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MGF PROJECT SERVICES

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Report

For

Manitoba-Hydro

Capital Expenditure Review

For

The Keeyask Hydroelectric Dam
The Bipole III, Manitoba-Minnesota
and GNTL Transmission Lines

The Public Utilities Board

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Disclaimer

This report has been prepared by MGF Project Services Inc. on the instruction of the The Manitoba Public Utilities Board to provide an independent review of Manitoba Hydro's Capital Expenditure Program.

It has been completed in accordance with generally accepted professional practices using information solely and exclusively provided by The Manitoba Public Utilities Board, their independent consultants, Manitoba Hydro and information in the public domain.

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SECTION 1 - Executive Summary

This Report is confidential and for the sole review of The Manitoba Public Utilities Board and Manitoba Hydro.

MGF Project Services Inc. was retained by The Manitoba Public Utilities Board as an Independent Expert Consultant to review Manitoba Hydro's capital expenditure program and to provide expert opinion on Manitoba Hydro's updated costs for the Keeyask Hydroelectric Dam, the Bipole III Transmission Line and Converter Stations, the Manitoba - Minnesota Transmission Line and The Great Northern Transmission Line.

The following is a summary of this Report:

Keeyask Hydro Electric Dam

The Joint Keeyask Development Agreement between the Keeyask Cree Nations is in our opinion inline with industry best practice.

The General Civil Contract (GCC) and its performance is the largest single contributor to planned cost and schedule not being met.

The contracting strategy was schedule driven and resulted in using a cost reimbursable pricing mechanism for the GCC. The Contractor gets paid for its actual costs rather than the performance of the construction work. The Contractor is currently behind schedule and over budget.

The largest single contributor to the budget increase from $6.5 billion to $8.7 billion is the [redacted] sum added to the original GCC on account of the Contractor's poor productivity and increased indirect costs as the GCC would take longer to perform. 1a, 8a

Other major cost contributors comprise delay claims, management costs, project support services, interest & escalation and contingency.

The GCC Contractor is not meeting the revised productivity factors for concreting and earthworks in the Amending Agreement No. 7 dated 28th February 2017, adding further cost and schedule pressure to the likely forecasted final cost and completion date.

The current contingency is insufficient and will soon be fully committed to cover other increasing costs.

The performance issues related to the GCC and their consequent impacts on other contracts will result in the Final Project Cost being in the $9.5 billion to $10.5 billion range.

Manitoba Hydro staff are competent and professional but they are not a construction manager with the experience and skills to direct the GCC. As such, its project management and control effectiveness is low.

There is an opportunity for Manitoba Hydro to implement contract management improvements, take ownership for the GCC and drive the GCC contractor to higher levels of predictable performance, to accelerate project schedule and to lower the likely forecast cost at completion

HVDC Converter Stations

This project is well managed by Manitoba Hydro and the potential for cost over-runs is low.

Manitoba Hydro's contracting strategies are commercially astute, allocating risk appropriately between the parties and using predominantly lump sum or unit rate pricing mechanisms which place the risks of productivity, cost and schedule on its contractors.

The HVDC Converter Stations were competitively tendered to three of the most experienced technology vendors and two bids were very close in price, indicating a successful competitive tender. The same observation applies to the Synchronous Condensers scope.

The Bipole III Basis of Estimate (which includes the Converter Stations) document is well written and documented. It would be improved if benchmarking and industry metrics were included.

We would recommend that Manitoba Hydro's Estimating Team prepare the overall estimate with input from each department, thereby ensuring consistency and accuracy in the Estimates.

Bipole III Transmission Line

This project is generally well organized and managed efficiently.

Manitoba Hydro's contracting strategies are commercially astute, allocating risk appropriately between the parties and using predominantly lump sum or unit rate pricing mechanisms which place the risks of productivity, cost and schedule on its contractors.

The project is currently on schedule although some activities are slipping from their critical paths which may jeopardize the August 2018 completion.

A key risk to completion by August 2018 is the poor performance by Rokstad Power Corporation. Manitoba Hydro is managing this risk [redacted] Whether this maintains the August 2018 is uncertain at this time. 1a, 8a

Manitoba – Minnesota Transmission Line

This project is currently on schedule. As it further develops, its schedule should be updated more frequently than the current two month frequency.

Manitoba Hydro's estimating methodology is consistent with industry standard. Industry benchmarking suggests the cost estimate is below market value.

MGF recommends that the cost estimate is updated pursuant to an Estimate Preparation Plan and in accordance with a Basis of Estimate. Where possible the values of awarded contracts should be incorporated rather than previous estimated costs.

Great Northern Transmission Line

This project is well organized and managed efficiently.

The project is progressing, with Rights of Way being cleared in advance of subsequent construction activity.

The Construction Management Agreement meets exceptional commercial business practice and protects Manitoba Hydro's interest.

Minnesota Power's cost estimating methodology is consistent with industry standard for the class of Estimate produced. The cost estimate is considered high when benchmarked to other similar projects so further reviews are recommended.

General

The Manitoba Hydro teams on all projects are very capable and dedicated.

The Keeyask Generating Station project presents the greatest threat to Manitoba Hydro on account of the GCC contract with a contractor that is under performing and being compensated on cost reimbursable pricing mechanism.

The recovery of this project will require Manitoba Hydro taking a construction management, hands-on approach to design and implement a recovery plan and hold the GCC contractor to perform.

SECTION 2 - Introduction

MGF Project Services Inc. (MGF) have been requested by the Manitoba Public Utilities Board to carry out a review of Manitoba Hydro's (MH) Capital Expenditure, associated with a public evidentiary process.

Manitoba Hydro is undertaking a substantial capital program expansion through the construction of a large new generating station and transmission lines. As many of these projects have seen a substantial increase in capital cost since project inception, The Manitoba Utilities Board has requested this review.

This Report is confidential and for the review of The Manitoba Public Utilities Board and Manitoba Hydro only.

The Projects include:

- The Keeyask Hydroelectric Dam: is a large, complex and remotely located project 725 kilometers northeast of Winnipeg on the Lower Nelson River. The Keeyask Generating Station will include the following structures:
  - 695 megawatt seven-unit Powerhouse/Service Bay complex on the north side of Gull Rapids
  - Seven bay Spillway on the south side of Gull Rapids
  - 23 Km of dykes built on the north and south sides of the reservoir
  - North, central and south dams across Gull Rapids
- The Bipole III HVDC Converter Stations: are specialized stations which form the terminal equipment for the 500kV HVDC Transmission Line, converting alternating current (AC) to direct current (DC), for transmission and back to AC for distribution. The Bipole III project consists of two (2) converter stations, namely the Keewatinohk Converter Station located in northern Manitoba, northeast of Gillam and the Riel Converter Station located in southern Manitoba, east of Winnipeg.
- The Bipole III Transmission Line: is a 1,385 kilometer 500kV DC transmission line originating at the Keewatinohk Converter Station travelling west of Lake Manitoba and terminating at the Riel Converter Station
- The Manitoba to Minnesota Transmission Line: is a 213 kilometer 500kV AC transmission line from the Dorsey Converter Station northwest of Winnipeg, terminating at the United States border near Piney MB
- The Great Northern Transmission Line: is a 361 kilometers single-circuit 500kV AC transmission line from the Minnesota-Manitoba border to the Iron Range Substation near Grand Rapids, Minnesota

The process adopted while compiling the report was to work closely with Manitoba Hydro and where time permitted, exchanging our Observations and Findings with them for their viewpoint. Manitoba Hydro was very co-operative and engaging throughout the process.

This Report details our Observations, Findings, Conclusions and Recommendations.

SECTION 3 - The Keeyask Hydroelectric Dam

SCOPE ITEM 1:

Review, assess, and determine the reasons for project cost overruns from the $6.5 billion final pre-construction budget with respect to:

i. Design or project scope changes;
ii. Deviations from estimated quantities;
iii. Labour productivity;
iv. Labour costs;
v. Labour hiring constraints with respect to: Competition with other large civil projects in Canada; Remote location; and Northern and First Nations jobs.

Inputs into the $6.5 billion budget should be reviewed and assessed as required.

Finding No. 1: Keeyask - Community Initiatives (Payment Obligations)

Observations & Findings

The table below compares community initiatives for 2014 and 2017.

Network / Project Number	Work Package	CEF2014 Phase 2 Estimate (2014$)	2017 CPJA Budget (2016$)	Variance ($)	Variance (%)
255740	Keeyask Adverse Effects	[redacted]			
255741	Keeyask Operational Employment				
244009	K-Operational Employment PMT Obligation				
243996	K-Ad Effects Payment Obligation (LCKD)				

1a, 8a 7a

Manitoba Hydro has committed the above funds to various community initiatives. Variations in estimates are due to the 2017 estimate including interest capitalized on cash payments − the CEF2014 estimate was the present value of future payments.

Conclusions & Recommendations

Community initiatives are an industry norm for major capital projects being developed and Manitoba Hydro's approach is very effective.

Source of Information & Reference Materials

- Map to Comparison of Keeyask 2014 to 2017.xlsx
- Keeyask Generating Station, Basis of Estimate Document, 2014 Capital Project Justification Addendum, dated August 2014
- Keeyask Generating Station, Basis of Estimate Document, 2017 Capital Project Justification Addendum, dated January 2017
- Keeyask Generating Station, 2017 Capital Project Justification Addendum, Comparison of 2014 Estimate to 2017 Estimate, dated August 2017

Finding No. 2: Keeyask - Licensing and Planning

Observations & Findings

Manitoba Hydro has indicated that the "Licensing Phase is substantially complete and remaining funds were removed." This results in a $5 million saving to the project.

Conclusions & Recommendations

Manitoba Hydro is reporting that the Licensing Phase is "substantially complete" and as such, we would expect little to no cost variation costs associated with this activity.

Source of Information & Reference Materials

- Map to Comparison of Keeyask 2014 to 2017.xlsx
- Keeyask Generating Station, 2017 Capital Project Justification Addendum, Comparison of 2014 Estimate to 2017 Estimate, dated August 2017

Finding No. 3: Keeyask - Labour Costs & Labour Hiring Constraints

Observations & Findings

Upon a review of the market place and demand for labour over the period that the Keeyask Project commenced development to date, indicates that there has been ample supply of labour for the development of the Keeyask Project. However, the choice of a 21 days on, 7 days off rotation cycle is not as attractive as the more common 14 days on, 7 days off rotation (as in Northern Alberta).

To compete for labour, Schedule 12-3 entitled "Proposed Letter of Agreement, Burntwood/Nelson Agreement" of the Joint Keeyask Development Agreement was developed to stipulate that special

measures needed to be implemented during the construction of the project to facilitate the employment, training and retention of First Nations members and other Northern Aboriginals, which measures might conflict with existing Burntwood/Nelson Agreement provisions relating to referral, recruitment or placement procedures.

LOA 35 executed on 1st January 2016 instituted a 13% completion bonus to attract and retain labour for the project. It is difficult to ascertain whether this was a critical component to project cost over-runs as most major capital projects in Canada have some form of retention mechanism, so this could have been reasonably predictable and costed for.

The Joint Keeyask Development Agreement provides for the consultation with, participation of and business opportunities for members of the Keeyask Cree Nation (KCN). There is the potential for equity participation in the project and for Direct Negotiated Contracts with KCN joint ventures.

Manitoba Hydro advised MGF that they have had great success with local Aboriginal labour, however they have exhausted all availability.

Conclusions & Recommendations

The commitments in the Joint Keeyask Development Agreement to KCN and other Northern Aboriginal groups is, in our opinion, an industry best practice. LOA 35 provides an industry typical attraction and retention mechanism. The 21 days on, 7 days off rotation cycle is not as attractive as the more typical 14 days on, 7 days off used on many other capital projects.

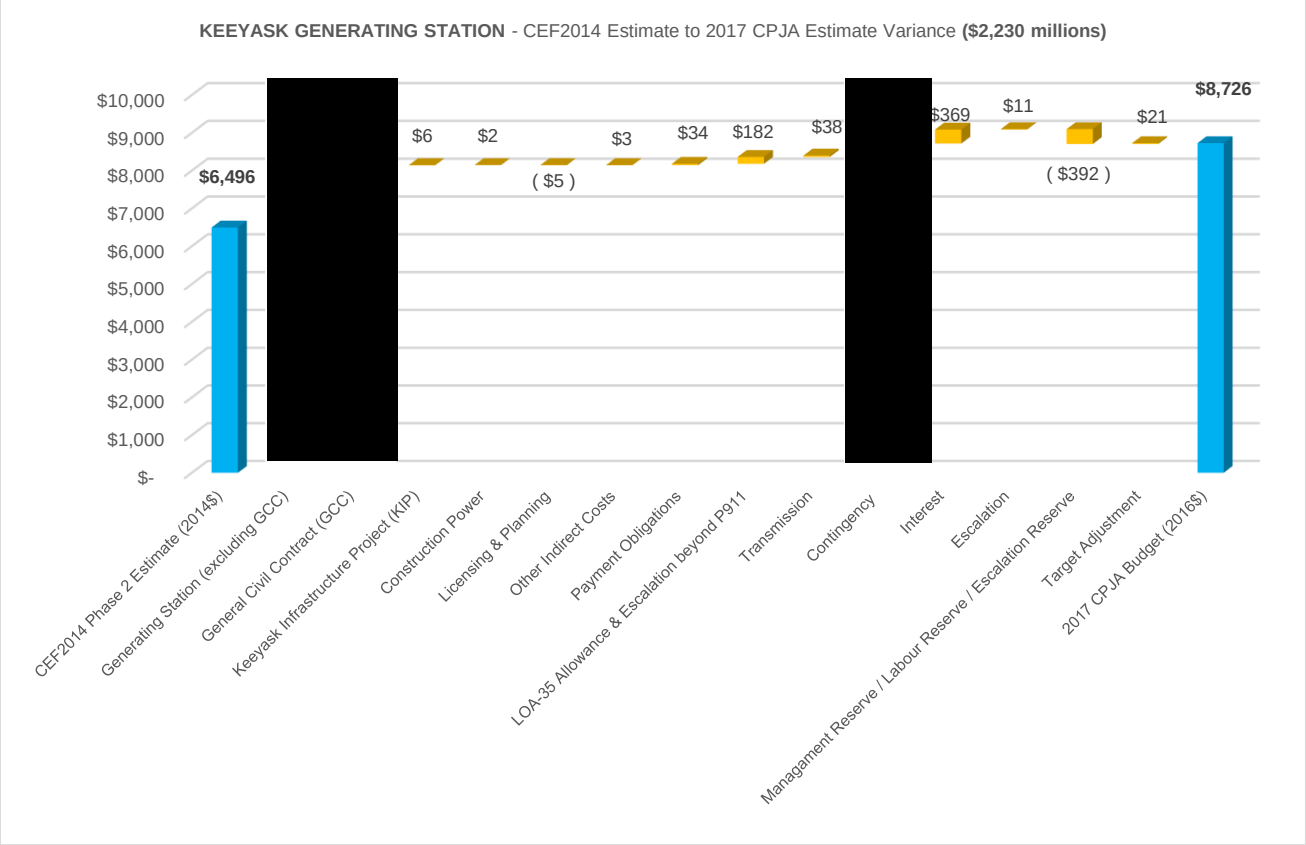
Source of Information & Reference Materials

- The Joint Keeyask Development Agreement (JKDA)
- JKDA Schedule 1-2 Construction Agreement
- JKDA Schedule 4-6 Construction Advisory Committee
- JKDA Schedule 4-7 Monitoring Advisory Committee
- JKDA Schedule 12-3 Proposed Letter of Agreement, Burntwood/Nelson Agreement
- JKDA Schedule 13-1 Identified Work Packages and Allocation

Finding No. 4: Keeyask - Project Cost Variance Review

Observations & Findings

Based on our review, the following provides a build-up of how the project costs have evolved from the CEF2014 ($6.496 billion) to the 2017 CPJA ($8.726 billion):



1a , 7a
4b

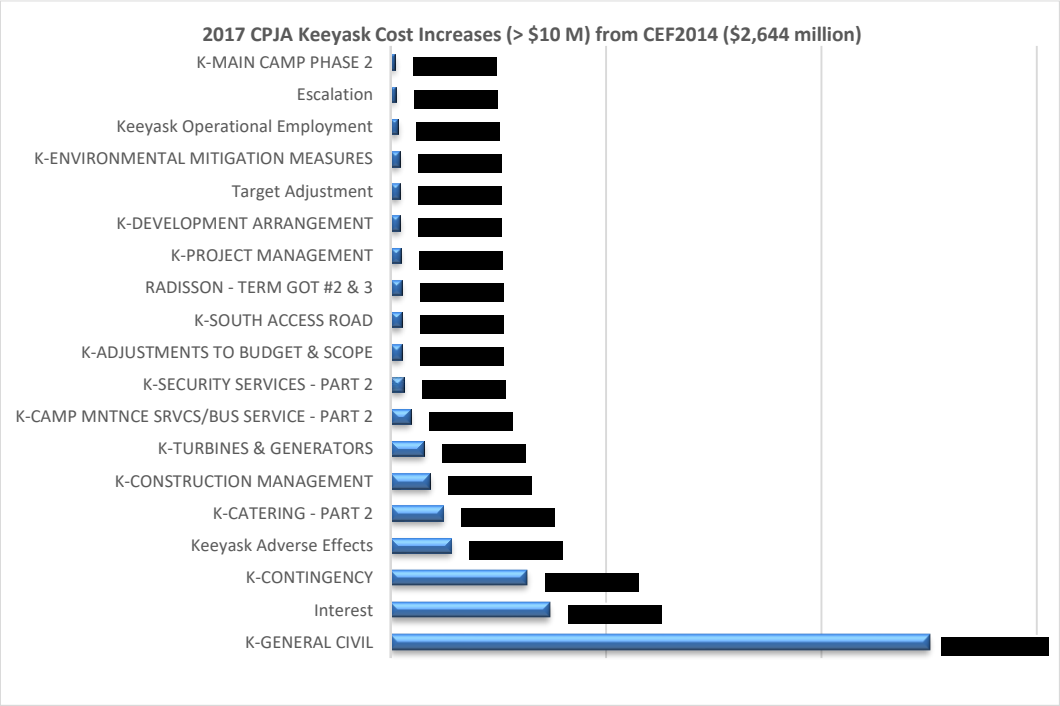
- 2013$: Expressed in fiscal year 2013/2014
- 2014$: Expressed in fiscal year 2014/2015
- 2016$: Expressed in fiscal year 2016/2017

The following provides a summary of key project variances from the $6.5 billion final pre-construction budget to the $8.7 billion current budget.

Final Pre-Construction Budget	6,496,076,546
Additions	2,783,971,637
Omissions	-554,009,510
Total	**8,726,038,673**

Total Budget Additions: $2.784 billion

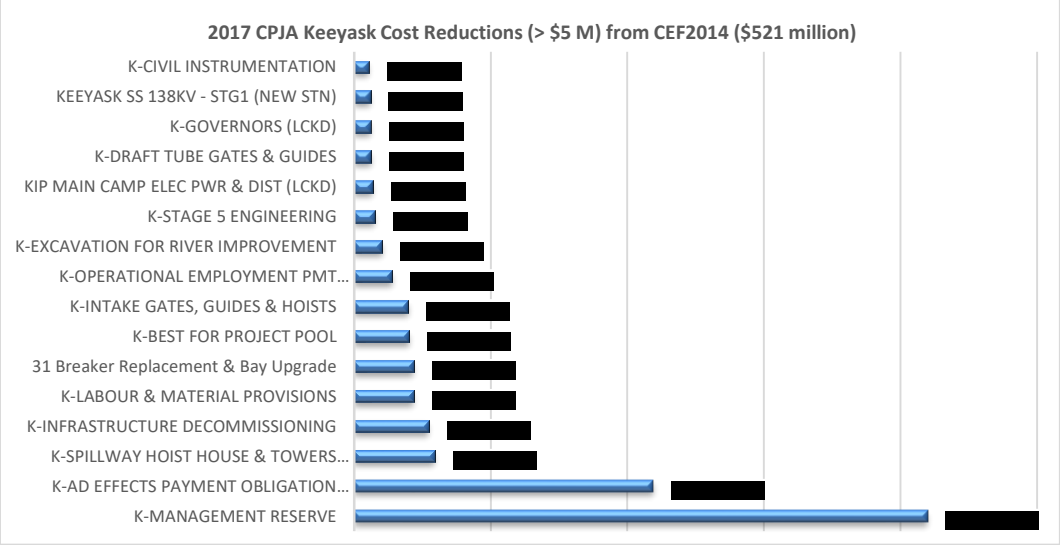
The following table sets out $2.644 billion of project cost increases out of the $2,784 million. The remaining $140 million is distributed across several other cost elements.



1a 7a

Total Budget Omissions: $554 million

The table below table sets out $521 million in project omissions. The remaining $33 million is distributed across several other cost elements.



1a 7a

Conclusions & Recommendations

The largest contributor to the overall project cost is the [redacted] increase in the value of the General Civil Contract (GCC) on account of Amending Agreement No. 7. Over [redacted] of the $2.23 billion net addition is due to the GCC, caused by concrete and earthwork productivity that is less than planned and additional indirect costs. 1a

Source of Information & Reference Materials

- Keeyask Generating Station, 2017 Capital Project Justification Addendum, Comparison of 2014 Estimate to 2017 Estimate, dated August 2017
- Map to Comparison of Keeyask 2014 to 2017.xlsx
- Keeyask Generating Station, Basis of Estimate Document, 2014 Capital Project Justification Addendum, dated August 2014
- Keeyask Generating Station, Basis of Estimate Document, 2017 Capital Project Justification Addendum, dated January 2017

Finding No. 5: Keeyask - Project Cost Overruns – Interest

Observations & Findings

Network / Project Number	Work Package	CEF2014 Phase 2 Estimate (2014$)	2017 CPJA Budget (2016$)	Variance ($)	Variance (%)
	Interest	1,379,944,641	1,749,184,959	369,240,318	26.8%

Manitoba Hydro has noted that increases to the project's base costs have increased interest costs.

Currently, interest represents 20% of the budgeted "Total In-Service Cost" ($8.7 billion).

Conclusions & Recommendations

MGF concludes that the costs associated with the interest rate are a function of funding the overall capital project.

MGF's recommendation is that contingency carried should consider the risk exposures associated with interest in the same manner it does with escalation.

MGF views Manitoba Hydro's current contingency as insufficient and further interest adjustments will likely be required.

Source of Information & Reference Materials

- Keeyask Generation Station Project Capital Cost and Schedule Risk Analysis and Contingency Estimate for Manitoba Hydro, 9th March 2014
- Keeyask Generation Station Project Capital Cost and Schedule Risk Analysis and Contingency Estimate Final for Manitoba Hydro, 7th March 2017
- Keeyask Generating Station, Basis of Estimate Document, 2014 Capital Project Justification Addendum, dated August 2014
- Keeyask Generating Station, Basis of Estimate Document, 2017 Capital Project Justification Addendum, dated January 2017
- Capital Project Justification Addendum No.4, dated 4th November 2014

Finding No. 6: Keeyask - Project Cost Overruns – General Civil Contract (GCC)

Observations & Findings

Network / Project Number	Work Package	CEF2014 Phase 2 Estimate (2014$)	2017 CPJA Budget (2016$)	Variance ($)	Variance (%)
243994	K-General Civil	[redacted]	[redacted]	[redacted]	[redacted]

1a 7a

CEF2014 – Phase 2 Budget (2014$)

Total Estimated Value:[redacted]

2017 CPJA Budget (2016$)

- CEF2016 Plan - [redacted]
- Delay Estimate - [redacted]
- Trends - [redacted]
- Approved Contract Changes - [redacted]
- Forecasted Contract Changes - [redacted]

1a 7a

Total Estimated Value:[redacted]

In comparing the Bill of Quantities (BOQ) provided within Amending Agreement No. 7, dated 28th February 2017 and the Original Contract, dated 10th March 2014, MGF has identified variances in both quantities and unit prices which have resulted in the increase to the overall cost.

Increased cost relating to the General Civil Contract is directly due to the adjustments in unit rates, on account of poor productivity experienced on the project. Poor productivity results in additional man-hours being required to perform the work compared to the man-hour assumptions carried in the Original Contract.

Based on documents viewed, [redacted] of the increased costs relate directly to the revision of unit prices. [redacted] are due to the increase of the "to-go" costs which are noted as being more than the total previous budget for Indirects, Temporary Utilities, Construction Facilities, Contingency and Crane Operator cost elements. 1a

[redacted] of the increase was due to quantities, [redacted] resulting from Proposed Extra Work and another [redacted] in schedule incentive profit.

The total of these contributing factors account for 80% of the [redacted] increase related to this cost element. 1a

Conclusions & Recommendations

MGF concludes that the increased costs from the Original Contract to the Amending Agreement No.7, are a direct result of the revised productivity rates and increased man-hours required to complete the project.

Source of Information & Reference Materials

- Schedule J, "Volume 4 – Bill of Quantities, Prices and Target Price Estimated" of the Manitoba Hydro and BBE Hydro Constructors Limited Partnership Contract, Amending Agreement #7, dated 28th February 2017
- "Volume 4 – Bill of Quantities, Prices and Target Price Estimated" of the Original Contract, dated 10th March 2014
- BBE Hydro Constructors LP, Keeyask Project Re-Baseline, December 2016, Basis and Assumptions, Dated 9th December 2016
- BBE Hydro Constructors LP, Keeyask Project Re-Baseline, December 2016, Basis and Assumptions, dated 9th December 2016, Attachment 2 – Construction Bill of Quantities, Rev. 2, Dated 23rd September 2016
- BBE Bid BOQ - 243994-0020-016203-RFP-BBE JV-FoP Keeyask BBE JV Final BOQ-2013-12-05
- BOQ Sent to BBE on Sept 25 - 243994-0030-016203-EST-Construction BOQ-20160705
- AA7 BOQ - extract from AA7 243994-0020-016203-CON-Amending Agreement 7-20170228
- Design BOQ - Hatch to Manitoba Hydro on Sept 23, 2017 - 243955x0010-016002-BOM-Design BOQ-20160308
- RFP BOQ with Sourcing- 243994-0020-016203-RFP-Part1 Form II Bill of Quantities
- 243994-0030-016203-EST-Construction BOQ-20160705
- 243994-0020-016203-RFP-BBE JV-FoP Keeyask BBE JV Final BOQ-2013-12-05

Finding No. 7: Keeyask - Project Cost Overruns – Generating Station

Observations & Findings

The following observation relates to the cost elements within the MGF reviewed line item "Generating Station (excluding GCC)".

A point to highlight are those costs which are attributed to "Delay Estimates". This is a result of an additional 11 months added to the project schedule.

Direct Cost Work Packages - Turbines & Generators (Including Governors):

Network / Project Number	Work Package	CEF2014 Phase 2 Estimate (2014$) CAD$	2017 CPJA Budget (2016$) CAD$	Variance ($) CAD$	Variance (%)
244021	K-Turbines and Generators	[redacted]	[redacted]	[redacted]	[redacted]
244023	K-Governors (LCKD)	[redacted]	[redacted]	[redacted]	[redacted]
	TOTAL	[redacted]	[redacted]	[redacted]	[redacted]

1a 7a

CEF2014 – Phase 2 Budget (2014$)

Total Estimated Value: [redacted]

2017 CPJA Budget (2016$)

- CEF2016 Plan - [redacted]
- Delay Estimate - [redacted]
- Trends - [redacted]

1a 7a

Total Estimated Value: [redacted]

The following are the noted variances provided by Manitoba Hydro:

- [redacted] change to offset currency risk
- [redacted] change to accelerate schedule
- [redacted] for offloading and handling equipment
- [redacted] estimated delay impact from GCC delay
- [redacted] for escalation of contract
- [redacted] Miscellaneous

1a 7a

Direct Cost Work Packages - Intake Gates:

Network / Project Number	Work Package	CEF2014 Phase 2 Estimate (2014$) CAD$	2017 CPJA Budget (2016$) CAD$	Variance ($) CAD$	Variance (%)
244026	K-Intake Gates, Guides and Hoists	[redacted]	[redacted]	[redacted]	[redacted]

1a 7a

CEF2014 – Phase 2 Budget (2014$)

Total Estimated Value: [redacted]

2017 CPJA Budget (2016$)

- CEF2016 Plan - [redacted]
- Delay Estimate - [redacted]
- Trends - [redacted]
- Approved Contract Changes - [redacted]

Total Estimated Value: [redacted]

1a 7a

The following are variances provided by Manitoba Hydro:

- [redacted]

1a

Direct Cost Work Packages - Spillway Gates (Including Hoist House & Towers):

Network / Project Number	Work Package	CEF2014 Phase 2 Estimate (2014$) CAD$	2017 CPJA Budget (2016$) CAD$	Variance ($) CAD$	Variance (%)
244025	K-Spillway Gates, Guides, HST & MNRL Crane	[redacted]	[redacted]	[redacted]	[redacted]
250580	K-Spillway Hoist House & Towers (LCKD)	[redacted]	[redacted]	[redacted]	[redacted]
	TOTAL	[redacted]	[redacted]	[redacted]	[redacted]

1a 7a

CEF2014 – Phase 2 Budget (2014$)

Total Estimated Value: [redacted]

2017 CPJA Budget (2016$)

- CEF2016 Plan - [redacted]
- Delay Estimate - [redacted]
- Trends - [redacted]
- Approved Contract Changes - [redacted]

Total Estimated Value: [redacted]

1a 7a

The following are variances provided by Manitoba Hydro:

- [redacted]

1a

Direct Cost Work Packages - Excavation for River Improvement:

- Scope was deleted in 2016 Estimte

Service Work Packages – Catering (delay estimate is for increased man-hours & delay):

Network / Project Number	Work Package	CEF2014 Phase 2 Estimate (2014$) CAD$	2017 CPJA Budget (2016$) CAD$	Variance ($) CAD$	Variance (%)
243960	K-Catering – Part 2	[redacted]	[redacted]	[redacted]	[redacted]

1a 7a

CEF2014 – Phase 2 Budget (2014$)

Total Estimated Value: [redacted]

2017 CPJA Budget (2016$)

- CEF2016 Plan - [redacted]
- Delay Estimate - [redacted]
- Trends - [redacted]
- Approved Contract Changes - [redacted]

Total Estimated Value: [redacted]

1a 7a

The following are variances provided by Manitoba Hydro:

- Increased in CPJ Addendum; related to increased man-hours in GCC estimate

Service Work Packages – Maintenance:

Network / Project Number	Work Package	CEF2014 Phase 2 Estimate (2014$) CAD$	2017 CPJA Budget (2016$) CAD$	Variance ($) CAD$	Variance (%)
243961	K-Camp Mntnce Srvcs/Bus Service – Part 2	[redacted]	[redacted]	[redacted]	[redacted]

1a 7a

CEF2014 – Phase 2 Budget (2014$)

Total Estimated Value: [redacted]

1a 7a

2017 CPJA Budget (2016$)

- CEF2016 Plan - [redacted]
- Delay Estimate - [redacted]
- Trends - [redacted]
- Approved Contract Changes - [redacted]

Total Estimated Value: [redacted]

1a 7a

The following are variances provided by Manitoba Hydro:

- Increased in CPJ Addendum; related to increased staffing requirements at site & delay of GCC

Service Work Packages – Security:

Network / Project Number	Work Package	CEF2014 Phase 2 Estimate (2014$) CAD$	2017 CPJA Budget (2016$) CAD$	Variance ($) CAD$	Variance (%)
243962	K-Security Services – Part 2	[redacted]	[redacted]	[redacted]	[redacted]

1a 7a

CEF2014 – Phase 2 Budget (2014$)

Total Estimated Value: [redacted]

2017 CPJA Budget (2016$)

- CEF2016 Plan - [redacted]
- Delay Estimate - [redacted]
- Trends - [redacted]
- Approved Contract Changes - [redacted]

Total Estimated Value: [redacted]

1a 7a

The following are variances provided by Manitoba Hydro:

- Increased in CPJ Addendum; related to increased staffing requirements at site & delay of GCC

Service Work Packages – First Aid:

Network / Project Number	Work Package	CEF2014 Phase 2 Estimate (2014$) CAD$	2017 CPJA Budget (2016$) CAD$	Variance ($) CAD$	Variance (%)
243964	K-First Aid Services – Part 2	[redacted]	[redacted]	[redacted]	[redacted]

1a, 7a

CEF2014 – Phase 2 Budget (2014$)

Total Estimated Value: [redacted]

2017 CPJA Budget (2016$)

- CEF2016 Plan - [redacted]
- Delay Estimate - [redacted]
- Trends - [redacted]
- Approved Contract Changes - [redacted]

1a, 7a

Total Estimated Value: [redacted]

The following are variances provided by Manitoba Hydro:

- Increased in CPJ Addendum; related to increased staffing requirements at site & delay of GCC

Other Indirect Work Packages – Construction Management:

Network / Project Number	Work Package	CEF2014 Phase 2 Estimate (2014$) CAD$	2017 CPJA Budget (2016$) CAD$	Variance ($) CAD$	Variance (%)
243954	K-Construction Management	[redacted]	[redacted]	[redacted]	[redacted]

1a, 7a

CEF2014 – Phase 2 Budget (2014$)

Total Estimated Value: [redacted]

2017 CPJA Budget (2016$)

- CEF2016 Plan - [redacted]
- Delay Estimate - [redacted]
- Trends - [redacted]
- Approved Contract Changes - [redacted]
- Forecasted Contract Changes - [redacted]

Total Estimated Value: [redacted]

1a, 7a

The following are variances provided by Manitoba Hydro:

- [redacted] to increase site staff as a result of cultural action plan
- [redacted] increase due to GCC delay
- [redacted] transfer of Hatch Scope for Support during Construction
- Remainder Miscellaneous & Escalation

1a, 7a

Other Indirect Work Packages – Project Management:

Network / Project Number	Work Package	CEF2014 Phase 2 Estimate (2014$) CAD$	2017 CPJA Budget (2016$) CAD$	Variance ($) CAD$	Variance (%)
243953	K-Project Management	[redacted]	[redacted]	[redacted]	[redacted]

1a, 7a

CEF2014 – Phase 2 Budget (2014$)

Total Estimated Value: [redacted]

2017 CPJA Budget (2016$)

- CEF2016 Plan - [redacted]
- Delay Estimate - [redacted]
- Trends - [redacted]
- Approved Contract Changes - [redacted]
- Forecasted Contract Changes - [redacted]

Total Estimated Value: [redacted]

1a, 7a

The following are variances provided by Manitoba Hydro:

- [redacted] for support consultants in CPJ Addendum 1a, 7a
- [redacted] delay estimate in CPJ Addendum
- Remainder Escalation & Miscellaneous

Variances in Cost Summaries and Supporting Cost Detail Sheets (By Network) were noted in 2014 estimate.

Other Indirect Work Packages – Best for Project Pool:

Network / Project Number	Work Package	CEF2014 Phase 2 Estimate (2014$) CAD$	2017 CPJA Budget (2016$) CAD$	Variance ($) CAD$	Variance (%)
243982	K-Best for Project Pool	[redacted]	[redacted]	[redacted]	[redacted]

1a, 7a

CEF2014 – Phase 2 Budget (2014$)

Total Estimated Value: [redacted]

2017 CPJA Budget (2016$)

- CEF2016 Plan - [redacted]
- Trends - [redacted]

Total Estimated Value: [redacted]

1a, 7a

The following are the noted variances provided by Manitoba Hydro:

- Best for Project Pool was used to incentivize other contractors to meet GCC Schedule; it is no longer required

Other Indirect Work Packages – South Access Road:

Network / Project Number	Work Package	CEF2014 Phase 2 Estimate (2014$) CAD$	2017 CPJA Budget (2016$) CAD$	Variance ($) CAD$	Variance (%)
243958	K-South Access Road	[redacted]	[redacted]	[redacted]	[redacted]

1a 7a

CEF2014 – Phase 2 Budget (2014$)

Total Estimated Value: [redacted]

2017 CPJA Budget (2016$)

1a 7a

- CEF2016 Plan - [redacted]
- Approved Contract Changes - [redacted]
- Forecasted Contract Changes - [redacted]

Total Estimated Value: [redacted]

The following are variances provided by Manitoba Hydro:

- The contract award for the south access road exceeded the original estimates; this was offset by a transfer of [redacted] from labour & material provisions

1a

Other Indirect Work Packages – Permanent Ice Boom:

Network / Project Number	Work Package	CEF2014 Phase 2 Estimate (2014$) CAD$	2017 CPJA Budget (2016$) CAD$	Variance ($) CAD$	Variance (%)
243741	K-Permanent Ice Boom	[redacted]	[redacted]	[redacted]	[redacted]

1a 7a

CEF2014 – Phase 2 Budget (2014$)

Total Estimated Value: [redacted]

1a 7a

2017 CPJA Budget (2016$)

- CEF2016 Plan - [redacted]
- Delay Estimate - [redacted] 1a 7a
- Trends - [redacted]
- Approved Contract Changes - [redacted]

Total Estimated Value: [redacted]

The following are variances provided by Manitoba Hydro:

- Ice boom modifications as a result of ice boom failures

Other Indirect Work Packages – Main Camp – Phase 2:

Network / Project Number	Work Package	CEF2014 Phase 2 Estimate (2014$) CAD$	2017 CPJA Budget (2016$) CAD$	Variance ($) CAD$	Variance (%)
243966	K-Main Camp Phase 2	[redacted]	[redacted]	[redacted]	[redacted]

1a 7a

CEF2014 – Phase 2 Budget (2014$)

Total Estimated Value: [redacted]

2017 CPJA Budget (2016$)

- CEF2016 Plan - [redacted] 1a 7a
- Delay Estimate - [redacted]
- Approved Contract Changes - [redacted]
- Forecasted Contract Changes - [redacted]

Total Estimated Value: [redacted]

The following are variances provided by Manitoba Hydro:

- Increase of [redacted] to expand camp; remainder miscellaneous changes 1a 7a

Other Indirect Work Packages – Infrastructure Decommissioning:

Network / Project Number	Work Package	CEF2014 Phase 2 Estimate (2014$) CAD$	2017 CPJA Budget (2016$) CAD$	Variance ($) CAD$	Variance (%)
243969	K-Infrastructure Decommissioning	[redacted]	[redacted]	[redacted]	[redacted]

1a 7a

CEF2014 – Phase 2 Budget (2014$)

Total Estimated Value: [redacted]

2017 CPJA Budget (2016$) 1a 7a

- CEF2016 Plan - [redacted]

Total Estimated Value: [redacted]

The following are variances provided by Manitoba Hydro:

- Primarily related to the inclusion of salvage in the estimates

Other Indirect Work Packages – Labour & Material Provisions:

Network / Project Number	Work Package	CEF2014 Phase 2 Estimate (2014$) CAD$	2017 CPJA Budget (2016$) CAD$	Variance ($) CAD$	Variance (%)
243983	K-Labour & Material Provisions	[redacted]	[redacted]	[redacted]	[redacted]

1a 7a

CEF2014 – Phase 2 Budget (2014$)

Total Estimated Value: [redacted]

1a 7a

2017 CPJA Budget (2016$)

- CEF2016 Plan - [redacted]

Total Estimated Value: [redacted]

The following are variances provided by Manitoba Hydro:

- Labour & Material Provisions were used to offset the awarded contract values for direct negotiated contracts such as the south access road and reservoir clearing

Partnership, Monitoring, Mitigation – Development Agreement:

Network / Project Number	Work Package	CEF2014 Phase 2 Estimate (2014$) CAD$	2017 CPJA Budget (2016$) CAD$	Variance ($) CAD$	Variance (%)
243977	K-Development Arrangement	[redacted]	[redacted]	[redacted]	[redacted]

1c 7a

CEF2014 – Phase 2 Budget (2014$)

Total Estimated Value: [redacted]

2017 CPJA Budget (2016$) 1c 7a

- CEF2016 Plan - [redacted]
- Delay Estimate - [redacted]
- Trends - [redacted]

Total Estimated Value: [redacted]

The following are variances provided by Manitoba Hydro:

- Increase in partnership implementation funding

Partnership, Monitoring, Mitigation – Environment:

Network / Project Number	Work Package	CEF2014 Phase 2 Estimate (2014$) CAD$	2017 CPJA Budget (2016$) CAD$	Variance ($) CAD$	Variance (%)
243980	K-Environmental Mitigation Measures	[redacted]	[redacted]	[redacted]	[redacted]

1c 7a

CEF2014 – Phase 2 Budget (2014$)

1c 7a

Total Estimated Value: [redacted]

2017 CPJA Budget (2016$)

1c 7a

- CEF2016 Plan - [redacted]
- Delay Estimate - [redacted]
- Trends - [redacted]

Total Estimated Value: [redacted]

The following are variances provided by Manitoba Hydro:

1c 7a

- [redacted] increase related to delay of GCC
- [redacted] for mercury management, socioeconomic monitoring, and heritage protection
- remainder escalation & miscellaneous

Partnership, Monitoring, Mitigation – Adjustment for Budget & Scope:

Network / Project Number	Work Package	CEF2014 Phase 2 Estimate (2014$) CAD$	2017 CPJA Budget (2016$) CAD$	Variance ($) CAD$	Variance (%)
255786	K-Adjustments to Budget & Scope	[redacted]	[redacted]	[redacted]	[redacted]

1a 7a

CEF2014 – Phase 2 Budget (2014$)

Total Estimated Value: [redacted]

1a 7a

2017 CPJA Budget (2016$)

- CEF2016 Plan - [redacted]
- Trends - [redacted]

Total Estimated Value: [redacted]

The following are variances provided by Manitoba Hydro:

- Each year, escalation is added to the base cost estimates based on policy P911 escalation rates. At the same time, remaining escalation is calculated by financial planning, which results in a reduction in the allowance for remaining P911 escalation. In 2014 and 2015, the amount of escalation removed by financial planning exceeded the amount of escalation added to the base costs by $25 million. Because of concerns that the remaining P911 escalation allowance was not sufficient, these funds from the original escalation allowance were retained in the estimate.

