Department of Transportation Federal Highway Administration's Construction Management Expert Technical Group</i> Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects – Section 109: Measurement and Payment". <i>U.S. Department of Transportation Federal Highway Administration</i> 		

1.4 Contract Development

1.4.1 Contractual agreement for design and construction projects

Overall, and in the evaluator's opinion, was this best practice properly applied in this project?		Yes.
Policies and Procedures		
Was the contractual agreement appropriate for the project?	Design build was the most appropriate delivery method for this project.	
Execution Practice		
Describe the roles and responsibilities of the agency and contractor.	Conformed to the appropriate roles for owner and constructor in a DB contract.	
Explain the procedure used to negotiate and award the final contractual agreement.	Agreement was developed as a P3 then converted in a two-week period to a Design Build Agreement.	
Example Indicators of Use		
Were the process used to negotiate and award the contractual agreement appropriate for this project?	Constructor was chosen through a three stage public procurement: RFQ, technical proposal and full proposal.	
Did the contract agreement clearly define the roles and responsibilities of the agency and contractor?	Yes.	
Did any changes occur in the roles and responsibilities of the agency or contractor that were significantly different than the original contract agreement?	Some DB terms were brought into the agreement in the last two weeks: progress payments and schedule specifications. These terms suffered from a lack of detail and specificity. It is common for such details to be agreed after selection and upon execution of the agreement but time did not permit this on the PMH1 project.	
Subjective Evaluation of Practices:		
The bulk of the Design Build Agreement was of high quality.		

- American Association of State Highway and Transportation Officials – *AASHTO Guide for Design-Build Procurement, 1st Edition*
- Construction Management Association of America: Construction Management Standards of Practice: *Contract Administration*
- Design-Build Institute of America: *Transportation Sector Design-Build Done Right, Design-Build Best Practices*
- Federal Highway Administration: *23 CFR Part 636 Design-Build Contracting Final Rule 3/14/2014.*

1.4.2 Specify scope of work, schedule, and cost

Overall, and in the evaluator's opinion, was this best practice properly applied in this project?		Not reviewed.
Policies and Procedures		
Were the scope of work, schedule, and cost clearly defined in the contract?		Yes. The Design Build Agreement contained a full set of performance specifications for the completed facility and a full set of technical specifications to which the design was required to comply.
Were the defined scope of work, schedule, and cost reasonable for the contract terms and project duration?		Schedule was short and delivery intensity was high relative to other projects of this size. Probably necessary to minimise disruptions to traffic on Highway 1 during construction.
Execution Practice		
Explain the development of the scope of work for the contractual agreement between the owner and contractor.		Not reviewed.
Explain the development of the schedule for the contractual agreement between the owner and contractor.		Not reviewed.
Explain the development of the cost for the contractual agreement between the owner and contractor.		Not reviewed.
Example Indicators of Use		
Who was involved in the development of the contractual scope of work, schedule, and cost?		Not reviewed.
Was the scope of work defined clearly in the contract?		Yes.
Was the initial master schedule developed by the owner appropriate for the project?		The owner did not develop a master schedule. The owner's initial strategy was to execute the PMH1 project through a public-private partnership, in which case the owner would not have had direct responsibility for overseeing the schedule.
Was the overall cost developed appropriate for the project?		Not reviewed.
Subjective Evaluation of Practices:		

- Construction Management Association of America – Construction Management Standards of Practice: *Project Management*
- Project Management Institute – Project Management Book of Knowledge (PMBOK): *Construction Project Scope Management; Project Time Management; Project Cost Management*

1.4.3 Controls on scope and the change management process

Overall, and in the evaluator's opinion, was this best practice properly applied in this project?		Mostly yes.
Policies and Procedures Did the agency follow formal project controls and change management procedures? Were the project controls processes appropriate for the scope and scale of the project?		Yes, as seen through the Change Certificate Process. Yes, most change orders were resolved quickly.
Execution Practice Describe the change management process used for this project. Describe the measures that were in place to ensure the control of scope, cost, and schedule. Explain the process used to mitigate potential changes in scope, cost, and schedule.		At each change, the Constructor was required to submit cost and schedule estimates that, in most cases were treated as amendments to the fixed price of the Design Build Agreement. Changes could be made only through a Change Certificate. Certificates had to specify changes to scope, schedule and cost. TI Corp retained approval authority for all Change Certificates. There was a separate process for minor works changes. Mitigation of changes by the Province was not effective because the Province had no ability to independently forecast and assess looming changes. Some change certificates were made necessary to correct the Province's errors in budget-making.
Example Indicators of Use How many change orders were approved for this project? Who had the authority to approve change orders? Were change orders documented properly? Were approved changes in scope generally consistent with the identified objectives for this project?		59 Vice President Technical Services, TI Corp. Yes. Yes.
Subjective Evaluation of Practices: The change management process in the contract was sound but the Province struggled with a lack of construction management capacity to take full advantage of it.		

- AACE International – *Professional Practice Guide #12: Construction Project Controls, 2nd Edition*
- National Cooperative Highway Research Program – Report 821: *Effective Project Scoping Practices to Improve On-Time and On-Budget Delivery of Highway Projects*
- Project Management Institute – Project Management Book of Knowledge (PMBOK): *Construction Project Scope Management*

1.4.5 Sequencing of work

Overall, and in the evaluator’s opinion, was this best practice properly applied in this project?		Yes.
Policies and Procedures		
Was the work logically sequenced in the contract and during the execution?	Not reviewed	
Did changes in the work impact the sequencing of work after award?	Yes. Addition of the Fraser Wetlands Bridges to scope, the utility delays and changes in the sources of gravel all forced changes in the Constructor’s sequencing of work.	
Execution Practice		
Describe the process for sequencing the work for the project in the contract and during the execution.	Not reviewed.	
Describe the process for adjusting the sequence of work due to changes.	Owner allowed the Constructor to decide upon the modifications to sequence after satisfying itself that those modifications met the contractual requirement for the mitigation of events.	
Example Indicators of Use		
Was a work breakdown structure developed, reviewed, and used for sequencing work activities?	Yes.	
How did delays to the project impact the sequence of work?	Lengthened the master project schedule by about four months.	
Who was involved in the review of changes and associated adjustments to the sequence of work?	Constructor’s project manager, and the Vice President Technical Services, TI Corp.	
Subjective Evaluation of Practices:		
TI Corp played its proper role of testing the Constructor’s proposed changes for sufficient mitigation and, otherwise, allowed the Constructor to proceed as it thought best.		

- Construction Industry Institute Knowledge Base: *RT-334 Best Practices for Preventing Out-of-Sequence Construction Activities and Minimizing their Impacts*
- Project Management Institute: *Practice Standard for Work Breakdown Structures*

1.4.6 Dispute resolution process

Overall, and in the evaluator's opinion, was this best practice properly applied in this project?		Yes.
Policies and Procedures Did the agency require alternative dispute resolution methods for the project?	Yes, an expert panel and arbitration.	
Execution Practice Describe the dispute resolution process that was used for the project.	First efforts to settle disputes were negotiated at lower levels of management, then at upper levels. If negotiations failed then disputes were escalated to the resolution process.	
Example Indicators of Use Were any dispute prevention measures included in the contract? Were any alternative dispute resolution techniques put in place on the project? How many disputes did the project have? Who was to be involved in the dispute resolution process if an issue arose on the project?	Yes. No. None that required escalation to the resolution process. First, the lowest level of management possible; thereafter, each of Constructor and TI Corp were to designate people to resolve the dispute.	
Subjective Evaluation of Practices: The practices put in place for this project followed best practices and were used to good effect throughout the project. In addition, TI Corp maintained a healthy relationship with the Constructor.		