Other Expenditures:

Network / Project Number	Work Package	CEF2014 Phase 2 Estimate (2014$) CAD$	2017 CPJA Budget (2016$) CAD$	Variance ($) CAD$	Variance (%)
243976	K-Transportation – Part 2	[redacted]			
244013	K-Reservoir Clearing				
243986	K-Stage 1 Cofferdams				
243972	K-Main Camp Communications Phase 2				
244024	K-Powerhouse Cranes				
243959	K-Camp Operations				
244037	K-600V Switchgear & Switchboard				
244039	K-MV Station Service Equipment				
244001	K-North & South Dykes				
243974	K-Job Referral Service – Part 2				
243998	K-Social Mitigation & Waterways Management				
243984	K-Management Agreement				
246440	K-PH Complex Suprstrctr & Buiding Env				
243971	K-Main Camp Electrical Power – Phase 2				
250581	K-Station AC Distribution				
243975	K-Construction Office – Part 2				
244036	K-Unit Control & Monitoring System				
246442	K-Transition Concrete Structures				
243978	K-Project-Wide Technical Information				

1a 7a

Network / Project Number	Work Package	CEF2014 Phase 2 Estimate (2014$) CAD$	2017 CPJA Budget (2016$) CAD$	Variance ($) CAD$	Variance (%)
244035	K-Gen/XFMR Protective Relaying Equipment	[redacted]			
246433	K-Service Bay Concrete Structure				
244011	K-Operational Employment				
244038	K-Motor Control Centers				
244027	K-Draft Tube Crane				
243999	K-Rock & Unclassified Excavation				
250589	K-Waste Water System				
246431	K-Powerhouse Concrete Structure				
244006	K-North, Central, South Dams				
243967	K-3D Model Development				
250593	K-Station HVAC System				
243979	K-Lowering/Rmval of River Mngmnt Strctres				
244014	K-Architectural Finishing				
250590	K-Stations Service & Cooling Water Syst				
243995	K-Stage 2 Cofferdams				
250583	K-Cable Raceways & Support System				
244045	K-Generating Station Communications				
244003	K-Powerhouse Approach Channel				
244017	K-North Access Road Ramp				
246432	K-Trailrace Concrete Structure				
250588	K-Fuel Oil Piping System				

1a 7a

Network / Project Number	Work Package	CEF2014 Phase 2 Estimate (2014$) CAD$	2017 CPJA Budget (2016$) CAD$	Variance ($) CAD$	Variance (%)
244002	K-Access Road to Powerhouse & Parking LT	[redacted]			
250596	K-Intake Monorail Crane				
244007	K-Spillway Approach Channel				
244042	K-Elec & Mech Systems & Services (LCKD)				
244018	K-South Access Road Ramp				
250585	K-Station Lighting System				
244043	K-Air Gap & Vibration Monitoring Systems				
244004	K-Intake Concrete Structure				
250595	K-Spillway Fire Suppression System				
243943	K-Compressed Air System				
244008	K-Spillway Concrete Structure				
243985	K-Temporary Ice Boom (LCKD)				
244020	K-Piezometer System				
246444	K-Transmission Tower Spur				
244031	K-Station Bonding & Ground Grid				
250582	K-Station DC Distribution				
250587	K-Station Fire Alarm/Detection System				
249021	K-Stg 2 River Diversion Erosion P (LCKD)				
249035	K-Service Bay – Main Door				
250586	K-Station Security System				

1a 7a

Network / Project Number	Work Package	CEF2014 Phase 2 Estimate (2014$) CAD$	2017 CPJA Budget (2016$) CAD$	Variance ($) CAD$	Variance (%)
244029	K-Shaft Seal Water System	[redacted]			
244005	K-Powerhouse Discharge Channel (LCKD)				
249023	K-Stg 1 River Divrsn Erosion Prot (LCKD)				
243997	K-Hydr Design Input to Stg 2 Cofferdams				
244030	K-Oil Management System				
250594	K-Powerhouse Complex Fire Suppression Sy				
250592	K-Unit Dewatering System				
244032	K-Exciters				
249022	K-Powerhouse Complex Elevators				
244019	K-Domestic Water System				
243990	K-Stg 1 Spillway Cofferdam (LCKD)				
243963	K-Employee Retentn Support Srvs – Part 2				
250591	K-Clearwater Drainage System				
246443	K-Wing Wall Concrete Structures (LCKD)				
244000	K-Quarry Development				
243838	K-Spillway Excavation (LCKD)				
250584	K-Blackstart Standby Power System				
244012	K-Powerhouse Excavation (LCKD)				
244041	K-Isolated Phase Bus				
244040	K-Spillway Standby Power Supply				
249026	K-Stoplogs, Bkhd/DT Tube Gates & Folls				

1a 7a

Network / Project Number	Work Package	CEF2014 Phase 2 Estimate (2014$) CAD$	2017 CPJA Budget (2016$) CAD$	Variance ($) CAD$	Variance (%)
249025	K-Permanent Spillway Stoplogs & Guides	[redacted]			
244044	K-138KV Surge Arrstrs & Discnct Swtch				
244033	K-Generator Circuit Breakers				
244034	K-Generator Step-Up Transformers				
249027	K-Intake Trashracks & Guides				
244016	K-Civil Instrumentation				
249028	K-Draft Tubes Gates & Guides				
243955	K-Stage 5 Engineering				

1a 7a

The above table only shows variances.

CEF2014 – Phase 2 Budget (2014$)

Total Estimated Value: $376.2 million

2017 CPJA Budget (2016$)

- CEF2016 Plan - $357.4 million
- Delay Estimate - $17.7 million
- Trends - $6.9 million
- Approved Contract Changes - $4.3 million
- Forecasted Contract Changes - $10.3 million

Total Estimated Value: $396.6 million

This category “Other,” within the Cost Estimate, in the sum of $396.6 million appears to be a “catch-all” for various scope and service elements. The largest cost increases are due to Transportation, Reservoir Cleaning, Stage 1 Cofferdam and Camp Communications requirements.

Conclusions & Recommendations

The cost increases are due to the performance of the General Civil Contract (GCC) contractor. The GCC contractor is behind schedule which causes delays and cost increases on other services and scopes of work related to the project, therefore raising the total project cost.

Source of Information & Reference Materials

- Map to Comparison of Keeyask 2014 to 2017.xlsx
- Keeyask Generating Station, Basis of Estimate Document, 2014 Capital Project Justification Addendum, dated August 2014
- Keeyask Generating Station, Basis of Estimate Document, 2017 Capital Project Justification Addendum, dated January 2017
- Keeyask Generating Station, 2017 Capital Project Justification Addendum, Comparison of 2014 Estimate to 2017 Estimate, dated August 2017

SCOPE ITEM 2:

Determine whether the current state of design work, engineering work and geotechnical analysis supports the $8.7 billion cost estimate. If not, identify what changes in the contingencies, reserves or forecast at completion cost are required.

Finding No. 1: Keeyask - Klohn Crippen Berger Report

Observations & Findings

The last bullet point on page 15 of the Klohn Crippen Berger Report states “The only potential issue may be the timing of the drawing production, which may have created some delays in construction”.

In the video conference with BBE Hydro Constructors Limited Partnership (BBE) on 23rd October 2017, BBE advised MGF that construction had not been delayed on account of the issue of Issued for Construction (IFC) drawings.

Conclusions & Recommendations

The production of Issued for Construction drawings has not impacted BBE’s progress.

Source of Information & Reference Materials

- Video conference with BBE on Monday 23rd October 2017

SCOPE ITEM 3:

Review and assess Manitoba Hydro's cost estimating methodologies, identifying best practices and short-comings, beginning with the development of the $6.5 billion final pre-construction budget and with specific attention to the changes that have resulted in the $8.7 billion forecast at completion budget. Identify whether sufficient contingency amounts are included in the $8.7 billion forecast at completion budget.

Finding No. 1: Keeyask - Manitoba Hydro Cost Estimating Methodologies

Observations & Findings

The review of the Basis of Estimate and associated attachments identified areas of significant disconnects and insufficient details with which to understand the development of the $6.5 billion final pre-construction budget and the $8.7 billion forecast at completion budget.

Manitoba Hydro's Basis of Estimate for the "2014 Capital Project Justification Addendum" provides, at a high level, the evolution of the estimate. KGS Acres Ltd. produced the cost estimate in 2007 which was later updated in December 2009. Price adjustments over the years were made using escalation calculations to select cost elements of the cost estimate. This is an area upon which Manitoba Hydro can improve.

It was difficult to align the levels of detail and structure of the estimates with the various cost reports, despite the fact that the project has an established Work Breakdown Structure (WBS). The estimate basis has not been aligned with either the WBS or the summary tables provided within the Basis of Estimate itself. The detailed cost summary in the Basis of Estimate seems to align with Manitoba Hydro's SAP cost reports which appear to drive much of Manitoba Hydro's estimating formats, development process and ultimately its estimating philosophies.

The following are examples of items we expected to find in the Basis of Estimate but which were missing:

- Estimate classification
- Benchmarking references
- Estimate deliverables checklist
- Listing of documents available or relied upon at the time of the estimate
- Engineering progress
- Change logs (by date, number, value and parties impacted). Only a summary of Contract Change values was provided. Attachments noted as being included within the BBE Basis of Estimate were not available upon request and it was indicated that these may not have been provided to Manitoba Hydro
- Basis for quantities (model, manual take-offs, factors, allowances, etc.)
- Schedule basis (identifying major milestone dates)

Conclusions & Recommendations

In general Manitoba Hydro is very strong in capturing and reporting costs and has a very capable group. It is MGF's opinion that additional governance and cost control, not accounting, measures need to be implemented. Tighter pre-tender and project sanction estimates can be developed by addressing the observations and findings above.

More consistent alignment is recommended between the level of project execution reporting and financial reporting (i.e. different metrics are used to benefit both groups in different ways). Development and use of a logical Work Breakdown Structure and Cost Breakdown Structure is recommended and to use these to structure budgets and reports in a consistent manner throughout the project.

Source of Information & Reference Materials

- AACE International Recommended Practice No. 34R-05, BASIS OF ESTIMATE, TCM Framework: 7.3 – Costs Estimating and Budgeting.
- Keeyask Generating Station, Chronological History of Approved Project Budget (CEF08 – CEF16)
- Keeyask Generating Station, Final Design Phase, Basis of Cost Estimate Report December 2009 Cost Estimate, dated June 1, 2010
- Keeyask Generating Station, Basis of Estimate Document, 2014 Capital Project Justification Addendum, dated August 2014

Finding No. 2: Keeyask - Manitoba Hydro Cost Estimating Methodologies

Observations & Findings

2017 CPJA Budget (2016$)

The 2017 CPJA Budget has been developed through the combination of estimates as well as values represented as Approved Contract Changes and Forecasted Contract Changes which, depending on the compensation method and terms outlined within the Contract to which the Contract Change applies to, could also be considered only an estimate (i.e. Cost Reimbursable vs. Fixed Price). The following categories of estimate update "type" have been presented by Manitoba Hydro, as a basis for the 2017 CPJA Budget (2016$).

- CEF2016 Plan: These are estimates that were generated by the respective Work Package Lead (WPL) assigned to a given work package (there have been some 59 WPLs identified as preparing 149 work packages).

  Templates were provided by Manitoba Hydro's Cost & Schedule Section which were then issued to the WPL for population. Upon completion of these templates, the estimates were loaded into SAP, Manitoba Hydro's cost management system. Based on a distribution curve assigned to the costs, in terms of when and how the expected spend would occur, cash flows were produced and various time driven cost adjustments could be accounted for.

The templates included the following “Sunk Costs” and “Planned Costs” for the following fiscal years until completion of the project. These have been presented per the following categories:

- Labour
- Expenses
- Contracts
- Consulting (Consulting was new to the 2017 Estimate)

- Delay Estimate: WPL’s generated estimates associated to their respective work package(s) based on a one-year schedule delay to the first unit In-Service Date, which was driven by the contractor’s schedule. Costs were allocated into Labour, Expenses, Contracts and Consulting categories.
- Trends: WPL’s generated estimates for other known trending costs not associated with delay. These have been identified as including Project Change Authorizations (PCA) waiting for approval and other potential PCAs not yet formalized.
- Approved Contract Changes: Approved contract changes were based on information compiled from the Contract Revision Register (CRR).
- Forecasted Contract Changes: These are referenced in the basis as pending Contract Changes and were based on information compiled from the Contract Revision Register (CRR).

Pending Contract Changes are identified by WPLs for changes that are known, but not yet finalized. Manitoba Hydro’s Cost & Schedule Section confirmed that no delay costs or trends identified by the WPLs were duplicated in the list of pending Contract Changes.

CEF2016 Plan: Costs noted within the CEF2016 Plan Estimate Summary Sheets are planned for as late as 31st March 2023.

CEF 2016 Estimate Sheets were provided in the Basis of Estimate appendices as supporting details to the cost estimate, however, the values included within these estimate sheets did not align with the values carried in the actual estimate. In the 2014 Capital Project Justification Addendum, Basis of Estimate variances occur because of SAP’s use of a more accurate treatment of overhead. It was also noted through conversations that these variances are the result of updated labour rates themselves which are to be applied throughout the next fiscal year. Rates current at the time the CEF 2016 Estimate Sheets were generated, and then adjusted prior to being carried in the final estimate. This was not specified within the 2017 Capital Project Justification Addendum, Basis of Estimate and the reconciled estimate sheets that were provided in 2014 were also neither provided nor developed for the 2017 Estimate. This made one-for-one reconciliations difficult to perform.

Manitoba Hydro’s overhead is calculated at 5% and includes:

- Personal Computers
- Tools and Consumables
- Accounts Payable Group
- Supply Chain Management Group
- Software Licensing & Maintenance (i.e. Autocad, Mapinfo, etc.)

Delay Estimate: Delay estimate values and descriptions have been presented within the Basis of Estimate document.

Trends: Manitoba Hydro has indicated that these costs are largely due to estimates that had been completed by the Transmission Group. The Keeyask Project Team did not have copies of these.

Approved Contract Changes: Manitoba Hydro provided the Project Contract Revision Register and an appendix within the Basis of Estimate. There was not a list of Approved Contract Changes in the estimate.

Forecasted Contract Changes: Manitoba Hydro provided a copy of the Project Contract Revision Register and an appendix within the Basis of Estimate. There was not a list of Pending Contract Changes included in the estimate.

Conclusions & Recommendations

CEF2016 Plan: MGF recommends that future estimates have appropriate reconciliations to reflect the control budget, including narratives to support the Basis of Estimate developed by WPLs.

MGF was provided with the detailed CEF 2016 Estimate Sheets used as the input basis to SAP, however, no reconciled details were provided in relation to the output of SAP and the eventual build-up of costs associated to the CEF 2016 Plan costs.

Estimated values carried in the budget are based on SAP cost modelled and time phased outputs which is an excellent approach for generating a control budget that considers future matters such as escalation and interest, albeit the estimate and SAP reporting structures need to align.

Delay Estimates & Trends: Manitoba Hydro's Keeyask Project, Costs and Schedule Group should hold the accountability for all change management, including the review and approval process associated with potential, proposed and approved project changes. A Change Log should be developed and used for tracking and managing changes for current projects.

MGF has not seen a Consolidated Project Change Log. What has been expressed as the project Change Log is simply a document management tool, which does not provide a summary of values by change, the history of the change nor how changes have evolved from either trends or Project Change Authorizations (PCAs). The Change Log is an important project management tool which should capture all potential, pending and approved changes on the project and provide an increased level of traceability. This is extremely valuable when attempting to reconcile actual costs with the approved changes.

Source of Information & Reference Materials

- Keeyask Generating Station, Basis of Estimate Document, 2014 Capital Project Justification Addendum, dated August 2014
- Keeyask Generating Station, Basis of Estimate Document, 2017 Capital Project Justification Addendum, dated January 2017
- Email dated 15th November 2017 (Blair Purvis), Subject: "Re: PEWS"

Finding No. 3: Keeyask - Inconsistent Estimate and Cost Structure

Observations & Findings

MGF reviewed the line item entitled “Keeyask Generating Station (excluding GCC)” as reported in the CEF 2014 and 2017 CPJA Budget, to understand how the costs were assembled.

Manitoba Hydro has used a variety of different formats and structures with which to assign costs to Scopes of Work. Note the following:

- The structure of the Cost Summary Tables included in the CPJA Basis of Estimate was not explained
- The Work Package WBS Summary was logical but the estimate summaries did not follow this structure
- The Detailed Estimate Summary was by Network, by Project and aligned with SAP, not the WBS or summaries within the Basis of Estimate

Conclusions & Recommendations

MGF recommends utilizing a single Work Breakdown Structure for consistent cost and schedule reporting.

Source of Information & Reference Materials

- Map to Comparison of Keeyask 2014 to 2017.xlsx
- Keeyask Generating Station, Basis of Estimate Document, 2014 Capital Project Justification Addendum, dated August 2014
- Keeyask Generating Station, Basis of Estimate Document, 2017 Capital Project Justification Addendum, dated January 2017
- Keeyask Generating Station, 2017 Capital Project Justification Addendum, Comparison of 2014 Estimate to 2017 Estimate, dated August 2017
- Capital Project Justification Addendum No.3, dated 30th October 2012
- Capital Project Justification Addendum No.4, dated 4th November 2014

Finding No. 4: Keeyask - $6.5 billion Estimate Adjustments, Updates and Inputs

Observations & Findings

Estimate updates used in developing the “Final Pre-Construction” Budget have been generated by Manitoba Hydro’s Work Package Leads and based on various Manitoba Hydro internal and external sources at various points in time.

Estimate reference information came through market underpinned contract values, data from recently completed projects, namely Wuskwatim and costs that were based on information included and prepared for previously issued estimates, from as early as 2006.

For these previously developed estimates, escalation adjustment methods have been applied in consideration of year over year market conditions experienced since the source pricing was established, ultimately with the intention of achieving a price reflective of the current market.

These costs were noted to include Internal Labour, Expenses as well as items identified as contract estimates.

The Basis of Estimate document provided in 2014, representing the $6.496 billion project value is said to be:

> *"…generally based on the phase 2 estimate, unless noted otherwise."*

"Other Direct Cost" elements, noted below have been specifically identified in the 2014 Basis of Estimate as being based on escalated 2009/10 Estimates:

- Intake and Spillway Gates
- Other Water-to-Wire Contracts
- Balance of Plant Contracts
- Reservoir Clearing Contracts (was adjusted in the Phase 1 Estimate)

In review of the estimate detail summary sheets it was stated some costs were based on an escalated cost from 2009$, or earlier.

Conclusions & Recommendations

In general, many of the earlier Manitoba Hydro estimates used for the Pre-Construction Budget are very well detailed and clearly outline the sources and methodology applied to the development.

Adjusting previously prepared estimates to later points in time is a common estimating practice. It is MGF's opinion that a complete re-estimate should have been performed as part of the pre-tender estimate.

Many variables including scope, market conditions, foreign exchange rates, commodity indices, labour rates (agreement specific), labour composition, productivities, regulations, cash flow assumptions for escalation and even technologies are likely to have changed greatly over a 5 to 8 year period.

Any estimate inaccuracies are potentially further compounded over time and even more if the escalation itself is improperly calculated or the selected indices are inappropriate for the application.

There were numerous adjusted estimates noted through our review and the adjustment methods appear to have been very broadly applied. This method of adjustment would be more suitable to a preliminary type estimate. A control budget should have more relevant and accurate market underpinning prior to execution.

Source of Information & Reference Materials

- Keeyask Generating Station, Basis of Estimate Document, 2014 Capital Project Justification Addendum, dated August 2014

SCOPE ITEM 4:

Review and assess Manitoba Hydro's scheduling methodologies, identifying best practices and short-comings.

Finding No. 1: Keeyask - Basis of Schedule

Observations & Findings

Currently there is no Basis of Schedule for the Integrated Master Schedules developed and managed by Manitoba Hydro.

BBE had provided a Basis of Schedule with the original baseline schedule. Since the re-baseline, a revised Basis of Schedule was submitted by BBE to Manitoba Hydro for approval. However, this was rejected by Manitoba Hydro due to a lack of sufficient detail.

As of 23rd October 2017 BBE has not re-submitted a more detailed Basis of Schedule.

Conclusions & Recommendations

A Basis of Schedule is an industry best practice and typically includes information about the Scope of Work (e.g. inclusions and exclusions), assumptions, execution strategy (e.g. standard or aggressive approach to the Work), options to accelerate the schedule and average and peak resource demand during the project.

The Basis of Schedule should be a "live" document which is frequently updated as any of the key aspects change and is generally updated and maintained by the scheduler.

Manitoba Hydro does have a "Develop Baseline Schedule" Procedure (CSS-011) that is noted as "Draft", dated 26th June 2013, which does address some of the above-mentioned requirements.

MGF would recommend that Manitoba Hydro implements its "Develop Baseline Schedule" Procedure CSS-011 to develop and maintain a Basis of Schedule so that the Basis of Schedule exists, is commonly understood and guides the consistent development and maintenance of the project's schedules.

Source of Information & Reference Materials

- AACE – 38R – 06, Documenting the Schedule Basis
- Manitoba Hydro "Develop Baseline Schedule" Procedure (Procedure Number: CSS-011) dated 26th June 2013

Finding No. 2: Keeyask - Hatch Schedule

Observations & Findings

The Keeyask Hatch schedule has a start date of 20th February 2013 and a completion date of 31st December 2020. The project is currently in progress with a status date of 5th November 2017. It has 3,871 normal activities of which 3,210 are complete, 132 are in progress and 529 are still planned. It contains 1,782 milestones, 1 summary and 634 LOE (Level of Effort) activities. The project baseline start date was 18th February 2013 with the baseline finish date of 29th May 2020. The project is currently behind schedule by 154 days.

Acumen Fuse is a software application which uses metrics to identify problematic areas and activities in a project schedule. It has hundreds of industry metric libraries including DCMA 14-Point Assessment, the US Government Accountability Office's (GAO) Scheduling Best Practices and the US National Defence Industrial Association's (NDIA) Generally Accepted Scheduling Practices (GASP). The Acumen Fuse analysis produced the following:

- Fuse Schedule Index: Is a single quality indicator resulting from a summary of detailed analysis. The Keeyask - Hatch baseline and forecast schedules each scored 82, giving them an 85% probability of success.
- Schedule Quality: Scored 82% versus a score of 75% or better which is considered a 'good' schedule.
- High float: Schedule paths with high amounts of float typically arise due to artificially constrained activities. The metric identifies activities with total float greater than 2 months and should not exceed 5%. This schedule scored 57%. Paths with float more than 2 months should be considered for acceleration and schedule optimization.
- Critical Path Length Index (CPLI): Measures the relative efficiency required to complete a milestone on time or how close a critical path is to the project target completion date. A project with an aggressive or conservative completion date may not carry the same overall duration as that of the critical path through the network. CPLI of greater than 1 indicates that a schedule is conservative with a very high chance of early completion. A CPLI of less than 1 is very aggressive with a very high chance that completion will overrun beyond the target project completion date. The Keeyask - Hatch schedule scored 0.89.
- Baseline Execution Index (BEI): Measures the efficiency with which actual work has been accomplished when measured against the baseline. The BEI score for this schedule is 0.78. The more activities that are completed on time or ahead of the baseline schedule will reflect a BEI of 1 or more. Conversely, a BEI of less than 1 indicates that the actual work is behind schedule.

Conclusions & Recommendations

With a Fuse score of 82%, this is a well-developed schedule. However, it is worth noting that many of their activities are currently behind schedule.

Source of Information & Reference Materials

- 2017.11.05 H341433-FSOW Updated Schedule to 5th November 2017.xer
- H341433 Baseline Rev13 25th September 2017

Finding No. 3: Keeyask - Schedule Baseline

Observations & Findings

Manitoba Hydro defines Baseline Revision as "…partially [changing] the baseline schedule without affecting the contract dates or budget. In other words, it is just re-sequencing of the work due to any opportunity. Contract Change Management procedure does not apply."

As per industry best and common practice, baseline schedules should not be modified outside of the Change Management process. The baseline schedule should only change if there is a change in cost (cost loaded Schedules) or Scope of Work. If the Scope remains the same, revised schedule dates should be made in the forecast schedule only, so Earned Value Management (EVM) metrics can be used.

Conclusions & Recommendations

Manitoba Hydro's Baseline Revision definition limits their ability to see a true picture of planned versus actual effort, as each new baseline resets the planned effort. This makes the schedule impact on subsequent contracts, such as Voith, impossible to ascertain with any accuracy.

Source of Information & Reference Materials

- Schedule Change Management CSS-010

Finding No. 4: Keeyask - BBE Schedule: Negative Float

Observations & Findings

The review of BBE's schedules revealed that 15 activities are slipping their constrained dates causing 1,030 activities to have negative float. The negative float ranges from 2 hours to 204 days. Negative float generally occurs when date constrained activities are slipping or have slipped from their scheduled finish date. Negative float indicates that the activity cannot finish by its scheduled finish date.

Further, there are 97 activities with negative float that are on the critical path.

Conclusions & Recommendations

Each additional day the critical path activities are delayed has the potential to delay the schedule by the amount of such delay or longer. Until these deficiencies in BBE's schedule are reviewed and corrected, Manitoba Hydro cannot have confidence in BBE's schedule, its completion date or the impact on interfaces with other contractors.

Manitoba Hydro should remind BBE of its obligations with respect to Contract Schedule (Article 3, General Specification) and ensure that BBE complies with this going forward. For example, Article 3.1 (i) states that the Contract Schedule shall "not have any negative float", yet BBE is currently maintaining a schedule with 1,030 activities with negative float, 97 of which are on the critical path. This is unacceptable schedule sanagement and, more importantly, not in accordance with the Contract.

Source of Information & Reference Materials

- BBE Approved Revised Baseline (Rev.01) - AA7.xer
- BBE updated schedule_DD Oct 06 2017(3) – Current Schedule.xer
- BBE Constrained Activities with Negative Float OB04-02.pdf
- BBE Activities with Negative Float – OB04-02.pdf
- BBE Critical Activities with Negative Float – OB04-2.pdf

Finding No. 5: Keeyask - BBE Schedule Quality

Observations & Findings

The BBE schedule has a start date of 10th March 2014 and has 23rd January 2022 as the completion date. The project is currently in progress with a status date of 6th October 2017. It has 7,781 normal activities of which 2,021 are complete, 186 are in progress and 5,574 are still planned. It contains 745 milestones, no summaries and 17 LOE (Level of Effort) activities.

The project baseline start date was 10th March 2014 with the baseline finish date being 8th October 2021. The project is currently behind schedule by 102 days.

Acumen Fuse is a software application which uses metrics to identify problematic areas and activities in a project schedule. It has hundreds of industry metric libraries including DCMA 14-Point Assessment, US Government Accountability Office's (GAO) Scheduling Best Practices and the US National Defence Industrial Association's (NDIA) Generally Accepted Scheduling Practices (GASP). The Acumen Fuse analysis produced the following:

- Fuse Schedule Index: Is a single quality indicator resulting from a summary of the detailed analysis. The BBE schedule scored 62, giving it an 59% probability of success.
- Schedule Quality: Scored 62% versus a score of 75% or better which is a considered a "good" schedule.
- Hard Constraints: Is the number of activities with hard or two-way constraints. Two-way activity constraints completely override Critical Path Methodology (CPM) calculations and break the schedule into two parts. This schedule contains 121 hard constraints.
- Negative Float: Is the number of activities with total finish float less than 0 working days. Negative float is a result of an artificially accelerated or constrained schedule and indicates the schedule is not possible based on the current completion dates. This schedule has 17% of the activities with negative float.

Conclusions & Recommendations

With a Fuse score of 62%, this is a medium quality schedule. We would recommend removing the hard constraints. If constraints are absolutely necessary, they should be soft or one-way constraints which do not violate CPM calculations. All constraints on the schedule should be reviewed as activities which are slipping the constraint dates are causing the negative float on the schedule.

Source of Information & Reference Materials

- BBE Approved Revised Baseline (Rev.01) – AA7.xer
- September 2017 – KGS-BBE Phase II Contract Schedule Rev 1 DD Oct 06 2017 (013).xer

Finding No. 6: Keeyask - BBE Forecast Completion Date

Observations & Findings

BBE is currently forecasting a completion date of 23rd January 2022 versus the planned completion date of 8th October 2021. Based on the September monthly progress figures, BBE has a concreting productivity factor of [redacted]

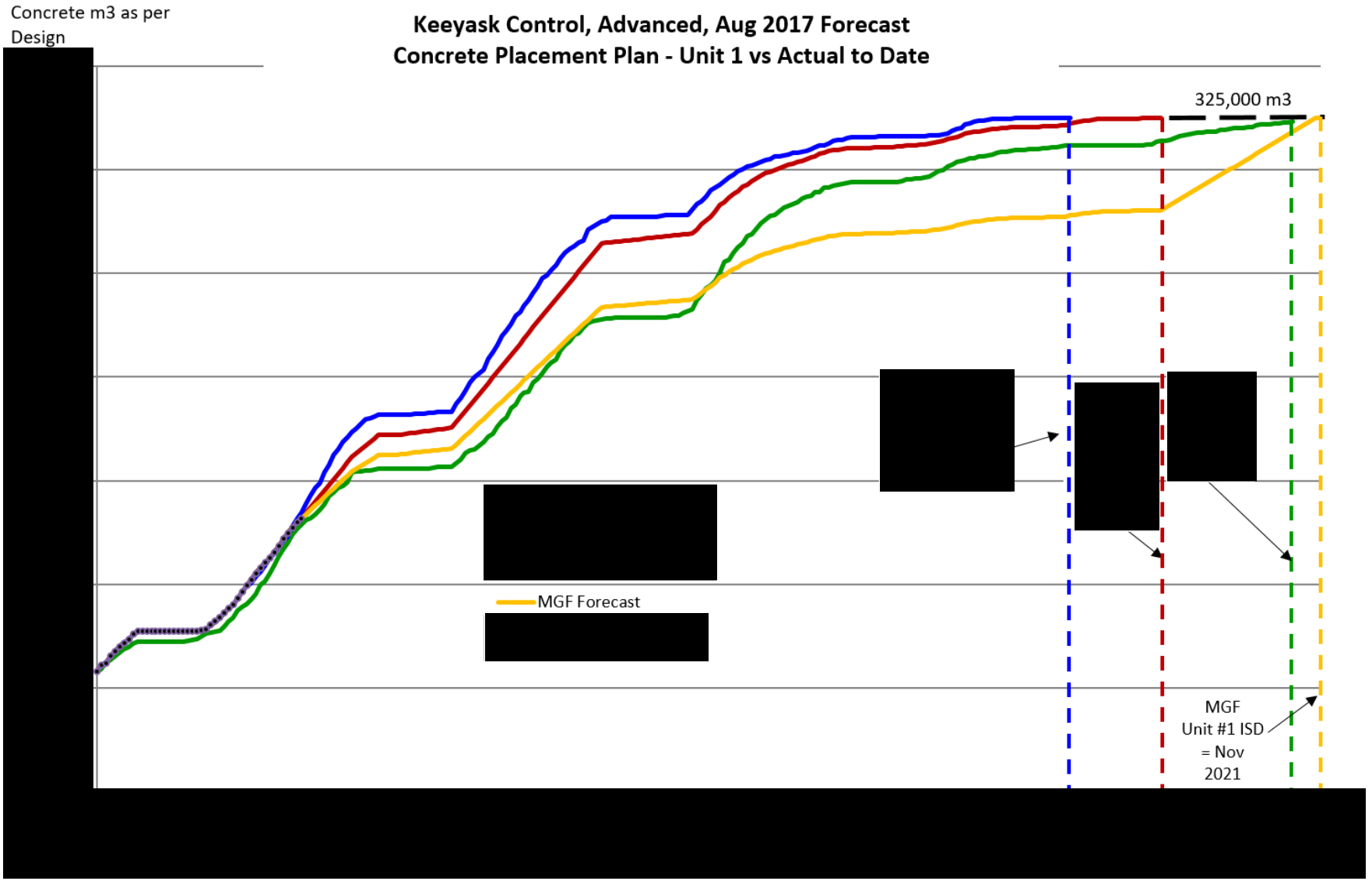
1a

Assuming the [redacted] productivity factor remains constant, we have applied a [redacted] increase to the duration of each concreting activity, excluding completed work, work being performed by others and activities involving curing of concrete, to estimate the potential impact to the completion date.

This results in a completion date of 25th November 2022, which is later than Manitoba Hydro's control date of 4th August 2022 for unit 7 to be in service.

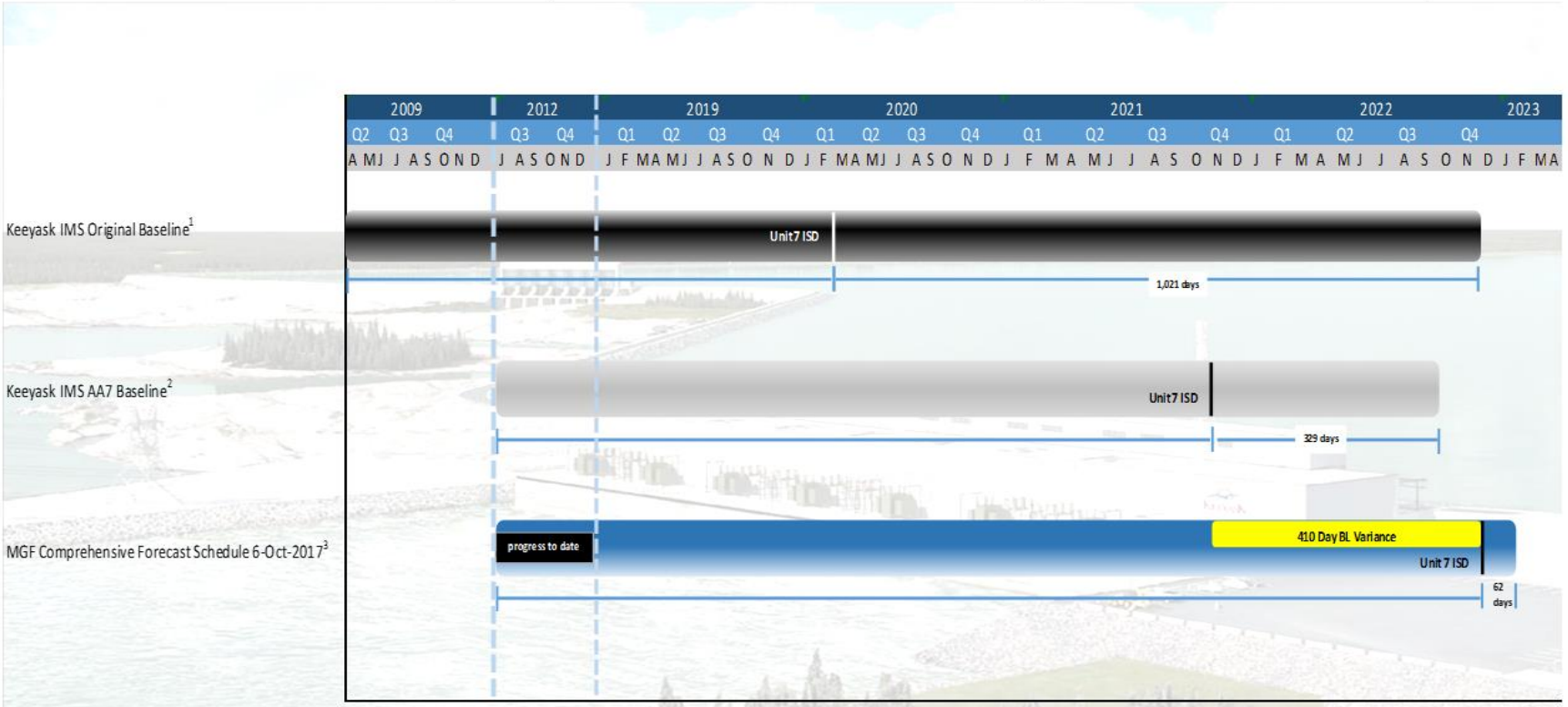
It is important to note that no mitigation strategies or schedule recovery options have been added to this forecast. Therefore, the order of magnitude estimated delay is the difference between 8th October 2021 and 25th November 2022.

ORDER OF MAGNITUDE DELAY IS 410 DAYS (progress to 6th October 2017)


Concrete m3 as per Design
Keeyask Control, Advanced, Aug 2017 Forecast
Concrete Placement Plan - Unit 1 vs Actual to Date
325,000 m3
MGF Forecast
MGF
Unit #1 ISD
= Nov
2021

1a

Keeyask Project Planned vs Forecast Dates Including Unit 7 In-Service Dates to Completion



1. Keeyask IMS Original Baseline: The 1,021 days after Unit 7 In Service date reflects the completion of Generating Station Site Decommissioning and Rehabilitation which does not appear on the current schedule.
2. Keeyask IMS AA7 Baseline: The 329 days after Unit 7 In Service date reflects the completion of construction of Egress Channels downstream of spillway which was constrained to start on or after 1st July 2022, followed by an Ancestral Feast 2022 (Fall).
3. MGF Comprehensive Forecast Schedule: The 62 days after Unit 7 In Service date reflects the completion of construction of Egress Channels downstream of spillway but no constraint has been added. If this activity can only happen in the summer months, the completion date would be 1st September 2023.

Conclusions & Recommendations

There are several factors which limit BBE's options to recover its schedule, such as environmental restrictions, weather, physical space and workforce accommodation. Two ways in which a schedule can be recovered are working longer hours or adding more resources. As productivity is an issue for BBE, neither of these strategies may produce the desired result as both will add cost and may further diminish the actual productivity.

A third way to recover the schedule is to change how the work is being executed. To recover the schedule BBE is proposing a winter concrete campaign which may help recover its schedule but this will add extra cost.

Source of Information & Reference Materials

- KGS-BBE Phase II Contract Schedule Rev 1 DD Cot 06 2017 (#013)

Finding No. 7: Keeyask - Integrated Master Schedule (IMS)

Observations & Findings

Acumen Fuse is a software application which uses metrics to identify problematic areas and activities in a project schedule. It has hundreds of industry metric libraries including DCMA 14-Point Assessment, the US Government Accountability Office's (GAO) Scheduling Best Practices and the US National Defence Industrial Association's (NDIA) Generally Accepted Scheduling Practices (GASP). The Acumen Fuse analysis produced the following:

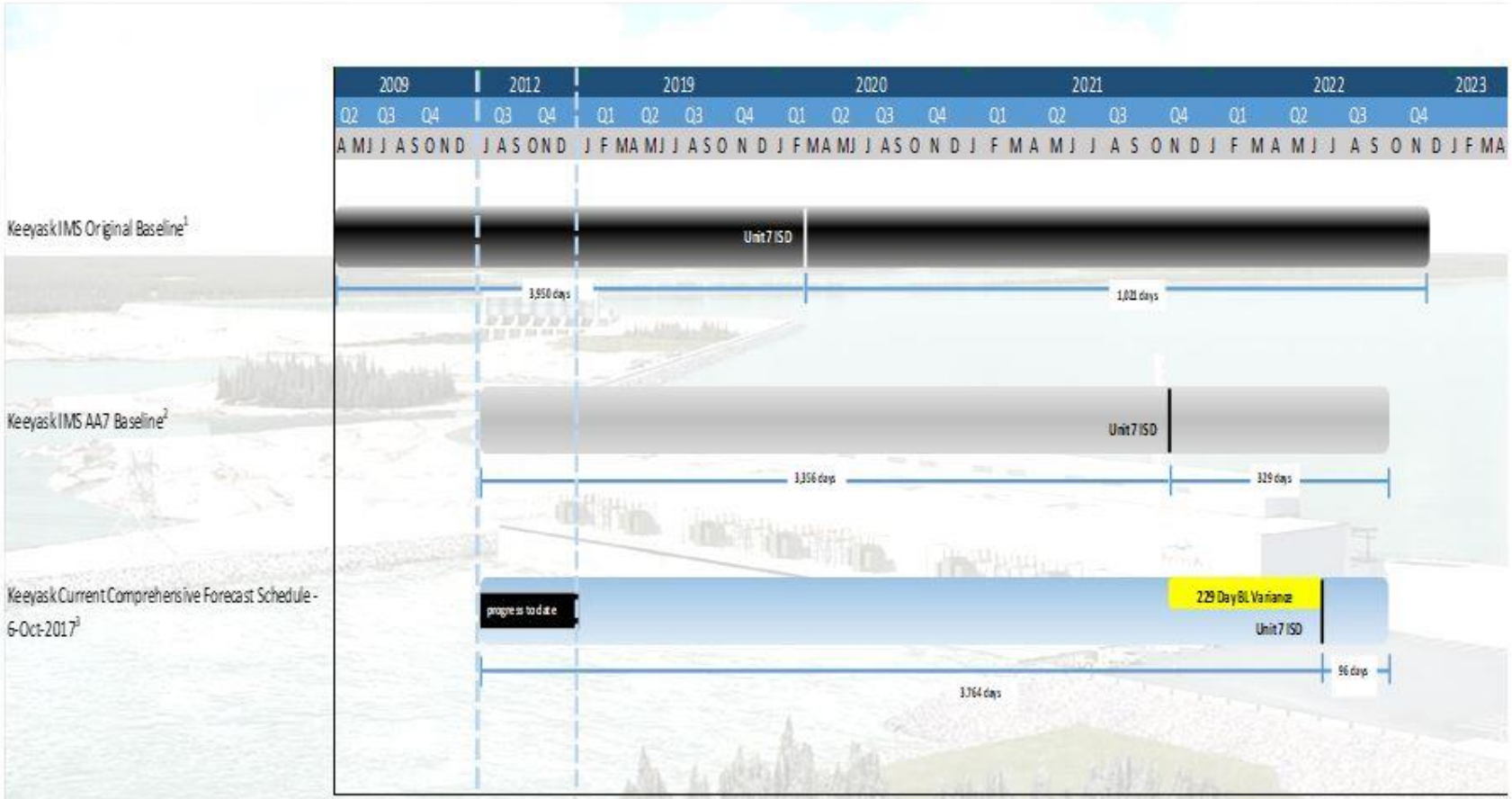
- Fuse Schedule Index: Is a single quality indicator resulting from a summary of detailed analysis. The Keeyask Integrated Master Schedule forecast schedule scored 72%. The forecast schedule is rated as having a 72% probability of success.
- High float: Schedule paths with high amounts of float typically arise due to artificially constrained activities or much longer competing critical paths. This metric identifies activities with total float greater than 2 months and should not exceed 5%. The Integrated Master Schedule scored 77%. Schedule paths with float more than 2 months should be considered for acceleration and schedule optimization.

The review of the Integrated Master Schedule indicated that it did not show the latest General Civil Contract dates. We discussed this matter with Manitoba Hydro who concurred with our observation, correcting the dates and returning the revised schedule now correctly showing progress from all the contractors' schedules.

ORDER OF MAGNITUDE DELAY FOR UNIT 7 ISD 229 Days (progress to 6th October 2017)

MGF
PROJECT SERVICES

Keeyask Project Planned vs Forecast Dates Including Unit 7 In-Service Dates to Completion



1. Keeyask IMS Original Baseline: The 1,021 days after Unit 7 In Service date reflects the completion of Generating Station Site Decommissioning and Rehabilitation which does not appear on the current schedule.
2. Keeyask IMS AA7 Baseline: The 329 days after Unit 7 In Service date reflects the completion of construction of Egress Channels downstream of spillway which was constrained to start on or after 1st July 2022, followed by an Ancestral Feast 2022 (Fall).
3. Keeyask Current Comprehensive Forecast Schedule – 6th October 2017: The 96 days after Unit 7 In Service date reflects the completion of construction on the Egress Channels downstream of the spillways.

Conclusions & Recommendations

With a Fuse score of 72%, MGF considers this schedule to be of medium quality. As with any Integrated Master Schedule, its quality in large part is directly related to the quality of the contractor schedules which are incorporated in to it. The Voith, Hatch and BBE schedules are imported directly in to this schedule and directly impact the score. The Integrated Master Schedule is showing slippage of 81 days on in service dates of turbine units 1 to 4 and 229 days on turbine units 5 to 7 as a result of slippage on the BBE schedule and the Voith schedule. Manitoba Hydro is working with both contractors to resolve the slippages.

Source of Information & Reference Materials

- Keeyask GS – IMS Comprehensive Schedule DD 171006.xer
- Keeyask GS – IMS Baseline Schedule – 20161008 - AA7.xer

Finding No. 8: Keeyask – Completion Dates

Observations & Findings

Dates: Multiple dates have been provided to MGF representing the same activities and completions. Outlined below are forecast and planned dates in the Integrated Master Schedule, the forecast and planned dates in the BBE schedule (also referred to as Target Date in some reporting), and the Manitoba Hydro Control Dates which are ten months later than the baseline dates.

	IMS Baseline	BBE Baseline (Target)	IMS Forecast	BBE Forecast	Control Date
Unit 1 In Service	17-Oct-20	17-Oct-20	29-Jan-21	29-Jan-21	14-Aug-21
Unit 2 In Service	16-Dec-20	16-Dec-20	30-Mar-21	30-Mar-21	13-Oct-21
Unit 3 In Service	14-Feb-21	14-Feb-21	29-May-21	29-May-21	12-Dec-21
Unit 4 In Service	15-Apr-21	15-Apr-21	28-Jul-21	28-Jul-21	10-Feb-22
Unit 5 In Service	14-Jun-21	14-Jun-21	2-Feb-22	26-Sep-21	11-Apr-22
Unit 6 In Service	13-Aug-21	13-Aug-21	3-Apr-22	25-Nov-21	10-Jun-22
Unit 7 In Service	7-Oct-21	7-Oct-21	28-May-22	23-Jan-22	4-Aug-22

Using the control dates, the in service dates are currently forecast to finish earlier than planned; however, using the baseline (contract dates), BBE is behind schedule and their delay has caused delays to the Voith in service dates for Generating Units 5 through 7.

Conclusions & Recommendations

To avoid confusion with the various dates, the significance of the different dates should be documented in the Basis of Schedule for the Integrated Master Schedule.

Source of Information & Reference Materials

- Email – Blair Purvis, Manitoba Hydro, dated 23rd November 2017
- KGS BBE Phase II Contract Schedule Rev 1 DD Oct 06 2017 (#13)

SCOPE ITEM 5:

Review and assess Manitoba Hydro's tender, contract management and cost control methodologies, and determine whether these methodologies support the $8.7 billion forecast at completion cost. If not, identify what changes in the contingencies, reserves or forecast at completion cost are required.

Finding No. 1: Keeyask - Tender Management

Observations & Findings

The key components of Tender Management are:

- Contracting Strategy
- Contractor Pre-qualification
- Individual Contract Plans
- Tender, Evaluate, Negotiate and Award

The review and assessment of Manitoba Hydro's Tender Management involved reviewing its documentation related to the key components above and testing the extent these were used on the following contracts:

- General Civil Contract – BBE
- Generators and Turbines – Voith
- Catering – Sodexo

Contracting Strategy

Standard # 103 Project Delivery Evaluation and Strategy dated 12th March 2015 was used in developing the contracting strategies for the above referenced contracts. The standard is sufficient, requiring the project team to consider or perform the following:

- Define key success factors
- Identify project drivers, e.g. schedule or cost
- Identify work packages, delivery options and contract types
- Screen possible work packages against key success factor and project drivers
- Create schedule for various project delivery strategy options
- Perform project risk analysis

- Determine preferred strategy and prepare board recommendation

No significant deficiencies were noted and no notable deviations were identified.

Prequalification

The purpose of prequalification is to ensure that owners have access to contractors with the capabilities, capacity and expertise to perform the required work and services. It is an important step to ensuring a successful project outcome.

Manitoba Hydro's prequalification procedure is available on its website and was used in prequalifying tenderers for both the General Civil Contract and the Generators and Turbines scopes. The Camp Services contract was pursuant to a Request for Information from a joint venture comprised of Sodexo and the Fox Lake and York Factory First Nations as a Direct Negotiated Contract in accordance with Schedule13-1 Identified Work Packages and Allocation.

The sample matrix to evaluate contractors for prequalification is comprehensive and addresses the following areas:

- Safety: safety program reviewed; WCB in good standing; overally safety record and number of accidents
- Experience: demonstrated construction experience on similar projects
- Availability: contractor available to perform the work within the desired timeframe
- Personnel: key contractor staff, including project manager, supervisors and office staff much have relevant experience of contract scope
- Track Record: contractor must have evidence of successful project completions on previous projects
- Qualification Statement: financial references given; principal projects listed
- Conflicts of Interest: conflict of interest forms completed
- Manitoba Content: contractor to maximize use of Manitoba labour (not used in prequalification but may be used in Tender Evaluation)
- Bonding: contractor eligible to bond for 50% of work or more than $500,000

The standard provides a Sample Evaluation Summary together with a Sample Scoring Guide to be used by evaluators to rank proposals.

A review of the prequalification practice produced no significant deficiencies or deviations from the corporate requirement.

Individual Contract Plans

The purpose of an Individual Contract Plan is to outline the key components required for a successful contract formation process and eventual post award contract management. For each work package or tender, this typically requires decisions on the following matters to allow the contract formation process to be successfully progressed:

- Scope of Work
- Estimated contract value
- Form of contract
- Compensation mechanism
- Approach to market (competitive tender or direct negotiation)
- Pre-qualified bidders
- Schedule milestones e.g. prepare tender, issue, evaluate, award, commence work, completion date.
- Evaluation plan

Manitoba Hydro addressed these matters in the following documents:

- Standard #206 Design Development and Procurement Document Preparation
- Standard #302 Develop Work Package Procurement Plan
- Standard #105 Developing the Work Breakdown Structure (WBS)
- Standard #103 Project Delivery System Evaluation and Strategy
- Standard #104 Work Package Charter Development
- Standard #402 Project Quality Plan
- ENV-003 Contractor Environmental Protection Plan

Standard #104 Work Package Charter Development was structured to reflect the chosen contracting type:

- Cost reimbursable contract – General Civil Work
- Fixed price contract – Generators and Turbines
- Direct negotiated contract – Catering Services

No significant deficiencies were noted and no notable deviations were identified.

Tender, Evaluate, Negotiate and Award

Standard #303 Tender, Evaluate, Negotiate and Award dated 12th July 2013 provides guidance and standardization on how contracts on the Keeyask Project are to be tendered, evaluated, negotiated and awarded. It sets out the necessary steps to conduct a bid process, evaluate bids received from tenderers, select a successful tenderer/proponent, negotiate a contract and award a purchase order.

The standard encompasses the following related documentation:

- Corporate Policy P1-6 Purchase Approvals
- Standard #206 Design Development and Procurement Document Preparation

- Standard #305 Changes to Procurement Documents
- Standard #801 Project Change Authorization
- KCP-001 Executive Approval Preparation
- PAS-001 Contract Change Management
- PAS-006 Consulting Purchase Order
- PLS-001 Project TEBO Strategy Development
- Partnership Agreements
- eform 0136 Purchase Recommendation & Authorization
- DOC-F-008 Project Change Authorization Form
- DOC-F-010 Notice of Contract Award
- F-301 Procurement Checklist

Standard #303 sets out its Tender, Evaluate, Negotiate and Award process as follows:

- Prepare Purchase Requisition (PR) and Obtain Approvals
- Prepare Procurement Documents and Issue
- Obtain Bids
- Evaluate Bids
- Obtain Approvals
- Negotiate (if applicable)
- Prepare Contract Binders
- Award

The Tender, Evaluate Negotiate and Award process was followed for the three referenced contracts and appears comprehensive. No significant deficiencies were noted and no notable deviations were identified.

Conclusions & Recommendations

The standards, procedures and processes supporting Contracting Strategy, Contractor Prequalification, Individual Contract Plans and Tender, Evaluate, Negotiate and Award are sufficient and well documents.

Source of Information & Reference Materials

- Manitoba Hydro Tender Management Documentation referenced in the Observations & Findings section

Finding No. 2: Keeyask - Contract Management

Observations & Findings

Standard #505 Contract and Work Package Management dated 29th June 2015 addresses work package management during the execution phases of a contract and outlines the requirement of the Work Package Lead (WPL) to manage the work package and associated contracts. The standard encompasses the following related documentation:

- Standard #204 Quality Management
- Standard #801 Project Change Authorization
- DOC-002 Naming, Filing and Format Conventions
- PSD-001 Lessons Learned
- PCC-002 Construction Contract Monitoring and Controls
- PAS-001 Contract Change Management
- DOC-F-009 Project Change Authorization Info-path form

Standard #505 describes the responsibilities of the Work Package Lead, the Engineer and the Purchaser who work together to manage the work packages and contracts. It also describes their roles in relation to the following major aspects of contract management:

- Scope Management
- Schedule Management
- Cost Management
- Payment and Accruals
- Purchase Order Maintenance
- Quality Management
- Document Management
- Communication Plan
- Resource Management
- Reporting Requirements
- Lessons Learned

It is industry best practice to perform contract audits to ensure the parties to the contract are complying with them. In our review, we only found one instance of a contract audit being performed, which we consider to be too low and infrequent for the number of contracts on Keeyask.

Conclusions & Recommendations

The Contract Management process appears comprehensive in terms of the standards to guide Manitoba Hydro in managing contracts. Manitoba Hydro should consider having periodic contract management audits to ensure Manitoba Hydro and their contractors are complying with their respective contracts.

Source of Information & Reference Materials

- Manitoba Hydro Contract Management Documentation referenced in the Observations & Findings section

Finding No. 3: Keeyask - Extra Work Orders (EWOs) − Indirects

Observations & Findings

MGF has reviewed the indirect percentage applied to Extra Work Orders.

MGF has reviewed extra work orders for the BBE contract and has observed that [redacted] is used for indirects. 1a
This figure is considerably less than the actual percentage for indirects.

A low indirect percentage will underestimate the projected cost to complete.

Conclusions & Recommendations

Manitoba Hydro should use indirects that reflect actuals.

Source of Information & Reference Materials

- Manitoba Hydro-000172, Manitoba Hydro-000211 rev 02, Manitoba Hydro-000247, Manitoba Hydro-000225

Finding No. 4: Keeyask - Cost Performance Index (Earned Value)

Observations and Findings

The Cost Performance Index (CPI) specifies how much you are earning for each dollar spent on the project. The Cost Performance Index is an indication of how well the project is remaining on budget.

If the CPI is less than one, you are earning less than the amount spent. In other words, you are over budget.

If the CPI is greater than one, you are earning more than the amount spent. In other words, you are under budget.

If the CPI is equal to one, this means earning and spending are equal.

Overall CPI (which is determined by dividing earned value by actual cost) for the Keeyask Project is 0.96, as per September 2017 Project Management Report. “It is near 1 because budgets were re-set in the Capital Project Justification Addendum”.

The CPI index for the cost incurred prior to 8th October 2016 was set to 1 rather than actual to date.

Conclusions & Recommendations

This results in inflating the CPI for the overall Keeyask project and does not reflect the actual, thereby giving a false view of performance. Manitoba Hydro should consider tracking the CPI from either the Amending Agreement No. 7 or project commencement, to give a more realistic figure.

Source of Information & Reference Materials

- Manitoba Hydro Monthly Project Management Report September 2017

Finding No. 5: Keeyask - Interest Earned on Advance Funding

Observations & Findings

BBE, as per its contract, is paid 2 months in advance since the start of the project, BBE were not requested to pass the interest on the advance monies to Manitoba Hydro.

This type of funding mechanism is not typical.

We have been advised by Manitoba Hydro that they have identified the issue and are in the process of recouping the interest monies.

Total cost is a follows:

Order of Magnitude Estimate $1,400,000

Notes:

- The costs are from project commencement to October 2017.

Conclusions & Recommendations

This issue is in the process of being rectified.

Source of Information & Reference Materials

- Meeting with Manitoba Hydro 28th September 2017
- BBE Contract

Finding No. 6: Keeyask - General Administration and Overhead (GA&O) on Procurement

Observations & Findings

BBE procurement personnel are reimbursed for time spent on purchasing equipment, tools and materials for the Keeyask project on behalf of Manitoba Hydro. In addition, BBE also includes [redacted] for GA&O for the cost of purchased equipment. 1a

This finding addresses the Construction Equipment and Construction Material/Tools categories.

Manitoba Hydro may wish to carry out this activity with their own personnel so as to save paying for GA&O

Order of Magnitude Estimate $65,500,000

Notes:

- The costs are based on project commencement to completion
- The above estimate excludes BBE's procurement personnel

Conclusions & Recommendations

If Manitoba Hydro processes future purchases internally, this will result in a reduction in GA&O.

The risk is, if materials are purchased late, it may give rise to BBE claiming delays.

However, MGF does not see the same level of risk with equipment purchases. A turnaround timeframe would need to be agreed upon.

Source of Information & Reference Materials

- October 2016 and June 2017 BBE Progress Statement
- To date costs for Non-Labour category provided by Manitoba Hydro up to July 2017

Finding No. 7: Keeyask - Craft to Foreman Ratio

Observations & Findings

On reviewing BBE's October 2017 Construction Monthly Report, the ratio of Craft to Foreman is 3.97:1.

This appears to be high.

Page 19 of the report states "Ratios of Workers" (apprentices, journeymen and lead hands) to foremen are used to evaluate:

- whether there is sufficient supervision to support the work; and,
- the impact on wage rate if supervision counts are too high.

Typical ratios for similar construction projects have higher craft to supervision ratios. MGF has allowed for a craft to foreman ratio of 6:1. This ratio is applied to the total project direct hours to determine the variance in supervision hours. An average blended labour rate for foreman is used to determine the extra cost.

Ratio of 6:1 versus actual Ratio of 3.97:1

Applying these ratios to the total 7,078,000 direct labour hours will result in a 603,205 hours' variance at a rate of $ 76.32, which will result in:

Order of Magnitude Estimate $91,600,000

Note the above figures include [redacted] for GA&O and Indirect costs. 1a

Conclusions & Recommendations

Manitoba Hydro to review Craft Foreman mixes with the goal of improving the ratios.

Source of Information & Reference Materials

- BBE October 2017 Monthly Cost Report No 7 Rev 0
- 2006 AACE Construction Productivity Article by James D. Whiteside

Finding No. 8: Keeyask - Trade & Cash Discounts

Observations & Findings

On reviewing BBE's Progress Payments relating to Construction Equipment and Construction Materials/Tools categories for October 2016 and June 2017, it was noted that Trade Discounts were negligible.

No cash (prompt payment) discounts were identified.

Trade Discount

If we take an average 10% as an example that BBE could achieve with the suppliers, this would represent Trade Discounts **to date** in the sum of:

Order of Magnitude Estimate $ 54,000,000

If we take an average 10% as an example that BBE could achieve with the suppliers, this would represent Trade Discounts **to completion** in the sum of:

Order of Magnitude Estimate $ 61,800,000

Total Overall Trade Discount:

Order of Magnitude Estimate $ 115,800,000

Cash Discount

If we take an average 2% as an example that BBE could achieve with the suppliers, this would represent Cash Discounts **to date** in the sum of:

Order of Magnitude Estimate $ 10,800,000

If we take an average 2% as an example that BBE could achieve with the suppliers, this would represent Cash Discounts **to completion** in the sum of:

Order of Magnitude Estimate $ 12,400,000

Total Overall Cash Discount:

Order of Magnitude Estimate $ 23,200,000

Conclusions & Recommendations

Manitoba Hydro to ensure all Contractors are negotiating Trade Discounts.

Also as BBE is receiving Progress Payments 2 months in advance all Cash Discounts should be passed to Manitoba Hydro.

Source of Information & Reference Materials

- Progress Payment Applications - October 2016 and June 2017
- BBE Projected Cash Flow

Finding No. 9: Keeyask - Increased use of Overtime and Double Time

Observations & Findings

The CPJ 2017 Addendum, Appendix 1 "Basis, Assumptions and Exclusions", Section 2 sets out that the construction work week will be 7 days per week, 10 hours per shift, with labour on a 21 day on and 7 day off rotation and assumed that standard time (ST), overtime (OT) and double time (DT) would be 63%, 23% and 14% respectively.

From analysis of the progress payments of October 2016, May 2017 and June 2017, the actual split is 54% standard time (ST), 22% overtime (OT) and 24% double time (DT).

From the above referenced progress payments, we have calculated a weighted average blended rate per hour of $61.70 and a [redacted] ratio to direct cost to allow for indirect costs. 1a

Assuming 5,552,196 hours from 7th October 2016 to the end of the contract, then excluding indirects, with the actual mix of ST, OT and DT, this results in:

Additional Cost Order of Magnitude $ 20,900,000

As DT is never 100% efficient, if and we assume a 30% loss in productivity for illustration purposes, then the increase in labour costs based on 5,552,196 hours, including indirects, rises to:

Additional Cost Order of Magnitude $ 40,900,000

Conclusions & Recommendations

The concern is that with a different mix of ST, OT and DT, the cost of labour will continue to rise, potentially resulting in a higher cost for the BBE Contract.

Manitoba Hydro should carry out an exercise on the cost of additional camp versus additional labour costs.

Sources of Information & Reference Materials

- BBE Monthly Progress Statement for October 2016, May 2017 and June 2017.
- CPJ 2017 Addendum, Appendix 1 “Basis, Assumptions and Exclusions”, Section 2
- Burntwood Nelson Agreement analysis by Manitoba Hydro for craft rates for ST, OT and DT

Finding No. 10: Keeyask - BBE Indirect Costs

Observations & Findings

On reviewing BBE’s September 2017 Construction Monthly Report for Indirect Costs to date, there is a cost difference of 6.4%. The cost overrun is determined by the variance between actual spend to date of 30.4% compared to actual physical progress of 24%.

Currently, the indirect budget is [redacted] 1a

If the cost overrun trend continues, the potential cost impact is:

Order of Magnitude Estimate [redacted] 1a

Notes:

- The above figure includes [redacted] for GA&O. 1a
- We have used the physical percentage complete from direct progress.

Conclusions & Recommendations

Manitoba Hydro to review and implement cost reductions on BBE’s Indirect costs.

Source of Information & Reference Materials

- BBE September 2017 Monthly Cost Report No 6 Rev 1

Finding No. 11: Keeyask - Transmission

Observations & Findings

This scope of work and costs are managed by Manitoba Hydro's Transmission Group.

Manitoba Hydro has noted variations in estimates due to:

- Increase of $21 million for 138 kV Generation Outlet Transmission (GOT) Lines
- Increase of $3 million for Terminations at Radisson
- Increase of $14 million for 138 kV Unit Lines

Conclusions & Recommendations

MGF recommends that Manitoba Hydro assigns a single owner of Cost Estimating and Scheduling. This will ensure no scopes of work are missed or overlapping, promote consistency in the development and appoint a custodian for all estimate back-up, methodologies and history.

This ensures that clear accountability is assigned and would align Manitoba Hydro's approach with industry best practice.

Source of Information & Reference Materials

- Map to Comparison of Keeyask 2014 to 2017.xlsx
- Keeyask Generating Station, 2017 Capital Project Justification Addendum, Comparison of 2014 Estimate to 2017 Estimate, dated August 2017

Finding No. 12: Keeyask - Board Recommendation

Observations & Findings

The Board Recommendation records the decision to approve a contract to the BBE joint venture for the General Civil Works "at a price not to exceed [redacted] billion excluding taxes and escalation." Please note the following: 1a

- Reference is made to Bechtel being "an experienced contractor", having been involved in the "construction of the civil works for the Limestone Generating Station". The Limestone Generating Station was completed in 1992 and involved 650,000 cubic metres of concrete and 7,100,000 cubic metres of earthwork; compared to the Keeyask Generating Station that was to commence work 22 years later in 2014 involving 350,000 cubic metres of concrete and 12,400,000 cubic metres of earthworks.

  What Bechtel did 22 years ago is only remotely relevant if its Limestone Generating Station construction management and supervision team was to be used on Keeyask.

  Note: We were advised by Manitoba Hydro that Bechtel were self-performing Contractor's on Limestone and this predicated their decision to appoint BBE, however was the question asked, what was Bechtel's history self-performing contracts in North America since Limestone.

- It is stated that BBE are "…the lowest cost and offer best value to the project". This is not strictly correct as BBE and the other proponents did not offer the "cost", but their assessment of an "Initial Target Price" that would equate to the total of all Actual Costs to be paid by Manitoba Hydro.
- The Board Recommendation further identifies the risk of concrete productivity, stating "[redacted] 1a [redacted]There is no further commentary on why this primary difference is not a high risk in the recommendation to award to BBE which is of concern. In addition, no mention of this risk is made or accounted for in the Contingency for Manitoba Hydro Held Risks' section of the Total Purchase Order Upset Limit calculation.

Conclusions & Recommendations

The above raises concerns on whether the risks inherent in the contracting strategy, e.g. a cost reimbursable compensation mechanism and potentially too aggressive concreting productivity factors were fully understood by Manitoba Hydro and how it would set up the contract to manage and mitigate such risks with their chosen contractor.

Source of Information & Reference Materials

- Board Recommendation dated 26th February 2014

Finding No. 13: Keeyask - Estimated Final Cost Range

Observations & Findings

Based on our findings in this Capital Review, in our opinion the Final Cost for the Keeyask project will not meet the budget of $8.7 billon, but rather be in the range of:

Order of Magnitude Estimate Range $ 9.5 billion to 10.5 billon

This Order of Magnitude Range addresses the current status and issues related to:

- Productivity
- Schedule
- Costs
- Indirects
- Craft to Foremen ratios
- Other related matters

It is difficult for MGF to advise where the Final Cost will land in this range, given the Productivity and Schedule performance of BBE and the fact the GCC Contract is Cost Reimbursable. However, we would advise:

1. If Manitoba Hydro addresses the current issues, taking control of the Project and its Contractors, the Final Cost will be at the lower end of the range
2. Keeping the status quo and leaving control with the Contractors will result in a Final Cost at the upper end of the range

Conclusions & Recommendations

These are many cost saving and contract management exercises that Manitoba Hydro can implement, which will drive down the Final Cost.

Our recommendation is to do this without delay.

Source of Information & Reference Materials

- This report and its findings

SCOPE ITEM 6:

Review and assess Manitoba Hydro's and the Keeyask Cree Nations' project governance structure and processes comparing to best practices and shortcomings. Provide an opinion how the governance has affected – both positively and negatively – project management, contractor management, and scheduling.

Finding No. 1: Keeyask - Joint Keeyask Development Agreement

Observations & Findings

Overview

The purpose of the Joint Keeyask Development Agreement ("JKDA") is to establish the Keeyask Hydropower Limited Partnership ("KHLP") comprised of:

- Cree Nations Partners
- York Factory First Nation
- Fox Lake Cree Nation
- The Manitoba Hydro-Electric Board

to complete the planning and design of the Keeyask Generating Station and all related works (the "Keeyask Project") and to carry on the business and affairs of the KHLP, including "…the design and the ownership, construction, operation, maintenance and control of the Keeyask Project".

Section 2.6 “Employment, Training and Business Opportunities” sets out opportunities for members of the Keeyask Cree Nations (“KCN”) with respect to:

- Pre-project training
- Construction employment
- Operational job
- Business opportunities during construction

The following articles set out how the KHLP will be established and financed; how the Keeyask Project will be developed and constructed; sets out the services Hydro will perform together with the arrangements for Power Purchase and Transmission:

- Article 4: The Limited Partnership and the General Partner
- Article 5: Financing the Limited Partnership
- Article 6: Project Development
- Article 7: Description of the Keeyask Project
- Article 8: Construction of the Project
- Article 9: Hydro Services
- Article 10: Power Purchase and Transmission Arrangements.

Construction Agreement

Schedule 1-2 “Construction Agreement” is part of the Joint Keeyask Development Agreement. The Construction Agreement identifies the “Owner” as the Limited Partnership and Hydro as the “Project Manager” to carry out the Scope of Work of the Keeyask Project, comprised of:

1. All required planning, engineering and designing
2. The Purchase of Insurance
3. Award of the contracts for construction
4. Commissioning of each of the turbines / generators and associated works to be supplied and installed
5. Procurement, award and administration of related contracts including Identified Work Packages
6. De-commissioning of camps and the clean-up of the construction site

Article 2 “Schedule for Construction” stipulates that:

1. The Project Manager (“Hydro”) shall commence the Scope of Work on the date specified by the Owner (the Limited Partnership)
2. The Project Manager shall develop detailed schedules with construction contracts, manufacturers and suppliers to construct, supply, install or commission specific parts of the Scope of Work
3. Parties agree to use their respective best efforts to complete the Scope of Work in approximately eight (8) years from the start of construction

Article 3 “Project Manager Responsibilities” sets out the responsibilities of the Project Manager as follows:

1. Solely responsible for the planning, designing, engineering and procurement to complete the Scope of Work
2. Responsible for obtaining and maintaining throughout the term of the Construction Agreement, all required licences, permits, orders, authorizations and approvals

3. Allocation and negotiation of Identified Work Packages
4. Supply of construction power
5. Supervise, control and direct all aspects of the Scope of Work
6. Provide timely updates of costs to the Owner and Owner shall use these updates to forecast and arrange the necessary funds to meet its cash flow requirements
7. Inform Owner of any material changes to the plan, design, engineering or actual costs to complete
8. Prepare and provide written monthly reports
9. Conduct all testing to complete the satisfactory installation and commissioning of each turbine/generator and related equipment
10. Ensure that all product, equipment and material warranties for components of the Keeyask Generating Station shall be assigned by contractors to the Owner upon the Final Completion Date

Article 4 "Invoices" requires the Project Manager to prepare and submit invoices to Owner for costs incurred in carrying out the Scope of Work. The Owner shall pay these invoices within ten (10) Business Days.

Construction Advisory Committee

Schedule 4-6 sets out the terms of reference of the Construction Advisory Committee (the "CAC"). The CAC is an advisory committee to KHLP and has no decision-making authority. It is intended to be a communication forum to discuss timely, accurate and pertinent information related to the Keeyask Project construction activities.

The CAC is comprised of five (5) Keeyask Cree Nations' Members, two (2) for TCN and one (1) each for War Lake, York Factory and Fox Lake and two (2) Hydro employees.

The purposes of the CAC and CAC meetings are summarized as follows:

- Provision of non-privileged information related to the Keeyask Project
- Discussion of major activities and events planned for or occurring during construction e.g. updates on engineering activities; contracts planned and awarded to date; project schedule status and reports on current and upcoming cultural events

Following the Construction Start Date, the CAC will meet monthly until the Final Closing Date, which is the first Business Day, one hundred and eighty (180) days following the date on which the last of the turbines comprising the Keeyask Generating Station is fully commissioned and comes in to service.

Monitoring Advisory Committee

Schedule 4-7 sets out the terms of reference of the Monitoring Advisory Committee (the "MAC"). Like the CAC, the MAC is an advisory committee to KHLP and has no decision-making authority. The MAC is comprised of five (5) Keeyask Cree Nations' Members, two (2) for TCN and one (1) each for War Lake, York Factory and Fox Lake and five (5) Hydro employees.

The purpose of the MAC and MAC meetings is summarized as follows:

- Discuss the environmental, social and economic monitoring activities planned to occur during construction, commissioning, operations and decommissioning of the Keeyask Project
- Review and comment on regulatory and public reporting materials

Proposed Letter of Agreement, Burntwood/Nelson Agreement

Schedule 12-3 entitled "Proposed Letter of Agreement, Burntwood/Nelson Agreement" of the Joint Keeyask Development Agreement is between Hydro Projects Management Association and Allied Hydro Council of Manitoba. Schedule 12-3 requires that special measures need to be implemented during construction to

facilitate the employment, training and retention of First Nations members and other Northern Aboriginals, which measures might conflict with existing Burntwood/Nelson Agreement (BNA) provisions relating to referral, recruitment or placement procedures.

The Limited Partnership has recognized the importance of successful recruitment, referral, placement, training and retention of Aboriginal employees on the Project and that Aboriginal cultural issues are addressed at all stages of the recruitment, referral, placement, training and retention process.

Schedule 12-3 amends the Burntwood/Nelson Agreement (BNA) as follows:

1. The Hydro Projects Management Association's membership will include the Limited Partnership
2. KCN shall appoint two representatives from their communities to the Project Site as advisors to the resident Site Manager
3. An Aboriginal union representative shall be hired to facilitate union interaction with Aboriginal employees, assist Aboriginal employees in matters related to discipline, liaise with the HR departments of major contractors and the Project's third-party retention service providers
4. The parties agree that no person covered by the BNA shall be subject to discrimination or harassment on the basis of any characteristics referred to in subsection 9(2) of the Human Rights Code of the Province of Manitoba and sets out the procedure to be followed regarding claims of discrimination or harassment
5. Sets out the goal to maximize the number of Aboriginal apprentices and trainees and encourages member unions to approach and recruit Aboriginal apprentices, trainees and journey persons.
6. Union site representatives will be required to take appropriate cross-cultural sensitivity and awareness training

Identified Work Packages and Allocation

Schedule 13-1 "Identified Work Packages and Allocation" of the Joint Keeyask Development Agreement details the following types of contracts:

1. Service Contracts
2. Infrastructure Contracts – Camps
3. Infrastructure Contracts – Roads
4. Principal Structures Contracts
5. Principal Structures Contracts (Schedule and Cost Critical)

All contract scopes include the supply of all supervision, administration, labour, mobilization/demobilization, materials, plant, tools, equipment, transportation, insurance and warranty of workmanship and materials. Each contract has been allocated to either the Cree Nations Partners, York Factory First Nation or the Fox Lake Cree Nation. As of 31st October 2017, the aggregate spend to date on these contracts is in excess of [redacted], as advised by Manitoba Hydro.

8

Conclusions & Recommendations

The JKDA and its associated Schedules provide an appropriate structure for the Keeyask Project:

- The JKDA establishes the Keeyask Hydropower Limited Partnership (KHLP) to carry on the business and affairs e.g. ownership, financing, construction, operation, maintenance and control of the Keeyask Project
- Section 2.6 “Employment, Training and Business Opportunities” sets out opportunities for members of the Keeyask Cree Nation
- Schedule 1-2 Construction Agreement defines the Scope of Work of the Keeyask Project, the Schedule for Construction and the responsibilities of the Project Manager
- Schedule 12-3 Proposed Letter of Agreement, Burntwood/Nelson Agreement addresses special measures to be implemented during construction to facilitate the employment, training and retention of First Nations members and other Northern Aboriginals
- Schedule 13-1 Identified Work Packages and Allocation - sets out the Contract Scopes to be directly negotiated with and performed by the Keeyask Cree Nations.

The Joint Keeyask Development Agreement embraces and implements the ownership and participation in the Keeyask Project with Manitoba Hydro. The JKDA itself does not directly impact Project Management, Construction Management and Scheduling. However, the appointment of Manitoba Hydro as the Project Manager does place the responsibility for Project Management, Construction Management and Scheduling on Manitoba Hydro.

Source of Information & Reference Materials

- The Joint Keeyask Development Agreement (JKDA).
- JKDA Schedule 1-2 Construction Agreement.
- JKDA Schedule 4-6 Construction Advisory Committee.
- JKDA Schedule 4-7 Monitoring Advisory Committee.
- JKDA Schedule 12-3 Proposed Letter of Agreement, Burntwood/Nelson Agreement.
- JKDA Schedule 13-1 Identified Work Packages and Allocation

SCOPE ITEM 7:

Assess Manitoba Hydro's updated Keeyask cost estimate for reasonableness, including whether appropriate contingencies and reserves have been provisioned.

Finding No. 1: Keeyask - Cost Contingency

Observations & Findings

In the Keeyask Generating Station Basis of Estimate Document 2017 Capital Project Justification Addendum, 14.0 Risk, Contingency on pages 4 and 5 it states "The contingency that was incorporated into the CPJ Addendum estimate was based on a P50 confidence level. Also, an additional 10 months of schedule contingency was added to the estimates, resulting in a total schedule delay of 21 months to the first unit In-Service Date".

In Appendix O - Contingency of Keeyask Generating Station Project Capital Cost and Schedule Risk Analysis and Contingency Estimates FINAL for Manitoba-Hydro dated 7th March 2017, contingency at the P90 confidence level is [redacted] as per Manitoba Hydro's presentation to MGF on 25th July 2017. 4b

Conclusions & Recommendations

BBE has not made its planned progress for either 2016 or 2017 and continues to plan work based on productivities it does not appear capable of achieving, hence MGF would recommend that Manitoba Hydro carry the P90 figure of [redacted] 4b

Source of Information & Reference Materials

- Keeyask Contract Summary as at 30th September 2017
- Keeyask Generating Station Basis of Estimate Document 2017 Capital Project Justification Addendum
- Appendix O – Contingency of Keeyask Generating Station Project Capital Cost and Schedule Risk Analysis and Contingency Estimates FINAL for Manitoba Hydro 7th March 2017 by Validation Estimating LLC.

SCOPE ITEM 8:

Identify aspects of the updated cost estimate and schedule that are at heightened levels of risk and recommend risk mitigation strategies that Manitoba Hydro should use.

Finding No. 1: Keeyask - Concrete Quantity Reporting

Observations & Findings

The concrete quantity in BBE's September 2017 Monthly Cost Report 06 Rev.0 is reported in three different places, each time with a different value.

On page 31:

- Total concrete to be placed is 278,962 cubic metres
- Installed concrete is nearly 100,000 cubic metres complete
- Concrete quantity to be installed is 278,962 - 100,000 = 178,962 cubic metres

On page 211:

- Total concrete to be placed is 341,480 cubic metres
- Installed concrete is 158,121 cubic metres complete
- Concrete quantity to be installed is 341,480 - 158,121 = 183,359 cubic metres

On page 264:

- Total concrete to be placed is 269,027 cubic metres
- Installed concrete is 81,213 cubic metres complete
- Concrete quantity to be installed is 269,027 - 81,213 = 187,814 cubic metres

Conclusions & Recommendations

Cost reports should be accurate as they are an important project controls tool. The estimates of total concrete to be placed have a range of 72,453 cubic metres (341,480 – 269,027) and the installed concrete estimates have a range of 76,908 cubic metres (158,121 – 81,213). Manitoba Hydro should not accept such inconsistent, inaccurate and unreliable reporting and should request BBE to review and revise with correct figures and improve their reporting going forward.

Source of Information & Reference Materials

- BBE September 2017 Monthly Cost Report 06 Rev. 0

Finding No. 2: Keeyask - Earthworks Total Fill

Observations & Findings

The document “Control, Advanced, Aug 2017 Forecast Earthworks Total Fill Placement Plan vs Actual to Date (Permanent Structures – Dams & Dykes)” was reviewed to determine if the completion dates depicted were achievable.

As per the October 2017 QURR and the BOQ-Rev 2 Monthly Report, the quantity of fill remaining is 5,874,585 cubic metres and the average fill placement for July and August 2017 was 237,216 cubic metres.

To meet the August 2021 completion date monthly production must be 244,774 cubic metres. This is an increase of 7,558 cubic metres or 3.2% per month over the 2017 July and August average of 237,216 cubic metres. This can likely be achieved by working longer shifts (less productivity) during the summer months to take advantage of the longer daylight hours or deploying more manpower if the camp can accommodate additional personnel.

To meet the February 2021 completion date monthly production would also have to be 244,774 cubic metres. This is an increase of 7,558 cubic metres or 3.2% per month over the 2017 July and August average of 237,216 cubic metres. This would include four (4) months of winter placement from October 2020 to February 2021 with fewer daylight hours and the potential for severe winter conditions. In view of the winter work, this schedule will likely be difficult to meet.

To meet the October 2020 completion date monthly production must be 293,729 cubic metres. This is an increase of 56,515 cubic metres or 23.8% per month over the 2017 July and August average of 237,216 cubic metres. Operating a double shift might make this monthly production possible, but camp space could be a constraint. This schedule does not appear to be achievable.

Other considerations that might preclude the required monthly production being achieved are:

1. Production is dramatically reduced for the initial lifts covering bedrock and invert.
2. Production is dramatically reduced nearing the crest elevation as the zones become very narrow as the rate of spread and compaction governs production.
3. Potential for heavy rains and/or impact from snowmelt and high water levels in local creeks, ponds, etc.

Conclusions & Recommendations

Manitoba Hydro should work with BBE to examine the basis of these proposed completion dates to test them for realism and achievability. The August 2021 completion date appears achievable with extra effort. The completion dates of October 2020 and February 2021 appear unlikely to be achieved.

Source of Information & Reference Materials

- Control, Advanced, Aug 2017 Forecast Earthworks Total Fill Placement Plan vs Actual to Date (Permanent Structures – Dams & Dykes)
- October 2017 QURR and BOQ-Rev 2 Monthly Report

SCOPE ITEM 9:

Identify changes to project governance or project management that would beneficially improve the execution of the remaining work and minimize risks.

Finding No. 1: Keeyask - Structural Steel Progress

Observations & Findings

The review of the Weekly Construction Report - week ending 6th October 2017 revealed the following weekly period and year to date performance:

The following table analyzes planned and actual structural steel quantities and hours spent installing structural steel for the period:

Period	Unit of Measure	Plan	Actual
Installed Quantity	Kilograms	132,472	78,124
Job Hours	Hours	[redacted]	[redacted]
		[redacted]	[redacted]

1a

The installed quantity in the period is 54,348 kgs or [redacted] less than planned, although actual productivity was [redacted] per man hour better than planned.

The following table analyzes planned and actual structural steel quantities and hours spent in installing structural steel year to date:

Year to Date	Unit of Measure	Plan	Actual
Installed Quantity	Kilograms	506,636	292,163
Job Hours	Hours	[redacted]	[redacted]
		[redacted]	[redacted]

1a

Year to date, BBE installed 214,473 kgs or [redacted] less structural steel than planned and its average productivity is [redacted] per man hour less than planned.

Conclusions & Recommendations

BBE failed to meet its schedule in 2016 and continues to do the same in 2017, even after the Amending Agreement No. 7 and renegotiation of target price and schedule. The analysis raises serious concerns with BBE's optimistic productivity rates, its ability to plan construction activities and to coordinate and supervise its construction workforce. The constant slippage brings in to question the finish date, the impact such delay will have on other contractors and what the final cost will be to Manitoba Hydro.

At the moment, Manitoba Hydro cannot have confidence in BBE's completion date and the final cost.

MGF recommends that Manitoba Hydro works with BBE on a recovery plan to improve BBE's construction management, construction planning, co-ordination and supervision of construction work. The schedule should be adjusted based on productivity factors that BBE can realistically achieve based on historic data and revise its forecast at completion cost based on this new schedule.

Source of Information & Reference Materials

- BBE Weekly Construction Report – week ending 6th October 2017

Finding No. 2: Keeyask - Earthworks Embankment Fill Measurement

Observations & Findings

During the site visit to the Keeyask site on 9th and 10th November 2017, MGF performed a survey of earthworks to compare to the value reported by BBE. The quantity of embankment fill claimed by BBE is approximately 10% higher than the quantity assessed by MGF.

Conclusions & Recommendations

Whilst the physical quantity of work performed does not impact payment to BBE, relying on incorrect quantities may result in an inaccurate assessment of progress made in the period or in the year to date analysis.

Manitoba Hydro should perform spot checks on the quantities claimed by BBE to ensure quantity progress being relied upon for scheduling is accurate.