- AACE International – *Professional Practice Guide #01: Contracts and Claims, 4th Edition*
- Construction Industry Institute Knowledge Base: *RT-023 Dispute Prevention & Resolution*
- Project Management Institute – Project Management Book of Knowledge: *Project Claims Management*

1.5 Project Management Development

1.5.1 Project governance to align agency, owner's representative, and contractor

Overall, and in the evaluator's opinion, was this best practice properly applied in this project?		Yes.
Policies and Procedures Was the project governance structure appropriate to achieve the project goals? Did the project governance structure define appropriate fiscal management practices for the project?		Yes. Delegation of authority was clear and complied with Treasury Board Directives. Yes. Treasury Board stipulated upper limits on both capital expenditure and on debt, thus placing controls on gross expenditures and on business performance.
Execution Practice Explain the project governance and organizational structure. Explain the levels of control for the agency and contractor including the alignment between the parties. Explain the owner's representative role in relation to the agency and contractor.		The Minister Responsible dictated a matrix of controls that was embedded in the Concession Agreement between the Province and TI Corp, under which TI Corp was to build and toll the project. The Minister's delegation of authority was reflected in the Design Build Agreement. Both TI Corp and the Constructor kept control of the project at high levels within their organisations. The Owner's Representative was limited to acting in matters pertaining to the contract itself. The Owner's Representative was further limited by TI Corp retaining the authority to approve any change to scope, schedule or budget.
Example Indicators of Use Were appropriate roles included in discussions for fiscal management of the project? What was the project governance structure used for checks and balances in making decisions? Was the timing of the various decision boards coordinated to facilitate appropriate decision making? What types of external assurance processes were in place to provide objective evaluation of key decisions?		Yes. There was a proper delegation of authority from Treasury Board through the Minister Responsible to the Board of TI Corp. Yes. TI Corp staff obtained approvals from TI Corp Board when appropriate. Yes. Approvals did not result in any impediments or delays to the project's execution. Parent companies of the consortium members were guarantors but no performance bond was required.
Subjective Evaluation of Practices: Well-executed and in conformance with Treasury Board requirements.		

- Project Management Institute: *Governance of Portfolios, Programs, and Projects: A Practice Guide*
- Governance Structure And Design-Build Project Performance, *Transportation Research Board 2017 Annual Meeting*

1.5.2 Roles and responsibilities of owner's representative and other major functions

Overall, and in the evaluator’s opinion, was this best practice properly applied in this project?		Yes.
Policies and Procedures		
Did the agency define the roles and responsibilities of the owner’s representative?	Yes. The role of the Authority’s Representative was properly defined and restricted to the role of contract management.	
Execution Practice		
Describe the roles and responsibilities of the owner’s representative according to the contract.	The Owner’s Representative is to ensure that the Constructor has met its obligations under the agreement before it is paid. As such, the Owner’s Representative was limited to acting in matters pertaining to the contract itself.	
Explain any changes or modifications that occurred to the roles and responsibilities of the owner’s representative.	None.	
Example Indicators of Use		
Were the roles and responsibilities consistent with the project objectives?	Yes.	
Did the roles and responsibilities change over time?	No, although the Owner’s Representative was also acting in the separate role of Business Advisor to the project.	
Did the agency receive the expected owner’s representative services for the project?	Yes.	
Were policies and regulations on the use of owner’s representative services followed properly?	Yes.	
Was the owner’s representative granted decision-making authority for the project?	The Owner’s Representative was further limited by TI Corp retaining the authority to approve any change to scope, schedule or budget.	
Subjective Evaluation of Practices:		
The Owner’s Representative was restricted to a limited role in this project. This central retention of control was not a positive feature in this project, given the changes to the scope and to the sources of gravel that the Province made prior to executing the Design-Build Agreement.		

- AACE International – *Professional Practice Guide #14: Portfolio & Program Management, 2nd Edition*
- Construction Management Association of America: *An Owner's Guide to Construction and Program Management*
- Construction Management Association of America – Construction Management Standards of Practice: *Program Management*

1.5.3 Procuring owner's representative services according to agency and government policies and regulations

Overall, and in the evaluator's opinion, was this best practice properly applied in this project?		No.
Policies and Procedures Did the agency follow a formal procurement policy and government legislation for the procurement of the owner's representative given the project scope, scale and delivery method?		Initially yes but not throughout the duration of the project.
Execution Practice Explain the RFQ/RFP process used to procure the owner's representative services. Explain the evaluation and selection process.		CH2M Hill was chosen through a RFQ process. Owner's representation services were subsequently passed to KPMG through a direct award. CH2M Hill was one of several firms that was pre-qualified to provide engineering services to the Gateway Program.
Example Indicators of Use Were procurement policies and regulations followed in a reasonable manner? Was the procurement process open and transparent? Were any procurement protests filed? Did an adequate number of qualified firms respond to the owner's representative solicitation?		No. Award of the services was transferred to KPMG in a direct award. The value of services was increased subsequently through direct awards. KPMG was never pre-qualified to provide engineering services. Initially, yes. No. Yes.
Subjective Evaluation of Practices: The Province met the letter of the law with respect to its procurement procedures, it did not follow through with good administration of this procurement.		

- Construction Management Association of America: *An Owner's Guide to Construction and Program Management*
- Federal Highway Administration: *23 CFR Part 636 Design-Build Contracting Final Rule 3/14/2014*
- Project Management Institute – Project Management Book of Knowledge (PMBOK): *Project Procurement*

1.5.9 Management of contingency allocation and approval of use

Overall, and in the evaluator's opinion, was this best practice properly applied in this project?		No.
Policies and Procedures Did the agency properly allocate contingency for changes on this project? Did the agency properly manage the contingency approval process for changes on this project?		No. At about 2% of the total project cost, the initial contingency for the project was insufficient. Yes. Authority to approve contingency allocations was clearly delegated to the Board of TI Corp, which applied that authority properly.
Execution Practice Explain the process for developing the budget contingency. Explain the process for allocating contingencies to cover the cost of change orders.		Set by Connect BC as the contingency required to deliver the PMH1 project as a private-public partnership then never revisited when the delivery method change nor during project execution. TI Corp's Board of Directors controlled the budget process through which funds were transferred from the contingency line item to the change order line items
Example Indicators of Use Was the budget contingency developed based on project risks? Was the developed contingency a justifiable and appropriate amount for this project? Did the agency release contingencies for use appropriately? Was contingency used to cover the cost of realized project risks? Were contingencies used for changes associated with delays caused by third-parties (e.g., utilities, railroad, etc.)?		Yes. No. Yes. Yes. Yes.
Subjective Evaluation of Practices: While they were properly administered, the amount initially budgeted for contingencies was insufficient given the risks that the Province assumed in the project. Given the small contingency, the absence of a risk register is even more problematic. Earned value management was not applied to the PMH1 project.		
<ul style="list-style-type: none"> AACE International Recommended Practice: 40R-08 <i>Contingency Estimating – General Principles</i> AACE International –Professional Practice Guide #8: <i>Contingency</i>, 4th Edition National Cooperative Highway Research Program – Report 658: <i>Guidebook on Risk Analysis Tools and Management Practices to Control Transportation Costs</i> 		

1.6 Construction Management and Project Control

1.6.1 Analysis and management of the master schedule

Overall, and in the evaluator's opinion, was this best practice properly applied in this project?		No.
Policies and Procedures		
Did the agency and contractor develop and manage the project schedule in a reasonable manner?	No. The Province relied heavily upon the Constructor to develop and manage the schedule.	
Execution Practice		
Explain the process used to develop the project master schedule.	Initial development was not reviewed. Subsequent changes were proposed by the Constructor. These proposals sometimes required 90 days to complete.	
List and describe the major project milestones and the critical path.	Major milestones were defined in the Design Build Agreement, Schedule 3. Critical path was identified in PDF versions of the master project schedule.	
Describe the issues the lead to major schedule delays on the project.	Utility delays, changes in sources of gravel and additions to scope.	
Example Indicators of Use		
Were delays the result of actions by the agency, contractor, or owner's representative?	Utility delays were caused by third parties. Delays due to gravel and scope additions were caused by the Province.	
What delays were caused to key critical path activities?	Yes.	
Were changes to the schedule discussed and approved in a reasonable manner?	No. Updates to the schedule took up to 90 days whereas they should have taken 30 days. The Province was unable to independently review the updates at their full level of detail.	
Subjective Evaluation of Practices:		
The Constructor followed best practices in its management of the schedule but the Province was unable to fully verify the necessity of the schedule changes that the Constructor brought forward for approval.		