Source of Information & Reference Materials

- Site visit and physical remeasurement

Finding No. 3: Keeyask - Earthworks Productivity

Observations & Findings

As per the BBE Quantity Unit Rate Report (QURR) of 25th September 2017, the budgeted man-hours per cubic metre for earthwork is [redacted] The actual average productivity achieved to date is [redacted] man-hours per cubic metre as per the QURR Report dated 25th September 2017. The lower productivity will result in increased direct costs, indirect costs and a longer schedule. 1a

We applied the [redacted] difference in earthwork productivity between actual and forecast to the to-go earthwork quantity using an average blended labour rate of $61.70 to determine the direct cost impact. In addition, we added the [redacted] mark-up for GA&O and applied the [redacted] ratio of indirect cost / direct. This results in an increase in earthworks cost of: 1a

Order of Magnitude Estimate $88,400,000

Conclusions & Recommendations

If BBE continue to miss their productivity targets then completion is likely to be delayed, resulting in higher earthwork cost and increased indirect costs for the BBE contract. This cost should be set against the project contingency.

Source of Information & Reference Materials

- KGS 2017 Capital Project Justification Addendum section 3.5
- BBE Monthly Cost Report run date 25th September 2017 (QURR)
- BBE Amended Contract bid item level to go estimate volume 4

Finding No. 4: Keeyask - Review of Earthmoving Equipment

Observations & Findings

MGF has reviewed the most recent hour meter readings for major pieces of earthmoving equipment and we comment on potential cost impacts to completion of project. The schedule indicates that earthworks will be completed within 35 months from December 2017.

MGF have observed idle Manitoba Hydro purchased CAT 740 articulated trucks, while similar rental equipment is in use. The possible explanation for this could be that the purchased trucks have meter readings in excess of 10,000 hours and are not economical.

Running repairs and maintenance costs tend to rise steeply starting around the 6,500-hour mark for heavy earthmoving equipment. At 8,500 hours, most owners decide if they are going to invest more funds in maintenance or replace with new. At 10,000 hours, earthmoving equipment, generally speaking, is economically at the end of its useful life.

Hour meter readings for the earthmoving equipment at Keeyask on 11/19/17 were as follows:

- CAT 740 articulated trucks have an average hour meter reading of 10,198
- CAT dozers have an average hour meter reading of 7,033
- CAT rigid frame trucks have an average meter reading of 8,944
- CAT excavators have an hour meter reading of 9,255

The project has recently rented Komatsu HM400 articulated trucks to replace the aging fleet of CAT 740 articulated trucks. Is this a permanent or temporary measure?

A decision will have to be made in the very near future whether to rent or purchase replacement units for the dozers, excavators, and rigid frame trucks. If the decision is to replace in kind, the cost to do so will be $38,000,000. If the decision is to rent in kind, the cost to do so for 35 months will be $39,900,000 ($1,140,000 per month).

MGF has done a comparison of rental vs. purchase for the earthmoving equipment over a 35-month period. For the 35-month period, purchase would cost $1,900,000 less than rental. However, 33 months is the "break even" point. For any period less than 33 months, it would be cheaper to rent than purchase.

For the rental period stipulated by Manitoba Hydro for Multitiek-700KCA, and the Herman Nelson 1.2M BTU heaters, it would be cheaper by $423,500 to purchase these units.

Conclusions & Recommendations

Rent in lieu of purchasing of earthmoving equipment if planned to work for less than 33 months.

Schedule impact: None

Source of Information & Reference Materials

- MGF Calculation Sheet #1 and #2
- The salvage rates used in the calculations are from the equipment hourly calculation sheet provided to MGF and marked "Reference Doc. C"
- The hour meter readings used are from the "Equipment Up and Down" list provided to MGF and marked "Reference Doc. B"
- The equipment and rental rates and durations used are from the 19th November, 2017 rental list provided to MGF and marked "Reference Doc. C"
- MGF narrative marked "Reference Doc. D"
- Excerpts from CAT handbook marked "CAT 1", "CAT 2" and "CAT 3"
- Email equipment rental and purchase quotes from K-Rents (Komatsu) and Finning (CAT)

Finding No. 5: Keeyask - Scaffold and Crane Costs

Observations & Findings

The October 2017 BBE Monthly Cost Report shows spend to date from Amending Agreement No. 7 for the Scaffold and Crane category in the sum of [redacted] compared to the total budget of [redacted] for the period October 2016 to completion. 1a

The physical progress to date based on attachment 12.10 QURR in the October 2017 BBE Monthly Cost Report is at [redacted]

Additional Scaffold cost will result in:

Order of Magnitude Estimate CAD $103,500,000

Notes:

- The above figure includes Indirects and [redacted] for GA &O 1a
- We have used the physical percentage complete
- In the October 2017 Report, the following was the expenditure for the month:

Labour	[redacted]
Material	[redacted]
Total	**4,344,935**

1a

Conclusions & Recommendations

Manitoba Hydro to review and implement cost reductions.

MGF recommends Manitoba Hydro retains a Scaffold Inspector on site to ensure cost effective scaffolding strategies.

Source of Information & Reference Materials

- BBE Monthly Cost Report 07 Rev 0 for October 2017

Finding No. 6: Keeyask - Concrete Placement

Observations & Findings

The review of the Weekly Construction Report – week ending 6th October 2017 revealed the following:

- 2017 Planned Quantities - 78,877 cubic metres
- 2017 Year to Date Plan - 61,172 cubic metres
- 2017 Year to Date Placed - 48,834 cubic metres

Year to date concrete placement is down 12,338 cubic metres from the plan or 20%.

The following table analyzes planned and actual placed quantities and hours spent in concrete placement in the period:

Period	Unit of Measure	Plan	Actual
Placed Quantity	Cubic Metres	3,149	1,085
Job Hours	Hours	[redacted]	[redacted]
No. of placements	Each	15	11

1a

The planned number of placements was not achieved in the period; BBE performed 73% of its plan.

BBE expended [redacted] extra hours in placing 2,064 cubic metres **less** concrete.

Conclusions & Recommendations

BBE failed to meet its schedule in 2016 and continues to do the same in 2017, even after the Amending Agreement No. 7 and renegotiation of target price and schedule.

The analysis raises serious concerns with BBE's optimistic productivity rates and its ability to plan and execute concreting activities. The constant slippage brings in to question when BBE will most likely finish and at what final cost to Manitoba Hydro.

BBE needs to improve its construction management practices and, more accurately, plan and execute concreting activities. We would recommend that BBE revises its schedule with productivity rates that it has actually achieved on this project to produce a more accurate and realistic schedule and associated cost. This will allow Manitoba Hydro to better understand BBE's forecast at completion cost and a more probable completion date. This information will help plan and sequence other contractors interfacing with BBE to avoid potential delay and disruption claims.

Source of Information & Reference Materials

- BBE Weekly Construction Report – week ending 6th October 2017

Finding No. 7: Keeyask - Concrete Productivity

Observations & Findings

The cost and schedule of the Amending Agreement No. 7 is based on an average concrete productivity rate of [redacted] man-hours per cubic metre. The actual average productivity achieved to date is [redacted] man-hours per cubic metre. The difference in concrete productivity between forecast and actual is [redacted] man-hours per cubic metre. 1a

If the actual average productivity of [redacted] man-hours per cubic metre remains the same, then applying the shortfall in productivity to the total concrete quantity as measured from 7th October 2016 until the end of the contract using an average blended labour rate of $61.70 results in additional costs: 1a

Order of Magnitude Estimate

Direct cost (including GA&O)	[redacted]	1a
Indirect costs	[redacted]	
Total	**136,500,000**	

It should be noted that the original Contract was based on the Limestone project, built 25 years ago, which achieved [redacted] man-hours per cubic metre. 1a

In addition, the actual average productivity is likely to worsen as the Contract has more complicated structures to pour and three further winter seasons to work through.

Conclusions & Recommendations

If concrete productivity is not brought back in line with the assumption in the contract schedule and forecast to completion, then the cost of concrete will increase by approximately $136.4 million.

Manitoba Hydro should closely monitor and manage productivity as with winter work been planned for this season and the fact that more intricate pours are being performed the productivity factor may further deteriorate.

Source of Information & Reference Materials

- Manitoba Hydro concrete productivity analysis tables November 23, 2017 File
- BBE Monthly Progress Statement for October 2016, May 2017 and June 2017

Finding No. 8: Keeyask - Extended Overtime

Observations & Findings

MGF reviewed BBE's Progress Payments for May and June 2017 and noted that some personnel were working greater than 16 hours per day.

There were 73 instances of personnel working greater than 16 hours per day. In some instances, there are personnel working up to 21 hours per day and, in some cases, working 16 hours per day for three consecutive days.

These extended hours will not be as productive as straight time hours and will result in diminishing output for every hour worked. This raises concerns about personnel safety.

Note: In May and June 2017, the total hours worked were 726,354, of which 326,000 were overtime.

Conclusions & Recommendations

Manitoba Hydro should consider working in line with the standard 10 hours per day where possible, to improve productivity. The camp expansion cost would need to be considered in this decision.

Source of Information & Reference Materials

- May and June 2017 BBE Progress Payment backup

Finding No. 9: Keeyask - Reporting

Observations & Findings

MGF's review has identified issues related to reporting that may impact successful project management. Examples identified comprise:

- Late reporting, e.g. BBE's monthly report is due by the 7th of the following month and as advised by Manitoba Hydro, is typically not submitted to Manitoba Hydro until the 14th of the month
- Incorrect reporting
    - potential discrepancy in quantities of earthworks claimed by BBE
    - schedule reporting based on 1,030 activities with negative float, of which 97 are on the critical path whilst the Contract stipulates that the Schedule shall have no activities with negative float
- Inconsistent reporting e.g. BBE has reported in its September 2017 Monthly Report three differing figures for both the total concrete quantity to be placed and the installed concrete to date

The risk is that Manitoba Hydro is treating reports as "rely upon" and making decisions potentially based on incorrect data.

Conclusions & Recommendations

Persistent late submission of the monthly report and provision of reports with inaccurate and conflicting data is unacceptable. This situation would be serious enough on a lump sum fixed price contract but is amplified considering the BBE contract is cost reimbursable, with Manitoba Hydro holding the risks of schedule, productivity and cost.

We recommend Manitoba Hydro enforces its contract with BBE and demands BBE's compliance with it so that Manitoba Hydro receives timely report with the required accuracy of content so that Manitoba Hydro can make data driven decisions on matters of progress and cost.

Source of Information & Reference Materials

Finding No. 10: Keeyask - Construction Management

Observations & Findings

In Construction **"Time is Money**"

In Traditional Fixed Contracts **"Time is the Contractor's Money"**

In Cost Reimbursable Contracts **"Time is the Owner's Money"**

The three main Contract types to consider are:

- Fixed Price Lump Sum (FPLS): The Contractor is paid FPLS amount regardless of incurred expenses or duration
- Unit Price: The Contract is based on estimated quantities. The Contractor is paid unit rates against actual quantities. Generally, the unit rates will include the Contractors overheads & profit
- Cost Reimbursable (in this case): The Contractor is paid for all its allowed costs, plus profit and General Administration & Overheads (GA&O)

The GCC Contract strategy of adopting a cost reimbursable commercial arrangement for this project was flawed from the outset, with a predictable outcome, i.e. it promotes and rewards inefficient work and doesn't encourage efficient work.

However, the design and construction methods for such a project are predictable, therefore, there is no reason why the Contract strategy adopted could not have been Lump Sum or at the very least Unit Rate (with Provisional Sums/Quantities for unforeseen below surface work).

Ensuring a good level of design upfront would have lent itself to these Contract types, thereby transferring the Construction risk from the Client to the Contractor.

With the current Contract strategy, the Client is taking all the risk on Productivity, Schedule and Cost.

As all construction decisions affect Manitoba Hydro financially, therefore they need to move actively into the role of a Construction Manager. Guiding & instructing the Contractor on more efficient:

- Crew make-ups
- Work methods
- Shift lengths
- Supervision
- Etc.

The application of incorrect machinery and work methods causes delay and additional cost. The following picture depicts an example where both Schedule and Cost are pushed out in favour of the Contractor and at the expense of the Client.

While the above is an example, the poor productivity achieved on site reflects poor Supervision and Management by the Contractor. If Manitoba Hydro want to reduce cost and schedule overruns they should have a more hands on approach.

Conclusions & Recommendations

Manitoba Hydro needs to take ownership of the site, as they are the party exposed. They need to hire experienced site supervisors (with trade backgrounds) to implement a more efficient workplan.

Source of Information & Reference Materials

- Site visits and general findings

SECTION 4 - HVDC Converter Stations

SCOPE ITEM 10:

Review and assess Manitoba Hydro's cost estimating methodologies with respect to the final pre-construction budget of $2.68 billion and forecast at completion budget of $2.78 billion, identifying best practices and short-comings.

Finding No. 1: HVDC Converter Stations - Manitoba Hydro Internal Labour Cost Capital Expense vs. Operational Expense (Beyond Finish Date)

Observations & Findings

On reviewing back-up files provided by Manitoba Hydro to support the CEF-16 Estimate, budgeted "Labour Costs", we have noted costs that extend beyond the July 2018 "In-Service Date" and into 2021. These costs are included in the $2.78 billion Capital budget.

The following are the budgeted values for Labour Costs by year:

Year	Budget (CEF-16)	(Assumed) CapEX	(Assumed) OpEX
2017	$35,694,634	$35,694,634	
2018	$40,226,246	$23,465,310	$16,760,736
2019	$28,338,108		$28,338,108
2020	$6,503,469		$6,503,469
2021	$106,668		$106,668
	$110,869,125.02	**$59,159,944**	**$51,708,981**

Note: The above costs are based on the budget relating to the July 2018 In-Service Date.

Conclusions & Recommendations

Based on the schedule presented by Manitoba Hydro, the In-Service Date is noted as occurring during year 2018. It would be expected that a significant portion of the costs associated with any period following the In-Service Date should be allocated as Operational Expenditures, i.e. $51,708,981.

Source of Information & Reference Materials

- BPIII_MCP_Labour_FY2017(20160531).xlsm
- Manitoba Hydro 2017/18 & 2018/19 General Rate Application, Appendix 5.4, Page 12
- BPIII Master Programme (MGF Planned vs. Actual)

Finding No. 2: HVDC Converter Stations - Manitoba Hydro Cost Estimating Methodologies

Observations & Findings

Based on the level of information available and the intended use of the cost estimate, we reviewed the estimate classifications that have been indicated by Manitoba Hydro for the following budgets:

- CEF14 ($2.68 billion)
- CEF16 ($2.78 billion)

MGF's review of Manitoba Hydro's cost estimating methodology for Bipole III Converter Stations with respect to the final pre-construction budget of $2.68 billion and forecast at completion budget of $2.78 billion is outlined within this section.

The pre-construction budget of $2.68 billion cost estimating methodology is explained in detail in the BPIII 2014 Basis of Estimate Document and is "Deterministic" as defined by AACE RP – 18R-97. Manitoba Hydro's cost estimating methodology is consistent with industry standard for the particular Class of Estimate and for the estimate's intended purpose.

A summary of the estimating basis for quantity and unit rates, is as follows:

- Internal Labour Estimate – based on estimated hours by year by labour rates and overhead. Generally internal labour hours were estimated on the basis of similar past work. BOE item 11.1.5
- Outsourced Labour Estimate – based on estimated contract costs for each specific contract for the network. Generally based upon similar past work packages or budget quotations BOE item 11.1.2
- Material and Expenses – Material Take Off quantities were provided by Engineering. Material costs were then estimated based on recent quotations, pricing and invoices. BOE item 11.1.3
- Contract Estimates – Based on similar proposals that had recently been received. 'Budget bids' BOE item 11.1.4

The estimating methodology for the forecast at completion budget of $2.78 billion is also "deterministic". Quantities, rates and unit costs remained unchanged except for the inclusions of the "previously out of scope provincial road upgrades and an increase in contingency levels to a P75 confidence level to better address project risks to the completion of the work."

Best Practices that have been identified:

- The BPIII 2014 Basis of Estimate document is well-written and closely aligns with the suggested structure and content outlined within AACE Recommended Practice Number 34R-05
- The use of estimating templates promotes consistency and familiarity with the estimate

Short-comings:

- The Basis of Estimate did not include Benchmarking and/or Industry Metrics based on data from similar projects
- A Basis of Estimate document was not developed for CEF16, identifying the changes in project scope definition, scope of work, Contingency development and updated pricing
- Design/Material Take Off and Construction Waste Allowances are neither identified nor included for Material Key Quantities
- Use of Estimating Software will eliminate possible math errors and familiarity with estimate reports. Manitoba Hydro's cost estimating methodology for the final pre-construction estimate for the Bipole III Converter Station Project was based on a first principle estimating methodology "using quantities and historical project unit rates dependent on design criteria"

It was indicated that each department, section or business unit with assigned scope to the project were responsible for producing their cost estimates and cash flows for internal labour, external labour, materials, equipment and contracts required for their respective project component.

Conclusions & Recommendations

MGF recommends that the Manitoba Hydro Estimating Team prepare the overall estimate with input from each department. The Manitoba Hydro Estimating Team would detail and reconcile scope, quantities and unit rates provided by each department. This would ensure consistency and accuracy in the estimates produced.

The method with which the financial aspects of the project are reconciled and revised for past and future expenditure each year within SAP, appear sound from a budget management perspective.

The fact that many of the project cost adjustments and calculations occur within SAP does reduce the level of transparency. Reconciliations should be conducted to update the physical quantity and item based cost estimates, to which rates of placement, production rates, and quantities can be detailed. This too, would aid in aligning with the project Work Breakdown Structure (WBS) and Cost Breakdown Structure (CBS).

Source of Information & Reference Materials

- 2016 Estimate Basis Notes
- CPJ Update Notes (Final)
- BPIII 2014 Basis of Estimate (BOE) Document

Finding No. 3: HVDC Converter Stations - Risk Management

Observations & Findings

The Bipole III Converter Stations Project Controls Report of June 2017 identified in the Risk Management section the following: “Future Risk: Majority or major component installation occurring this summer. Interfaces with SLI may cause delays to system installation. Concern with aggressiveness of Synchronous Condensers commissioning schedule”.

The Bipole III Converter Stations Project Controls Report of September 2017 states “There is a risk to the project ISD due to the following - Complexity of interfaces between Contractors and installation damage causing delays to system installation and pre-commissioning, installation delays impacting system commissioning (AC Switchyard), delivery delay of components impacting aggressive commissioning schedules submitted by contractors”.

The ‘Dashboard’ page of the September 2017 report goes on to state “Recent Contractor submissions show delays in activities that could jeopardize the ISD and the Contractor’s critical paths keep changing, increase the difficulty to forecast any potential impact to ISD.”

The September 2017 report further states “HVDC contractor critical path changes in every weekly submission and does not reflect the plan that is being discussed during the progress meeting and RFI responses which is the risk.”

Conclusions & Recommendations

The risk which was identified in June 2017 was not mitigated by September 2017 and poses a risk to the In-Service Date (ISD) being met. It is unacceptable for a project at this stage to have the critical path changing from week to week.

It raises concerns with the contractor’s ability to plan and execute its work and equally, why Manitoba Hydro having been aware of the risk, has failed to mitigate it. Risk management is a dynamic and ever present activity on a project and needs to be proactively performed if projects are to be successful.

Source of Information & Reference Materials

- Bipole III 2017 06 Converter Stations Project Controls Report
- Bipole III 2017 07 Converter Stations Project Controls Report
- Bipole III 2017 08 Converter Stations Project Controls Report
- Bipole III 2017 09 Converter Stations Project Controls Report
- Page Dashboard_Bipole III 2017 09 Project Controls Report
- Page Risk Management_Bipole III 2017 09 Project Controls Report
- Page Risk Management_Bipole III 2017 08 Project Controls Report
- Page Risk Management_Bipole III 2017 07 Project Controls Report
- Page Risk Management_Bipole III 2017 06 Project Controls Report

Finding No. 4: Bipole III - Integrated Master Schedule for Converter Stations

Observations & Findings

The Bipole III Integrated Master schedule contains 25,650 activities versus the baseline schedule which contains 19,386 activities.

As with any Integrated Master Schedule, its quality in large part is directly related to the quality of the schedules which are incorporated in to it. The Keewatinohk Converter Station (KCS) schedule, the Riel Converter Station (RCS) schedule, General Converter Stations, and the Transmission Connector Line schedules are imported weekly into the IMS with progress updates. This method for updating the IMS is precise; however, it isn't without risk. If certain elements of the individual schedules are changed, the progress may not be imported correctly into the IMS resulting in inaccurate dates.

Whilst an Acumen Fuse was not done on these individual schedules, the following describes the overall findings for these schedules.

Keewatinohk 230 kV AC Switchyard schedule:

The Keewatinohk schedule has a start date of 11th Jun, 2014 and has 17th January, 2018 as the completion date. The project is currently in progress with a status date of 27th October, 2017. It has 2,206 normal activities of which 2,080 (94%) are complete, 18 (1%) are in progress and 108 (5%) are still planned. It contains 118 milestones, 0 summaries, and 228 Level of Efforts (LOE).

The project baseline start date was 3rd July, 2014 with the baseline finish date being 7th October, 2017. The project is currently 93 days behind schedule.

The main issues on this schedule are the percentage of activities (70%) using a relationship type other than Finish to Start (FS) and the percentage of missed activities (46%).

Riel Synchronous Condensers schedule:

The Riel Synchronous Condenser schedule has a start date of 1st April, 2015 and has 25th December, 2018 as the completion date. The project is currently in progress with a status date of 16th October 2017. It has 7,602 normal activities of which 4,107 (54%) are complete, 330 (4%) are in progress and 3,165 (42%) are still planned. It contains 1,238 milestones, 0 summaries, and 452 Level of Efforts (LOE). As a re-baseline was just approved in October, 2017, the baseline and forecast dates are the same.

The main issues in this schedule are activities using the Start to Start, Finish to Finish, and Start to Finish (SS/FF/SF) relation (13%), missed activities (35%), and activities with a high duration (10%).

Transmission Department Schedules

The Transmission Project Department schedules include the following:

- Long Spruce 230kV Station
- Riel Electrode Line
- Ridgeway 230kV/66kV Breaker Replacement
- Rosser 230kV Breaker Replacement
- Rosser 230kv Breaker Replacement
- R49R T/L Sectionalization at Riel

- Dorsey Station
- Richer Station
- Ridgeway Station
- Riel Expansion
- Keewatinoow Collector Lines Henday
- Keewatinoow Electrode Line
- McPhillips 115kV Breaker Replacemnt
- Keewatinohk – Limestone U/G Fibre Optic Installation
- Henday 230kV Station Modification
- Keewantinoow CS Collector Line Long Spruce to Henday L61K

Across all of the Transmission Department schedules residing in the Bipole III Master schedule, the main issues are the activities missing logic (57%), activities using the Start to Start, Finish to Finish, and Start to Finish (SS/FF/SF) relation (48%), missed activities (61%), and activities with a high duration (39%).

As these schedules are built using critical path methodology (CPM), it is essential to have all activities linked together. Activities with high durations can be symptomatic of incorrectly identified support activities or activities that have not been broken down into enough detail. Supporting activities need to be identified as LOE activities in the schedule so they do not drive the critical path. Other high duration activities need to be decomposed into smaller discrete units so logic can be properly assigned to the network. A schedule containing primarily Start to Start and Finish to Finish (SS/FF) relations is a strong indicator the activities are too high level. The level of confidence in the forecast start and finish dates on this schedule would improve significantly if the logic issues are resolved.

Conclusions & Recommendations

The mechanical aspects of these schedules should be fixed to improve the quality and reliability of the completion dates for the project.

Source of Information & Reference Materials

- BPIII Master Schedule Aug-11-17-DD.xer
- 033102 HVDC SMC Original Baseline.xer
- 033401 – KCS 230 kV AC Switchyard Project – Latest Rev – 20171027.xer
- 033401 – KCS 230 kV AC Switchard Project – Original Baseline 20141125.xer
- 033852 Synchronous Condenser Over Target – Baseline and Lastest Rev Oct. 2017.xer
- BPIII OCT 2016-(CEF 16).xer

SCOPE ITEM 11:

Review and assess the tendering and contracting methodologies for the converter stations, identifying best practices and short-comings.

Finding No. 1: HVDC Converter Stations - Tendering & Contracting

Observations & Findings

MGF's review of the Manitoba Hydro's tendering of major HVDC converter station contracts > $25 million produced the following considerations.

- Approach to Market: appropriate use of competitive tender e.g. HVDC converter equipment & Keewatinohk 230kV AC switchyard and single sourced directly negotiated contracts e.g. Keewatinohk Site Development
- Contract types: appropriate use of contract types and allocation of risks was made e.g. HVDC Equipment on a design, supply, construct, install and commission contract. The Keewatinohk Camp Operations Services scope on a services based contract
- Pricing mechanism: appropriate choices were made for pricing mechanisms relative to contract scope, the degree of scope definition and risk. For example, HVDC Converter Equipment with payment against key lump sum milestones achieved by the Contractor that are defined in the Contract; and the Keewatinohk Camp Operations Services on a cost reimbursable pricing mechanism, comprised of reimbursing actual costs incurred plus a management fee

Conclusions & Recommendations

In tendering the HVDC converter station contracts, Manitoba Hydro has made has appropriate use of approaches to market, contract types and pricing mechanisms to successfully manage the scopes and risks associated with their contracts.

Finding No. 2: HVDC Converter Stations - Compensation Mechanisms

Observations & Findings

The Converter Station Contract Revision Register (CRR) as of 30th September 2017 shows open contracts with a remaining spend of $302,704,674. This is broken down by compensation mechanism as follows:

- Lump sum $253,083,916
- Unit price $12,234,989
- Cost reimbursable $37,385,769

Lump sum and unit rate priced contracts amount to 88% of the remaining spend which provides higher predictability in the forecast final cost.

Conclusions & Recommendations

Manitoba Hydro's choice of compensation mechanisms is appropriate for the contracts required for the converter station projects and is a sensible allocation of risk between Manitoba Hydro and its contractors.

Source of Information & Reference Materials

- Converter Stations Contract Summary

Finding No. 3: HVDC Converter Stations - Variation Management

Observations & Findings

We reviewed random variations to test if the management of variations was performed in accordance with the contract in terms of appropriate documentation, scope description and pricing. We found that most of the approvals were in accordance with the process outlined in the respective contract and Manitoba Hydro's corporate Contract Change Management Procedure.

It was noted that a few lump sum priced variations had a 15% mark-up added to the lump sum. This is in error; lump sum prices should be inclusive of all costs associated with the variation as per Section 5.7.2 of Schedule XV – Variation Procedures of the Contract. Section 5.7.3 of Schedule XV - Variation Procedure states that the 15% mark-up is only to be applied where a variation is priced on the basis of actual costs incurred. For example, the variation for the [redacted] should have the 15% fee removed from the calculation of its cost. 1a

Conclusions & Recommendations

Variations previously processed should be reviewed to ensure that the 15% mark-up has not been incorrectly applied and paid to the contractors.

Source of Information & Reference Materials

- Sample Variation Orders
- Manitoba Hydro Schedule XV Variation Procedure

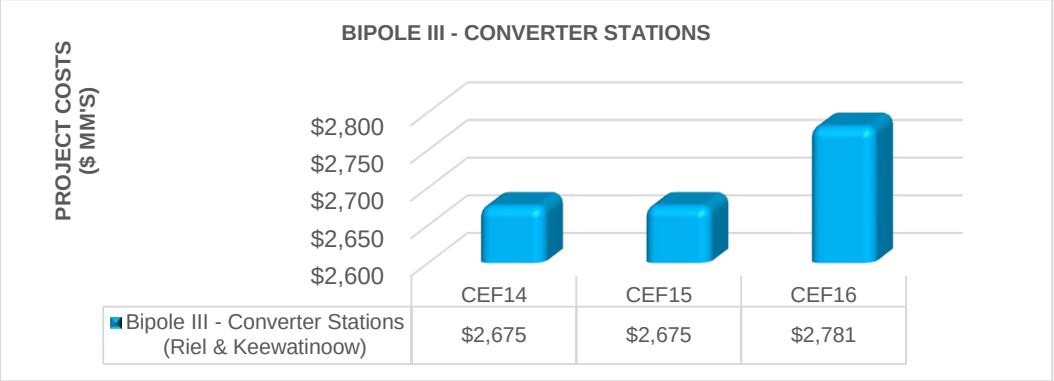
SCOPE ITEM 12:

Review and assess the reasons for the capital cost increases from the 2014 control budget of $2.68 billion to the current forecast at completion amount of $2.78 billion.

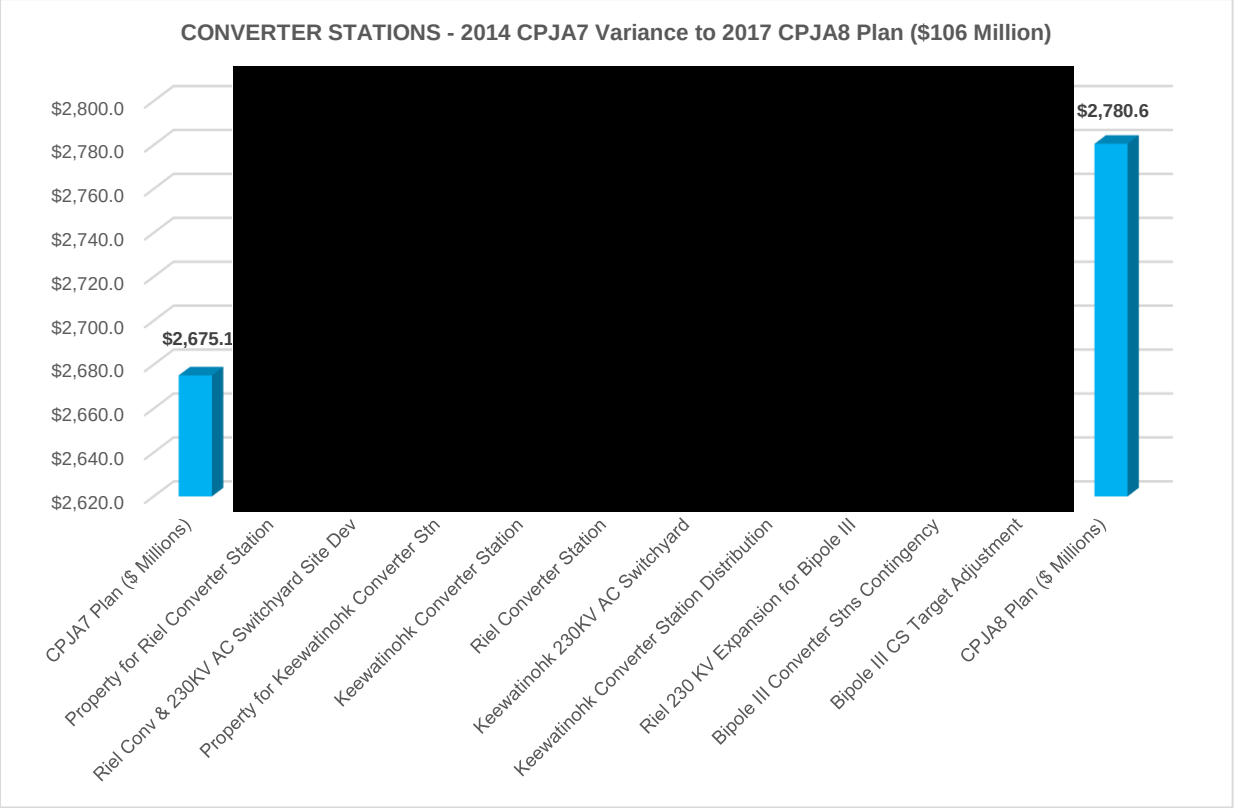
Finding No. 1: HVDC Converter Stations - Project Cost Overruns

Observations & Findings

MGF reviewed the "Bipole III Project, Basis of Estimate Document, September 2014 Cost Estimate Update", in addition to the justification for adjustments to the current budget of $2.78 billion. The budget comparison between CEF14, CEF15 and CEF16 are summarized below:



The budget increased by $106 million between CEF14 and CEF16. The revised budget maintains an In-Service Date of July 2018. The table below illustrates the cost elements, identifying variances to the original budget.



1a

Manitoba Hydro increased the 2014 Control Budget in CPJ Addendum #08(b) by approximately $106 million. This increase was subsequently approved by the MHEB on 26th October 2016. Changes to the scope included within the justification were as follows:

- Provincial Road 280 Upgrade
- Provincial Road 290 Upgrade
- Conawapa Access Road Upgrades

In addition, the estimate was adjusted to an increased confidence level of P75, i.e. 75% chance of achieving the estimate value. This confidence level adjustment increased the Contingency.

Costs which were once shared between the Bipole III and Conawapa Projects have now been fully allocated to the Bipole III Project in light of the Conawapa Generating Station project being “shelved”.

Manitoba Hydro provided MGF with an additional document entitled “Basis for the Current Converter Stations Budget” which was reviewed in early September. Whilst this document does not satisfy the requirements of a formal Basis of Estimate document, it did provide an explanation for some of the increases to the current budget.

Key changes from the pre-construction budget have been attributed to the following:

- Unallocated Contingency adjustment to increase budget confidence: [redacted]
- Cost Recovery from loss of Conawapa Project cost sharing: [redacted]
- HVDC Contract commodity escalation reserve to increase budget confidence: [redacted] 1a
- BNA Agreement LOA payments reserve amount: [redacted]
- Possible Post-Construction PR280/290 upgrade agreement with MHI: [redacted]

Conclusions & Recommendations

The budget was primarily increased to account for scope items mentioned above and to add further Contingency to address remaining project uncertainties.

Source of Information & Reference Materials

- 2016 Estimate Basis Notes
- CPJ Update Notes (Final)
- Bipole III Estimate Details by Network CEF 14 vs CEF16 MGF

SCOPE ITEM 13:

Assess Manitoba Hydro's updated converter station cost estimate for reasonableness, including whether appropriate contingencies and reserves have been provisioned in relation to outstanding uncertainties.

Finding No. 1: HVDC Converter Stations - Estimate Reasonableness

Observations & Findings

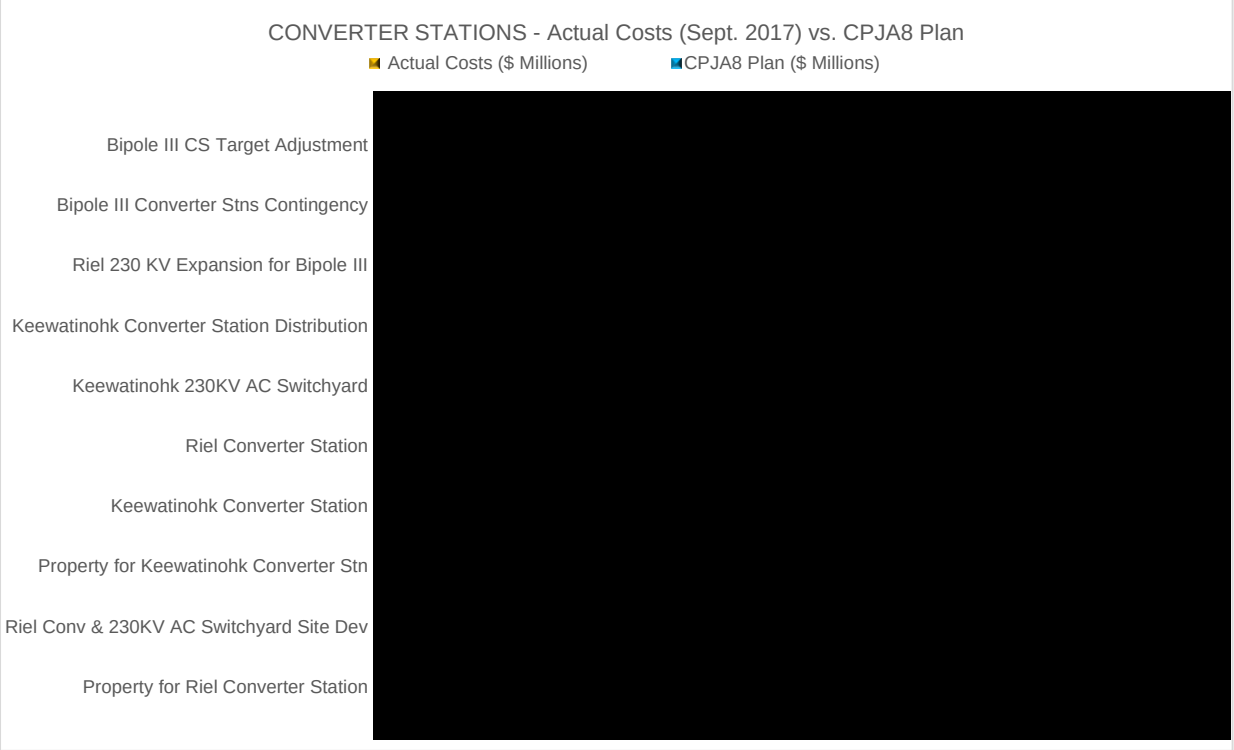
MGF's review of various reports produced the following observations and assessments:

- The review of "Actual Life to Date Amount" indicates $2,136,260,097 in actual spend to 30th September 2017. This represents 77% of the current project budget and aligns with that reported in the September 2017 Monthly Project Controls Report
- The September 2017 Monthly Project Controls Report indicates a Contingency of [redacted] broken down as follows:
    - Dispersed - [redacted] 1a
    - Allocated to Scope - [redacted]
    - Allocated to Contracts - [redacted]
    - Unallocated - [redacted]
- In reviewing the Risk Management section of the September 2017 Monthly Project Controls Report, the primary risk is schedule. There are no current risks impacting the project In-Service Date, but instances of late equipment delivery and component installation damage have been noted
- Future risks to the project In-Service Date have are on account of the following:

- Complexity of interfaces between Contractors
- Installation damage causing delays to system installation and pre-commissioning
- Installation delays impacting the system commissioning (AC switchyard)
- Delivery delay of components impacting aggressive commissioning schedules submitted by Contractors

- Whilst mitigation actions have been addressed, schedule and cost risks still exist and plans to potentially accelerate activities will result in additional costs
- The last entry on the Bipole III Risk Register, MFR 169 Converter Station tab was April 2017 which would imply that the Risk Register may not be up to date

The following table compares the Actual Costs (September 2017) to the CPJA 8 Plan



1a, 7a

Cost Summary

- CPJA8 (CEF-16): $2,780.56 MM
- Actual Costs (September 2017): $2,136.26 MM
- Costs To-Go (September 2017), Excl. Contingency: [redacted]
- Costs To-Go (September 2017), Incl. Contingency: $644.3 MM

1a

Conclusions & Recommendations

Based on the selected contracting strategies and the fact that a large portion of the project is based on a lump sum commercial model, the estimate is considered reasonable. Remaining project risks have been identified in relation to achieving the planned In-Service Date and it is MGF's view that the remaining unallocated contingency is reasonable.

Source of Information & Reference Materials

- BPIII CS CPJ Comparison vC14 vs vC16 Actual spend to Sept 30, 2017.xls
- 2017 09 Project Controls Report
- Bipole III Risk Register, MFR 169 Converter Station tab
- Transmission Bipole III Converter Stations, Project Controls Monthly Report September 2017

Finding No. 2: HVDC Converter Stations - Variation Management

Observations & Findings

The converter stations have approximately $320 million of spend to completion in August 2018. Of this value, the respective percentage spend by pricing mechanism is as follows:

- 83% on a lump sum basis
- 4% on a unit rate basis; and
- 13% on a cost reimbursable basis

Variations to date have not had a significant impact.

Conclusions & Recommendations

The potential for a cost over-run is low for the converter station scopes.

Source of Information & Reference Materials

- Converter Stations CRR Report
- September 2017 Project Controls Risk Management
- September 2017 Project Controls Risk Management

Finding No. 3: HVDC Converter Stations - Contingency Review

Observations & Findings

Contingency was carried in the final pre-construction budget at a value of [redacted] with no provisions for a management reserve, as this had been addressed within the Transmission Line Project. Contingency was set using a P50 value on an estimate value of $2.107 billion, which was inclusive of the Riel 230kV

7a

Expansion ($229 million) and Keewatinoow Converter ($1.878 billion). It was noted that at the time the contingency was assessed there were sunk costs against the project at a value of $307 million.

The Converter Station has a scheduled In-Service Date of July 2018. The total contingency carried for the project was [redacted] 7a

MGF has reviewed a third-party consultant's report that had been developed as part of the Bipole III Project risk and contingency review in August of 2014. In this report, suggested contingencies and reserves had been identified and presented as follows:

- Contingency (Cost) - Riel 230kV Expansion
  - P10, [redacted]
  - P50, [redacted]
  - P90, [redacted]
- Contingency (Cost) - Keewatinoow Converter (KCS) 7a
  - P10, [redacted]
  - P50, [redacted]
  - P90, [redacted]
- Bipole III - Contingency (Schedule)
  - P50, [redacted]
- Converter - Reserve Risks
  - Lost Season - [redacted]
  - Labour Shortage - [redacted]

The justification and recommendation for the reserves within the report were outlined as follows and it was suggested that Manitoba Hydro fund an amount to cover the costs of one of the risks:

- Lost Season, [redacted] a moderate to high probability was identified for one of the following to occur, which would result in an additional construction season. These are noted as delay impacts: 1a
  - Weather – KCS
  - Labour shortage
- Labour Shortages, [redacted] moderate probability that suppliers would experience poor productivity. The reserve did address the fact that the commercial strategy was based on EPC lump sums. Not a delay impact 1a

It was recommended that for the project business case analysis, Manitoba Hydro use the P95 value, plus escalation.

CPJA 8b authorized an additional [redacted] to address previously out of scope items and remaining risks. This authorization increases the Contingency carried within the project to a "P75 confidence level." The difference between the P50 and P90 values carried within the third-party report for the Converter Station scope was [redacted] This value did not account for any reserve, as indicated above. 7a

The noted variance between the contingency (P50) value presented by the third party consultant and the value carried by Manitoba Hydro within the project was approximately [redacted] 7a

Conclusions & Recommendations

The current value of contingency at a P75 confidence level does not appear to be based on a current or updated Contingency review. As such, this would not take into consideration the events and updated risks that the project has been or may be exposed to.

Manitoba Hydro's corporate standard states that contingency is set at a P50 or 50% confidence level.