- AACE International *Professional Practice Guide #01: Contracts and Claims, 4th Edition*
- AACE International – *Professional Practice Guide #04: Planning and Scheduling, 4th Edition*
- AACE International – Recommended Practice 78R-12: *Original Baseline Schedule Review – As Applied in Engineering, Procurement, and Construction*
- American Association of State Highway and Transportation Officials – *Guide Specifications for Highway Construction, 2nd Edition: Section 108.02*
- Project Management Institute: *Practice Standard for Scheduling, Second Edition*
- Construction Management Association of America – *Construction Management Standards of Practice: Time Management*
- Project Management Institute – *Project Management Book of Knowledge: Project Time Management*

1.6.2 Utilize formal work scheduling methods and maintain an up-to-date progress schedule

Overall, and in the evaluator’s opinion, was this best practice properly applied in this project?		Partial.
Policies and Procedures		
Does the agency require formal project schedule?	Yes but the schedule specification was more general that it should have been.	
Was the work scheduling process for the project used appropriately?	Yes.	
Was the progress schedule updated regularly?	Monthly, although they took 90 days to complete.	
Execution Practice		
Describe the types of scheduling systems in place to ensure timely delivery.	The Constructor was using critical path method scheduling in Primavera project management software.	
Describe the process for updating the schedule and reporting any changes to appropriate parties.	The Design Build Agreement did not require regular updates to the schedule; however the Constructor did provide them.	
Example Indicators of Use		
What does the agency require in terms of formal project scheduling?	Only that the Constructor apply “good industry practice”.	
Was a milestone schedule available for this project and reviewed consistently?	Yes.	
Was a critical path method schedule available for the project?	Yes.	
How was a work breakdown schedule created and followed?	The Constructor created the schedule in accordance with Schedule 3 of the Design Build Agreement.	
How were project schedule changes and updates reported and who were the schedule changes reported to?	Monthly report from Constructor to TI Corp.	
Subjective Evaluation of Practices:		
The Province should have been more specific in its requirements of the project schedule, as examples: activity durations, clear identification of external interface points (e.g. utility agreements, procurement), earned value reporting.		

- AACE International Recommended Practice: *33R-15 Developing the Project Work Breakdown Structure*
- American Association of State Highway and Transportation Officials – Guide Specifications for Highway Construction, 2nd Edition: *Section 108.02 Progress Schedules*

1.6.3 Changes and delays due to third-parties

Overall, and in the evaluator's opinion, was this best practice properly applied in this project?		Yes.
Policies and Procedures Were third-parties to the project responsible for causing changes or delays to construction work?	Yes, principally the utilities: Kinder Morgan, Metro Vancouver (water main) and BC Hydro.	
Execution Practice Explain the process used to address changes or delays to the construction work caused by third-parties. Describe how changes were submitted and approved to address delays caused by third-parties.	Constructor was required to mitigate the delays with re-sequencing within its project schedule then, when the Toll Commencement Date could no longer be attained due to these delays, submit Notice of a Supervening Event. Initially as Supervening Events, then declared to be Relief Events, ultimately resolved with Change Certificates.	
Example Indicators of Use Did delays from third-parties or effect the critical path of the project's schedule? Was the project's cost impacted by delays caused by third-parties? Were any changes approved for this project for delays caused by third-parties? Who reviewed changes due to delays caused by third-parties?	Yes, they caused delays that summed to about 4 months. The significant delays are described in Section 5.2.3 above. Yes, they caused an additional \$99 million in costs. Yes. The TI Corp Board of Directors	
Subjective Evaluation of Practices: The contractual provisions and the management of these near-inevitable delays were handled well by both the Constructor and TI Corp.		

- American Association of State Highway and Transportation Officials – Guide Specifications for Highway Construction, 9th Edition: *Section 105.06 Cooperating with Utilities*
- American Association of State Highway and Transportation Officials – Guide Specifications for Highway Construction, 2nd Edition: *Section 108.06 Determining Compensation and Contract Time Extension for Excusable Delays*

1.6.5 Verifying construction percent complete and milestone reporting using field management

Overall, and in the evaluator's opinion, was this best practice properly applied in this project?		No.
Policies and Procedures Were reports of percent complete and milestones reviewed and verified in the field for each progress payment submitted by the contractor?		Only superficially: the Province's section managers reviewed and approved the Constructor's monthly reports of % complete but had no formal means by which they could independently verify the reports.
Execution Practice Explain the process used for reporting percent complete and milestones for progress payments. Describe how field management reviewed verified the reporting by the contractor for progress payments.		No schedule of values set in advance. No independent report submitted by section managers.
Example Indicators of Use How were percent complete and milestones reported by the contractor to the owner? Were proper agency project management authorities in the field involved in reviewing and verifying percent complete and milestones for progress payments? What was the process for addressing discrepancies in the percent complete and milestones reported by the contractor and the field verified percent complete?		The schedule of values was set in the Design Build Agreement at high level for this complex project (18 items) and the Constructor reported at this level. This proved difficult to measure percent complete. Yes. There was an informal process where field management would resolve discrepancies before the draw was completed.
Subjective Evaluation of Practices: Given the lack of an agreed schedule of values, TI Corp did an adequate job managing pay estimates.		

- American Association of State Highway and Transportation Officials – Guide Specifications for Highway Construction, 2nd Edition: *Section 109.01 Measuring Quantities*
- Alternative Payment and Progress Reporting Methods, Report to the U.S. Department of Transportation Federal Highway Administration's Construction Management Expert Technical Group
- Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects – Section 109: Measurement and Payment". U.S. Department of Transportation Federal Highway Administration

1.6.6 Ongoing risk assessment and mitigation management

Overall, and in the evaluator's opinion, was this best practice properly applied in this project?		No.
Policies and Procedures Were project risks properly identified and managed during design and construction of the project?		No. The project risk register was not maintained after the Design Build Agreement was concluded.
Execution Practice Explain the risk identification process. Explain the risk management and control process.		Partnerships BC managed the creation of a risk register with Provincial agencies and proponents identifying risk items, estimating outcomes for those items and estimating the risk of each item with a Monte Carlo simulation of the probability distribution around each risk. None exercised during the project's execution.
Example Indicators of Use Was the approach used to identify project risks reasonable for this project? When new risks were identified, were they properly allocated for contractual responsibility? Were risks properly monitored and managed? Were risks properly mitigated?		Yes. The Province's requirements in the <i>Capital Asset Management Framework</i> were followed. No new risks were identified. No. The Province relied upon the Constructor to identify occurrences of anticipated events. Yes, once identified by the Constructor.
Subjective Evaluation of Practices: The Province laid down a solid framework for risk management in the procurement processes and the Design Build Agreement but did not use that framework to reassess the project risks as the project was executed.		

- AACE International Recommended Practice: *72R-12 Developing a Project Risk Management Plan*
- Construction Industry Institute Knowledge Base: *RT-280 Probabilistic Risk Management in Design and Construction Projects*
- Construction Management Association of America – Construction Management Standards of Practice: *Risk Management*
- National Cooperative Highway Research Program – Report 658: *Guidebook on Risk Analysis Tools and Management Practices to Control Transportation Costs*
- Project Management Institute: *Practice Standard for Project Risk Management*

1.6.8 Evaluation of change order requests

Overall, and in the evaluator’s opinion, was this best practice properly applied in this project?		Partially.
Policies and Procedures		
Were change orders reviewed, evaluated, and approved according to contract?	Yes.	
Execution Practice		
Explain the process for approving cost increase change orders.	The Constructor was required to submit proposals for changes to scope, schedule and cost. When dealing with a Supervening Event, the proposals also had to demonstrate what mitigation measures were included.	
Describe the process of managing the payment of change order costs from the agency to the contractor.	Each Change Certificate specified either an increase to the fixed price of the Design Build Agreement or that payments would be made on a time and materials basis. We found that TI Corp chose the appropriate payment method for each of the Change Certificates.	
Example Indicators of Use		
Was the flow of funds to the contractor managed accordingly?	Yes.	
Who was involved in the review and approval of change orders and associated costs?	The Authority’s Representative, then TI Corp’s Vice President Technical Services. TI Corp Board approval was sought for major change orders.	
Were additional costs approved according to the contractual policies and procedures?	Yes.	
How were the cost increases associated with change orders justified?	TI Corp had no means to independently estimate those costs.	
Subjective Evaluation of Practices:		
TI Corp reviewed and approved change orders within its limited ability to independently verify the cost estimates put forward by the Constructor.		

- AACE International – *Professional Practice Guide #01: Contracts and Claims, 4th Edition*
- Report on Supplemental Agreement Reasons, *AASHTO-FHWA Project 631 Overrun Study. Federal Highway Administration*

1.6.9 Accelerating construction due to schedule delays

Overall, and in the evaluator's opinion, was this best practice properly applied in this project?		Yes.
Policies and Procedures Was the basis for accelerating the project reasonable and in alignment with the stated project goals?		Yes. The delay expected by TI Corp would have resulted in a loss of about \$70 million in toll revenues. In addition, traffic delays would have persisted through the longer construction period.
Execution Practice Explain the decision-making process to accelerate construction of this project. Describe the policies and procedures used by the agency to decide to accelerate the project.		TI Corp identified and assessed five options for dealing with the Relief Event and chose the expected value of the least-cost option. The TI Corp Board wrote to the Minister Responsible advising of the potential impact of the Relief Event on Treasury Board's approval of the project and received a mandate from the Minister to resolve the issue.
Example Indicators of Use Did the contract contain clauses for construction acceleration? Was sufficient justification made to accelerate the project? Were market conditions and the construction industry environment at the time of deciding to accelerate the project considered in the decision? Were the consequences of completing the project late considered in the decision to accelerate the project?		Yes. Yes. Yes. Yes.
Subjective Evaluation of Practices: The Province's decision to accelerate construction appears, after the fact, to be the best option. There should have been a more complete documentation of the available options, of the costs, risks and benefits of each option, and of the decision at the time it was made. There could have been a more complete documenting of the decision at the time it was taken.		

- American Association of State Highway and Transportation Officials – Guide Specifications for Highway Construction, 2nd Edition: *Section 108.06 Determining Compensation and Contract Time Extension for Excusable Delays*
- National Cooperative Highway Research Program – *Report 662: Accelerating Transportation Project and Program Delivery*
- National Cooperative Highway Research Program – *Scan 07-02: Best Practices in Accelerated Construction Techniques*

1.6.10 Managing work performed on contractor force account or time and material type payment method

Overall, and in the evaluator's opinion, was this best practice properly applied in this project?		Mostly yes.
Policies and Procedures		
Was a contractor force account or time and materials type payment method used for any portion of the project?	Yes. It was used in both the gravel change order and in the acceleration change order.	
Execution Practice		
Explain the situation in which a force account type payment system was used on the project.	TI Corp and the Constructor were unable to agree, at the time the Change Certificate was issued, on the increase in the fixed price of the project that the Change Certificate should entail. They were also unable to agree upon a maximum amount that the sum of time and material costs was not to exceed.	
Explain the reasons for initiating the use of a force account type payment system for the project.	TI Corp and the Constructor agreed that it was the best way to continue the execution of the project on schedule.	
Example Indicators of Use		
Was a force account type payment method used in alignment with the original contract?	Partially. The force account payments were made as part of the draw requests specified in the Design Build Agreement, and that agreement was not specific as to how the amounts of the draws would be calculated.	
Who authorized the work performed using a force account type payment method?	The TI Corp Board of Directors.	
What were the terms of the authorized payment method?	Time and materials, as measured through increased field supervision on the parts of TI Corp and the Constructor, would be used to determine the amounts of the draws and, in the case of gravel, the change to the fixed price of the Design Build Agreement.	
How was the use of force account type payment method deemed cost effective?	Yes, in that it allowed work to continue on schedule.	
Subjective Evaluation of Practices:		
Force account payments were used in appropriate circumstances in this project. They would have easier to use if the Design Build Agreement anticipated the possibility of force account Change Certificates and been more specific about allowable costs.		

- American Association of State Highway and Transportation Officials – Guide Specifications for Highway Construction, 9th Edition: *Section 109.04 Extra Work and Force Account Work*
- Federal Highway Administration – Federal-aid Essentials: *Contractor Force Account*

10 APPENDIX: PROJECT PERFORMANCE MEASURES

The measures of construction management performance presented in this section are, with the exception of average cost and time growth, are commonly applied to major highway construction projects. Some of them are not applicable to the PMH1 project but are included nonetheless as a guide to good practices for future projects.

10.1 Cost Measures

Unit Cost (UC): A measure of dollars per unit of work, where the unit of work is a quantitative value such as area (ft³, cy) or lane miles. A common unit cost measure used in building construction is cost/SF, which can then be compared to similar projects, regardless of size and cost:

$$UC = \frac{\text{Final Contract Amount}}{\text{Area of Project}} \times \text{Cost Index} = \frac{\text{Unit Cost}}{\text{Unit of work}}$$

PMH1 was a compound project, i.e. a 700 metre long suspension bridge, about 37 kilometres of urban freeway and a half-dozen major intersections. Best practices suggest that this measure be applied separately to each major component, e.g. [1] per m² of bridge deck; [2] per lane-kilometer; and [3] per interchange. The costs of the PMH1 project were not broken down by component so we cannot apply this measure to the project.

Cost Growth (CG): A standard measure of project performance, cost growth is a measure comparing the change in contract amount to the original contract amount. The cost growth value is expressed as a percentage:

$$CG = \frac{\text{Final Contract Amount} - \text{Original Contract Amount}}{\text{Original Contract Amount}}$$

13% in PMH1, or 9% if adjusted for items that, in our opinion should have been initially included in the contract.

Average Cost per Change Order (AC/CO): A calculation of the average amount per change order experienced during construction of a project. Average cost per change order is expressed as \$/CO:

$$AC/CO = \frac{\text{Final Contract Amount} - \text{Original Contract Amount}}{\#CO}$$

In PMH1, \$322 million was added through 59 change certificates for a mean of \$5.5 million per Change Certificate. In our opinion about \$108 million of this cost in of the change orders have been included in the original contract amount. Removing those two

change orders from the measure, \$214 million was added through 57 change certificates for a mean of \$3.7 million per Change Certificate. The distribution around that mean is highly skewed, with a handful of large change certificates, i.e. with values over \$30 million, and many small change certificates with values under \$1 million.

A mean of \$3.7 million CDN per change order is higher than is normally experienced in major transportation projects. A recent study of six design build highway projects in Texas, ranging in size from \$200 million US to \$2.1 billion US, found a mean of \$290,000 US per change order among those projects.¹⁸⁷

Average Percent Increase per Change Order (A%/CO): A measure of incremental cost growth, average percent increase per change order can indicate that cost growth is a step function and can provide a way to assess the quality of the contract documents. Average percent increase per change order is expressed as a percentage:

$$A\%/CO = \frac{CG}{\#CO}$$

For PMH1, 9%/57 = 0.15%. This is, in our opinion, higher than is normally experienced in major transportation projects and indicates difficulties with the definition of project scope, as occurred in the PMH1 project.