Source of Information & Reference Materials

- Bipole III Project, Capital Cost and Schedule Risk Analysis and Contingency Estimate, dated 29th August 2014
- 2016 Estimate Basis Notes
- CPJ Update Notes (Final)
- BPIII 2014 Basis of Estimate (BOE) Document
- CPJA 8b

SECTION 5 - Bipole III Transmission Line

SCOPE ITEM 14:

Determine whether the current state of design and engineering work supports the $1.96 billion cost estimate. If not, identify what changes in the contingencies, reserves, or forecast at completion cost are required.

Finding No. 1: Bipole III Transmission Line - Stanley Consultants Inc.

Observations & Findings

On account of the one-week timeframe that Stanley Consultants Inc. ("Stanley") had to perform their work, MGF directed Stanley to those areas where it was felt that Stanley's efforts in the one week available would add best input and content for the review.

Stanley, through its review of the estimates, did review certain aspects of the design and engineering drawings and specifications but have not commented specifically on these.

Conclusions & Recommendations

As such, Stanley did not address this scope.

SCOPE ITEM 15:

Review and assess Manitoba Hydro's cost estimating methodologies, identifying best practices and short-comings.

Finding No. 1: Bipole III Transmission Line - Section N4

Observations & Findings

We performed a unit price comparison between CEF 16 Estimate and the Rokstad Power Company's Contract for section N4 of the transmission line. CEF 16 carried a cost of [redacted] 1a, 7a, 8a [redacted] The actual cost based on Rokstad's contract unit prices is [redacted] thereby reducing CEF 2016 by [redacted]

Conclusions & Recommendations

As contracts are placed, prior estimates should be updated with the contract rates to ensure the accuracy of estimates and forecast costs to completion. [redacted] Such low rates might indicate that Rokstad may have had an insufficient understanding of the scope and the cost to perform it. 1a, 8a

Source of Information & Reference Materials

- BPIII Estimate Rev 2 _ TLCC
- BPIII Transmission Line CPJA8 (2016) – 05

Finding No. 2: Bipole III Transmission Line - Manitoba Hydro Cost Estimating Methodologies

Observations & Findings

Manitoba Hydro's cost estimating methodology for the final pre-construction estimate for the Bipole III Transmission Line project was based on a first principles estimating methodology "*using quantities and historical project unit rates dependent on design criteria*".

This is also known as Deterministic Estimating methodology as defined by AACE RP – 18R-97, which is predominantly based on the use of unit cost line items. Manitoba Hydro's cost estimating methodology is consistent with the industry standard for the Class of Estimate and for the estimate's intended purpose.

It was indicated that each department, section or business unit with assigned scope to the project was responsible for producing their cost estimates and cash flows for internal labour, external labour, materials, equipment and contracts required for their respective project component.

It was difficult aligning the detail and structure of the various cost reports. The estimate basis did not align with either the Work Breakdown Structure or the summary tables provided in the Basis of Estimate. The detailed summary provided within the estimate packages did not align with the SAP cost reports.

Quantities, man-hours and unit rates associated with the physical scope were not clearly defined within the estimate summary sheets included within the estimate packages. From the estimate package provided, the information was not consolidated in any one location. This was limited to the estimate summary sheets that had been populated with accounting codes, descriptions and costs, which when checked and calculated, did not match the values carried in the estimate.

Conclusions & Recommendations

Manitoba Hydro is very strong in capturing and reporting costs. The team is comprised of a very knowledgeable and capable group; however, it is MGF's opinion that additional governance and control (not accounting) measures be implemented.

The 2014 pre-construction Basis of Estimate was extremely well done. Supporting back-up and more detailed explanation outlining the structure and relationship between the physical scope of work and resources with the cost / financial reporting system is suggested for the future.

Summaries should align with the Work Breakdown Structure and provide base costs, free of any escalation, taxes, contingency, interest, etc., as these should be shown separately.

Summaries should also be presented, outlining owner's costs, direct costs, indirect costs, etc. in accordance with the project Work Breakdown Structure and Cost Breakdown Structure. SAP reports and data dumps does not satisfy the requirements of an estimate summary or basis for the build-up of the estimate.

Source of Information & Reference Materials

- "Bipole III Design Parameters and Tower Quantities for Budgeting Purposes - 2014 07 16"
- Bipole III Project, Basis of Estimate Document, September 2014 Cost Estimate Update, dated March 2015
- BPIII Material Requirement Calculation Details - 2014 05 06
- BPIII T Line CPJA8 (2016) 2016-05 - BPIII Estimate Rev 2 _TLCC

Finding No. 3: Bipole III Transmission Line - CEF 2016 Estimate

Observations & Findings

The concern raised is with respect to Manitoba Hydro's cost estimating and forecasting capability as the "Estimate of Go Forward Costs" dated 16th June 2016 fails to include costs for Distribution Line Crossings and the Transmission Line Construction Yard. The notation advises that these costs are to be provided by others, but no cost is carried in the Total Estimated Cost of Construction.

Conclusions & Recommendations

The omission of these costs means that Manitoba Hydro is understating the "Estimate of Go Forward Costs." The degree to which this is replicated elsewhere is not defined or known, but it raises concerns on Manitoba Hydro's forecast costs to completion. MGF recommends that Manitoba Hydro implement a quality review of its "Estimated to Go Forward Costs" during its next review cycle to ensure adequate costs are provided for.

Source of Information & Reference Materials

- Estimate of Go Forward Costs dated 16th June 2016

SCOPE ITEM 16:

Review and assess Manitoba Hydro's tendering and contracting methodologies, including choices of contract types for the major contracts, identifying best practices and short-comings.

Finding No. 1: Bipole III Transmission Line - Contracting

Observations & Findings

Manitoba Hydro has used lump sum, unit rate, cost reimbursable and material supply contracts effectively. Examples of lump sum price contracts are as follows:

- Transmission Line Clearing
- GIS Upgrade

Examples of unit rate priced contracts are as follows:

- Precast Concrete Self-supporting Tower
- Transmission Line Construction Package

Examples of cost reimbursable or "Service Release Order" contracts are as follows:

- Inspection Services
- Lidar & Digital Imagery

Conclusions & Recommendations

Manitoba Hydro has made appropriate use of lump sum, unit rate and cost reimbursable contract types for the Bipole III Transmission Line project.

Source of Information & Reference Materials

- BPIII Transmission Contract Summary dated 30th September 2017

SCOPE ITEM 17:

Review and assess Manitoba Hydro's contract management and cost control methodologies, and determine whether these methodologies support the $1.96 billion forecast at completion cost. If not, identify what changes in the contingencies, reserves, or forecast at completion cost are required.

Finding No. 1: Bipole III Transmission Line - Risk Register

Observations & Findings

Upon review of the Bipole III risk register the following deficiencies were identified:

- The date of creation of the risk is not identified
- The dates that risks are to be potentially resolved are not identified
- The person responsible for the risk is not identified

Conclusions & Recommendations

Manitoba Hydro to add the missing attributes to its risk register. This complies with industry best practice and will enhance their effectiveness in managing risks.

Source of Information & Reference Materials

- Risk Register "MFR-169 Transmission Line

Finding No. 2: Bipole III Transmission Line - Contract Management

Observations & Findings

The Bipole III Project Charter states that Contract 031074 with Valard Construction LP for Specialty Anchors & Foundations Installation (N1) had been closed out in the amount of [redacted] The Bipole III Transmission Contract Summary as at 30th September 2017 identifies this contract to be open with an actual expenditure of [redacted] and with a contingency remaining of [redacted] 1a, 7a

Conclusions & Recommendations

The Transmission Contract Summary should be corrected to status this Contract as closed and ascertain whether the remaining contingency of [redacted] can be reallocated. 1a, 7a

Source of Information & Reference Materials

- Bipole III Project Charter dated 17th February 2017
- Bipole III Transmission Contract Summary as at 30th September 2017

Finding No. 3: Bipole III Transmission Line - Variation Management

Observations & Findings

Bipole III contract 031061 with Forbes is for transmission line sections N2, N3, S1 and S2. We reviewed BPIII 031061 Variation Summary to understand how variations were being managed. The Variation Summary generally follows good practice in that it:

- Allocates a variation number
- Identifies the transmission line section reference to which the variation pertains
- Provides a description of the variation
- Records the value of the variation
- Identifies if the variation is an increase or reduction in cost
- Provides the basis of determining the cost of the variation

The variation number sequence runs from 1 to 54. However, variations 24, 30, 31, 36, 37, 43, 45 and 49 do not appear on the summary, and therefore, it's not possible to determine whether these are variations pending a decision by Manitoba Hydro or agreement with the contractor, or whether they have been rejected.

The Variation Summary only records those variations that are "approved." A better practice would be to retain all variations on the Variation Summary and provide a status to each of these e.g. Approved, Under Negotiation/Pending or Rejected.

If the variations that are not identified on the Variation Summary are under consideration by Manitoba Hydro then there is potential for an increase in cost to Contract 031061. The biggest risk with contract variations is when potential or pending variations are not visibly being tracked or recorded.

Conclusions & Recommendations

Maintaining the Variation Summary with all variations, e.g. approved, pending and rejected would be a more effective way for Manitoba Hydro to manage variations. With respect to the 8 variations that are not reported on the Variation Summary, Manitoba Hydro should review and confirm that these variations are rejected and will have no further cost impact or if they are pending, put these variations in to the Variation Summary for proper variation management.

Source of Information & Reference Materials

- BPIII 031061 Variation Summary

Finding No. 4: Bipole III Transmission Line - Variation Management

Observations & Findings

Bipole III contract 031063 with Rokstad Power Company is for transmission line sections N1, N4, C1 and C2.

We reviewed the BPIII 031063 Variation Summary to understand how variations are being managed. The Variation Summary generally follows good practice in that it:

- Allocates a variation number
- Identifies the transmission line section reference to which the variation pertains
- Provides a description of the variation
- Records the value of the variation
- Identifies if the variation is an increase or reduction in cost
- Provides the basis of determining the cost of the variation

The variation number sequence runs from 1 to 29. However, variations 3, 4, 6, 7, 12, 14, 15, 19, 21, 22, 24 and 25 do not appear on the summary, and therefore, it's not possible to understand whether these are variations pending a decision by Manitoba Hydro or agreement with the contractor or whether they have been rejected.

The Variation Summary only records those variations that are "approved." A better practice would be to retain all variations on the Variation Summary and provide a status to each of these, e.g. Approved, Under Negotiation/Pending or Rejected.

If the variations that are not identified on the Variation Summary are under consideration by Manitoba Hydro, then there is potential for an increase in cost to Contract 031063.

The biggest risk with contract variations is when potential or pending variations are not visibly being tracked or recorded.

Conclusions & Recommendations

Maintaining the Variation Summary with all variations, e.g. approved, pending and rejected would be a more effective way for Manitoba Hydro to manage variations. With respect to the 12 variations that are not reported on the Variation Summary, Manitoba Hydro should review and confirm that these variations are rejected and will have no further cost impact, or if they are pending, put these variations in to the Variation Summary for proper variation management.

Source of Information & Reference Materials

- BPIII 031063 Variation Summary

Finding No. 5: Bipole III Transmission Line - Rokstad Power Company Schedule

Observations & Findings

Based on the proposed recovery plan dated 17th October 2017, Rokstad Power Corporation's contract has a completion [redacted] Rokstad has only one season to perform the remaining work in sections N1, N4, C1 and C2. Close monitoring of construction of [redacted] is important, especially for stringing in the winter construction period. 4, 8a

Work in sections N1, N4, C1 and C2 has not progressed to plan since the contract start. The risk is if construction in these sections is not progressed as per the schedule, work will need to be performed in another construction season, with a schedule impact of one year.

Conclusions & Recommendations

In-Service Date (ISD) is critical and there remains only one season of work before ISD. The construction work requires close planning and the schedule needs close monitoring to ensure the completion date of 21st April 2018.

Source of Information & Reference Materials

- Bipole III – Transmission Line Construction Report, July 27, 2017
- BPIII Transmission Line CPJA8 (2016) – 05
- Bipole III Project Construction Report, June 2017

Finding No. 6: Bipole III Transmission Line - Rokstad Power Company Schedule

Observations & Findings

The Rokstad Power Company Schedule has a start date of 21st Sep 2015 and a completion date of [redacted] The project is currently in progress with a status date of 20th August 2017. It has 4,794 normal activities of which 2,721 are complete, 16 are in progress and 2,057 are still planned. It contains 178 milestones, no summaries and 86 LOE (Level of Effort) activities. [redacted] The project is currently behind schedule by 8 days. 4b, 8a

Acumen Fuse is a software application which uses metrics to identify problematic areas and activities in a project schedule. It has hundreds of industry metric libraries including DCMA 14-Point Assessment, the US Government Accountability Office's (GAO) Scheduling Best Practices and the US National Defence Industrial Association's (NDIA) Generally Accepted Scheduling Practices (GASP). The Acumen Fuse analysis produced the following:

- Fuse Schedule Index: Is a single quality indicator resulting from a summary of detailed analysis. The Rokstad Power Company Schedule scored 69, giving it a 69% probability of success
- Schedule Quality: Scored 69% versus a score of 75% or better which is considered a 'good' schedule

- [redacted] Schedule paths with [redacted] typically arise due to artificially constrained activities. The metric identifies activities with [redacted] and should not exceed 5%. This schedule scored 49%. [redacted] 4b, 8a
- Baseline Execution Index (BEI): Measures the efficiency with which actual work has been accomplished when measured against the baseline. The BEI score for this schedule is 0.87. The more activities that are completed on time or ahead of the baseline schedule will reflect a BEI of 1 or more. Conversely, a BEI of less than 1 indicates that the actual work accomplished is unlikely to achieve the completion date

Conclusions & Recommendations

In our opinion, this is a medium quality schedule. Although the schedule is only 8 days behind the baseline finish date, approximately 50% of the activities are slipping from the November 2016 approved baseline dates. The concern is that as many of the slipping activities are on the critical path, any further delays to these activities will further delay the completion date of the project. A recovery plan has been developed and submitted by Rokstad Power Company to Manitoba Hydro, but has not been approved at this time.

Source of Information & Reference Materials

- 031063 RPC Update to 20th August 2017 – POBS Removed.xer
- 031063 RPC Approved Baseline November 2016 – POBS Removed.xe5

Finding No. 7: Bipole III Transmission Line - Master Schedule

Observations & Findings

The Bipole III Transmission Line Master Schedule has a start date of 25th January 2014 and a completion date of 31st July 2018. The project is currently in progress with a status date of 1st October 2017. It has 131 normal activities of which 93 are complete, 22 are in progress and 16 are still planned. It contains 54 milestones, no summaries and 40 LOE (Level of Effort) activities. The project baseline start date was 14th February 2014 with the baseline finish date of 31st July 2018. The project is currently on schedule.

Acumen Fuse is a software application which uses metrics to identify problematic areas and activities in a project schedule. It has hundreds of industry metric libraries including DCMA 14-Point Assessment, the US Government Accountability Office's (GAO) Scheduling Best Practices and the US National Defence Industrial Association's (NDIA) Generally Accepted Scheduling Practices (GASP). The Acumen Fuse analysis produced the following:

- Fuse Schedule Index: Is a single quality indicator resulting from a summary of detailed analysis. The Bipole III Transmission Line Master Schedule scored 36, giving it a 22% probability of success
- Schedule Quality: Scored 36% versus a score of 75% or better which is considered a 'good' schedule

- Missing Logic: This metric measures the total number of activities that are missing a predecessor, a successor or both. Missing Logic is a core project quality check and the score should not exceed 5%. The score for this schedule is 41%
- [redacted] Schedule paths with [redacted] typically arise due to artificially constrained activities. The metric identifies activities with total float greater than 2 months and should not exceed 5%. This schedule scored 74%. [redacted] 4b, 8a
- High Duration: Measures the number of activities with [redacted] and typically this should not exceed 5%. The score for this schedule is 47% and this generally indicates that the schedule is too high level for adequate planning and controls
- Baseline Execution Index (BEI): Measures the efficiency with which actual work has been accomplished when measured against the baseline. The BEI score for this schedule is 0.87. The more activities that are completed on time or ahead of the baseline schedule will reflect a BEI of 1 or more. Conversely, a BEI of less than 1 reflects work that is finishing behind schedule

Conclusions & Recommendations

The overall quality of the schedule is considered low. In speaking with Manitoba Hydro's scheduler, we were advised that the Bipole III Master Transmission Line Schedule is a high-level schedule only. For detailed information, the Bipole III Master Programme schedule should be used.

As the Bipole III Transmission Line In-Service Date is 31st July 2018, this project has been identified as progressing on schedule. However, it is worth noting that approximately 61% of the normal activities are slipping from their baseline dates.

The overall Bipole III project is on schedule but the transmission line contractors are not. Recovery plans from both contractors have been submitted to Manitoba Hydro for review.

Source of Information & Reference Materials

- BPIII TL Master Schedule September 2017 POBS Removed.xer
- BPIII TL Master Schedule Baseline 2016 POBS Removed.xer

SCOPE ITEM 18:

Review, assess, and determine the reasons for project cost overruns since the final pre-construction control budget of $1.66 billion.

Finding No. 1: Bipole III Transmission Line - Project Cost Overruns from $1.66 billion Final Pre-Construction Budget

Observations & Findings

We reviewed the “Bipole III Project, Basis of Estimate Document, September 2014 Cost Estimate Update”. The overall project cost has increased by $302 million from the $1.66 billion final pre-construction control budget to $1.96 billion.

Table 1: Comparison of Budgets

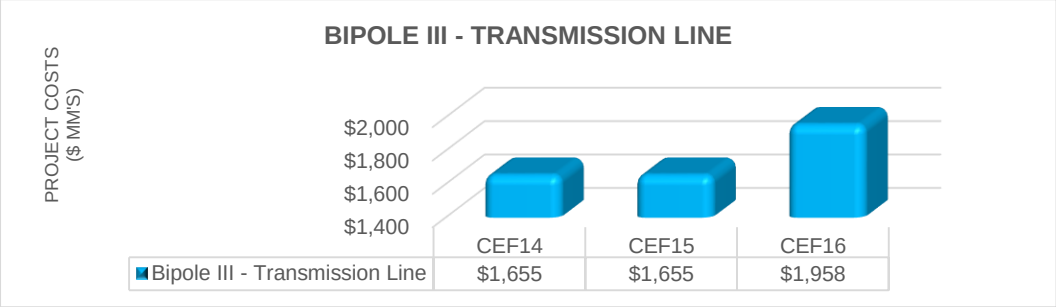
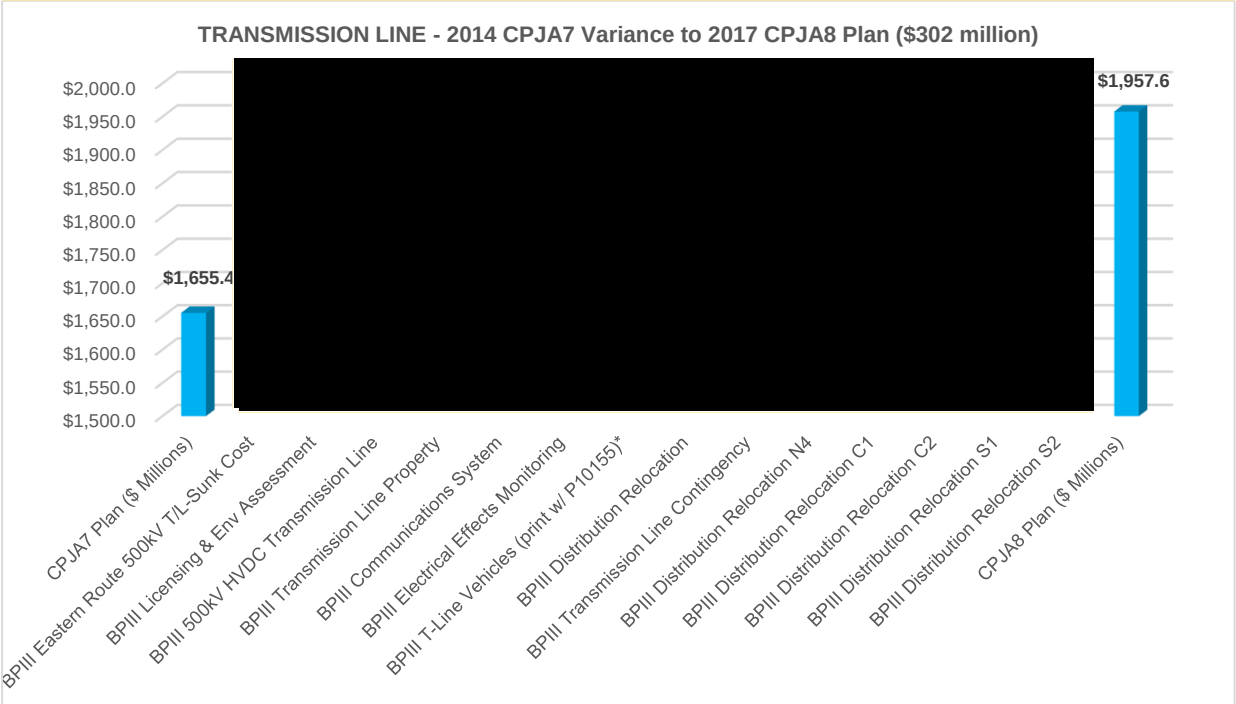


Table 2, below identifies the variances resulting in the project cost increase of $302 million.



1a

Values above are reflective of Manitoba Hydro planned costs, that were provided by Manitoba Hydro in September 2017.

Key contributing factors driving the overall project cost increases are related to the following cost elements:

- BPIII 500 kV HVDC Transmission Line (P:10155) - [redacted]
- BPIII Transmission Line Property (P:14518) - [redacted]
- BPIII Transmission Line Vehicles (P:20255) - [redacted]
- BPIII Transmission Line Contingency (P:23817) - [redacted]

1a, 4b, 8a,

These cost elements account for [redacted] project cost increase. There is a $5 million cost reduction related to the communications system that reduces the project cost increase to $302 million.

1a, 4b, 8a,

Manitoba Hydro provided MGF with an additional document entitled “Scope Summary - from Bipole III TL CPJ 8A,” that was referred to during a meeting in early September. This document does not satisfy the requirements of a formal Basis of Estimate, but does provide high level explanations for variations to the budgets presented in CEF16 from CEF14.

The justification for the $302 million cost increase is presented in this document as follows:

[redacted] increase: 1a, 4b, 8a

- Higher than planned “actual” market rates associated to anchors and foundations, tower assembly, erection and stringing contracts
- Delay claims (weather and material)
- Construction schedule compression (including schedule acceleration by helicopter tower erection in sections N2, N3, S1 and S2
- Biosecurity matting in S1 & S2
- Increased equipment and vehicles to support construction

[redacted] increase: 1a, 4b, 8a

- Additional materials required for southern route changes
- Costs associated with delays in materials
- Premiums to accelerate materials
- Engineering and material management contract cost increases

[redacted] increase: 1a, 4b, 8a

- Increased property costs for finalized southern route
- Inclusion of Land Valuation Appraisal Council (LVAC) certification
- Legal fees

[redacted] increase: 1a, 4b, 8a

- Increase in material management costs
- Increase in project and construction management costs

[redacted] increase:

- [redacted] 1a, 4b, 8a
- [redacted]

[redacted] increase: 1a, 4b, 8a

- Increase to project contingency (from P50 to P80)

$48 million decrease:

- Interest and escalation reduction due to compressed schedule and later than planned spends

Conclusions & Recommendations

Many of the additional costs appear to be a result of a project that was perhaps not at a stage of readiness at the time of project approval in terms of permit approvals, design development, land acquisitions and execution planning (i.e. procurement cycle and delivery time, market underpinned costing based on a tested and firm strategy, etc.).

Addressing many of the above elements prior to entering the project execution phase would have likely de-risked many of the project costs incurred.

Source of Information & Reference Materials

- Bipole III Project, Capital Cost and Schedule Risk Analysis and Contingency Estimate, dated 29th August 2014
- Scope Summary – from Bipole III TL CPJ 8A, presented 5th September 2017
- BPIII T Line actual costs to Sept. 2017 – ACTUALS
- BPIII T Line Contingency Drawdown Tracking_2017 08 09
- CPJA8 CPJA7 Comparison

SCOPE ITEM 19:

Assess Manitoba Hydro's updated forecast at completion capital cost, including whether appropriate contingencies and reserves have been provisioned, and schedule estimates for reasonableness.

Finding No. 1: Bipole III Transmission Line - Sections N1 and N4

Observations & Findings

Manitoba Hydro carries [redacted] its Estimate to Go Forward dated 16th June 2016 for the counterpoise scope. The cost of this work valued in accordance with Rokstad Power Company's Contract No. 031063 is [redacted] 1a, 4b, 8a

Conclusions & Recommendations

The estimated cost should be updated in accordance with Rokstad's contract. This will reduce the forecast at completion cost by [redacted] 1a, 4b, 8a

Source of Information & Reference Materials

- BPIII Estimate Rev 2 _ TLCC
- BPIII Transmission Line CPJA8 (2016) – 05
- Manitoba Hydro Contract No. 031063

Finding No. 2: Bipole III Transmission Line - Contingency

Observations & Findings

The following observations are taken from the September 2017 Bipole III Project Construction Report and the October 2017 Milestone Schedule:

- Project is 68% complete
- Targeted completion is 31st July 2018
- Contingency balance as of 1st November 2017 is [redacted] of the forecast work to go 7a

Conclusions & Recommendations

Based on the performance to date, it would appear that the contingency amount for the 500kV Transmission Line will be sufficient. The contracts for the 500kV Transmission Line are either lump sum or unit rate, so the risk is low that the contingency would be exceeded. This may be impacted by Rokstad's performance issues.

Source of Information & Reference Materials

- September 2017 Bipole III Project Construction Report
- PCS Log
- PCA Log
- October 2017 Milestone Schedule

Finding No. 3: Bipole III Transmission Line - Contingency Review

Observations & Findings

Contingency and management reserve carried in the final pre-construction budget was [redacted] in Contingency and [redacted] in Management Reserve). Contingency was set using a P50 value on an estimate value of $1.191 billion and a scheduled In-Service Date of July 2018. The total Contingency plus Management Reserve carried for the project was [redacted] 7a

MGF has reviewed a Manitoba Hydro third-party consultant's report that was developed as part of the Bipole III Project Risk and contingency review in August of 2014. This report identified and proposed the following contingencies and reserves:

- Contingency (Cost)
  - P10, [redacted]
  - P50, [redacted]
  - P90, [redacted] 7a
- Bipole III - Contingency (Schedule)
  - P50, [redacted]
- Transmission - Reserve Risks

- Lost Season, [redacted]
- Bidding Market, [redacted] 7a
- Biosecurity, [redacted]

The justification and recommendation for the reserves within the report were outlined as follows and it was suggested that Manitoba Hydro fund an amount to cover the costs of the risks:

- Lost Season, [redacted]- a moderate to high probability was identified for one of the following to occur, which would result in an additional construction season. These are noted as delay impacts: 7a 8a
  - Late permits
  - Weather
  - Labour Shortage
- Bidding Market, [redacted]- moderate probability that the "historical" cost of local suppliers used in the estimate will not reflect the pricing of international contractors faced with a mega-project in a tough environment. Not a delay impact 7a 8a
- Biosecurity, [redacted] - a moderate probability that permit requirements will require the use of matting to be used for construction of Southern segments. Not a delay impact
- Two additional risks associated to the Converter Stations had been included within the listing of reserves:
  - Lost Season, [redacted] 7a 8a
  - Labour Shortage, [redacted]

It was recommended that for the project business case analysis, Manitoba Hydro use the P95 value, plus escalation.

CPJA 8a authorized an additional [redacted] to address remaining risks and schedule protection. This authorization increases the contingency carried within the project to [redacted] or as stated by Manitoba Hydro, a P80 or 80% confidence level. The difference between the P50 and P90 values carried within the third-party report for the Transmission Line scope was [redacted] This value does not account for any reserve, as indicated above. 7a 8a

In the "Scope Summary – from Bipole III TL CPJ 8A" document provided to MGF, Manitoba Hydro has indicated that *"…it is assumed that at completion of the project risks will have materialized and budget dollars previously allocated for Contingency will be depleted."*.

The remaining risks and the allocation of the available contingency [redacted] were provided by Manitoba Hydro as follows:

- [redacted] - biosecurity measures, schedule acceleration [redacted], and route alterations 1a, 7a, 8a
- [redacted]

- [redacted]
- [redacted]- potential material changes and quantity variations, [redacted]
- [redacted]- cover contract contingency for material supply and anchor foundation installation 1a, 7a, 8a
- [redacted]
- [redacted] potential schedule acceleration resultant interest and escalation changes to maintain the In-Service Date

Conclusions & Recommendations

The current value that Manitoba Hydro has indicated is at the P80 confidence level, and does not appear to be based on a current or updated review. This does not take into consideration events and updated risks that the project has been or may be exposed to.

Manitoba Hydro's corporate standard currently states that a set contingency of P50 or 50% confidence level is used.

This may be impacted by Rokstad's performance issues.

Source of Information & Reference Materials

- Bipole III Project, Capital Cost and Schedule Risk Analysis and Contingency Estimate, dated 29th August 2014
- Scope Summary – from Bipole III TL CPJ 8A, presented 5th September 2017
- BPIII T Line actual costs to Sept. 2017 – ACTUALS
- BPIII TLine Contingency Drawdown Tracking_2017 08 09
- CPJA8 CPJA7 Comparison

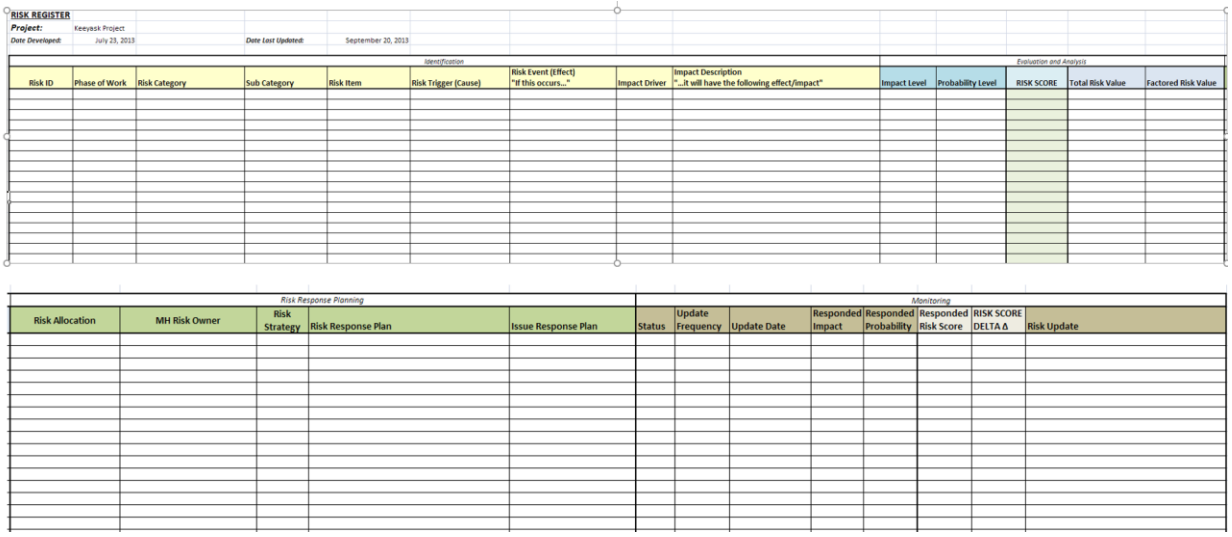
SCOPE ITEM 20:

Identify aspects of the updated cost estimate and schedule that are at heightened levels of risk and recommend risk mitigation strategies that Manitoba Hydro should use.

Finding No. 1: Bipole III Transmission Line - Risk Review

Observations & Findings

Manitoba Hydro does not have a specific Risk Management Plan for the Bipole III Transmission Line Project which has been identified as a requirement for all projects in the Keeyask and Converter Station Projects Procedure (RSK-001). Illustrated below is the Risk Register template included in the Procedure.



RISK REGISTER

Project: Keeyask Project

Date Developed: July 23, 2013 Date Last Updated: September 20, 2013

Identification									Evaluation and Analysis				
Risk ID	Phase of Work	Risk Category	Sub Category	Risk Item	Risk Trigger (Cause)	Risk Event (Effect) "If this occurs..."	Impact Driver	Impact Description "...it will have the following effect/impact"	Impact Level	Probability Level	RISK SCORE	Total Risk Value	Factored Risk Value

Risk Response Planning					Monitoring							
Risk Allocation	MH Risk Owner	Risk Strategy	Risk Response Plan	Issue Response Plan	Status	Update Frequency	Update Date	Responded Impact	Responded Probability	Responded Risk Score	RISK SCORE DELTA Δ	Risk Update

Overall, the Risk Register used for the Bipole III Transmission Line project appears to be thorough, containing typical information necessary to track and monitor potential projects risks; however, key information that is missing includes the date the Register was last updated and the date the specific Risk line item was last updated.

Some of the "potential" risks identified in the register related to specific issues that had already occurred on the project (e.g., BPIII TLR 38 - Section [redacted] Tower steel damaged by Contractor during Tower Erection Operation) and they were classified with a low probability which puts into question whether risks are being assessed correctly. 1a, 1c, 4b

Conclusions & Recommendations

MGF recommends the date the Register was last updated and the date the Risk ID was last updated be added to the Risk Register. The probability assessed to the specific risks should also be reviewed for accuracy.

Source of Information & Reference Materials

- RSK-001 Keeyask and Converter Station Projects Procedure
- Practice Standard for Risk Management (Project Management Institute)
- Bipole III Risk Register

Finding No. 2: Bipole III Transmission Line - Schedule Risk

Observations & Findings

The Transmission Line Integrated Master Schedule is a high level schedule which uses constraints rather than logic to set the start date for many of the activities. The schedule is currently progressing on schedule; however, the majority of the activities are slipping from their baseline dates. The biggest risk to the schedule is the stringing productivity by Rokstad. Manitoba Hydro requested a recovery plan from Rokstad which was not approved. [redacted] 1a

Conclusions & Recommendations

[redacted] The risk to the project in service date is still high and will remain so until a new contractor is assigned the work. 1a, 4b

Source of Information & Reference Materials

- Letter to Mr. Chris Poullis, Vice President Transmission Services dated 8th November 2017
- MH BPIII TL Maser Schedule Sept 2017 POBS Removed.xer
- MH BPIII TL Master Schedule Baseline 2016 POBS Removed.xer

Finding No. 3: Bipole III Transmission Line - Contractor Risk

Observations & Findings

Both Rokstad Power Corporation (Rokstad) and Forbes Brothers Ltd. (Forbes) have had performance issues which continue in to the 2017/2018 winter season.

An analysis of the respective unit prices provided by Rokstad and Forbes would suggest that Rokstad may have front loaded its tender. [redacted] 1a, 4b, 7a, 8a

Manitoba Hydro in its letter dated 3rd October 2017, Manitoba Hydro addressed lack of progress issues with Rokstad, [redacted]

[redacted]

[redacted] 1a, 4b, 7a, 8a

[redacted]

Conclusions & Recommendations

[redacted] 1a, 4b, 7a, 8a

Source of Information & Reference Materials

- Transmission, Bipole III Project Construction Report, September 2017
- Scope Summary – from Bipole III TL CPJ 8A
- Forbes Contract, Submission Form C.1.1 – Cost of Performing the Work, Section N2
- Manitoba Hydro letter dated 8th November 2017

SECTION 6 - Manitoba – Minnesota Transmission Project

SCOPE ITEM 21:

Determine whether the current state of design and engineering work supports the $453 million cost estimate. If not, identify what changes in the contingencies, reserves, or forecast at completion cost are required.

Finding No. 1: MMTP Transmission Line - Stanley Consultants Inc.

Observations & Findings

On account of the one-week timeframe that Stanley Consultants Inc. (“Stanley”) had to perform their work, MGF directed Stanley to those areas where it was felt that Stanley’s efforts in the one week available would add best input and content for the review.

Stanley, through its review of the estimates, did review certain aspects of the design and engineering drawings and specifications but have not commented specifically on these.

Conclusions & Recommendations

As such, Stanley did not address this scope.

Source of Information & Reference Materials

SCOPE ITEM 22:

Review and assess Manitoba Hydro’s cost estimating methodologies that support the $453 million cost estimate, identifying best practices and short-comings.

Finding No. 1: MMTP - Cost Estimating Methodologies

Observations & Findings

A formal Basis of Estimate document which normally describes the cost estimating methodologies for the project was not prepared by Manitoba Hydro.

MGF describes Manitoba Hydro’s cost estimating methodology as follows:

- Estimate methodology is “deterministic” as defined by AACE RP – 18R-97, which involves the predominant use of unit cost line items. Manitoba Hydro’s cost estimating methodology is consistent with industry standard
- Detailed Estimates sheets are developed by Manitoba Hydro’s subject matter experts in each respective field involved in the project (civil design, controls, apparatus procurement,

construction, commissioning, etc.) Some Excel estimate sheets include estimate preparation background and assumptions

- The estimate reflects Manitoba Hydro's most detailed scoping exercise, which includes a final preferred route for the transmission line, planning for indigenous opportunities in the project and final system studies out of Manitoba Hydro's planning and design groups
- Details for the breakdown of costs are included for the Transmission Line Construction and Design spreadsheets that includes estimated quantities and unit rates
- Estimate details for other Network/WBS were likewise developed in Excel spreadsheets and were input into SAP
- Interest and Escalation calculations are done automatically within Manitoba Hydro's accounting software (SAP)

Best Practices Identified

- The level of project definition as described in the scope of work is considered reasonable to develop the quantities
- Historical project unit rates and recent pricing is reasonable for the class of estimate
- Using Project Estimate templates provides consistency and familiarity with the estimate

Short-comings

- A Basis of Estimate was not created for the $453 million cost estimate
- Estimate detail sheets provided do not capture the level of detail provided in the Network / WBS scope of work
- Scopes of work for each Work Breakdown Structure are outdated and need revising
- Design/Material Take Off and Construction Waste Allowances are not identified or included for Equipment and Material Key Quantities. Allowances will be developed by the estimating team and department leads

Conclusions & Recommendations

MGF recommends that an appropriate Basis of Estimate (BoE) be developed for the project. Preparing a BoE is an industry Best Practice for all levels of estimates as it supports in ensuring many aspects of the project are understood, and/or necessary assumptions made at the time of estimate development have been documented.

As outlined by AACE International Recommended Practice No. 34R-05, "a well written basis of estimate will:

- Document the overall project scope
- Communicate the estimator's knowledge of the project by demonstrating and understanding of the scope and schedule as it relates to cost
- Alert the project team of potential cost risks and opportunities
- Provide a record of key communications made during estimate preparation

- Provide a record of all documents used to prepare the estimate
- Act as a source of support during dispute resolution
- Establish the initial baseline for scope, quantities and cost for use in the cost trending throughout the project
- Provide historical relationships between estimates throughout the project lifecycle
- Facilitate the review and validation of the cost estimate"

A Basis of Estimate should:

- Be factually complete, but concise
- Be able to support facts and findings
- Identify estimating team members and their roles
- Describe tools, techniques, estimating methodology and data used to develop the cost estimate
- Identify other projects that were referenced or benchmarked during the estimate preparation
- Be prepared in parallel with the cost estimate
- Establish the context of the estimate, and support estimate review and validation
- Qualify any rates or factors that are referenced either in the estimate or BoE"

Suggested guidelines for the structure, topics and contents are also included within the Recommended Practice that will assist Manitoba Hydro in ensuring consistent and transparent cost estimates.

Source of Information & Reference Materials

- email from Patrick Allan, Section Head, Transmission Projects Management Section, dated 15th November 2017
- TL and CD Estimate - Dorsey 500kv Tie Line – 246409.xls
- MMTP Summary of the Environmental Impact Statement – file name mmtp_is_summary
- Network P:16957 WBS 246409 based on Overall SOW - MMTP - 500kV Transmission Line dated 2016-11-16
- Network P:16958 WBS 246410 based on Overall SOW - MMTP - Dorsey Stn dated 2015-06-01
- Network P:21616 WBS 250480 based on Overall SOW - MMTP - Glenboro Station dated 2015-06-01
- Network P:16959 WBS 246411 based on Overall SOW - MMTP – Riel Transformer Addition dated 2016-09-30
- AACE International Recommended Practice No. 34R-05, Basis of Estimate, TCM Framework: 7.3 – Cost Estimating and Budgeting, dated 2nd May 2014

SCOPE ITEM 23:

Review and assess Manitoba Hydro's proposed tendering and contracting methodologies, including choices of contract types for the major contracts.

Finding No. 1: MMTP - Tendering & Contracting

Observations & Findings

Manitoba Hydro has not placed significant contracts for this project as yet. However, it should follow and learn from the experience of performing the Bipole III Transmission Line contracts. These were a mix of lump sum, unit rate, cost reimbursable and material supply contracts. Any variations arising on these contracts should be taken account of in the development of tenders for the MMTP project so that issues are not repeated.

Conclusions & Recommendations

Manitoba Hydro can apply the lessons learned on the Bipole III Transmission Line project in developing its contracting strategy for this project and the required suite of contracts with which to execute the project.

SCOPE ITEM 24:

Review and assess Manitoba Hydro's proposed construction management, contractor management, construction risk management, and scheduling methodologies.

Finding No. 1: MMTP - Schedule

Observations & Findings

The 26410 Dorsey 500kV Station Terminate Tie Line Project schedule was created from an existing template which promotes and ensures consistency between similar projects. It had a start date of 23rd July 2013 and is currently in progress with a completion date of 13th November 2020. The project is currently on schedule. As of 2nd October 2017, the schedule has 151 normal activities of which 9 are complete, 14 are in progress and 128 are still planned. The schedule is being updated every two months but should be updated more frequently once construction activities commence.