Delivery intensity (DI): A calculation of the unit cost of design and construction work put in place in a facility per a unit of time.

$$DI = \frac{\text{Unit Cost}}{\text{Actual Contract Duration}} = \frac{\left(\$/m^2 \right)}{(\text{Day or Month})}$$

Since PMH1 was a compound project, we could not calculate unit cost. Instead we used DI = Final Contract Amount / Actual Contract Duration = \$2 million per working day. Without this measure it is difficult to differentiate high intensities due to high productivity, a good thing, from high intensities due to high costs per unit of work, a bad thing.

¹⁸⁷ Shrestha, P., O'Connor, J., and Gibson, G.E. (2012). "Performance Comparison of Large Design-Build and Design-Bid-Build Highway Projects." American Society of Civil Engineers, *Journal of Construction Engineering and Management*, 138(1), 2012. The largest of these projects is the Grand Parkway in Houston, the completion of third tolled ring road around the Houston-Galveston area. All of the Grand Parkway components will cost about \$5 billion US.

10.2 Schedule Measures

Time Growth (TG): Measures the change in time with respect to the original contract completion date. Time growth is either positive, indicating the project was completed later than the original contract completion date, while negative means the project was completed earlier than the original completion date. Time growth is expressed as a percentage and measurements are expressed in days:

$$TG = \frac{\text{Actual Contract Duration} - (\text{Original Contract Duration} + \text{Number of Days Added by Change order})}{\text{Original Contract Duration} + \text{Number of Days Added by Change Order}}$$

For the PMH1 project, TG = 0%.

Average Cost and Time Growth: Provides the overall average growth in budget and schedule realized on a project.

$$\text{Avg. CG and TG} = \frac{CG + TG}{2}$$

For the PMH1 project, this = 4.5%. In our sample of about 1,626 US projects, generally small projects, the mean is 6.8%. This measure is not widely used since it implicitly equates the values of a 1% increase in cost with a 1% decrease in schedule, which is not always the case.

Average Percentage of Additional Days Granted (AD%): The average percent of additional days granted can indicate if the owner was willing to reduce time pressure on the contractor. Average percent of additional days granted is expressed as a percentage:

$$AD\% = \frac{\text{Number of Days Added by Change Order}}{\text{Original Contract Duration}}$$

For the PMH1 project, AD% = 0%.

Average Time per Change Order (AT/CO): Calculates the average time amount (in days) to complete each change order experienced during construction of a project. Average time per change order is expressed in Days/CO:

$$AC/CO = \frac{\text{Number of Days Added by Change Order}}{\#CO}$$

For the PMH1 project, AC/CO = 0%.

Delivery Speed (DS): Measures the area of work put in place (production) per a unit of time.

$$DS = \frac{\text{Area put in place}}{\text{Actual Contract Duration}} = \frac{(ft^2)}{(\text{Day or Month})}$$

Not calculated as PMH1 was a compound project.

10.3 Quality Measures

Number of Modifications per Million Dollars: This normalization calculation provides a comparable value across projects to understand the amount of modifications that occurred on a project, regardless of the cost of the project. Modifications can be changes, rework, non-compliance reports, or any other similar documentation of work that is modified.

$$\text{Number of Modifications per Million Dollars} = \frac{\text{Number of Modifications}}{\$1,000,000}$$

Not calculated for this project as it is outside the scope of this review.

Disputes Cost as Percentage of Original Cost (DC): Disputes are considered requests by contractors for work performed that the contractor believes is outside the scope of the contract. Dispute cost can be considered due to poor design or direction from the agency to the contractor, which is a reflection of the project's quality.

$$DC = \frac{\text{Total Cost of Disputes}}{\text{Original Contract Amount}}$$

Not calculated for this project as it is outside the scope of this review.

11 APPENDIX: CHANGE CERTIFICATES UNDER THE DESIGN BUILD AGREEMENT

		<i>Capitalised</i>	<i>Expensed</i>
CC-003	Dogwood Trailer Park	\$2,600,000	
CC-005	Barnston	\$4,729,000	
CC-014	Kensington Widening	\$953,000	
CC-019	Waterlot Development	\$107,000	
CC-020	GVRD Pipe	\$2,018,000	
CC-119	GVRD Sewer Betterment	\$6,680,000	
CC-021	BCTC Wood to Steel Poles	\$1,532,000	
CC-023	160th Ave Off-Ramp	\$319,000	
CC-027	Fraser Heights Bridge	\$31,000,000	
CC-093	Fraser Heights Changes	\$4,923,000	
CC-028	Brown Pit	\$5,457,000	
CC-053	Brown Pit	\$8,187,000	
CC-098	Brown Pit	\$6,956,000	
CC-100	Brown Pit	\$1,558,000	
CC-101	Brown Pit	\$2,484,000	
CC-104	Brown Pit	\$2,236,000	
CC-107	Gravel Unit Pricing	\$30,881,000	
CC-132	Gravel Premium to Total Completion	\$14,241,000	
CC-035	Brunette Interchange South	\$700,000	
CC-036	Gagliardi Underpass	\$234,000	
CC-038	Unforeseeable Contamination	\$54,000	
CC-039	Coke Property	\$2,100,000	
CC-042	Korean Church Wall	\$656,000	
CC-043	Brunette Interchange (ICBC)	\$1,175,000	
CC-047	Hazardous Building Material Clean Up	\$103,000	
CC-049	Pedestrian Fences	\$1,480,478	
CC-052	Barnes Wheaton	\$55,000	
CC-055	Terasen Gas C70 Temp Relocate	\$2,219,000	
CC-057	Manor Street Sound Wall	\$329,000	
CC-058	Commuter Cycling at Cape Horn Interchange	\$3,501,000	
CC-070	PST Credit	(\$20,000,000)	
CC-074	112th Ave Pedestrian	\$51,000	
CC-075	1b GEC Deletion 1b	\$476,000	
CC-075	1c GEC Deletion 1c	\$224,000	
CC-076	202 Park & Ride - KF	\$25,902,275	
CC-080	Expansion Joints	\$411,603	
CC-081	110th Street Sound Wall	\$232,000	
CC-083	Toll Gantry - Superpave	\$688,000	
CC-083	Toll Gantry - Force Account	\$2,925,000	
CC-087	Cariboo Force Account	\$882,000	
CC-091	176th Street & 96th Avenue	\$141,000	
CC-109	ITS Fibre Upgrade	\$168,000	
CC-110	Wilson Farm (force account)	\$3,878,000	

		<i>Capitalised</i>	<i>Expensed</i>
CC-113	ITS Third Party Ducts	\$457,000	
CC-112	BNSF Gravel and Geo-grid	\$673,000	
CC-120	BNSF Properties North Road	\$5,000,000	
CC-123	Kinder Morgan Crossing at 156 Street	\$4,600,000	
CC-125	Fortis BC Framework Change	\$87,000	
CC-126	Demo Environmental Assessment		\$130,000
CC-131	PMB Demo Impacts Area Reduction		\$7,860,000
CC-138	FHB OGFC	\$194,000	
CC-139	Brunette Interchange NW Quadrant	\$200,000	
CC-143	CPR Track 2 West Extension	\$1,167,000	
CC-146	1 8 Lane Configuration	\$9,100,000	
CC-128	129 Cape Horn Change Certificate	\$99,100,000	
CC-045	Pinnacle Property	\$668,119	
CC-144	PMB Safety Grate	\$884,065	
	Minor Works	\$1,203,008	
	Total	\$278,779,548	\$7,990,000

12 APPENDIX: GRAVEL COSTS RECORDED UNDER CHANGE CERTIFICATE CC-0132B

	<i>Pricing Section</i>	<i>Credits</i>	<i>Debits</i>	<i>Net Increase</i>
1	stripping to waste	(\$4,040,253)	\$6,108,791	\$2,068,538
2	excavation to waste	(\$11,304,015)	\$17,100,027	\$5,796,012
3	load/haul/place borrow	(\$8,821,821)	\$9,206,420	\$384,599
4	load/haul/place surcharge & SGSB	(\$25,879,678)	\$38,388,911	\$12,509,233
5	structural excavation & backfill	(\$1,438,707)	\$2,628,607	\$1,189,900
6	detours - excavation & subbase	(\$755,053)	\$1,304,832	\$549,779
7	utilities - haul & dump waste	(\$747,844)	\$1,676,889	\$929,045
8	MSE walls - haul & dump waste	(\$1,732,461)	\$2,727,434	\$994,973
9	MSE walls - load/haul/place gravel	(\$2,182,535)	\$5,164,214	\$2,981,679
10	2 nd stage mse walls - load/haul/place	(\$456,173)	\$1,249,540	\$793,367
11	CIP walls - load/haul/place backfill	(\$206,163)	\$545,634	\$339,471
12	job-wide pit development	(\$4,193,650)	\$6,025,260	\$1,831,610
13	O/S rent truck rate adjustment	(\$341,844)	\$1,837,854	\$1,496,010
14	direct rates adjustment on added work		\$1,335,849	\$1,335,849
15	process/load/haul bridge end fill	(\$5,642,240)	\$6,620,215	\$977,975
16	process @ Strong / purchase commercial SGSB		\$16,375,973	\$16,375,973
17	purchase cobbles		\$847,481	\$847,481
18	drainage to waste	(\$1,559,308)	\$2,285,231	\$725,923
19	topsoil	(\$1,538,310)	\$1,850,280	\$311,970
20	environmental compensation to waste	(\$2,710,402)	\$4,227,080	\$1,516,678
21	environmental compensation to waste	(\$496,797)	\$864,828	\$368,031
22	direct cost for lost productivity due to longer haul		\$1,895,446	\$1,895,446
23	Port Mann Bridge haul to waste / haul backfill	(\$452,172)	\$983,116	\$530,944
24	traffic control & flagging (labour & vehicles)		\$1,445,108	\$1,445,108
25	erosion control incremental increased manhours		\$473,815	\$473,815
26	survey - onshore		\$678,948	\$678,948
27	quality control - onshore		\$633,626	\$633,626
28	environmental monitoring		\$170,114	\$170,114
29	extra staff for force account tracking		\$1,685,912	\$1,685,912
30	project wide staff for supervision of extra work		\$9,800,568	\$9,800,568
31	equipment moves & security		\$236,206	\$236,206
32	escalation for 2013 / 2014 rates		\$661,208	\$661,208
33	insurance & fees		\$1,354,090	\$1,354,090
34	re-design due to change in material sources		\$350,000	\$350,000
35	contingencies	(\$2,954,343)	\$5,908,687	\$2,954,344
37	profit & overhead 15%		\$11,554,710	\$11,554,710
		(\$77,453,769)	\$166,202,904	\$88,749,135

Sums do not equal Change Certificate total due to classification and rounding.

13 GLOSSARY OF TERMS IN THE DESIGN BUILD AGREEMENT

Terms in capital letters are terms defined in the Design Build Agreement and the definitions in that agreement used here. Terms not defined in that agreement are provided here with standard industry definitions.

<i>Authority Change</i>	A Change Certificate that is initiated by TI Corp.
<i>Authority's Representative</i>	The person who, under the Design Build Agreement, has the authority to approve amendments to the contract, Change Certificates and invoices for progress payments. In the PMH1 project, the Authority's Representative could not exercise these authorities without the approval of TI Corp's Vice President of Technical Services.
<i>Change Certificate.</i>	An amendment of the scope, schedule or price of the contract. Known generically as a change order.
<i>Consequential Losses</i>	Losses suffered as a result of being unable to meet the obligations in contracts with third parties, e.g. utility agreements and agreements with municipalities.
<i>Direct Losses</i>	Generally, any increases in expenditure required to meet the obligations of the Design Build Agreement due the occurrence of an event.
<i>Indirect Losses</i>	Losses of revenues, profits or lost business opportunities due to the occurrence of an event.
<i>Draw Request</i>	A request for payment for work progressed that shows the percentage completion of each item of work, soft costs, fees and applicable taxes.
<i>Latent Defect</i>	A defect in the pre-existing infrastructure within the project that was not discovered in the course of the Constructor's work.
<i>SGSB</i>	Select granular sub-base – a grade of gravel.
<i>Tolling Commencement Components</i>	Unrestricted free movement of traffic on Highway 1 and the Lougheed Highway. The agreement goes on to specify the minimum number of lanes that must be open between the Brunette Avenue Interchange and the 160 Street Interchange.

Events

<i>Compensation Event</i>	Generally, a failure on the part of the Province to deliver unfettered access to the site. Examples of areas in which the Province could fail to deliver include utility agreements, right-of-way required for the project, environmental clearances or aboriginal claims. The definition in the Design Build Agreement runs to some three pages.
<i>No Threshold Compensation Event</i>	Several types of compensation events have no deductible, i.e. no minimum value beyond which they must pass before they will be considered for compensation by TI Corp.
<i>Excluded Event</i>	An Unavailability Event, a Traffic Disruption Event or some other event that is directed by the Authority or a government agency and have minimal adverse impact.
<i>Force Majeure Event</i>	An event that, through no cause or fault of either TI Corp or Kiewit/Flatiron, prevents one or both of them from performing under the agreements. Earthquakes, floods and wars are examples of force majeure events.
<i>Non-Compliance Event (NCE)</i>	Failure of the Constructor to meet one of the performance measures in Schedule 10, Appendix D of the Design Build Agreement. These measures relate to the Constructor's timely fulfillment of all obligations in the agreement, specifically mentioning traffic management, environmental compliance, quality management and communication.
<i>Nonconformity</i>	Failure of the Constructor to fulfill its obligations with respect to either the completeness of work or the quality of work.
<i>Non-Excusable Event</i>	A wrongful act or omission.
<i>Relief Event</i>	Generally, an intercession within the project site that delays the completion of work but does not necessarily add to project cost. Delays caused by emergency services, utilities, and labour disputes with other parties are cited as examples.
<i>Seismic Event</i>	Earthquakes, snowslides, landslides, but not floods.
<i>Special Event</i>	Holidays and days on which major events such as concerts and festivals occur and, therefore, no restrictions on traffic flow are allowed to the Constructor.
<i>Traffic Disruption Event</i>	A Lane Delay, Lane Closure, Full Closure or Traffic Stoppage that is not permitted under the Design Build Agreement.

Unavailability Event The closure of a lane for any reason.

Dates

Substantial Completion Date Date on which all Primary Highway Components are completed to the Authority's satisfaction. In essence, when the facility is open for service and all defects have been corrected.

Substantial Completion Target Date. 31 December 2012 for the Eastern Segment, 31 December 2013 for the Central and Western Segments unless amended.

Existing Port Mann Bridge Demolition Target Date Two years after the Substantial Completion Date.

Substantial Completion Longstop Date One year after the Substantial Completion Target Date.

Tolling Commencement Date The date on which the Tolling Commencement Components of the project are substantially complete.

Tolling Commencement Target Date 1 December 2012.

Schedules

Project Schedule A summary schedule for major milestones of design, investigation, construction and all related activities.

Works Schedule The detailed schedule for design, investigation, construction and all related activities, including all tasks defined to "industry standards".

14 BIBLIOGRAPHY

Organised by topic.