Acumen Fuse is a software application which uses metrics to identify problematic areas and activities in a project schedule. It has hundreds of industry metric libraries including DCMA 14-Point Assessment, the US Government Accountability Office's (GAO) Scheduling Best Practices and the US National Defense Industrial Association's (NDIA) Generally Accepted Scheduling Practices (GASP). The Acumen Fuse analysis produced the following:

- Schedule Quality: Scored 61% versus a score of 75% or better which is considered a 'good' schedule
- Logic Density: Assesses the average number of logic links per activity. An average of less than two indicates the schedule should be reviewed and updated with additional logic links. The

schedule scored 3.71. An upper limit of four is also recommended as logic density above this threshold indicates an overly complex logic within the schedule. The logic density peaks at 4.11 in 2019. These activities should be reviewed and updated

- Missed Activities: This measures the number of activities that have slipped from their baseline performance and is a measure of how good execution performance is. The schedule has 33 missing activities and all of these have high float thereby have no impact on the currently forecasted project finish date

Conclusions & Recommendations

The project is on schedule as per status date of 2nd October 2017. Once construction activities commence, the schedule should be reviewed and updated more frequently than the current every two months. Activities related to the logic density peaking at 4.11 in 2019 should be reviewed and updated to reduce potential complexity.

Finding No. 2: MMTP - Riel 500 or 230KV Stn. − Inst. Transformer Schedule

Observations & Findings

The Riel 500 or 230kV Stn – Inst. Transformer schedule has a start date of 23rd July 2013 and a completion date of 16th November 2020. The project is currently in progress with a status date of 2nd October 2017. It has 87 normal activities of which 10 are complete, 2 are in progress and 75 are still planned. It contains 16 milestones, no summaries and 17 LOE (Level of Effort) activities. The project baseline start date was the 5th January 2016 with the baseline finish date being 16th November 2020. The project is currently on schedule.

Acumen Fuse is a software application which uses metrics to identify problematic areas and activities in a project schedule. It has hundreds of industry metric libraries including DCMA 14-Point Assessment, the US Government Accountability Office's (GAO) Scheduling Best Practices and the US National Defence Industrial Association's (NDIA) Generally Accepted Scheduling Practices (GASP). The Acumen Fuse analysis produced the following:

- Fuse Schedule Index: is a single quality indicator resulting from a summary of detailed analysis. The Riel 500 or 230kV Stn – Inst. Transformer forecast schedule scored 64, giving it a 62% probability of success
- Schedule Quality: Scored 64% versus a score of 75% or better which is considered a 'good' schedule
- Missing Logic: This metric measures the total number of activities that are missing a predecessor, a successor or both. Missing Logic is a core project quality check and the score should not exceed 5%. The score for this schedule is 15%
- High float: Schedule paths with high amounts of float typically arise due to artificially constrained activities. The metric identifies activities with total float greater than 2 months and should not exceed 5%. This schedule scored 86%. Paths with float more than 2 months should be considered for acceleration and schedule optimization

- High Duration: Measures the number of activities with total float greater than 2 months and typically this should not exceed 5%. The score for this schedule is 41% and this generally indicates that the schedule is too high level for adequate planning and controls

Conclusions & Recommendations

The overall quality of the schedule is medium quality. The biggest areas for improvement include fixing logic areas, removing hard constraints on completed activities and modifying remaining hard constraints to soft constraints. The high duration is a concern, however Manitoba Hydro indicated that construction contracts have not been awarded. We recommend that these long duration activities be decomposed into more detail once contracts have been awarded and contractor schedules have been approved.

Finding No. 3: MMTP - Glenboro Transmission Line Re-Alignment Schedule

Observations & Findings

The Glenboro Transmission Line Re-Alignment has a start date of 1st July 2015 with a completion date of 13th November 2020. As of 2nd October 2017, the schedule has 26 normal activities of which 2 are complete, 1 is in progress and 23 are still planned. It contains 5 milestones, no summaries and 19 LOE (Level of effort) activities.

There is no baseline schedule for this scope of work. The schedule was recently created (no date on the information reviewed) to address some additional scope which was estimated but not scheduled in the 2016 budget. As there is no baseline schedule, Earned Value Management cannot be performed.

Acumen Fuse is a software application which uses metrics to identify problematic areas and activities in a project schedule. It has hundreds of industry metric libraries including DCMA 14-Point Assessment, the US Government Accountability Office's (GAO) Scheduling Best Practices and the US National Defence Industrial Association's (NDIA) Generally Accepted Scheduling Practices (GASP). The Acumen Fuse analysis produced the following:

- Schedule Quality: Scored 64% versus a score of 75% or better which is considered a 'good' schedule
- Missing Logic: This metric measures the total number of activities that are missing a predecessor, a successor or both. Missing Logic is a core project quality check and the score should not exceed 5%. The score for this schedule is 39%
- High Duration: measures the number of activities with total float greater than 2 months and typically this should not exceed 5%. The score for this schedule is 28% and this generally indicates that the schedule is too high level for adequate planning and controls

Conclusions & Recommendations

The schedule should be reviewed and address issues related to Missing Logic. Inaccurate logic in a schedule may put the project finish date at risk, as the correct critical path may not be identified or understood.

The identified High Duration activities should be decomposed into more detail to properly understand and monitor the plan.

Source of Information & Reference Materials

- MMTP – MGF Request – October 2017

Finding No. 4: MMTP - Glenboro Phase Shifter Schedule

Observations & Findings

The Glenboro Line G82R Phase Shifter schedule has a start date of 1st March 2013 and a completion date 5th May 2021. The project is currently in progress with a status date of 2nd October 2017. It has 117 normal activities of which 5 are complete, 7 are in progress and 105 are still planned. It contains 31 milestones, no summaries and 23 LOE (Level of Effort) activities.

Acumen Fuse is a software application which uses metrics to identify problematic areas and activities in a project schedule. It has hundreds of industry metric libraries including DCMA 14-Point Assessment, the US Government Accountability Office (GAO) Scheduling Best Practices and the US National Defence Industrial Association (NDIA) Generally Accepted Scheduling Practices (GASP). The Acumen Fuse analysis produced the following:

- Fuse Schedule Index: Is a single quality indicator resulting from a summary of detailed analysis. The Glenboro Line G82R Phase Shifter forecast schedule scored 60, giving it a 55% probability of success
- Schedule Quality: Scored 60% versus a score of 75% or better which is considered a 'good' schedule
- Missing Logic: This metric measures the total number of activities that are missing a predecessor, a successor or both. Missing Logic is a core project quality check and the score should not exceed 5%. The score for this schedule is 40%
- Negative float: Ideally there should not be any negative float in a schedule. Negative float is a result of an artificially accelerated or constrained schedule and indicates that a schedule is not possible based on current completion dates. The analysis determined that 11% of activities contained negative float
- High Duration: Measures the number of activities with total float greater than 2 months and typically this should not exceed 5%. The score for this schedule is 40% and this generally indicates that the schedule is too high level for adequate planning and controls

Conclusions & Recommendations

The overall quality of the schedule is medium quality. The biggest areas for improvement include fixing logic areas, removing hard constraints on completed activities, modifying remaining hard constraints to soft constraints.

Source of Information & Reference Materials

- MMTP – MGF Request – October 2017

Finding No. 5: MMTP - Dorsey Stn: Manitoba − US 500kV Tie Line schedule

Observations & Findings

Dorsey Stn: Manitoba - US 500kV Tie Line schedule has a start date of 1st April 2010 and a completion date of 13th November 2020. The project is currently in progress with a status date of 31st July 2017. It has 84 normal activities of which 23 are complete, 23 are in progress and 38 are still planned. It contains 28 milestones, no summaries and 14 LOE (Level of Effort) activities. The project baseline start date was 12th July 2013 with the baseline finish date of 13th November 2020. The project is currently on schedule.

Acumen Fuse is a software application which uses metrics to identify problematic areas and activities in a project schedule. It has hundreds of industry metric libraries including DCMA 14-Point Assessment, the US Government Accountability Office (GAO) Scheduling Best Practices and the US National Defence Industrial Association (NDIA) Generally Accepted Scheduling Practices (GASP). The Acumen Fuse analysis produced the following:

- Fuse Schedule Index: Is a single quality indicator resulting from a summary of detailed analysis. The Dorsey Stn: Manitoba – US 500kV baseline schedule scored 42, giving it a 30% probability of success
- Schedule Quality: Scored 45% versus a score of 75% or better which is considered a 'good' schedule
- Missing Logic: This metric measures the total number of activities that are missing a predecessor, a successor or both. Missing Logic is a core project quality check and the score should not exceed 5%. The score for this schedule is 29%
- Logic Density: Assesses the average number of logic links per activity. An average of less than two indicates the schedule should be reviewed and updated with additional logic links. The schedule scored 3.00. An upper limit of four is also recommended as logic density above this threshold indicates an overly complex logic within the schedule. The logic density rises to 4.2 and 4.71 in years 2019 and 2020. These activities should be reviewed and updated
- High float: Schedule paths with high amounts of float typically arise due to artificially constrained activities. The metric identifies activities with total float greater than 2 months and should not exceed 5%. This schedule scored 66%. Paths with float more than 2 months should be considered for acceleration and schedule optimization
- High Duration: Measures the number of activities with total float greater than 2 months and typically this should not exceed 5%. The score for this schedule is 38% and this generally indicates that the schedule is too high level for adequate planning and controls
- Baseline Execution Index (BEI): Measures the efficiency with which actual work has been accomplished when measured against the baseline. The BEI score for this schedule is 0.27. The more activities that are completed on time or ahead of the baseline schedule will reflect a BEI of 1 or more. Conversely, a BEI of less than 1 reflects less than forecasted schedule execution

Conclusions & Recommendations

The overall quality of the schedule is medium quality. Manitoba Hydro uses a common template for these schedules which is good for consistency across schedules. However, the template should be modified as required for project specific information. The most important improvement required to this schedule is to review the logic which is the leading contributor to the poor Acumen Fuse score. Missing logic needs to be added to this schedule; leads should be removed; Start to Start and Finish to Finish Relations should be replaced with Finish to Start relations where possible. The High Duration and insufficient detail is a concern. Manitoba Hydro has indicated that construction contracts have not been awarded yet and we would recommend that these long duration activities are decomposed into more detail once contracts have been awarded and contractor schedules are approved.

Source of Information & Reference Materials

- MMTP – MGF Request – October 2017

SCOPE ITEM 25:

Assess Manitoba Hydro's updated capital cost estimate of $453 million for reasonableness, including whether appropriate contingencies and reserves have been provisioned.

Finding No. 1: MMTP - Estimate Reasonableness

Observations & Findings

Manitoba Hydro's Development Plan presently includes the construction of a new 500kV Transmission Line between Winnipeg and Duluth, Minnesota. The transmission line will originate at Dorsey Converter station and head south to the Manitoba-Minnesota border.

The project also includes associated upgrades at Dorsey, Riel and Glenboro stations. This scope of work addresses the design and construction of the new 500kV transmission line and the associated licensing, environmental assessment and property acquisition requirements. The In-Service Date for the project is 31st May 2020.

The following table is the summary provided by Manitoba Hydro outlining the MMTP Network Level Budget.

Manitoba Minnesota Transmission Project

Network Level Budget

Plan version: CPJ

Investment program: 2.5.13.1.01.1

Network/WBS	Description	Planned Dollars (CAD$)
246409	Dorsey-U.S 500kV Tie Line	[redacted]
P:16957	WBS level plan (interest & esc.)	
P:16957	**Dorsey-U.S 500kV Tie Line**	
246410	Dorsey 500 kV Stn- Terminate Tie Line	
P:16958	WBS level plan (interest & esc.)	
P:16958	Dorsey 500kV Stn - Terminate Tie Line	
246411	Riel 230/500 kV Stn - Install Transfrmr	
P:16959	WBS level plan (interest & esc.)	
P:16959	Riel 230/500kV Stn-Auto Transform Instal	
246416	MB-US 500 kV Facilities-Communication	
P:16961	WBS level plan (interest & esc.)	
P:16961	MB-US 500kV Facilities - Communication	
246417	MB-US 500 kV Facilities-Lic.& Env	
P:16962	WBS level plan (interest & esc.)	
P:16962	**MB-US 500kV Facilities-Lic. & Env.**	
250480	Glenboro Phase Shifter	
P:21180	WBS level plan (interest & esc.)	
P:21180	Glenboro Phase Shifter	
250863	Glenboro Transmission Line Re-Alignment	
4304577	Glenboro South 66kV Line Relocation	
P:21616	WBS level plan (interest & esc.)	
P:21616	Glenboro Transmission Line Re-Alignment	
254740	Project Contingency	

1a, 4b, 7a

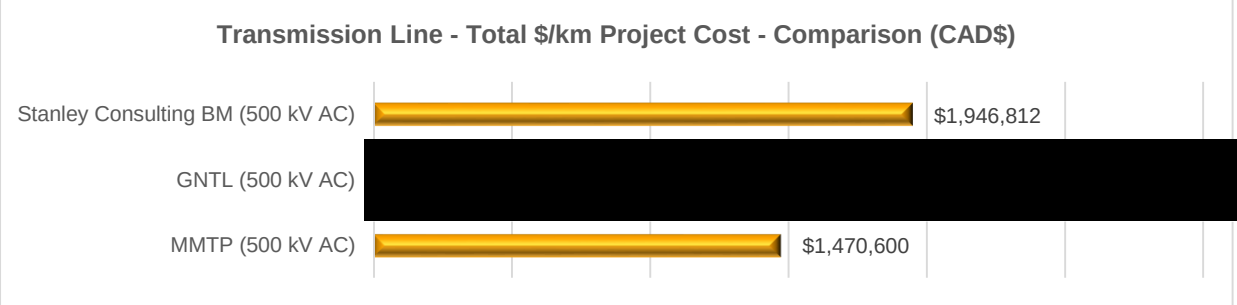
255903	Management Reserve	$	[redacted]
255904	Indigenous Relations Opportunities	$	
P:25309	WBS level plan (interest & esc.)	$	
P:25309	MMTP Contingency	$	
257274	MMTP Indigenous Agreements	$	
P:28314	WBS level plan (interest & esc.)	$	
P:28314	MMTP Agreements and Programs	$	
	TOTAL	**453,209,197.65**	

1a, 4b, 7a,

MGF's review has focused on the transmission line and related scope of work, which represents [redacted] of the total project budget ([redacted] excl. Contingency).

- Dorsey 500kV T/L - [redacted]
- 500kV Facilities - [redacted]
- Glenboro Tie T/L - [redacted]
- Subtotal - [redacted]
- Contingency Prorated ([redacted] - [redacted]
- Total - [redacted]

These costs were broken down line item by line item to align with benchmark categories. The total value was converted to USD$ (at 0.787 USD per 1 CAD$) for a total of [redacted] The current project metrics suggest the costs for MMTP are lower than what other similar industry projects.



1d

We have set out below those activities whose costs are lower than other similar industry projects:

- Site Access Materials - Site access is based on ground conditions. This project corridor based on route maps provided, passes through areas requiring a higher level of site access than benchmark projects. Given probable conditions and standard site access methods this category is worth further review.
- Material Receipt Yards - Material receipt yard costs vary depending on the amount of civil work that is required to be performed to establish material laydown yards. Additions such as civil upgrades can increase costs. Further review is required to determine the extent to which yards are being upgraded and thus requiring restoration upon completion of use.
- Access Road/Clearing - Access/road clearing is the work required to be performed to provide off-ROW access. There appears to be no budget for this activity and given the expected ground conditions, this is of high concern and needs review, unless the budget for this resides elsewhere in the cost estimate.
- Clearing - Clearing cost is a function of the amount of vegetation to be removed to allow for construction access and installation. Given the existing conditions based on route selection, this appears to be low.
- Anchors - Anchor costs are a function of the foundation design. MMTP and GNTL have similar foundations; additional review to explain why costs for MMTP are much lower than GNTL is required.
- BFD/Aerial Markers – these costs are a function of environmental requirements; the included costs are much lower than benchmark and GNTL. This warrants additional review to confirm if BFD/Aerial Markers estimate is sufficient.
- Optical Fiber Ground Wire – these costs are a function of the OPGW selected. The costs appear low based on length of line.
- Overhead Ground Wire (OHGW) – these costs are a function of the OHGW selected. The costs appear low based length of line.
- Reclamation - Reclamation drivers are the amount of ground disturbed during construction and the extent to which grounds need to be restored to original conditions. Given the region in which the line is being routed it should be expected that restoration costs would be lower than typical.
- Construction Management (CM) & Inspection - CM and inspection costs are a function of the duration of construction as well as the number of inspectors required to verify construction compliance. Based on project complexity and length of construction these costs appear low.
- Construction Management (CM) - CM costs appear to be low based on scope and length of construction. The cost included appears low compared with benchmark values.
- CM Indirects - CM Indirects are a function of additional inspection, design work, or other construction related work. These costs should be reviewed in conjunction with CM cost.
- Legal (Internal) - Legal costs are a function of the amount of effort required to acquire land and permitting functions. Lower values indicate an easier approval process.
- Design Engineering - Design engineering costs are a function of the time and effort to develop operating design. Lower values would indicate either usage of standardized design or a more streamlined design process.

- Permitting - Permitting costs are a function of the effort required to research, develop applications, and obtain approvals of permitting applications for the line. Lower costs indicate a more streamlined permitting plan.

Areas of higher than expected costs have been identified as follows:

- Tower Steel - Tower steel is a function of the type and design of the towers required for the project. Given the type and configuration this costs appear high.
- Conductor - Line appears to be utilizing ACSR, key drivers are conductor type and whether conductor is bundled adding additional cost. Given voltage and load factors, the cost appears to be a little high but not excessive.
- Environmental – Environmental costs are driven by the level of environmental inspection and approvals required to permit the project. Given a greater amount of approval/review and a satisfactory permitting of the project, this may not be a concern but requires additional review based on difference to similar project (GNTL). MMTP appears to be at a higher cost.
- Survey & Geotech - Survey & Geotech work is based on work scope and amount of activities necessary to permit and perform construction. Higher number of survey activities required can drive up this cost. This activity needs further review.
- Community Affairs - Community affairs are driven much like public involvement and are a function of company outreach to inform public of the project and receive public input related to the permitting process. Harder to permit areas will drive community affairs costs higher.
- [redacted] 8a
- Public Involvement - Public involvement costs are driven by the required effort to obtain permitting. Project costs can vary based on the level of effort as public involvement can be viewed as an 'up front' permitting cost. Higher permitting costs can indicate project resistance early on but can result in lower follow-on permitting costs.

Conclusions & Recommendations

For comparison purposes, using similar project metrics converted from USD/mile, MMTP's current budget appears to be in the lower range of benchmarking metrics used.

MGF recommends that the items identified above are reviewed in further detail to ensure adequate budget has been provisioned.

MGF also recommends implementing an industry standard project stage gate process is recommended.

Source of Information & Reference Materials

- Overall SOW - MMTP - 500kV Transmission Line
- MMTP Network Level Budget
- Stanley Consulting Email, Re: Memo #1 – MGF High Level Cost Estimate Validation (GNTL and MMTP), dated 5th December 2017

SECTION 7 - Great Northern Transmission Line

SCOPE ITEM 26:

Compare the current GNTL estimated capital costs with estimates for similar projects and assess whether the estimated cost is reasonable.

Finding No. 1: GNTL - Capital Cost Comparison – Similar Projects

Observations & Findings

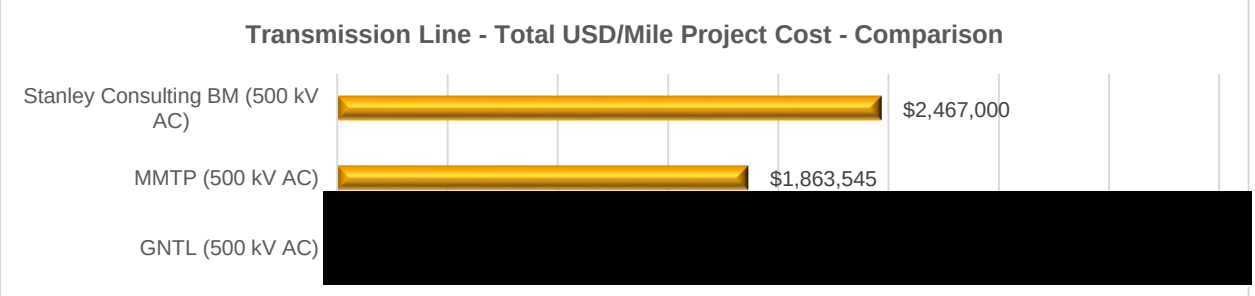
The transmission line scope of work represents 89% of the overall project budget, which is where MGF has focused this project review.

The following table represents a comparison of the GNTL Project to the Manitoba Minnesota Transmission Project (MMTP) and benchmarking data provided by Stanley Consultants Inc. ("Stanley"). These projects are based on AC transmission and a per mile cost.

Data provided by Stanley was based on the following assumptions. Currency assumed by Stanley's is US dollars, who based their estimate on referenced material from Midcontinent Independent System Operator (MISO), Western Electricity Coordinating Council (WECC) and various projects located in the great northern plains (Minnesota, North Dakota, Montana, Nebraska and Alberta Canada). The estimates are regionally based on actual project costs, with pricing escalated to reflect 2018 costs.

The costs were broken down line item by line item to align with benchmark categories. The CAD$ values were converted to USD$ (at 0.787 USD per 1 CAD$).

The current project metrics indicate that the costs for GNTL are higher than other similar industry projects.



1d

We have set out below those activities whose costs are lower than other similar industry projects:

- Conductor - Line appears to be utilizing ACSR, key drivers are conductor type and whether conductor is bundled adding additional cost. Given voltage and load factors, the cost appears to be a little high but not excessive
- Site Access Materials - Site access is based on ground conditions. This project corridor based on route maps provided, passes through areas requiring a higher level of site access than benchmark projects. This value appears very high given probable conditions and standard site access methods and should be further reviewed
- Material Receipt Yards - Material receipt yard costs vary depending on the amount of civil work required to establish material laydown yards. Additions such as civil upgrades can increase costs. Further review is required to determine to what extent the yards are being upgraded and thus likely restoration upon completion of use
- Construction Management (CM) & Inspection - CM and inspection costs are a function of duration of construction as well as the number of inspectors required to verify construction compliance. Longer working hours, additional work days, and longer planned construction periods drive this cost
- Project Development - Project development costs are an internal function driven by the complexity of the project. Given an international project with project specific structures and high voltage, this cost is expected to be higher than benchmark values. Routing and permitting values also drive this cost
- PM & Engineering - Project management and engineering costs are an internal function that is driven by the complexity of the project. Given an international project with project specific structures and high voltage, this cost is higher than benchmark values
- Construction Management - CM costs appear to be high based on scope and length of construction relative to benchmark projects. This category needs further review
- CM Indirects - CM Indirects are a function of additional inspection, design work, or other construction related work. These costs should be reviewed in conjunction with CM cost
- Permitting Fees - Permitting fees are a function of required regulatory fees
- Public Involvement - Public involvement costs are driven by the required effort to obtain permitting. Project costs can vary based on the level of effort as public involvement can be viewed as an ‘up front’ permitting cost. Higher permitting costs can indicate project resistance early on but can result in lower follow-on permitting costs
- Land Analysis - Land analysis is a function of determining the land value and ownership on potential routes. Land analysis can be driven higher with multiple routes being considered and a larger number of routes being investigated
- Total Development CPM - Project development portion is higher than benchmark data and requires additional review to understand the reasons for the additional costs

Areas of lower than expected costs have been identified as follows:

- Grounding - Grounding costs are based on soil conditions and resistivity. The soils in the region of this project appear to be favourable to grounding conditions. For a 500kV line, the cost differential should not be this great even with these favourable conditions, so it is probable that additional grounding costs are nested within other budgetary areas
- Material Subtotal - Material costs in this format are being driven by the site access costs. Overall, removing the site access costs, this line item is lower than benchmark for material costs
- Reclamation - Reclamation cost drivers are related to the amount of ground disturbed during construction and the extent to which ground needs to be restored to original conditions. Given the region in which the line is being routed we would recommend that these restoration costs are further evaluated
- Environmental - Environmental is driven by the level of environmental inspection and approvals required to permit the project. Given a lesser amount of approval/review and satisfactory permitting of the project, these lower costs are the result
- Legal - Legal costs are a function of the amount of effort required to acquire land and permitting functions. Lower values may represent an anticipated easier approval process
- Design Engineering - Design engineering costs are a function of the time and effort to develop operating design. Lower values would indicate either usage of standardized design or a more streamlined design process
- Permitting - Permitting costs are a function of the effort required to research, develop applications, and obtain approval of permitting applications for the line. Lower costs indicate a more streamlined permitting plan

Conclusions & Recommendations

MGF finds the [redacted] transmission line estimate for the GNTL Project to be high when compared to other similar projects. 1d

MGF recommends that further review is required and the items identified above are reviewed in further detail to ensure adequate budget has been provisioned.

Implementing an industry standard project stage gate process is recommended.

It is understood that there are provisions in place for the management of contingency draw-downs and as it stands the budget has been approved. MGF does, however, recommend that Manitoba Hydro maintain the greatest level of involvement in the areas of planning, selecting and implementation of contracting strategies, contract awarding process, management of change reviews and approvals as well as design reviews to ensure maximum value to Manitoba Hydro is achieved at a reasonable cost.

MGF recommends a detailed review of the revised estimate is performed as soon as possible. This review should be accompanied with a Basis of Estimate which addresses the items identified above.

Source of Information & Reference Materials

- CMA Pre-Constr - T-Line Project Scope Document,pdf
- GNTL Preconstruction Budget and Basis of Estimate Rev 5.26.2016.xls
- 500kV-MP_RouteCosts-5.17.2016.rev.h4.xls
- 500kV-MP_RouteCosts-5.17.2016.rev.h4.xls
- AACE International Recommended Practice No. 34R-05, BASIS OF ESTIMATE, TCM Framework: 7.3 – Costs Estimating and Budgeting.
- GNTL Preconstruction Budget and Basis of Estimate Rev 5.26.2016.xls
- Stanley Consulting Email, Re: Memo #1 – MGF High Level Cost Estimate Validation (GNTL and MMTP), dated 5th December 2017

SCOPE ITEM 27:

Review and assess the Construction Management Agreement between Minnesota Power and Manitoba Hydro's subsidiary for reasonableness, identifying whether the agreements follow best practices or have short-comings and whether Manitoba Hydro's interests are protected.

Finding No. 1: GNTL - Structure of Construction Management Agreement

Observations & Findings

The Great Northern Transmission Line (GNTL) Construction Management Agreement (CMA) between Minnesota Power (MP) and 6690271 Manitoba Ltd. (6690271) governs the finalization of pre-construction activities and construction related activities of the GNTL Project and remains in effect until construction is complete and the Project is placed in service.

The CMA provides key definitions to understand the roles of the Parties to the CMA and how it is designed to operate. Minnesota Power is a:

(i) CUU Transmission Owner (CUU TO) – transmission function.
(ii) Transmission Line Payer (TLP) – merchant function.
(iii) Construction Manager (CM) – appointed by the Participants and retained by the CUU TO's

A Participant means any CUU TO or TLP but does not include the Construction Manager. 6690271 performs the following roles:

- CUU Transmission Owner
- Transmission Line Payer (TLP)

CUU Transmission Owners are defined as Owners of the Facilities, the Discretely Owned Substation Assets and the Underlying System Improvements (USI). MP is 100% owner of Discretely Owned Substation Assets and USI; and ownership of the Facilities was divided between MP (51%) and 6690271 (49%). Immediately after the CMA was executed, 6690271 assigned its 49% ownership to MP resulting in MP being the sole owner of the Project.

The Project is comprised of the following components:

(i) Facilities (all aspects of the 500kV transmission line.)
(ii) Discretely Owned Substation Assets (the Warroad River Series Compensation Station & the 500/230kV Iron Range Substation.)
(iii) Underlying System Improvements (specified MP system improvements that are identified in Appendix G of the CMA.)

Transmission Line Payers (TLP) are the Parties funding the development and construction of the Project. Under the CMA there are two (2) TLP's, MP and 6690271 respectively responsible for 46% and 54% of the costs of the Projects (the "CM Costs").

The Management Committee (MC) is established pursuant to Article 9: Participants' Rights, Duties and Obligations for the oversight and management of matters arising under the CMA. Each Participant shall be represented on the MC. All decisions by the MC must be unanimous, therefore 6690271 has a veto right.

The table of contents of the CMA is comprehensive, follows best practice and is as follows:

- Article 2: Management of the Construction Manager
- Article 3: Contracting Responsibilities
- Article 4: Certain Pre-Construction Duties
- Article 5: Project Budget and Management of CM Costs
- Article 6: Funding
- Article 7: Description of Construction Manager Duties
- Article 8: Financial Accounting; Reporting; Independent Oversight
- Article 9: Participants' Rights, Duties and Obligations
- Article 10: Representations and Warranties
- Article 11: Completion and Acceptance of Work
- Article 12: Construction Work Warranties
- Article 13: Indemnification
- Article 14: Confidentiality Provisions
- Article 15: Breach, Cure and Default
- Article 16: Term and Termination of Agreement
- Article 17: Limitations of Liability
- Article 18: Dispute Resolution
- Article 19: Notices
- Article 20 Miscellaneous Provisions

Conclusions & Recommendations

The structure of the Construction Management Agreement meets acceptable commercial business practice.

Source of Information & Reference Materials

- Great Northern Transmission Line Construction Management Agreement dated April 12, 2016

Finding No. 2: GNTL - Management of the Construction Manager (Article 2)

Observations & Findings

Article 2: Management of the Construction Manager provides for the engagement of the Construction Manager to perform the CM Services, Real Property Management Services and the Agency Authority given to and accepted by the Construction Manager.

Section 2.1 addresses the appointment of Minnesota Power to act as Construction Manager for each Participant and the fact that a Participant is serving in the capacity of Construction Manager as well as Participant, does not in any way change, modify or release such Person from its rights, interest and obligations in its capacity as a Participant under the Construction Management Agreement.

Section 2.2 requires the Construction Manager to furnish its Services at no charge in excess of its actual cost to coordinate, manage, administer, oversee and enforce the performance of the Construction Work through the Final Completion of the Project.

The Construction Manager owes the Participants a duty of care to apply the skill and judgement of its organization to the Construction Management Services in accordance with the Construction Management Agreement, all Applicable Laws, Good Utility Practice and the directives and policies of the Management Committee.

In addition to the Construction Management Services, the Construction Manager shall provide Real Property Management Services to acquire Real Property in accordance with the Right of Way Strategies and Guidelines Plan.

Each CUU TO designates and appoints the Construction Manager as its designated and disclosed agent to carry out on behalf of each Participant, the Construction Management Services and the Real Property Management Services.

Conclusions & Recommendations

Article 2 Management of the Construction Manager of the Construction Management Agreement meets acceptable commercial business practice.

Source of Information & Reference Materials

- Great Northern Transmission Line Construction Management Agreement dated April 12, 2016

Finding No. 3: GNTL - Contracting Responsibilities (Article 3)

Observations & Findings

Article 3: Contracting Responsibilities addresses the contracting and bidding requirements that the Construction Manager is to comply with together with identifying which approvals are required from the Management Committee (MC) in relation thereto. For example:

(i) Section 3.2.1.2 (i): MC approves CM's pre-bid qualification process.
(ii) Section 3.2.1.2 (ii): MC approves the list of interested bidders who will be invited to pre-qualify and will approve the eventual "Approved Bidders' List.
(iii) Section 3.2.1.6: MC shall approve the Bid Process Guidelines setting out the guidelines and procedures to be utilized during the bid process.
(iv) Section 3.2.2.1: CM shall provide a copy of all contracts, amendments and change orders to the MC.
(v) Section 3.2.3: CM may only enter into a Project Construction Contract with a Participant with the approval of the MC.
(vi) Section 3.2.4: CM can only amend or revise the Approved Bidders List with MC consent.
(vii) Section 3.2.5: CM shall present all Major Contracts, Major Change Orders and Material Actions to MC for approval *prior* to entering in to or undertaking such Major Contracts, Major Change Orders and Material Action,

Conclusions & Recommendations

Article 3 Contracting Responsibilities of the Construction Management Agreement meets acceptable commercial business practice. It provides Manitoba Hydro's subsidiary 6690271 with the right of approval to key decisions on the tendering, award and management of contracting.

Source of Information & Reference Materials

- Great Northern Transmission Line Construction Management Agreement dated April 12, 2016

Finding No. 4: GNTL - Certain Pre-Construction Duties (Article 4)

Observations & Findings

Article 4: Certain Pre-Construction Duties addresses the Construction Work Schedule, Scope of Work, Project Plan, Approved Design and Pre-Construction Estimated Project Budget that shall be developed by the Construction Manager and submitted to the Management Committee for approval. These pre-construction duties shall be performed in accordance with Good Utility Practice and Applicable Law, compromising the following:

(i) Section 4.1: Preparing the Project Plan.
(ii) Section 4.2: Identifies the Approved Design for the Project that must be developed in accordance with Section 4.10 Design Criteria.
(iii) Section 4.3: Development Period Government Approvals.
(iv) Section 4.4: Preparation of Pre-Construction Estimated Project Budget.
(v) Section 4.5: Preparing the Equipment and Materials Procurement Plan.
(vi) Section 4.6: Implementing the Right of Way and Guidelines Plan.
(vii) Section 4.7: Develop and implement the Risk Management Plan.
(viii) Section 4.8: Prepare the Basis of Estimate.
(ix) Section 4.9: Implement the Change Control Guidelines.
(x) Section 4.10: Design Criteria.
(xi) Section 4.12: Use the Standard Forms (contracts and purchase orders) approved by the Management Committee.

Conclusions & Recommendations

Article 4 Certain Pre-Construction Duties meet acceptable commercial business practice. The above activities shall be approved by the Management Committee and any changes require the approval of the Management Committee before the Construction Manager may proceed with any change, thereby protecting the interests of 6690271.

Source of Information & Reference Materials

- Great Northern Transmission Line Construction Management Agreement dated April 12, 2016

Finding No. 5: GNTL - Project Budget and Management of CM Costs (Article 5)

Observations & Findings

Article 5: Project Budget and Management addresses the project budget and cost accounting. Key components of this Article are:

(i) Section 5.1: describes the Construction Manager's responsibility for updating the Pre-Construction Estimated Budget and submitting to MC for approval.

(ii) Section 5.4.1.3: Construction Manager will evaluate and in good faith determine the projected effect of any Participant-Directed Program Change Request affecting the Construction Work or the Project Budget. The Management Committee will approve such determination before the Project Budget or Construction Work Schedule is adjusted.

(iii) Section 5.4.2: modifications to the Approved Design, the Project Plan or the Project Budget may be proposed by the Construction Manager as a Program Change Request to the Management Committee for approval.

(iv) Section 5.5: addresses specifically what are eligible and recoverable CM Costs and those cost that are not chargeable to the Project.

Conclusions & Recommendations

Article 5 Project Budget and Management meets acceptable commercial business practice. The activities are appropriate for the successful and transparent management of the Construction Management Agreement and these activities require approval by the Management Committee.

Source of Information & Reference Materials

- Great Northern Transmission Line Construction Management Agreement dated April 12, 2016

Finding No. 6: GNTL - Funding (Article 6)

Observations & Findings

Article 6 generally describes the processes by which the Construction Manager shall be compensated for the CM Costs expended by it in performing the Services.

Section 6.1 states that the Construction Manager shall be compensated for CM Costs expended by it in the performance of the Services or in connection with the Construction Work. Section 6.2 sets out the Application for Payment process with invoices submitted to each Transmission Line Payer on a monthly basis complete with Supporting Documentation and in accordance with each Transmission Line Payer's Participant Payment Percentage. The Construction Manager has the obligation to reconcile all payments made and if the Construction Manager has received funds in excess of the actual CM Costs to which it is entitled, then the Construction Manager shall pay to each Participant the applicable Participant Payment Percentage of such excess.

Section 6.5 sets out the process by which the Final Payment will be calculated and any under or over payment to the Construction Manager will be processed. This shall be undertaken within ninety (90) days after the Final Completion.

Section 6.12 provides that the obligations of the Transmission Line Payers are several in proportion to their respective Participant Payment Percentages. This means each TLP is severally obligated to the extent of its Participant Payment Percentage for the payment of the CM Costs.

Conclusions & Recommendations

Article 6 Funding meets acceptable commercial business practice. The activities are appropriate for the successful and transparent management of the Funding requirements of the Construction Management Agreement and reinforces that the Parties are severally liable to the extent of their Participant Payment Percentages.

Source of Information & Reference Materials

- Great Northern Transmission Line Construction Management Agreement dated April 12, 2016

Finding No. 7: GNTL - Description of Construction Management Duties (Article 7)

Observations & Findings

Article 7.1 provides a series of conditions precedent that have to be satisfied before the Construction Manager may commence construction thereby protecting the Transmission Line Payers. These conditions precedent are as follows:

(i) Management Committee has approved the Approved Design
(ii) Management Committee has approved the Updated Right of Way Strategies and Guidelines Plan
(iii) Management Committee has approved the Project Insurance
(iv) Management Committee has approved the Procurement Plan
(v) Management Committee has approved the Risk Management Plan
(vi) 6690271 has provided notice of its satisfaction or waiver of all 6690271 Construction Phase Conditions Precedent
(vii) MPM (Minnesota Power in its capacity as a Transmission Line Payer) has provided notice of its satisfaction or waiver of all MPM Construction Phase Conditions Precedent.
(viii) Management Committee has retained its Independent Oversight Engineer.
(ix) Management Committee has approved the Bid Process Guidelines
(x) Management Committee has approved the Project Plan
(xi) Management Committee has approved the Design Criteria

Section 7.3 Material Documents requires the Construction Manager to use commercially reasonable efforts to provide to each of the Participants all material documents related to the Project such as engineering and design matters, procurement and contracting strategies, final Permits, overall coordination and administration of the Project, project controls and processes, meeting minutes, etc.

Section 7.4 Project Meetings provides a list of planned meetings for GNTL. These include Discipline Team Meetings, Full Team Meetings and Management Team Meetings, which each Participant has the right to participate in and the Construction Manager must provide each Participant with notice of such meetings including copies of all agendas, meeting documentation and prior meeting minutes.

Section 7.5 Consultation and Approval obliges the Construction Manager to consult with and discuss with 6690271 any material decision it proposes to make in respect of the matters identified in Appendix N –

Proposed Appendix N Decision. The Construction Manager shall provide 6690271 with a written outline and supporting basis for each Proposed Appendix N decision. 6690271 has the right to provide to the Construction Manager written revisions to the Proposed Appendix N Decision for the Construction Manager's consideration. The Construction Manager shall not proceed with implementing any Proposed Appendix N Decision until it has received the approval of the Management Committee.

Proposed Appendix N Decision comprise matters such as revisions to:

(i) Integrated Baseline, Budget, Schedule and Cash Flow
(ii) Risk Management
(iii) Procurement Plan
(iv) Tower Evaluation Studies
(v) Conductor Design
(vi) Construction Specification
(vii) Major Equipment Specifications
(viii) Commissioning

Section 7.6 Approval obliges the Construction Manager not to proceed with making any material decision in respect of the matters identified in Appendix O – Proposed Appendix O Decision. Proposed Appendix O Decision matters comprise:

(i) Insulator Type Selection
(ii) Tower Testing
(iii) Sub-Synchronous Resonance Screening
(iv) Structure Design
(v) Control and Relay Schematics
(vi) Emergency Response Plan

The Construction Manager shall provide the Management Committee with a written outline and supporting basis for each Proposed Appendix O Decision. If the Management Committee does not approve the Proposed Appendix O Decision, 6690271 has the right to provide the Construction Manager with written revisions to the Proposed Appendix O Decision for the Construction Manager's consideration ("Appendix O Revisions"). The Construction Manager has the right to again seek approval from the Management Committee of the Proposed Appendix O Decision with or without incorporating the Appendix O Revisions. If not approved by the Management Committee, then the dispute resolution process set out in Section 18.1.2.1 shall resolve the dispute.

Section 7.8 Contract Administration addresses the contract administration duties of the Construction Manager. It is worth noting that the Construction Manager shall not enter into any Major Change Order or take any Material Action until the Management Committee has voted to approve same; sections 7.8.4 (i) and 7.8.4 (ii) refers.

Section 7.15.1.1 Construction Manager Rights and Obligations allows the Construction Manager to adjust, defend and settle insured claims against a Participant, so long as such is within the policy limits provided by any of the applicable insurance policies maintained in accordance with the Project Insurance. The Construction Manager needs the approval of the Management Committee to settle claims above the policy limits.

Section 7.15.2.5 permits the Construction Manager to settle any individual uninsured claim up to [redacted] and to release any Third Party from liability or potential liability up to a limit of [redacted] 1d

Conclusions & Recommendations

Article 7 Description of Construction Management Duties provides a comprehensive scope of the Construction Manager's duties together with appropriate protective approval mechanisms to protect 6690271's interests.

Source of Information & Reference Materials

- Great Northern Transmission Line Construction Management Agreement dated April 12, 2016

Finding No. 8: GNTL - Financial Accounts; Reporting; Independent Oversight (Article 8)

Observations & Findings

Article 8 generally describes the Construction Manager's duties with respect to the preparation and contents of progress and financial accounts and reports. The reports include Progress Reports, Financial Reports, Year-end Financial Reports and Final Completion Reports

Section 8.5 Independent Oversight Engineer provides for the Management Committee to retain an engineering consulting firm to provide objective and independent oversight of the Construction Work and the Construction Manager's performance of the Services. All information and reports provided by the Independent Oversight Engineer may be used by any Participant in furtherance of exercising its rights under the Construction Management Agreement and in resolving any dispute pursuant to Article 18 Dispute Resolution.