14.1 On Staff Retention

Cronin, B. et al. *Attracting, Recruiting, and Retaining Skilled Staff for Transportation System Operations and Management*. National Cooperative Highway Research Program (NCHRP) Report 693. National Academies of Sciences, Engineering, and Medicine. July, 2012.

Gallagher, S. and Villwock-Witte, N. *Millennials in the Transportation Workforce*. Transportation Research Record Volume 2552. 2016

Johns, R.C. et al. *Project Delivery Workforce Management Review*. Center for Transportation Studies, University of Minnesota. March 2007.

Harper, C. and Bogus, S. M. *Recruiting, Retaining, and Promoting for Construction Careers at Transportation Agencies*. University Transportation Centers Program. Forthcoming in 2018.

Long, D. *West Virginia Department of Transportation Workforce Study*. Rahall Appalachian Transportation Institute, Marshall University. May 2014

McRae, G. *Assessing VTrans [Vermont Department of Transportation] Employee Retention: Who stays, who leaves and what to do about it*. University of Vermont Transportation Research Center, forthcoming in 2018

Perkins, R. A. et al. *Serving Future Transportation Needs: Succession Planning for a State Department of Transportation Organization, Its People & Mission*. University of Alaska - Fairbanks, FHWA-AK-RD-12-01; INE/AUTC 12.02, June 2011.

World Road Association (PIARC). Technical Committee on Good Governance for Road Administration (B1). *Human Resources for the Future*. 2012R11. 2012

14.2 On the Choice of Delivery Method

Plusquellec, T. et al. *Design-Build in Construction: Performance and Impact on Stakeholders*. Interuniversity Research Centre on Enterprise Networks, Logistics and Transportation, l'Université Laval, CIRRELT-2016-57, October 2016.

Science Applications International Corporation, AECOM and University of Colorado-Boulder. *Design-Build Effectiveness Study – As Required by TEA-21 Section 1307(f)*. January 2006.

Texas A&M Transportation Institute. *Design-Build Highway Projects: A Review of Practices and Experience*. PRC 15-53 F, November 2016.

Tran, D. et al. *Strategic Program Delivery Methods: A Synthesis of Highway Practice*. NCHRP Synthesis 504, National Academies of Sciences, Engineering and Medicine. 2017.

14.3 On Enterprise Risk Management in Highway Agencies

D'Ignazio, J., Molenaar, K.R., Hallowell, M. and Fortunato, B. *Executive Strategies for Risk Management by State Departments of Transportation*, NCHRP Project 20-24(74), National Cooperative Research Program, Transportation Research Board of the National Academies. 2011.

Molenaar, K.R., Dickmann, J.E. and Ashley, D.B. (2006). *Guide to Risk Assessment and Allocation for Highway Construction Management*, Report # FHWA-PL-06-032, Federal Highway Administration, U.S. Department of Transportation, American Association of State Highway Transportation Officials, and the National Cooperative Highway Research Program. October 2006.

O'Har, J.P., Senesi, C.W., Molenaar, K.R. *Development of a Risk Register Spreadsheet Tool for Enterprise and Program-Level Risk Management*, Transportation Research Record: Journal of the Transportation Research Board, National Academies, 2604. 2017

Rose, D., Molenaar, K.R., Javernick-Will, A., Hallowell, M., Senesi, C., and McGuire, T. *Successful Implementation of Enterprise Risk Management in State Transportation Agencies*. National Cooperative Highway Research Program, Research Report 08-36 (121). April 2015.

14.4 On Project Management

Federal Highway Administration, U.S. Department of Transportation. *Construction Quality Assurance for Design-Build Projects*. FHWA-HRT-12-039, April 2012.

Federal Highway Administration, U.S. Department of Transportation. *Large Project Management and Oversight: Report to the Senate Subcommittee on Transportation, Treasury and General Government; The House Subcommittee on Transportation, Treasury and Independent Agencies*. May 2003.

Christian Jensen, Staffan Johansson, and Mikael Lofstrom, *Project Relationships – A Model for Analyzing Interactional Uncertainty*. International Journal of Project Management, Vol. 24, No. 1, 2006) 4-12.

14.5 On Contingencies

Chong, U. and Hopkins, O. *An International Experience on the Evolution of Road Costs During the Project Life Cycle*. Transport Policy, 48. May 2016.

Diab, M.F. et al. *Modeling the Construction Risk Ratings to Estimate the Contingency in Highway Projects*. Journal of Construction Engineering and Management, 143(8). American Society of Civil Engineers. August 2017.

Hammad, M. W. et al. *Allocation and Management of Cost Contingency in Projects*. Journal of Management in Engineering, 32(6). American Society of Civil Engineers. November 2016.

Love, P. et al. *Estimating Construction Contingency: Accommodating the Potential for Cost Overruns in Road Construction Projects*. Journal of Infrastructure Systems, 21(2). American Society of Civil Engineers. June 2015.

Maria-Sanchez, P. et al. *Contract Change Order Data Analysis for Assessing the Contingency for Transportation Projects*. Transportation Research Board 94th Annual Meeting, January 2015.

Molenaar, K.R., and Tran, D. *Alternative Contracting Method Performance in US Highway Construction*. Federal Highway Administration, U.S. Department of Transportation. DTFH61-13-R-00019. 2017.

14.6 On Performance Measurement

Gransberg, D., Dillon, W., Reynolds, L., and Boyd, J. *Quantitative Analysis of Partnered Project Performance*, ASCE Journal of Construction Engineering and Management, 125(3). 1999.

Konchar, M. and Sanvido, V. *Comparison of US Project Delivery Systems*, ASCE Journal of Construction Engineering and Management, 126(6). 1998.

Molenaar, K.R., and Navarro, D. *Key Performance Indicators in Highway Design and Construction*, Transportation Research Record, 2228. 2011.

Pocock, J., Hyun, C., Liu, L., and Kim, M. *Relationship Between Project Interaction and Performance Indicators*, ASCE Journal of Construction Engineering and Management, 122(2). 1996.

Shrestha, P., O'Connor, J., and Gibson, G.E. *Performance Comparison of Large Design-Build and Design-Bid-Build Highway Projects*. ASCE Journal of Construction Engineering and Management, 138(1). 2012.

Sullivan, J., El Asmar, M., Chaloub, J., and Obeid, H. *Two Decades of Performance Comparisons for Design-Build, Construction Manager at Risk, and Design-Bid-Build: Quantitative Analysis of the State of Knowledge on Project Cost, Schedule, and Quality*, ASCE Journal of Construction Engineering and Management, 143(6), 04017009. 2017.

Date: July 23, 2018

To: Ministry of Finance c/o
Doug Foster, Assistant Deputy Minister,
Strategic Initiatives

Reference: 278423

Re: Port Mann Bridge/Highway 1 Construction Review - Management Response

We are in receipt of the Port Mann Bridge/Highway 1 (PMH1) Construction Review Report, prepared by Perrin, Thorau and Associates Ltd. The scope of the review included the governance, oversight, procurement and construction management functions of the Province as they applied to PMH1. This work covered a period from 2006 to 2011 and involved the Ministry of Transportation and Infrastructure, the Transportation Investment Corporation and Partnerships BC. The Ministry and both agencies have taken part in the review.

We are pleased to note that the review concluded that overall the governance arrangements for the project were appropriate and that the board and the management team followed good practices. Further, the review concluded that the Design-Build approach was the best choice of delivery method for the project, and that overall the Design-Build Agreement was a comprehensive and effective document.

The Report includes a number of recommendations that involve project-management-related issues related to project and construction management capacity, contingency management, pricing of public inputs, change order management, scheduling and progress payments.