The Independent Oversight Engineer, inter alia, will:

(i) Review Funding Requests, Change Orders, Contract Amendments and associated documentation
(ii) Inspect and determine whether Construction Work has been properly performed
(iii) Monitor the obligations of the Construction Manager
(iv) Conduct monthly review of the design, procurement and construction
(v) Verify Project Completion

Conclusions & Recommendations

Article 8 Financial Reports; Reporting; Independent Oversight meets acceptable commercial business practice. The Article provides for comprehensive reporting and the appointment of the Independent Oversight Engineer provides additional protection to the interests of 6690271.

Source of Information & Reference Materials

- Great Northern Transmission Line Construction Management Agreement dated April 12, 2016

Finding No. 9: GNTL - Participant's Rights, Duties and Obligations (Article 9)

Observations & Findings

Article 9.1 Participants Act Through Management Committee provides that oversight and management of matters that arise under the Construction Management Agreement will be determined by the Management Committee. The Management Committee has the authority to direct the means, manner and methodology used by:

(i) The Construction Manager to carry out the Services; or
(ii) Any Contractor to carry out Construction Work in accordance with the express provisions of the Construction Management Agreement (Section 9.1.1 refers)

Section 9.1.3 sets out the Management Committee composition with Section 9.1.4 addressing meetings, notice of meetings and associated governance. Section 9.1.4.2 addresses the quorum for a Management Committee meeting. Section 9.1.4.3 provides for each Participant having a representative on the Management Committee and each representative having one vote. Section 9.1.4.4 requires the unanimous affirmative vote of all representatives of the Management Committee, which in effect give 6690271 a veto. Section 9.10 permits the Management Committee to suspend, delay or interrupt Construction Work and Section 9.12 allows each Participant to audit or inspect the Records of the Construction Manager.

Conclusions & Recommendations

Article 9 Participant's Rights, Duties and Obligations provides appropriate mechanisms for oversight and management of the Construction Management Agreement. The requirement for all decisions to be by unanimous affirmative vote provides 6690271 with a right to veto those matters with which it disagrees or would not support.

Source of Information & Reference Materials

- Great Northern Transmission Line Construction Management Agreement dated April 12, 2016

Finding No. 10: GNTL - Representations and Warranties (Article 10)

Observations & Findings

Article 10 generally sets out the particular representations and warranties of the Participants and the Construction Manager.

Section 10.1 sets out the Construction Manager's representations and warranties, which representations and warranties survive the execution and delivery of the Construction Management Agreement. Section 10.2 provides the same for the Participants, on a several, not joint basis.

Conclusions & Recommendations

Article 10 Representations and Warranties meets acceptable commercial business practice.

Source of Information & Reference Materials

- Great Northern Transmission Line Construction Management Agreement dated April 12, 2016

Finding No. 11: GNTL - Completion and Acceptance of Work (Article 11)

Observations & Findings

Article 11 addresses the terms governing the commissioning, completion and acceptance of the Project. Section 11.1.1 states that the Construction Manager makes no performance guarantees nor guarantees the successful commissioning of the Project, with Section 11.1.2 addressing the procedure and requirements regarding the Initial Notice of Commissioning. Section 11.1.3 obliges the Management Committee to advise the Construction Manager of any inadequacy, inaccuracy or otherwise unacceptable information or result set forth in a Notice of Commissioning and specifies the Construction Manager's responsibility to correct such deficiency.

Section 11.2 sets out the process for the Construction Manager to advise the Management Committee that Substantial Completion has been achieved and Section 11.4 addresses the process for achieving Final Completion. In both cases the Management Committee has the authority to vote to approve or reject such Notices.

Conclusions & Recommendations

Article 11 Completion and Acceptance of Work meets acceptable commercial business practice.

Source of Information & Reference Materials

- Great Northern Transmission Line Construction Management Agreement dated April 12, 2016

Finding No. 12: GNTL - Construction Work Warranties (Article 12)

Observations & Findings

Article 12 Construction Work Warranties addresses the warranty requirements for Contractors engaged on the Project, addressing matters such as the scope, duration and enforcement of warranties.

Section 12.1 provides for the Construction Manager to make commercially reasonable efforts to obtain warranties from Contractors with respect to the performance of the Construction Work. The Construction Manager shall also make commercially reasonable efforts to procure from each Contractor pursuant to its respective Project Construction Contract, an undertaking from the Contractor to procure from all its Subcontractors, warranties with respect to any Materials, Equipment or services provided by each such Subcontractor. Such Subcontractor warranties shall be enforceable by, or be assignable to, the Participants (Section 12.1.3 refers).

Conclusions & Recommendations

Article 12 Construction Work Warranties provides appropriate mechanisms to obtain for the benefit of the Participants warranties from Construction Contractor and their Subcontractors.

Source of Information & Reference Materials

- Great Northern Transmission Line Construction Management Agreement dated April 12, 2016

Finding No. 13: GNTL - Indemnification (Article 13)

Observations & Findings

Article 13 addresses Third Party Indemnification and Environmental Indemnity by Discrete Substation Owners and USI Owners. Section 13.1.1 provides that each Participant shall severally to the extent of its ownership indemnify the Construction Manager from Third Party claims, except to the extent such claims arise from an act or omission of the Construction Manager for which the Participants are indemnified under Section 13.1.2 or for which there is contributory negligence under Section 13.1.3. Sections 13.3 and 13.4 address Insurer Obligations and Indemnification Costs respectively.

Conclusions & Recommendations

Article 13 Indemnification Representations and Warranties meets acceptable commercial business practice.

Source of Information & Reference Materials

- Great Northern Transmission Line Construction Management Agreement dated April 12, 2016

Finding No. 14: GNTL - Confidentiality Provisions (Article 14)

Observations & Findings

Article 14 sets out the confidentiality obligations of the Parties defining matter such as Confidential Information, required disclosure, public disclosure, inadequate remedy at law issues and additional regulatory requirements.

Conclusions & Recommendations

Article 14 Confidentiality Provisions meets acceptable commercial business practice.

Source of Information & Reference Materials

- Great Northern Transmission Line Construction Management Agreement dated April 12, 2016

Finding No. 15: GNTL - Breach, Cure and Default (Article 15)

Observations & Findings

Article 15 sets out the provisions relating to Breach, Cure and Default addressing matters such as Events of Breach, Notice of Breach, Cure, Default and Default Rights. The Participants further agree in this Article that the dispute resolution provisions set forth in Article 18 are and shall be the sole and exclusive remedy of the Participants for the resolution of all disputes, claims or controversies arising under this Agreement.

Conclusions & Recommendations

Article 15 Breach, Cure and Default meets acceptable commercial business practice.

Source of Information & Reference Materials

- Great Northern Transmission Line Construction Management Agreement dated April 12, 2016

Finding No. 16: GNTL - Term and Termination of Agreement (Article 16)

Observations & Findings

Article 16 generally addresses the:

(i) Effective Time
(ii) Term
(iii) Termination by Participants
(iv) Termination by the Construction Manager; and
(v) the Effect of Termination.

Section 16.2.1.2 provides the right by Participants to terminate the Construction Management Agreement for convenience and for the Management Committee to terminate for cause as per Section 16.2.1.3, if the Construction Manager has:

1. Committed an act of material fraud
2. Failed to follow any material policy or directive of the Management Committee
3. Abandoned or suspended performance of the services for at least thirty (30) consecutive days
4. Assigned its rights or obligations without the prior written consent of the Management Committee
5. Failed or refused to perform any obligations under the Construction Management Agreement
6. Failed or refused to comply with any Applicable Law
7. Breached a Major Contract as a result of intentional misconduct or wilful misconduct
8. Experienced an Insolvency Event
9. Committed a breach of fiduciary duty when acting as an agent under the Construction Management Agreement.

The Construction Manager has the opportunity to cure in accordance with Section 16.2.1.3.1 failing which the Process for Termination in Section 16.2.1.3.4 is followed.

The Construction Manager may terminate the Construction Management Agreement for Good Reason in accordance with Section 16.2.1.4 where Good Reason means:

- Failure of 6690271 to make the required payments
- Failure or refusal of 6690271 to perform any other obligation under the Construction Management Agreement

and 6690271 fails or refuses to cure such default within the proscribed period. Section 16.2.3 Effect of Termination addresses matters such as Duties upon Termination, Property Rights, winding up the Services and Construction Work together with any payment obligations to Contractors and Third Parties.

Conclusions & Recommendations

Article 16 Term and Termination of Agreement meets acceptable commercial business practice.

Source of Information & Reference Materials

- Great Northern Transmission Line Construction Management Agreement dated April 12, 2016

Finding No. 17: GNTL - Limitations of Liability (Article 17)

Observations & Findings

Section 17.1 provides that no party under the Construction Management Agreement shall be liable to the other party for any "special, incidental, consequential, indirect, exemplary, treble or punitive Damages or any other penalty, with the exception of Third Party claims set out in Section 13.1.

In accordance with Section 17.2 the Construction Manager shall not be liable for Damages to the Participants, except for Damages arising from:

- Construction Manager's fraud; or
- Construction Manager's gross negligence, intentional misconduct or wilful misconduct

with the exception of the Construction Manager's liability for Third Party claims that are indemnified pursuant to Section 13.1.2

Conclusions & Recommendations

Article 17 Limitations of Liability Term meets acceptable commercial business practice.

Source of Information & Reference Materials

- Great Northern Transmission Line Construction Management Agreement dated April 12, 2016

Finding No. 18: GNTL - Dispute Resolution (Article 18)

Observations & Findings

Subject to the provisions of Articles 16 and 17 of the Construction Management Agreement, Article 18 sets out the dispute resolution provisions that govern all disputes, claims and controversies arising out of the Construction Management Agreement. Section 18.1.1 addresses disputes between the Participants and Section 18.1.2 between the Construction Manager and the Participants.

Appendix Q: Dispute Resolution Procedures sets out the procedures for resolution for all disputes arising under the Construction Management Agreement. The procedure is comprehensive, addressing:

1. Notification to all Parties of a Dispute
2. Resolution of the Dispute by each Participant assigning an executive for the purpose of resolving such dispute or controversy within ten (10) Business Days following the commencement of discussions to resolve such Dispute.
3. If the Dispute remains unresolved then the disputing Participant may initiate non-binding mediation. Section 2.2 Non-Binding Mediation addresses the selection of the mediator, location in Minneapolis-St. Paul, MN, the governing rules and how the mediation shall be terminated.
4. Disputes not resolved by either the executives of the Participants or pursuant to Non-Binding Mediation shall be finally settled under the Regular Track Procedures of the Construction Industry Arbitration Rules of the American Arbitration Association by three (3) arbitrators appointed in accordance with the Arbitration Rules.
5. The proceedings comprised of all documents and testimony including depositions and expert reports shall be confidential.
6. Both Participants have the right to seek immediate injunctive and other equitable relief through the courts in the event of any material breach of the Construction Management Agreement by the other Party that would cause the non-breaching party irreparable injury for which there would be no adequate remedy at law.

Conclusions & Recommendations

Article 18 Dispute Resolution meets acceptable commercial business practice.

Source of Information & Reference Materials

- Great Northern Transmission Line Construction Management Agreement dated April 12, 2016

Finding No. 19: GNTL - Notices (Article 19)

Observations & Findings

Article 19 Notices contains the Notice provisions for the Construction Management Agreement.

Conclusions & Recommendations

Article 19 Notices meets acceptable commercial business practice.

Source of Information & Reference Materials

- Great Northern Transmission Line Construction Management Agreement dated April 12, 2016

Finding No. 20: GNTL - Miscellaneous Provisions (Article 20)

Observations & Findings

Article 20 Miscellaneous Provisions contains the usual miscellaneous provisions found in a contract for example, ‘binding obligations’, ‘amendment and waiver’, ‘severability’, ‘survival’, ‘execution in counterparts’, ‘force majeure’, ‘governing law’ and ‘venue’.

Conclusions & Recommendations

Article 20 Miscellaneous Provisions meets acceptable commercial business practice.

Source of Information & Reference Materials

- Great Northern Transmission Line Construction Management Agreement dated April 12, 2016

SCOPE ITEM 28:

Assess the current forecast at completion capital cost for reasonableness, including whether appropriate contingencies and reserves have been provisioned.

Finding No. 1: GNTL - Estimate Review -- Forecast at Completion (FAC)

Observations & Findings

In May 2016, Minnesota Power submitted an updated estimate for the GNTL Project. Since the 2013 USD$677 million cost estimate, project costs have [redacted]

The variance noted between the estimate total and the total approved budget is [redacted]

The table below summarizes the project costs. The transmission line scope of work represents 89% of the overall approved budget of [redacted] The supporting back-up provided to MGF for review is the 2016 Cost Estimate totalling [redacted] prepared by Minnesota Power. 1d

MGF's findings within this review are based upon the 2016 Cost Estimate provided. The noted variance between the cost estimate and the approved budget is a [redacted]

A cost estimate review was addressed in "Scope Item 26", reviewing many of the cost elements included in the transmission line scope of work. It was noted in this review that costs are considered to be at the high range as compared to other similar projects.

Scope of Work	MP (2013 USD) Cost Estimate	MP (2016 USD) Cost Estimate	Variance (USD) Cost Estimate	Approved Budget (USD) (June 2017 Mo. Rpt)	Variance (USD) Est. vs. Budget	Project %
GNTL 500kV Transmission Line	**$579,685,986.81**	[redacted]				**89%**
Iron Range 500kV Substation	$42,994,380.00					7%
Warroad River Series Compensation Station	$49,258,220.00					3%
Existing 230kV Transmission System Modifications – 230 kV Line Portion	$3,891,710.90					1%
Substation Upgrades – Blackberry	$275,000.00					0%
Substation Upgrades – Arrowhead	$137,500.00					0%
Substation Upgrades – Forbes	$137,500.00					0%
Substation Upgrades – Hilltop	$137,500.00					0%
Required Network Upgrades	$430,000.00					0%
Project Total Cost	**$676,947,798**					**00%**

1d

Note: Values above, include Contingency (No Contingency Incl. for Network Upgrades) and Capitalized Property Taxes ($44.2 million)

MGF's reference for the "Approved Budget" was taken from Minnesota Power's "Monthly Progress Report (June 2017)".

The following elements have been carried as Contingency in the sum of [redacted] of the base cost.

- Landowner Payment Contingency - [redacted]
- Engineering and Program Management, Construction Phase Contingency - [redacted]
- Construction Phase Contingency - [redacted]
- 500kV Line - [redacted]
- Iron Range 500kV Substation, Construction Phase Contingency - [redacted]
- Iron Range 500kV Substation - [redacted]
- Warroad River Series Compensation Station, Construction Phase Contingency - [redacted]
- Warroad River Series Compensation Station - [redacted]
- Existing 230kV Transmission System Modifications, Construction Phase Contingency - [redacted]
- Existing 230kV Transmission System Modifications - [redacted]
- 230 kV Substation Upgrades - [redacted]

1d

Minnesota Power's cost estimating methodology is consistent with the industry standard for the class of estimate and for the estimate's intended purpose. The level of project definition is considered reasonable to develop quantities and unit prices.

MGF considers that the cost estimate prepared is comparable to a Class 4 estimate, as per AACE standards and based on the level of scope definition and estimate methodology used in developing the estimate.

A "COST ASSUMPTIONS" summary was provided; however, a detailed Basis of Estimate was not.

Expected items to be included would consist of the following:

- Purpose
- Project Scope Definition
- Methodology
- Estimate Classification
- Design Basis
- Planning Basis
- Cost Basis
- Allowances
- Reconciliation
- Benchmarking
- Estimate Quality Assurance

- Estimating Team
- Attachments
- Estimate Deliverable Checklists
- Reference Documents
- Exclusions
- Exceptions
- Risks and Opportunities
- Containments
- Contingencies
- Management Reserve

Based on USD/mile metrics for the project, GNTL ([redacted] is significantly higher than those project metrics seen for past projects (USD$2.47 million) and compared to MMTP (USD$1.86 million). 1d

Conclusions & Recommendations

The Contingency is reasonable for this project, but would point out that the overall project cost is considered high when compared with other similar projects.

MGF recommends that an updated estimate, which has been supported through additional technical and commercial deliverables, as well as market underpinning (i.e. quotations or even awarded contracts) be developed and reviewed as soon as possible. This will ensure a higher level of confidence.

MGF also recommends that regardless of which stage the cost estimates are produced, that a Basis of Estimate is produced.

It was noted that Manitoba Hydro's Transmission Projects Department (TPD) has collaborated with internal Manitoba Hydro subject matter experts to conduct a review of the "Pre-Construction Estimate Project Budget and Basis of Estimate" provided by Minnesota Power. This is good practice, and it was also noted that the transmission line approved budget has been reduced, but the overall project total remains unchanged.

This would further reinforce MGF's view that continued oversight should be maintained.

Source of Information & Reference Materials

- Great Northern Transmission Line Project Scope Document – Revision 1
- AACE International Recommended Practice No. 34R-05, BASIS OF ESTIMATE, TCM Framework: 7.3 – Costs Estimating and Budgeting.

SCOPE ITEM 29:

Assess Minnesota Power's approach to establishing the contingency for GNTL and whether appropriate risk areas and magnitudes of uncertainty are recognized.

Finding No. 1: GNTL - Iron Range 500/320kV Sub − MTEP 3831 Schedule

Observations & Findings

The GNTL 107621 – Iron Range 500/230kV Sub-MTEP 3831 schedule has a start date of 1st December 2015 and a completion date of 2nd February 2021. The project is currently in progress with a status date of 31st October 2017. It has 353 normal activities of which 77 are complete, 31 are in progress and 245 are still planned. It contains 188 milestones, 4 summaries and 0 LOE (Level of effort) activities.

Acumen Fuse is a software application which uses metrics to identify problematic areas and activities in a project schedule. It has hundreds of industry metric libraries including DCMA 14-Point Assessment, the US Government Accountability Office's (GAO) Scheduling Best Practices and the US National Defence Industrial Association's (NDIA) Generally Accepted Scheduling Practices (GASP). The Acumen Fuse analysis produced the following:

- Fuse Schedule Index: Is a single quality indicator resulting from a summary of detailed analysis. The GNTL 107621 Iron Range 500/230kV Sub-MTEP 3831 schedule scored 81, giving it an 84% probability of success
- Schedule Quality: Scored 81% versus a score of 75% or better which is considered a 'good' schedule
- High duration: Is the total number of activities that have a duration longer than 2 months. High duration activities are generally an indication that a plan is too high level for adequate planning and controls. The number of high duration activities should not exceed 5% and this schedule scored 32%. Four of the activities identified with high durations are the summary activities of Engineering, Procurement, Construction and Project Closeout. These activities are planning packages which should be broken down into more detail as the project proceeds and more details become available

Conclusions & Recommendations

With a Fuse score of 81, we consider this to be a "good" schedule. The schedule will be improved when the summary activities of Engineering, Procurement, Construction and Project Closeout can be broken down in to more detail as the project proceeds and these details become available.

Source of Information & Reference Materials

- GNTL Program Master Schedule DD 10.31.17.xer

Finding No. 2: GNTL - 500kV MTEP 3831 Schedule

Observations & Findings

The GNTL 105471 500kV Transmission Line MTEP 3831 schedule has a start date of 1st October 2011 and a completion date of 2nd February 2021. The project is currently in progress with a status date of 16th September 2017. It has 868 normal activities of which 277 are complete, 114 are in progress and 477 are still planned. It contains 249 milestones, 6 summaries and 21 LOE (Level of effort) activities.

Acumen Fuse is a software application which uses metrics to identify problematic areas and activities in a project schedule. It has hundreds of industry metric libraries including DCMA 14-Point Assessment, the US Government Accountability Office's (GAO) Scheduling Best Practices and the US National Defence Industrial Association's (NDIA) Generally Accepted Scheduling Practices (GASP). The Acumen Fuse analysis produced the following:

- Fuse Schedule Index: Is a single quality indicator resulting from a summary of detailed analysis. The GNTL 105471 500kV Transmission Line MTEP 3831 schedule scored 60, giving it a 55% probability of success
- Schedule Quality: Scored 60% versus a score of 75% or better which is considered a 'good' schedule
- High Float: is the number of activities with total float greater than 2 months and this should not exceed 5%. This schedule scored 51% which indicates that schedule paths have artificially constrained activities. Schedule paths with float of more than two months should be considered for acceleration and schedule optimization
- High duration: is the total number of activities that have a duration longer than 2 months. High duration activities are generally an indication that a plan is too high level for adequate planning and controls. The number of high duration activities should not exceed 5% and this schedule scored 44%. Four of the activities identified with High Duration are summary activities, namely Engineering, Procurement, Construction and Project Closeout

Conclusions & Recommendations

With a Fuse score of 60%, we consider this to be a "medium quality" schedule. We recommend that all logic issues should be corrected to improve the quality and reliability of the schedule and that activities with high duration should be reviewed and broken down into more detail as the information becomes available.

Source of Information & Reference Materials

- 105471 – GNTL 500kV Transmission Line MTEP 3831 - GNTL Program Master Schedule DD 10.31.17.xer

Finding No. 3: GNTL - 107626 Blackberry Sub Mods MTEP 3831

Observations & Findings

The 107626 Blackberry Sub Mods MTEP 3831 schedule has a start date of 3rd September 2019 and has 25th January 2021 as the completion date. The project is currently planned with a status date of 16th September 2017. It has 14 planned activities and contains 3 milestones, 4 summaries and no LOEs (Level of Effort).

Acumen Fuse is a software application which uses metrics to identify problematic areas and activities in a project schedule. It has hundreds of industry metric libraries including DCMA 14-Point Assessment, US Government Accountability Office's (GAO) Scheduling Best Practices and the US National Defence Industrial Association's (NDIA) Generally Accepted Scheduling Practices (GASP). The Acumen Fuse analysis produced the following:

- Fuse Schedule Index: Is a single quality indicator resulting from a summary of the detailed analysis. The 107626 Blackberry Sub Mods MTEP 3831 schedule scored 67, giving it a 65% probability of success.
- Schedule Quality: Scored 67% versus a score of 75% or better which is a considered a "good" schedule.
- Missing Logic: Is the total number of activities that are missing a predecessor, a successor, or both. This number should not exceed 5% and 12% of the activities on this schedule are missing logic. Missing logic impacts the quality of results derived from a time and risk analysis.
- High Duration: Is the total number of activities that have a duration longer than 2 months. High duration activities are generally an indication that a plan is too high level for adequate planning and controls. The number of high duration activities should not exceed 5% and this schedule scored 18%. This project is still in the planning phase. Activities should be broken down into more as the planning phase proceeds.

Conclusions & Recommendations

With a Fuse score of 67, we consider this to be a "medium quality" schedule. We recommend that all logic issues should be corrected to improve the quality and reliability of the schedule and that activities with high duration should be reviewed and broken down into more detail as the information becomes available.

Source of Information & Reference Materials

- GNTL Program Master Schedule DD 10.31.17

Finding No. 4: GNTL - 107625 230kV Line Mods MTEP 3831

Observations & Findings

The GNTL 107625 230kV Line Mods MTEP 3831 schedule has a start date of 2nd January 2019 and has 15th January 2020 as the completion date. The project is currently planned with a status date of 1st January 2019. It has 15 normal activities of which 0 are complete, 0 are in progress and 15 are still planned. It contains 3 milestones, 4 summaries and no LOEs (Level of Effort).

Acumen Fuse is a software application which uses metrics to identify problematic areas and activities in a project schedule. It has hundreds of industry metric libraries including DCMA 14-Point Assessment, US Government Accountability Office's (GAO) Scheduling Best Practices and the US National Defence Industrial Association's (NDIA) Generally Accepted Scheduling Practices (GASP). The Acumen Fuse analysis produced the following:

- Fuse Schedule Index: Is a single quality indicator resulting from a summary of the detailed analysis. The GNTL 107625 230kV Line Mods MTEP 3831 schedule scored 55, giving it a 48% probability of success.
- Schedule Quality: Scored 55% versus a score of 75% or better which is a considered a "good" schedule.
- Missing Logic: Is the total number of activities that are missing a predecessor, a successor, or both. This number should not exceed 5%. On this schedule, 17% of the activities are missing logic which impacts the quality and reliability of the schedule.
- High Duration: Is the total number of activities that have a duration longer than 2 months. High duration activities are generally an indication that a plan is too high level for adequate planning and controls. The number of high duration activities should not exceed 5% and this schedule scored 39%. This project is still in the planning phase. Activities should be broken down into more as the planning phase proceeds.

Conclusions & Recommendations

With a Fuse score of 55, we consider this to be a "medium quality" schedule. We recommend that all logic issues should be corrected to improve the quality and reliability of the schedule and that activities with high duration should be reviewed and broken down into more detail as the information becomes available.

Source of Information & Reference Materials

- GNTL Program Master Schedule DD 10.31.17

Finding No. 5: GNTL - 107623 500kV Series Comp − MTEP 3831 Schedule

Observations & Findings

The GNTL 107623 – 500kV Series Comp-MTEP 3831 schedule has a start date of 1st December 2015 and a completion date of 2nd February 2021. The project is currently in progress with a status date of 31st October 2017. It has 71 normal activities of which 5 are complete, 14 are in progress and 52 are still planned. It contains 22 milestones, 3 summaries and zero LOE (Level of effort) activities. The project baseline start date was 18th February 2013 with the baseline finish date of 29th May 2020. The project is currently behind schedule by 154 days.

Acumen Fuse is a software application which uses metrics to identify problematic areas and activities in a project schedule. It has hundreds of industry metric libraries including DCMA 14-Point Assessment, the US Government Accountability Office's (GAO) Scheduling Best Practices and the US National Defence Industrial Association's (NDIA) Generally Accepted Scheduling Practices (GASP). The Acumen Fuse analysis produced the following:

- Fuse Schedule Index: Is a single quality indicator resulting from a summary of detailed analysis. The schedule scored 69, giving it a 68% probability of success.
- Schedule Quality: Scored 69% versus a score of 75% or better which is considered a 'good' schedule.
- Insufficient Detail: measures the number of activities that have a duration longer than 10% of the total duration of the project. This number should not exceed 5% and this schedule scored 28%. Activities with a high duration relative to the duration of the project are generally an indication that a plan is too high level for adequate planning and controls. In this schedule, these activities are used to define effort that does not directly generate a deliverable. These activities are cost loaded and will expand and contract with the critical path. These activities are currently set as Task Dependent activities but should be set as LOE activities. With these activities set as Task Dependent activities, there is the potential for these activities to incorrectly drive the critical path.
- High float: Schedule paths with high amounts of float typically arise due to artificially constrained activities. The metric identifies activities with total float greater than 2 months and should not exceed 5%. This schedule scored 37%. Paths with float more than 2 months should be considered for acceleration and schedule optimization.
- High duration: identifies the total number of activities that have a duration longer than 2 months. This number should not exceed 5% and this schedule scored 32%. High duration activities are generally an indication that a plan is too high for adequate planning and control. Three of the activities identified with high duration are summary activities i.e. Engineering, Procurement and Construction. These are planning packages which should be broken down into more detail as the project proceeds and more details are available.

Conclusions & Recommendations

With a Fuse score of 69%, this is a medium quality schedule. We would recommend changing the activities currently set as Task Dependent to Level of Effort activities to improve the overall quality of the schedule.

Source of Information & Reference Materials

- GNTL Master Schedule DD 10.31.17

Finding No. 6: GNTL - 107627 - Arrowhead Sub Mods, 107628 Forbes Sub Mods, 107629 − Hilltop Sub Mods

Observations & Findings

The 107627 - Arrowhead Sub Mods, 107628 Forbes Sub Mods and 107629 - Hilltop Sub Mods schedules each have a start date of 3rd September 2019 and have 17th December 2019 as the completion date. These projects are currently planned with a status date of 16th September 2017. Each schedule has 11 planned activities and contain 3 milestones, 4 summaries and no LOEs (Level of Effort).

Acumen Fuse is a software application which uses metrics to identify problematic areas and activities in a project schedule. It has hundreds of industry metric libraries including DCMA 14-Point Assessment, US Government Accountability Office's (GAO) Scheduling Best Practices and the US National Defence Industrial Association's (NDIA) Generally Accepted Scheduling Practices (GASP). The Acumen Fuse analysis produced the following:

- Fuse Schedule Index: Is a single quality indicator resulting from a summary of the detailed analysis. The 107627 - Arrowhead Sub Mods, 107628 Forbes Sub Mods, 107629 - Hilltop Sub Mods schedules each scored 61, giving them a 57% probability of success.
- Schedule Quality: Each schedule scored 61% versus a score of 75% or better which is a considered a "good" schedule.
- Missing Logic: Is the total number of activities that are missing a predecessor, a successor, or both. This number should not exceed 5%. On these schedules, 14% of the activities are missing logic which impacts the quality and reliability of these schedules.
- High Duration: Is the total number of activities that have a duration longer than 2 months. High duration activities are generally an indication that a plan is too high level for adequate planning and controls. The number of high duration activities should not exceed 5% and these schedules scored 14%. These projects are still in the planning phase. Activities should be broken down into more as the planning phase proceeds.

Conclusions & Recommendations

With a Fuse score of 61, we consider these schedules to be "medium quality" schedules. We recommend that all logic issues should be corrected to improve the quality and reliability of each schedule and that activities with high duration should be reviewed and broken down into more detail as the information becomes available.

Source of Information & Reference Materials

- GNTL Program Master Schedule DD 10.31.17

Finding No. 7: GNTL - Baseline Schedules

Observations & Findings

For the GNTL project, there is only one Primavera P6 file for each schedule. Three of these schedules have progress (17623 – 500kV Series Comp-MTEP 3831, 107621 – Iron Range 500/230kV Sub-MTEP 3831, and 500kV Transmission Line MTEP 3831). The project team indicated the baseline schedule will reflect actual commencement dates for activities. This practice violates the Manitoba Hydro's Schedule Change Management process (CSS-010) which specifies the baseline schedule "freezes the original plan at the completion of initial planning … Should not be changed to match performance". This process (CSS-010) aligns with the Project Management Institute's (PMI) definition of a baseline as "the approved version of work product that can be changed using formal change control procedures and is used as the basis for comparison to actual results". .

Conclusions & Recommendations

Baseline schedules reflect the planned schedule progress. In Earned Value Management (EVM), the baseline schedule is compared to the Forecast schedule to determine the value of the work "earned". Without a baseline, the Earned Value cannot be determined.

Source of Information & Reference Materials

- Project Management Institute Practice Standard for Scheduling
- Project Management Institute Practice Standard for Earned Value Management
- Manitoba Hydro CSS-010 - Schedule Change Management
- GNTL Re-Baseline 10.31.17.xer
- GNTL Re-Baseline 09.16.2017.xer
- E-mail from GNTL Project Team

Finding No. 8: GNTL - Establishing Contingency and Risk Areas

Observations & Findings

The current GNTL Risk Management Plan (RMP) describes the scope, roles and owners risk, management approach risk, risk identification, risk assessment and prioritization, risk monitoring, risk response strategies, risk register, active risks and contingency management.

While reviewing the Risk Register it was noted that the cost estimate was dated 26th May 2016, while the Risk Register was dated 21st June 2017.

In addition, the register has a total of 17 Risk events identified as "High" cost impact amounting to $118 million with Risk item 5 amounting to $100 million.

Risk item 5

Risk Trigger or Cause – "Change in Program parameters, quantities more or less than estimated, unanticipated escalation, additional information"

Risk event or effect – "Budget component cost may be higher than estimated"

Impact – High

Cost Impact of Risk - $100 million

Response Plan - "Review assumptions made in preparing budget; regular monitoring of estimate and program information, fuel adjustment clause in construction contract. Review estimate and quantities after completion of Seg 2 access, clearing and geotech."

Mitigation Action Completed – "Estimate and assumptions were updated in May 2016. Update estimate toward the end of 2017 as bid pricing is received."

Conclusions & Recommendations

The Risk Register was established after the [redacted] pre-construction budget was estimated. Currently, there is no correlation between the Risk Register and Contingency amount. 1d

MGF strongly agrees with the plan to update the estimate at the end of 2017. A risk analysis work session is also suggested with the project team to develop inputs that support cost and schedule contingency development.

MGF considers the that risk mitigation costs to eliminate the "high" risk items should be included within the estimate (e.g. paying premium to have final design completed for the towers to eliminate delays in procurement and ultimately the project).

Source of Information & Reference Materials

- GNTL PGM_Risk Register for 7-12-17 Qtrly Review
- CMA Pre-Const - GNTL Risk Management Plan (Approved)
- Great Northern Transmission Line Project Scope Document – Revision 1

SECTION 8 - Conclusion

This section summarizes the conclusions we have drawn for the various projects reviewed as part of MGF's review of Manitoba Hydro's Capital Expenditures Program. In summary:

- the Keeyask Hydroelectric Dam poses the biggest threat to the Capital Expenditures Program
- the HVDC Converter Stations and Bipole III Transmission Line is nearing the finish line and Manitoba Hydro is aware of the remaining risks and working to mitigate these
- MMTP and GNTL are well organized and being set up for success.

We would provide the following specific conclusions on the specific projects as follows:

Keeyask Hydroelectric Dam

The cost reimbursable compensation mechanism in the General Civil Contract (GCC) is not typical for this kind of project. Rather than linking the compensation of the contractor to the quantity of work performed in accordance with contracted quality and time for completion obligations, the GCC contractor gets paid its actual costs irrespective of the quantity of work performed, the quality or the time it is takes to perform the work.

This cost reimbursable pricing mechanism has placed the following risks on Manitoba Hydro:

- Labour costs
- Labour availability
- Material costs
- Material performance
- Escalation
- Productivity
- Final contract costs
- Contractor's re-work
- Indirect costs
- Schedule
- Time and cost impacts due to GCC contractor

and as such, introduces significant unpredictability to the outcome of the GCC contract, in particular with an under-performing GCC contractor. The reality is that whilst Manitoba Hydro is accountable for the risks above, it is the GCC contractor who is leading and managing the activities that will trigger these risks.

The GCC contractor over promised in its tender, failed to perform the Original Contract and following the Amending Agreement No. 7 dated 28th February 2017, is continuing to miss the revised productivities for concreting and earthwork, which is of high concern given the following:

- There are four more years of this contract to go
- Concreting activities are becoming more complex with productivity likely to deteriorate
- Large earthwork scope still to be performed

The GCC contractor is behaving like a contractor engaged on a cost reimbursable contract where they have no risk. Selected data points are:

- Repeated failure to achieve agreed upon productivities
- 1,030 negative float activities in its schedule, of which 97 are on the critical path, when the Contract demands that the GCC contractor's schedule should not contain any negative float activities.
- Working without an approved basis of schedule
- Monthly progress reports repeatedly submitted 7 days late
- Inconsistent and inaccurate reporting

Unless and until Manitoba Hydro adopts a hands-on role of construction manager for the GCC, the time for completion of this contract, and the Keeyask Generating Station project generally, will take longer. As the GCC takes longer to perform, the GCC contractor's direct costs, indirect costs and escalation costs will continue to rise. The delay in completion of this contract will cause delay and disruption claims from other contractors, which Manitoba Hydro will have to pay.

If Manitoba Hydro is to regain control of this Contract, then it needs to directly exert its influence on the GCC contractor. To do this the following areas will need to be addressed:

- Construction management
- Site supervision
- Recovery plan
- GCC Contractor's role
- Cost control
- Schedule management
- Cost estimating and forecasting

Construction Management:

Manitoba Hydro needs to be proactive in the construction management of the GCC. This scope requires better planning and execution. It is likely that Manitoba Hydro will need to recruit key personnel for this activity.

Site supervision:

Manpower, productivity and co-ordination are critical success factors particularly on a cost reimbursable priced contract. If not done correctly, productivity goals are not met and higher costs are incurred for less output. It is likely that Manitoba Hydro will need to recruit key personnel with trade backgrounds for this activity.

Recovery plan:

The current plan is not working and appears to be continuously changed when progress is not met. This needs to be re-visited with better construction management and site supervision insight and planned with a labour force and productivities that are reasonably achievable.

GCC Contractor's role:

The GCC contractor has not performed and its role together with some key personnel will need to re-considered.

Schedule management:

The recovery plan with realistic targets and achievable productivity assumptions will need to be input in to a Contract Schedule that meets the requirements of the GCC contract.

Cost estimating, forecasting and cost control:

The Contract Schedule will need to be cost loaded so that activities are characterized by time and costs.

Unless Manitoba Hydro is prepared to make a step change in the management of the GCC contract, then it will continue to limp along, taking longer to perform and costing Manitoba Hydro more money. This could result in a final cost range of $9.5 billion to 10.5 billion.

If Manitoba Hydro is prepared to embrace a new contract management strategy to drive the GCC contractor to perform, then it will bring more predictability in terms of time and cost to this contract.

HVDC Converter Stations

This project is well managed and is expected to complete on time and within budget. Recommendation is to keep close monitoring of progress until completion.

Bipole III Transmission Line

This project is well managed and progressing on schedule. However, the critical paths of both Rokstad Power Corporation and Forbes Brothers Ltd. are slipping which may jeopardize completion in August 2018.

Manitoba – Minnesota Transmission Line

This project is on schedule. Its cost however appears low compared to other similar projects. We recommend that the cost estimate is reviewed and updated in due course.

Great Northern Transmission Line

The project is progressing, with Rights of Way being cleared, amongst other activities. The Construction Management Agreement is well considered commercially and serves to protect the interests of Manitoba Hydro. When benchmarked with other similar projects, its cost estimate is considered high and this should be reviewed in due course.

SECTION 9 - Abbreviations

Abbreviation	Definition
AA7	Amending Agreement No. 7
BBE	BBE Hydro Constructors Limited Partnership
BEI	Baseline Execution Index
BNA	Burntwood/Nelson Agreement
BOE	Basis of Estimate
BOQ	Bill of Quantities
CAC	Construction Advisory Committee
CBS	Cost Breakdown Structure
CEF	Capital Expenditure Forecast
CEO	Current Estimate Outlook
CM	Construction Management
CMA	Construction Management Agreement
CPI	Cost Performance Index
CPJA	Capital Project Justification Addendum
CPLI	Critical Path Length Index
CPM	Critical Path Methodology
CRR	Contract Revision Register
CUU TO	CUU Transmission Owner
DT	Double Time
EVM	Earned Value Management
EWO	Extra Work Orders
FAC	Forecast at Completion
Forbes	Forbes Brothers Ltd.
FPLS	Fixed Price Lump Sum
GA&O	General Administration and Overhead
GAO	US Government Accountability Office
GASP	Generally Accepted Scheduling Practices
GCC	General Civil Contract
GNTL	Great Northern Transmission Line
GOT	Generation Outlet Transmission
IFC	Issued for Construction
ISD	In-Service Date
JKDA	Joint Keeyask Development Agreement
KCN	Keeyask Cree Nations

Abbreviation	Definition
KHLP	Keeyask Hydropower Limited Partnership
LCKD	Locked
LOE	Level of Effort
LVAC	Land Valuation Appraisal Council
MAC	Monitoring Advisory Committee
MISO	Midcontinent Independent System Operator
MMTP	Manitoba Minnesota Transmission Project
MP	Minnesota Power
NDIA	US National Defence Industrial Association
OHGW	Overhead Ground Wire
OT	Overtime
PCA	Project Change Authorizations
PMI	Project Management Institute
PR	Purchase Requisition
QURR	Quantity Unit Rate Report
RMP	Risk Management Plan
ROW	Right of Way
Rokstad	Rokstad Power Corporation
ST	Standard Time
Stanley	Stanley Consultants Inc.
TLP	Transmission Line Payer
TPD	Transmission Projects Department
USI	Underlying System Improvements
WBS	Work Breakdown Structure
WECC	Western Electricity Coordinating Council
WPL	Work Package Lead

APPENDIX A

Klohn Clippen Berger Report

Klohn Crippen Berger

MGF Project Services

Keeyask Hydroelectric Project

Engineering Technical Comments on Design, Contracts and Construction Progress

December 2017

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1 INTRODUCTION

The Klohn Crippen Berger scope of work is to assist MGF in reviewing the following areas and activities related to the Keeyask Hydro Project.

- **Project Cost Estimate** – where are the overruns, are they in a specific area or across the project?
- **Project Design** – were the design technical specifications and drawings reasonable, and in particular was the contractor provided with a reasonable amount of information?
- **Cost Estimate changes** – what were they, were they reasonable and how did they impact the project costs?
- **Contracting Methodology** – is the contract format reasonable and appropriate for the project?
- **Schedule Review** – is the current General Civil Contract Amending Agreement #7 schedule reasonable or is there likelihood of additional slippage?
- **Project Execution and Construction Management** – was the project set up to be a success and is the project being managed effectively?

KCB has approached the assignment in a straightforward manner:

- Reviewing the cost overruns to date to identify the areas of concern;
- Reviewing the engineering associated with each area of concern;
- Looking at the changes to the cost estimates caused by extra work orders, quantity changes and the reasonableness of the unit prices;
- Reviewing of the contract format, specifically the measurement and payment sections;
- Reviewing the changes in the schedule for project; and
- Commenting on the project execution and construction management to date.

Finally, KCB has expressed opinions on the likelihood of the project meeting the current contracted costs and schedule.

2 COST REVIEW

2.1 Reference Documents

- Contract Summary – All Contracts – September 2017.xlsx

2.2 Contract Cost Review

Review of the table shows the project has awarded 247 contracts with a forecasted value totaling $4,644,369,106.43.

Adding up the original contract values comes to $2,722,776,658.18.

The increase in the project cost is therefore $1,921,592,448.25, which is one of the main reasons for this review.

To focus our work, we initially sorted all the contract information by contract value. Then we calculated the percentage increase for each contract. The contracts that increased are shown in the Table 1. The base data does show that some contracts did or are predicted to complete under budget for a total of $16,431,830.59 in savings, however the total savings are less than 1% of the total cost increase and are therefore insignificant in the total project cost.