We accept these recommendations, noting that these recommendations have been either fully implemented on more recent projects, including the Evergreen Line Rapid Transit Project, or are currently underway. It is timely and constructive to consider how these recommendations will be addressed and implemented on current and upcoming projects such as the Pattullo Bridge Replacement Project, which is in the early stages of procurement.


The report also includes a couple of observations relating to contract management and contingency allocation. Our responses to all the recommendations and observations in the Report are provided in the attached Appendix A.

The Ministry of Transportation and Infrastructure, the Transportation Investment Corporation and Partnerships BC would like to thank Perrin, Thorau and Associates Ltd. for their report and for their recommendations and comments, and for the opportunity to provide input.

Sincerely,

A handwritten signature in black ink, appearing to read "Pat C. Livolsi".

Patrick Livolsi
Assistant Deputy Minister, Infrastructure and Major Projects
Ministry of Transportation and Infrastructure

A handwritten signature in black ink, appearing to read "Irene Kerr".

Irene Kerr
CEO
Transportation Investment Corporation

A handwritten signature in black ink, appearing to read "Amanda Farrell".

Amanda Farrell
CEO
Partnerships BC

Attachments: Appendix A

Appendix A: Response to Report Recommendations and Comments

Rec #	Report Recommendation ¹	Status ²
1.0	If the Province believes that it will directly manage the design and construction of major transportation infrastructure projects in the future then it should maintain the people, business processes and information systems that enable it to do so. These include:	UNDERWAY Over the past two years, TRAN has been implementing a new major projects delivery approach to develop capacity, knowledge and succession for project delivery from within government, with focus on developing public servants expertise.
	<ul style="list-style-type: none"> • Independent cost and schedule estimation. The ability to estimate the cost and schedule of a large transportation infrastructure project using best practices and using project management information systems that are compatible with those used by the contractors for the duration of the project. 	UNDERWAY An independent cost estimator was a member of the Province's team for the Evergreen Line Rapid Transit Project, and this is now a standard approach for all major projects (most currently Highway 91-17 and Pattullo Bridge Replacement Project). TRAN is also exploring options on retaining independent schedule expertise to advise on Major Projects. Project management information systems are being evaluated as part of the records management system review outlined below.
	<ul style="list-style-type: none"> • Project, design and construction management records. The management of records created during project development, design and construction in a records management system that is designed for project management. 	UNDERWAY Government standard for records management is the Total Records and Information Management System (TRIM), and TRAN concurs that TRIM may not be the most appropriate records management system for major projects. TRAN is currently undertaking a review of records management systems for major projects. TRAN will work with the Ministry of Finance to select a new records management system designed specifically to manage the complexities of project management.

¹ Perrin, Thoreau & Associates Ltd., Public Policy Consultancy retained October 2017 by British Columbia Ministry of Finance

² Ministry of Transportation and Infrastructure

Appendix A: Response to Report Recommendations and Comments

	<ul style="list-style-type: none"> • Risk Management. The Province should, as a major project proceeds through design and construction, revise the risk register and use risk-based schedule and cost management tools to revise contingency funding and manage cost and schedule risks throughout the life of the project. 	<p>COMPLETE</p> <p>This is now standard practice for Major Projects. Risk registers are developed as part of the business case for a project, and are maintained and updated throughout the project lifecycle (procurement, design and construction). Risk registers are developed by Partnerships BC and are consistent with the Ministry of Finance's Enterprise Risk Management policies. A recent example is the Evergreen Line Rapid Transit Project and the recently released Pattullo Project, and this approach will be implemented on upcoming major projects.</p>
Rec #	Report Recommendation	Status
2.0	<p>Contingencies. The Province should publish a policy for the contingency funding of cost increases in surface transportation projects and the optimal distribution of contingency funding within projects and across projects in the Province's surface transportation programs.</p>	<p>COMPLETE</p> <p>Management of contingencies is aligned with detailed risk registers for Major Projects to quantify appropriate contingency amounts. Contingencies are reviewed on a regular basis as projects develop. Recent major projects have been approved with contingencies exceeding 10% of total project budgets to reflect the identified risks for those projects</p>
3.0	<p>Pricing of public inputs. The Province should consider the question of how best to value Crown assets when they are consumed as inputs into its maintenance and construction programs, keeping in mind the opportunity costs of those assets, and establish guidelines for the costing of these assets as they are consumed.</p>	<p>UNDERWAY</p> <p>It is not unusual for major projects to benefit from support available from Crown assets – for example, property rights or other assets. TRAN tracks/assigns costs for gravel usage. TRAN will work with the Ministry of Finance to develop specific guidelines for how such assets are to be valued for all projects. The guidelines will supplement guidance on the preparation of business cases and the development of project budgets.</p>
4.0	<p>Overhead and profit margins in change orders. In future contracts, the Province should revise its mechanisms for estimating markups in change orders. The mechanisms for overhead costs should not necessarily assume that overhead costs are a linear geometric function of direct and indirect costs,</p>	<p>UNDERWAY</p> <p>Contract language used for TRAN projects includes the treatment and valuation of change orders. This language has been updated and amended over successive projects to address issues such as how overhead, mark-up and profit should be dealt with.</p> <p>The contract language will be reviewed to address the recommendation that</p>

Appendix A: Response to Report Recommendations and Comments

	and the rate of profit should be commensurate with the risks and the commitment of capital that the change order requires of the contractor.	these costs should not necessarily be dealt with in a linear fashion and will be applied to future projects including the Pattullo Bridge Replacement Project.
Rec #	Report Recommendation	Status
5.0	Schedule specifications in the contract. The Province should specify scheduling and schedule reporting requirements in its contracts for major projects with submission deadlines, submission frequency requirements and requirements to resource-load schedules and thus produce a schedule of values.	UNDERWAY TRAN intends to build on this experience by supplementing the owner's team with an independent schedule advisor to assist in analyzing the contractor's schedule submissions and to integrate the contractors' schedule with the schedule of owner-led and third-party activities.
6.0	Schedule performance measures. The Province should measure and analyze schedule performance measures as projects are designed and constructed. Those measures should include variances from the planned value curve and earned value.	UNDERWAY An independent cost estimator was a member of the Province's team for the Evergreen Rapid Transit Project. Part of the cost estimator's role was to analyze the performance of the contractor on the basis of the schedule submitted by the contractor each month to the owner. This analysis included consideration of variances from the planned value curve and earned value.
7.0	Schedule of values for progress payments. The Province should use, as much as possible, a projects' schedule of values and estimates of earned value to determine the amounts of progress payments.	COMPLETE The Evergreen Line Rapid Transit Project adopted a detailed approach to the determination of the amounts of progress payments. The specific requirements were included in the contract language and implementation of progress payments during construction proved clear and easy to administer. TRAN is adopting this approach on future major projects.

Appendix A: Response to Report Recommendations and Comments

Report Comment	Status
<p>KPMG Contract. As a result of the amendments and increases to value and scope in this contract, the Province lost some opportunities for cost control and could have been vulnerable to protest from firms pre-qualified during the initial engineering selection process.</p>	<p>COMPLETE</p> <p>As the scope of the KPMG contract expanded the TI Corp Board provided direction to management to implement corrective measures for cost controls on this contract.</p> <p>The Province subsequently adopted an approach to procurement and management of owners' representatives that reflect the requirements over the project life. Contracts are awarded based on the anticipated full cost of services, deliverables are detailed and individuals and positions within the owner's representative contract are subject to Ministry review and approval. The Ministry also retains the right to substitute Ministry employees to any of the Contractor's positions.</p>
<p>Contingencies. Contingency amounts of between 6% and 10% are usually included in the budgets of similar transportation projects.</p>	<p>COMPLETE</p> <p>Recently approved major projects have contingencies established based on the evaluated risks of the project resulting in contingency amounts of just over 10% of total project budgets. Risk registers are updated as the risk profile changes during the course of a project, and the overall contingency is adjusted to reflect current risks.</p>