Table 1 Contract Percentage Increase

Name of Vendor	Description	Original Contract Value	Forecasted Contract Value	% increase
HATCH LTD.	Stage V Engineering	[redacted]		
U M A ENGINEERING LTD	Stage V Infrastructure Engineering			
REVAY AND ASSOCIATES LIMITED	Claims Avoidance & Support			
KPMG LLP	Senior Level Staff Augmentation Services			
RST INSTRUMENTS LTD.	Analog Thermistor Sensor			
RST INSTRUMENTS LTD.	Equipment			
COMMSTREAM GIGALINKS INC.	Main Camp Communications Phase II			
MIDWEST FENCE COMPANY LTD.	Supply of Fence Materials			
MULTICRETE SYSTEMS INC.	Supply of Pre-Cast Manhole Assembly			
M. SULLIVAN & SON LIMITED	Ice Boom			
VALLEN	Various Equipment			
IRON NORTH LIMITED PARTNERSHIP	Miscellaneous Site Construction			
ACKLANDS-GRAINGER INC.	Materials, Tools & Equipment			
MULTICRETE SYSTEMS INC.	Supply of Pre-Cast Manhole Assembly			
RST INSTRUMENTS LTD.	Piezometer			
PVA CANINE SERVICES LTD.	Canine substance detection KGS			
FOX, YORK AND SODEXO JOINT VENTURE	Security Services			

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Name of Vendor	Description	Original Contract Value	Forecasted Contract Value	% increase
KPMG LLP	Project Health Check	[redacted]		
BBE HYDRO CONSTRUCTORS LIMITED - AF	General Civil Works			
CANMEC INDUSTRIEL INC	Intake Gates, Guides & Hoists			
KEEYASK MAINTENANCE SERVICES JOINT	Maintenance Services			
FOX, YORK AND SODEXO JOINT VENTURE	Catering & Janitorial Services			
KEEYASK EMERGENCY MEDICAL SERVICES	Emergency Medical/Ambulance Service			
TRIPLE M MODULAR LTD	Main Camp Facility			
AMISK CONSTRUCTION	Work Area Site Development			
VALIDATION ESTIMATING, LLC	Risk Analysis & Contingency Estimating			
ABB INC.	Static Exciter			
VOITH HYDRO	Turbines & Generators			
ABC FIRE & SAFETY EQUIPMENT LTD.	Fire Prot. Systems Serv. & Insp - Keeyask			
CANMEC INDUSTRIEL INC	Spillway Gates, Guides & Hoists			
AMISK CONSTRUCTION	Reservoir Clearing			
STITTCO ENERGY LIMITED	Supply & Rental of Propane Tanks			
NORTH SOUTH CONSULTANTS INC	Coordination of First Nation Labour, Rental, & Disbursements			
KPMG LLP	Keeyask Recovery Plan			
PTI MANITOBA INC.	Generator Step Up Transformer			
VIBROSYSTM INC.	Air Gap & Vibration Monitoring Systems			
COH PROJECTS ET SERVICES INC	Powerhouse Cranes			
AMISK CONSTRUCTION	South Access Road			
ENGLOBE CORP.	E&M QA Inspection & Expediting Services			
ACONEX CANADA LIMITED	Web based Project Collaboration Tool PCT*			
L-KOPIA, INC.	Rail Track Survey; Thompson & Limestone			
CANMEC INDUSTRIEL INC	Fabrication & Mods for Spillway Stoplogs			
MULTICRETE SYSTEMS INC.	Supply of Grout Mix			
CANMEC INDUSTRIEL INC	Draft Tube & Monorail Cranes			
CAPITOL STEEL CORPORATION	Intake Trashracks & Guides			
TOROMONT CAT	Spillway & Blackstart Standby Diesel Gen Set			
CANMEC INDUSTRIEL INC	Stoplogs, Bulkhead/Draft Tube Gates & Followers			

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We noted that many of the contracts are relatively small and do not materially affect the overall project cost, for example fence materials have gone up over 1000% but that is still less than $14,000. What is more important is the percentage increase of each contract as percentage of the total project cost, to understand which contract changes are important to the overall project. Therefore, the total project increase was calculated for each contract and then the results were resorted according to the percentage of total project increase, see Table 2. Contracts with variances less than 0.1% or negative are not shown in Table 2.

Table 2 Contract Increase as Percentage of Total Project Cost Increase

Name of Vendor	Description	Original Contract Value	Forecasted Contract Value	% Contract Increase	% Project Increase
BBE HYDRO CONSTRUCTORS LIMITED - AF	General Civil Works	[redacted]			
FOX, YORK AND SODEXO JOINT VENTURE	Catering & Janitorial Services				
HATCH LTD.	Stage V Engineering				
TRIPLE M MODULAR LTD	Main Camp Facility				
VOITH HYDRO	Turbines & Generators				
KEEYASK MAINTENANCE SERVICES JOINT	Maintenance Services				
CANMEC INDUSTRIEL INC	Intake Gates, Guides & Hoists				
FOX, YORK AND SODEXO JOINT VENTURE	Security Services				
M. SULLIVAN & SON LIMITED	Ice Boom				
U M A ENGINEERING LTD	Stage V Infrastructure Engineering				
KEEYASK EMERGENCY MEDICAL SERVICES	Emergency Medical/Ambulance Service				
AMISK CONSTRUCTION	Work Area Site Development				
CANMEC INDUSTRIEL INC	Spillway Gates, Guides & Hoists				
AMISK CONSTRUCTION	Reservoir Clearing				
COMMSTREAM GIGALINKS INC.	Main Camp Communications Phase II				
AMISK CONSTRUCTION	South Access Road				
PVA CANINE SERVICES LTD.	Canine substance detection KGS				
REVAY AND ASSOCIATES LIMITED	Claims Avoidance & Support				
PTI MANITOBA INC.	Generator Step Up Transformer				
KPMG LLP	Senior Level Staff Augmentation Services				
ABB INC.	Static Exciter				

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Clearly the General Civil Contract with BBE is the critical contract for the project. If for example BBE was on budget and schedule the total project would only be over budget by $628M or 23%. But much of that 23% is directly related to civil delays, camp costs, turbine supply costs, etc. all would be significantly reduced. Therefore, the majority of our review will examine the General Civil Contract.

3 PROJECT DESIGN

3.1 Reference Documents

Technical Specifications

- V 3 - 243994-0030-016203-SPEC-Technical Specification 20141119, dated 19 Nov 2014
- V 12 - 243994-0030-016203-SPEC-Technical Specification-20130809, dated 18 July 2017

Latest contract documents

- 243994-0020-016203-CON-GCC Volume 5 20140310
- 243994-0020-016203-CON-GCC Volume 4 20170228
- 243994-0020-016203-CON-GCC Volume 3 20170228
- 243994-0020-016203-CON-GCC Volume 2 Drawings 20140310
- 243994-0020-016203-CON-GCC Volume 1 20170228.pdf
- 243994-0020-016203-CON-Amending Agreement 7-20170228
- 243994-0020-016203-CON-Amending Agreement 6-20160720
- 243994-0020-016203-CON-Amending Agreement 5-20160623
- 243994-0020-016203-CON-Amending Agreement 4-20160610
- 243994-0020-016203-CON-Amending Agreement 3-20160610
- 243994-0020-016203-CON-Amending Agreement 2-20160415
- 243994-0020-016203-CON-Amending Agreement 1-20140307

Drawing register

- HATCH IFC DWGS Aconex Report - January 1,2014 to October 5,2017

3.2 General Civil Technical Specification Review

Often increases in projects costs are related to changes in the design which occur after the contract is signed. These changes typically appear as revisions to the Issued for Construction Drawings or the Technical Specifications.

There have been 12 versions of the Technical Specifications produced between March 2014 and July 2017. The amended agreement in volume 2 includes technical specifications dated 10 March 2014.

Table 3 lists the specification sections and shows the revision versions of the sections at three dates, the amended contract version (10 March 2014), Version 3 in May 2015 and Version 12 from July 2017.

Table 3 Specification Revisions

Specification Section	AA#7 Contract March 2014		Version 3 May 2015		Version 12 July 2017	
	Revision	Pages	Revision	Pages	Revision	Pages
Division 01 – General Requirements						
01 10 05 Indirects	A	4	B	4	B	4
01 51 00 Temporary Utilities	B	8	B	8	B	8
01 52 00 Construction Facilities	B	4	B	4	B	4
01 54 11 Powerhouse Crane	A	4	B	4	B	4
Division 03 – Concrete						
03 11 00 Concrete Formwork	A	10	B	9	D	10
03 15 13 Waterstops	A	8	B	8	D	8
03 15 19 Embedded Anchors	B	8	C	7	D	8
03 21 00 Reinforcing Steel	A	8	B	8	B	8
03 30 00 Cast-In-Place Concrete	B	26	C	26	E	26
03 35 00 Concrete Finishing and Repair	A	10	B	9	B	9
03 35 05 Floor Hardener/Surface Sealer	A	4	A	4	B	4
03 39 00 Concrete Curing	A	4	A	4	A	4
03 40 00 Precast Concrete	A	8	B	8	B	8
03 41 33 Precast Concrete Beams and Girders	A	10	B	10	B	10
03 45 13 Precast Wall Panels	A	10	B	10	B	10
03 53 00 Concrete Floor Toppings	A	4	B	4	B	4
03 60 00 Equipment Grouting	A	6	B	6	B	6
Division 04 – Masonry						
04 22 00 Concrete Unit Masonry	A	6	B	6	B	6
Division 05 – Metals						
05 05 19 Drilled-In-Place Anchors	A	3	B	3	B	3
05 12 23 Structural Steel	A	14	B	14	C	14
05 31 23 Steel Decking	A	6	B	6	B	6
05 50 00 Miscellaneous Metal	A	8	B	9	C	10
Division 07 – Thermal and Moisture Protection						
07 11 13 Bituminous Dampproofing	[NOT CURRENTLY INCLUDED]					
07 21 13 Board Insulation	[NOT CURRENTLY INCLUDED]					
07 21 29 Sprayed Insulation	[NOT CURRENTLY INCLUDED]					
07 27 00 Air Barriers	[NOT CURRENTLY INCLUDED]					
07 62 00 Metal Flashing and Trim	[NOT CURRENTLY INCLUDED]					
07 64 00 Metal Wall Cladding	[NOT CURRENTLY INCLUDED]					
07 91 26 Joint Fillers	A	4	A	4	A	4
07 92 00 Joint Sealants	A	6	B	6	B	6
Division 08 – Openings						
08 11 00 Metal Doors and Frames	[NOT CURRENTLY INCLUDED]					

Specification Section	AA#7 Contract March 2014		Version 3 May 2015		Version 12 July 2017	
	Revision	Pages	Revision	Pages	Revision	Pages
08 36 19 Service Bay Door	A	8	A	8	C	10
08 50 00 Windows	[NOT CURRENTLY INCLUDED]					
08 70 05 Cabinet and Miscellaneous Hardware	[NOT CURRENTLY INCLUDED]					
08 71 00 Door Hardware	[NOT CURRENTLY INCLUDED]					
08 80 50 Glazing	[NOT CURRENTLY INCLUDED]					
Division 09 – Finishes						
09 21 16 Gypsum Board Assemblies	[NOT CURRENTLY INCLUDED]					
09 22 16 Non-Structural Metal Framing	[NOT CURRENTLY INCLUDED]					
09 22 26 Metal Suspension Systems	[NOT CURRENTLY INCLUDED]					
09 51 13 Acoustical Panel Ceilings	[NOT CURRENTLY INCLUDED]					
09 65 19 Resilient Tile Flooring	[NOT CURRENTLY INCLUDED]					
09 90 00 Painting and Coating	A	16	A	16	C	16
Division 10 – Specialties						
10 21 13 Metal Toilet Compartments	[NOT CURRENTLY INCLUDED]					
10 21 16 Shower and Dressing Compartments	[NOT CURRENTLY INCLUDED]					
10 28 10 Toilet and Bath Accessories	[NOT CURRENTLY INCLUDED]					
10 51 13 Metal Lockers	[NOT CURRENTLY INCLUDED]					
10 56 16 Fabricated Wood Storage Shelving	[NOT CURRENTLY INCLUDED]					
Division 14 – Conveying Equipment						
14 20 00 Elevators	A	14	B	14	F	16
Division 21 – Fire Suppression						
21 12 00 Fire Protection Standpipe System	A	14	A	14	A	14
21 13 00 Fire Suppression Sprinkler System	A	14	A	14	A	14
Division 22 – Plumbing						
22 11 00 Domestic Water System	A	10	A	10	B	8
22 13 00 Sanitary System	C	6	C	6	D	6
22 14 00 Clearwater Drainage System	B	10	B	10	C	8
22 15 00 Service Air and Brake Air Systems	A	10	A	10	C	12
Division 23 – Heating, Ventilating and Air Conditioning (HVAC)						
23 07 00 HVAC Duct Insulation	A	4	B	4	C	4
23 09 00 Instrumentation and Control for HVAC	C	20	C	20	E	20
23 30 00 Heating Ventilation and Air Conditioning System	A	32	A	30	C	44
Division 25 – Integrated Automation						
25 11 00 Unit Control and Monitoring System (UCMS)	A	16	A	16	A	16
Division 26 – Electrical						
26 05 00 Electrical General Requirements	A	8	B	8	B	8
26 05 21 Wire and Cable Systems	C	18	D	20	E	24
26 05 27 Embedded Grounding	A	4	A	4	B	4
26 05 28 Surface Grounding	A	8	B	6	D	8

Specification Section	AA#7 Contract March 2014		Version 3 May 2015		Version 12 July 2017	
	Revision	Pages	Revision	Pages	Revision	Pages
26 05 29 Cable and Wire Support Systems	A	12	A	12	C	14
26 05 43 Installation of Cables in Trenches and Ducts	A	6	B	6	B	6
26 11 02 600 V Load Centre Switchgear	A	10	B	10	C	6
26 12 25 Installation of MV Equipment	A	6	B	4	B	6
26 12 27 Installation of Motor Control Centres	B	4	C	4	C	4
26 13 19 GCB & IPB Installation	A	8	B	8	B	8
26 22 13 Low-Voltage Distribution System	A	16	B	16	C	14
26 29 10 Motor Starters and Control Stations	A	6	B	6	B	6
26 32 13 Standby Diesel Generators	C	18	D	16	E	18
26 33 00 Battery Systems, UPS and Inverters	C	28	D	28	D	28
26 36 23 Automatic Transfer Switches	A	6	A	6	B	6
26 50 00 Facility Lighting and Controls	C	12	D	12	E	14
Division 27 – Communications						
27 00 00 Communication Systems	C	16	D	16	D	16
Division 28 – Electronic Safety and Security						
28 13 00 Access Control & Intrusion Detection	C	10	C	10	D	10
28 23 00 Video Surveillance	A	8	B	8	C	8
28 31 00 Fire Detection and Alarm Systems	C	12	D	12	E	22
28 33 00 Spillway Warning System	A	6	A	6	A	6
Division 31 – Earthwork						
31 11 00 Clearing, Grubbing and Stripping	B	4	B	4	C	4
31 14 13 Stockpiling of Materials	A	4	B	4	B	4
31 23 01 Weight Scales	A	4	A	2	A	2
31 23 13 Foundation Preparation	D	10	D	10	D	10
31 23 16 Unclassified Excavation	D	6	E	6	E	6
31 23 17 Rock Excavation	B	10	C	8	D	10
31 23 18 Rock Excavation In-the-wet	C	8	C	8	C	8
31 23 19 Control of Water	B	4	B	2	B	2
31 23 23 Impervious Fill and Random Fill	E	10	F	10	G	10
31 23 24 Granular Fill	C	8	D	8	G	8
31 23 25 Road Topping	A	4	B	4	B	4
31 23 26 Riprap Bedding	A	4	B	4	C	4
31 23 27 Rockfill	B	4	C	4	D	4
31 23 33 Trenching and Backfilling	A	6	A	6	A	6
31 23 34 Perimeter Ditches Along the Dykes	B	6	B	6	B	6
31 25 00 Erosion and Sedimentation Control	A	4	A	4	A	4
31 26 00 Excavated Material Placement Areas (EMPA)	[NOT CURRENTLY INCLUDED]					
31 33 13 Rock Support and Protection	A	12	B	12	B	12
31 34 00 Geogrid Soil Reinforcement	[NOT CURRENTLY INCLUDED]					

Specification Section	AA#7 Contract March 2014		Version 3 May 2015		Version 12 July 2017	
	Revision	Pages	Revision	Pages	Revision	Pages
31 35 19 Geotextiles	A	4	A	4	A	4
31 36 13 Gabions	[NOT CURRENTLY INCLUDED]					
31 37 00 Riprap	B	4	B	4	D	4
31 52 00 Cofferdams	D	22	E	20	E	20
31 68 00 Post-Tensioned Foundation Anchors	A	10	A	8	B	10
31 81 00 Foundation Grouting	A	12	B	10	B	10
31 82 00 Foundation Drain Holes	B	4	B	4	B	4
Division 32 – Exterior Improvements						
32 31 13 Chain Link Fences and Gates	A	2	A	2	C	2
Division 33 – Utilities						
33 42 00 Corrugated Steel Pipe Culverts	B	4	B	4	C	4
33 72 00 Unit Protection and Control System	A	6	A	6	A	6
Division 34 – Transportation						
34 71 33 Guard Rails and Posts	A	6	A	6	B	6
Division 35 – Gates and Guides						
35 20 13 Bulkhead Gates, Stoplogs and Trashracks	B	6	B	6	D	8
35 20 17 Embedded Guides	A	6	A	6	C	6
Division 40 – Process Integration						
40 05 00 Mechanical & Piping General Requirements	A	14	A	14	B	16
40 23 19 Station Water, Cooling Water & Shaft Seal Water Systems	A	8	A	8	B	8
40 23 21 Dewatering & Filling System [	A	6	A	6	B	8
40 42 00 Piping Insulation	A	4	A	4	A	4
40 90 00 Piezometer Systems and Instrumentation	A	6	A	6	C	6
40 90 25 Instrumentation for Piping Systems	A	10	A	10	B	10
Division 41 – Material Processing and Handling Equipment						
41 22 00 Small Cranes	A	8	A	8	B	8
41 22 13 Crane Rails	A	6	A	4	B	6
Division 43 – Process Gas and Liquid Handling, Purification, and Storage Equipment						
43 20 00 Oil Storage & Handling System	A	10	A	8	C	12
Division 46 – Water Treatment, Waste Water Treatment and Oil Separation Equipment						
46 07 13 Domestic Water Treatment Plant	C	16	C	16	E	18
46 07 53 Wastewater Treatment Plant	A	30	A	26	C	12
46 25 00 Oil Water Separation Facility	A	6	A	6	B	10

Legend: 1 Revision from previous 2 or more Revisions from previous

Table 3 shows that many specifications have been changed over the course of the project, but not that many have been changed multiple times. KCB compared specifications Version 12 with Version 3 looking for major changes. Significant changes were observed in the following sections:

03 11 00 **Concrete Formwork** – revised to include many more payment items, i.e. much more detailed with respect to vertical surfaces and locations.

03 15 19 **Embedded Anchors** – revised to include more types of anchors for specific locations.

03 30 00 **Cast-in Place Concrete** – various changes to make production easier, but also added requirement for a layer of thermal crack protection reinforcing, which would add cost in some areas.

05 50 00 **Miscellaneous Metal** – added davits, bulkhead gate storage slot guides, crane end stops, miscellaneous metal supplier by purchaser, all will increase the costs associated with this section.

09 90 00 **Painting and Coating** – embedded guides were added. This is an expensive item to paint, requiring staging or scaffold and coordination with the gate installations.

14 20 00 **Elevators** – This specification underwent significant rework, including deletion of floors and stops as well as changes to the control system and dimensions, but cost may not have changed dramatically.

22 13 00 **Sanitary System** – many new pipe classes, fitting and valves were added to the specification. Impression is that this section may not have been well developed at bidding, thus costs for this section likely increased significantly.

22 15 00 **Service Air and Brake Air Systems** – revisions include addition of depression air and additional measurement and payment items. The addition of depression air will likely double the costs associated with this specifications section.

23 09 00 **Instrumentation and Control for HVAC** – major revisions, presumably to suit the specific equipment selected and control technology upgrades. Some price increase would be expected.

23 30 00 **HVAC System** – also significant revisions to the specifications, including addition of payment items for embedded piping. Changes also included dampers, AHU's, controls and assorted heaters.

26 11 02 **600V Load Centre Switchgear** – revised to include arcflash requirement.

26 22 13 **Low Voltage Distribution System** – multiple changes in this specification, driven perhaps by changes to the lighting and HVAC systems.

26 32 13 **Standby Diesel Generators** – the spillway genset was added and changes made to the technical details.

26 50 00 **Facility Lighting and Controls** – significant revisions to eliminate fluorescent lights and include LED technology as well as intelligent controls including occupancy sensors. Good technical improvement, but will have a cost impact.

28 31 00 **Fire Detection and Alarm System** – multiple revisions, likely to match up to the ventilation system controls as well as the plant control system.

31 23 24 **Granular Fill** – most of the sieve size percentages for the various fill have been adjusted. We assume this is to better suit the materials in the quarries and borrow areas.

31 37 00 **Riprap** – class 7and 8 riprap percent fines by weight was revised, likely also to suit the quarry materials.

35 20 13 Bulkhead Gates, Stoplogs and Trashracks – temporary stoplogs for the spillway have been added as well as the trashracks. These will impact the concrete pier construction as well. We assume the stoplogs were added to make more work areas available, in an attempt to recover some lost schedule.

46 07 13 **Domestic Water Treatment Plant** – the process and type of plant has been revised, but the nominal capacity remains the same.

46 07 53 **Waste Water Treatment Plant** - the process and type of plant has been revised, but the nominal capacity remains the same.

All the changes will have made some impact on the costs and together they show that the mechanical and electrical design was not as well advanced as the civil design back in 2014. Interestingly, very little changes have been made to the excavation, fills and concrete specifications, thus any significant cost changes in those areas should only be due to quantity changes.

3.3 Geotechnical Information Review

Several campaigns of geological/geotechnical investigations were carried out between 1962 and 2010 to investigation the structure foundations and potential borrow materials. These included drill holes, test pits, laboratory testing of materials, reconnaissance and detailed inspections and mapping, and geophysical surveys.

The investigations appear to have been reasonably comprehensive, both for construction materials and, in general, for the structures. There are relatively few investigations in or over water, which is understandable given safety concerns at rapids and fast-flowing river sections; the in-river areas beneath structures are areas of risk with respect to unknowns that are common to many similar projects.

Although geophysical investigations are identified as having been performed, contract drawings of investigations do not show their locations and the results are not included in Volume 5 of Contract 016203. It is not known whether this information was included in a “data room” or as additional information provided by Manitoba Hydro.

The regional bedrock geology drawing (1-00195-DE-11000-001 Rev E) in the contract, which covers the vicinity of the major structures, does not include the locations of drill holes and test pits. Addition of this information would facilitate understanding whether features such as deformation zones and contacts of geologic units had been adequately investigated. One must estimate where these features would occur on the locations of explorations plan (1-00195-DE-0019-0001 Rev D), then review logs of nearby drill holes to determine conditions at those features.

There is a brittle deformation zone (intense jointing and fracturing) which crosses the axis of principal structures beneath the central dam and central dam cofferdam. It was investigated with one drill hole (G-010). Water pressure testing was performed near the bedrock surface; it was not performed in the brittle zone, but the log indicates this zone was healed (i.e. had been broken but subsequent mineralization resulted in a solid rock mass).

A ductile deformation zone (shear or fault) is shown on the geology plan beneath the central dam and its cofferdam, mainly within water. This feature was not investigated, even though it is shown to continue onto the island near Gull Rapids.

KCB would expect identified features such as the deformation zones to be investigated and a description of the features to be provided, in order that bidders could assess potential impacts on cofferdam performance (e.g. need for dewatering) and foundation preparation (depth of excavation, type of treatment) beneath the major structures. We have not received historic investigation reports; it is possible that these features have been addressed. The text of Volume 5 states that “during each of the investigations, the bedrock outcrops and overburden exposures were examined and described.”

Volume 5, Section 6 is “Investigations by Areas of Interest”. It describes the cofferdams, groin, and excavated material placement areas (waste material deposition areas). Section 6 does not describe the main structures – dams, powerhouse and spillway. However, the contractor would perform excavation, grouting and foundation preparation beneath the structures and a description of investigations would be of interest to the contractor.

The material balance – available sources of various fills and aggregates and their possible use for construction – was reviewed (Drawing No. 1-00195-06200-0010 Rev OC). The engineer’s material balance represents one plan that could be followed, thus the term “possible use” to show that identified material volumes are adequate. The Contractor would be expected to develop its own plan. It is desirable to identify material sources well in excess of the actual requirement, in order to allow for wastage, materials for Contractor’s own use, and unanticipated requirements; available volumes of twice those required is a common target. This is generally achieved. The following are noted:

- The required rock excavations are shown as being 100% utilized. This is because demand is much greater than the required excavation volume. Abundant additional rock is available in nearby quarries.

- Impervious borrow source N5 on the north abutment is shown as being 77.6% utilized. This is the closest source to the major earthworks – North and Central Dams – on the north side of the main channel, and using N5 to its maximum extent is logical. In the event that N5 were to be exhausted, source N21 is available at a similar distance from the major structures, and N6 is at a greater distance. The material balance indicates that quantities in the three sources greatly exceed the requirements.

The earthfill dam and dyke designs depicted on the drawings vary somewhat to accommodate, for dams, the cofferdams and nearby concrete structures; and for dykes, the topography and foundation conditions. On the dam sections, some material zones are relatively thin, in particular on the upstream slopes; the materials will be slow to place and (where required) to compact and special placement techniques such as very careful placement to limit their width or the use of “side boards” at the design zone limits with to confine the materials may be required to properly construct them. Other than these narrow zones, the dams appear to be constructible without special placement techniques. The designs are as expected in the northern climate.

Placement of Zone 5 riprap bedding as shown at the upper parts of the dams will be challenging. The zone width narrows to 500 mm. However, the specified maximum size of the material is 500 mm; and 30% of the material by weight must be larger than 300 mm. It is common to specify minimum zone thicknesses of twice the maximum particle size to facilitate placement that permits a uniform distribution of all particle sizes. This narrow placement area is limited to a 2 m vertical height in the dams.

3.4 General Civil Contract Drawing Review

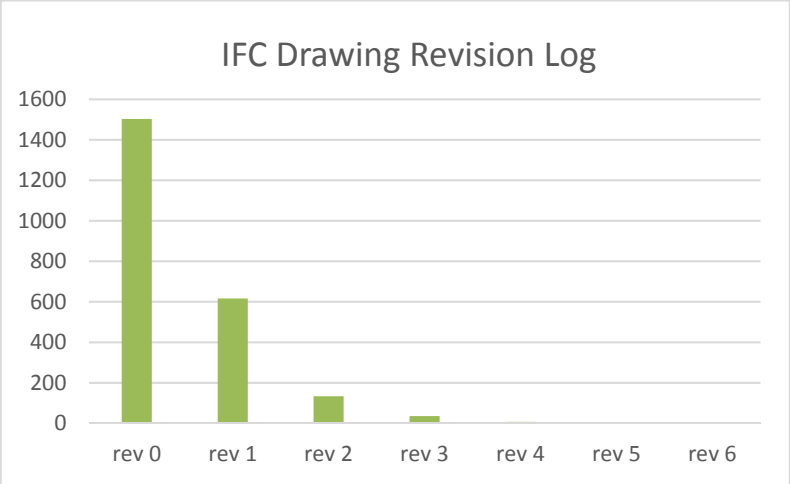
KCB has reviewed the list of approximately 2300 IFC drawings prepared by Hatch and listed in the drawing register (HATCH IFC DWGS Aconex Report - January 1,2014 to October 5,2017). We also reviewed the drawings associated with the General Civil Contract. We did not review each drawing in detail, however we did look to see if the major structures have sufficient detail to enable quantity takeoff and subsequent pricing. In general, the IFC drawing are clear and certainly define the majority of the permanent works.

By comparison we looked at the number of civil drawings for two similar sized projects we have been involved with and they were 2500 drawings and 1100 drawings respectively. For the 1100 drawing project KCB was as the civil designer inside a design build project team and the project included an RCC dam with integral spillway, long large tunnel, significant channels and a large 1100 MW powerhouse. The project with 2500 drawings was a 900 MW project with diversion tunnel, large earthfill dam with complex foundation issues and large spillway and powerhouse structures. The procurement was done with multiple contracts. The large contracts included excavations, concrete structures and generating equipment. In general, the design was substantially completed prior to award, thus there was limited opportunity for design innovations, only construction methodology.

As a further check, we looked at the revision history for the IFC drawings, if the drawings had undergone multiple revisions that would likely indicate changes to the scope or inadequate drawings to start. The revision log is summarized in Table 4 and the associated graph.

Table 4 IFC Drawing Revisions

Rev 0	Rev 1	Rev 2	Rev 3	Rev 4	Rev 5	Rev 6
1503	616	133	35	7	2	1

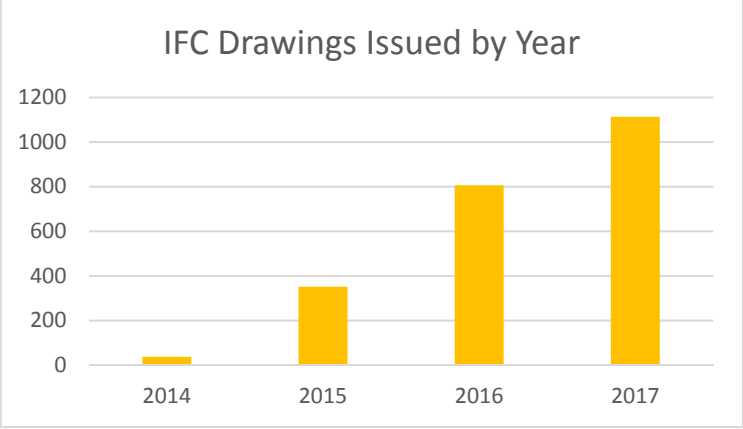


The vast majority of the drawings have not been revised after issued IFC, in fact drawings not rev 0 or Rev 1 are insignificant. This is good from the perspective of limiting the engineering effort and proof that the engineering was almost always on target and not being questioned by the contractor.

Finally, KCB looked at when the drawings were issued, to try and understand if the contractor was getting the drawings in a timely manner. Table 5 and the associated graph shows the IFC drawings by year of issue.

Table 5 IFC Drawing Years Issued

2014	2015	2016	2017
37	351	806	1113



The data shows that in 2014 the contractor priced the job with a limited number of drawings. The majority of the drawings were prepared in 2016 and 2017 which may have created two issues which would impact the costs:

- The contractor missed or did not allow for all the complexity of the project – i.e. underbid; and
- The engineer could have added more detail and work after the contract was signed.

In summary, our conclusions regarding the design engineering, drawings and information presented are:

- The information is generally good to very good based on the low number of IFC drawings revisions;
- The design is reasonable and well detailed;
- The number of drawings produced is reasonable for a project of this size;
- The revisions to the specifications have been generally related to the balance of plant work and generally should be low cost impacts to the entire project; and
- The only potential issue may be the timing of the drawing production, which may have created some delays in construction.

4 COST ESTIMATE CHANGES

4.1 Reference Documents

- Original Contract (OC) dated Mar 10, 2014
- Amending Agreement #7 (AA7) dated Feb 28, 2017
- Keeyask Contract Revision Register for Allocated Contingency - August 2017
- Hatch Stage IV Engineering Summary Report - GN-10.1 Rev 0.pdf

4.2 EWO's

Extra work orders (EWO's) normally occur in construction projects, which is one of the reasons for contingency in the project budget. The value of the EWO's are typically larger for projects where the design is not fully completed at the time of tender which was the situation for Keeyask.

We reviewed the EWO's for the GCC as extracted from the Keeyask Contract Revision Register for Allocated Contingency - August 2017. We sorted the information by year as part of the review.

Table 6 Extract from the Keeyask Contract Revision Register

Change Type	Entered on Date	Work Order #	Header Description	Amt Before PST
Approved				
	2016-10-31	Profit 000001	Profit Adjustment - All EWO's to October 2016	[redacted]
		EWO 000132	VE For CDCD rock groin widening	
		EWO 000129	VE For Sloped Walls and Roughness at Spillway Channel	
		EWO 000130	VE For Selection of Rock Bolt Size	
		EWO 000137	Material Substitutions for CB7A	
		EWO 000105	VE For Sloping Walls at PH Excavation Intake and Tailrace	
	2016-11-30	Profit 000002	Profit Adjustment - Initial Target Price	
	2017-06-30	Profit 000003	Forfeited Step Change Incentive Profit (SCIP) - May 2017	
	2017-07-31	Profit 000004	Forfeited Step Change Incentive Profit (SCIP) - June 2017	
			Approved Total	
Approved-G				
	2015-06-26	EWO - Claim 000022	August 2014 Blockade Costs	
		EWO - Claim 000144	May 2016 Blockade of PR280; BBEHC-NOTIC-000042 determination	
			Approved-G Total	
Approved-GP				
	2014-06-19	EWO 000001	MH Supplied Work Area A Quarry Rock (Deletion of Scope)	
		EWO 000002	Construction Fuel - For the supply and delivery of diesel fuel and gasoline.	
	2014-10-03	EWO 000003	Technical Specification Revision	
	2014-10-04	EWO 000004	Revised Baseline Schedule for the Powerhouse Cofferdam	
	2014-11-15	EWO 000005	Clear North Channel Rock Groin Ext	

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Change Type	Entered on Date	Work Order #	Header Description	Amt Before PST
	2014-11-16	EWO 000006	Cofferdams North Channel Rock Groin Ext	[redacted]
		EWO 000007	PHCG Top Up	
	2014-11-19	EWO 000008	Technical Specification Revision	
	2014-12-05	EWO 000011	Cofferdams North Channel Rock Groin Ext 2	
	2015-01-07	EWO 000016	June/July 14 MH Directed Work	
		EWO 000017	August 14 MH Directed Work	
		EWO 000018	September 14 MH Directed Work	
	2015-03-02	EWO 000019	October 14 MH Directed Work	
	2015-06-26	EWO 000020	G1 Site Restoration	
		EWO 000021	Technical Specification Revision	
		EWO 000023	Community Employment Sessions	
	2015-07-15	EWO 000024	Premium to work Remembrance Day 2014	
	2015-08-05	EWO 000025	Rock Fall Netting Anchors	
	2015-09-02	EWO 000028	Rock Excavation on PH North Wall STA 0+989 to 0+996	
	2015-09-17	EWO 000029	Cofferdam Top-up Prebuild	
		EWO 000030	Central Dam Cofferdam, North Extension	
	2015-10-01	EWO 000026	River Management Claim	
	2015-10-03	EWO 000031	Developing Estimate for South Access Road - Part A	
	2015-10-20	EWO 000038	February 15 MH Directed Work	
	2015-10-21	EWO 000039	Technical Specification Revision 05	
		EWO 000037	Equipment Delivery Dates	
		EWO 000033	January 2015 MH Directed Work	
	2015-11-09	EWO 000040	Cofferdam Winter top-up	
	2015-11-25	EWO 000041	December 2014 MH Directed Work	
	2015-11-27	EWO 000042	G3 Causeway Quantity Reconciliation	
		EWO 000043	March 2015 Directed Work	
		EWO 000044	Spillway Quantity Changes	
	2015-12-23	EWO 000045	N5 Causeway Quantity Reconciliation	
		EWO 000046	November 2014 Directed Work	
	2016-02-11	EWO 000044 r1	Spillway Quantity Changes (rev 1)	
	2016-02-17	EWO 000047	Implementation of Value Engineering Proposal	
	2016-02-29	EWO 000048	Spillway South Wall Additional Ex; Engineer's Determination	
	2016-03-13	EWO 000050	Technical Specification Revision 06 (EMPA Technical Specification 312600)	
	2016-03-14	EWO 000051	Draft tube pier nose armour deletion	
	2016-03-23	EWO 000055	Welded Rebar Mats	
		EWO 000044 r2	Spillway Quantity Changes (rev 2)	
	2016-03-29	EWO 000053	April 2015 Directed Work	
		EWO 000052	IFC Drawings for Rebar Replacement	
	2016-03-30	EWO 000056	Spillway Guides Member Substitution	
		EWO 000059	QCD Quantity Reconciliation	

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Change Type	Entered on Date	Work Order #	Header Description	Amt Before PST
	2016-03-31	EWO 000006 r1	Cofferdams North Channel Rock Groin Ext 1 Rev 2	[redacted]
		EWO 000011 r3	Cofferdams North Channel Rock Groin Ext 2 Rev 3	
	2016-04-12	EWO 000057	Island Cofferdam Quantity Reconciliation	
	2016-04-13	EWO 000060	NCRG Quantity Reconciliation	
	2016-04-18	EWO 000062	Technical Specification Revision 07 (Riprap Technical Specification 31 37 00)	
		EWO 000060 r1	NCRG Quantity Reconciliation Revision 1	
		EWO 000061	Technical Specification Revision 08 (Section 03 300 00 Cast-in-Place Concrete)	
		EWO 000064	May 2015 Directed Work	
		EWO 000063	Original CDCD Quantity Reconciliation (Directs and Indirects)	
		EWO 000058	North Channel Cofferdam Quantity Reconciliation	
	2016-04-22	EWO 000065	Powerhouse South Slope Erosion Protection	
	2016-04-27	EWO 000067	Shape Change for Pier #8 embeds	
		EWO 000068	Elevator travelling cables	
	2016-04-29	EWO 000071	Rebar Mill Proposal	
	2016-05-02	EWO 000073	Spillway gate guide welding revisions	
	2016-05-20	EWO 000074	Conduit Substitution	
		EWO 000079	Pipe Substitution	
		EWO 000080	Lifting Device; Temporary Precast Slab	
		EWO 000081	Spillway Precast Box Girder Grout Tube	
		EWO 000070	CDCD Off-Ramp Quantity Reconciliation	
		EWO 000082	Temporary Bracing Modifications for Spillway Stoplog Guides	
		EWO 000083	Spillway Precast Box Girder Drain Pipe	
		EWO 000084	On-Boarding Engineer's Determination	
	2016-05-31	EWO 000078	Addition of Waterstop type E	
		EWO 000077	Construction of Work Area A pads	
		EWO 000085	Video Surveillance Cable for Elevators	
		EWO 000086	Spillway Precast Box Girder Post Tensioning Pipes	
		EWO 000087	Piping Material Substitution	
	2016-06-04	EWO 000088	Pipe Material Sub. PH U2, 4-7 Draft Tubes/Dewatering System	
	2016-06-27	EWO 000090	Embedded Guide Shop Splice	
		EWO 000091	Personnel Risk Assessment	
	2016-06-30	EWO 000092	Spillway Precast Concrete Additions	
	2016-07-26	EWO 000095	Loss of PHCD as Haul Road Claim	
	2016-07-28	EWO 000096	W21 piping material change ERW to SAW	
		EWO 000097	North Dyke ZIC Class 2a and Class 6 Removal Outside of Core	
		EWO 000098	VE for TR Wall Reconfiguration	
		EWO 000099	VE for Modify Spillway Concrete Types	

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Change Type	Entered on Date	Work Order #	Header Description	Amt Before PST
	2016-07-29	EWO 000100	VE for Modify PH and Spillway Gravity Section Concrete Types	[redacted]
		EWO 000101	VE for 2015 PH Concrete Work	
		EWO 000110	Spillway Misc. Metal – Install Only	
		EWO 000102	Electrical Service to MH Site Trailers	
		EWO 000106	VE for Advancement of North Dyke Construction	
		EWO 000107	VE for ND Exploration Test Pits	
		EWO 000112	PHCD Quantity Reconciliation	
		EWO 000114	Finishing Slope on South side of Intake Channel	
		EWO 000113	May, June, July 2015 Directed Work	
		EWO 000094	Floor Hardener Floor Sealer	
		EWO 000111	Scope Deletion Spillway Wet Excavation	
	2016-07-31	EWO 000115	Spillway Base Slab Steel to Waterstop Clearance Issue	
	2016-08-17	EWO 000113r1	May, June, July 2015 Directed Work - Revision 1	
		EWO 000116	BBE Quality Team 2016	
	2016-08-29	EWO 000032	Revision to the Technical Specification 20150904	
		EWO 000104	VE for North Dyke Section Optimization	
		EWO 000108	VE for Island Cofferdam Revised Section	
		EWO 000117	Piping Material Class G CB7A Wall Thickness Change	
		EWO 000119	Class 1 Lift Thickness and Compaction Equipment	
		EWO 000122	Structural Steel Material Grade Substitution	
		EWO 000123	Changes to Embedded Anchor Specification for Spillway Piers	
		EWO 000124	Service Bay Waterstop Modification	
		EWO 000126	August 2015 Directed Work	
	2016-08-31	EWO 000120	September 2015 Directed Work	
		EWO 000118	VE for Deepening Channels in PH Excavation	
	2016-09-19	EWO 000125	Embedded Grounding Components	
		EWO 000127	Class 2b Material Engineer's Determination	
	2016-09-28	EWO 000128	January 2016 Directed Work	
	2016-09-30	EWO 000131	October & November 2015 Directed Work	
		EWO 000134	February 2016 Directed Work	
		EWO 000133	Service Bay Anchor Pockets	
	2016-10-11	EWO 000076	2015 Escalation Adjustment	
	2016-10-31	EWO 000076	2015 Escalation Adjustment	
		EWO 000135	Pipe Fittings Substitution	
		EWO 000136	March 2016 Directed Work	
		EWO 000138	QCD Quantity Reconciliation	
		EWO 000093	Spillway Bridge Girder Quantity Change	
		EWO 000139	April 2016 Directed Work	
		EWO 000140	CDCD Winterization	
	2016-11-30	EWO 000142	May 2016 Directed Work	

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Change Type	Entered on Date	Work Order #	Header Description	Amt Before PST
		EWO 000141	VE for Enhancements to Dam Sections	[redacted]
		EWO 000143	SWCD Quantity Reconciliation	
		EWO 000146	SW Hoist Tower Column Anchor Qty Change	
	2016-12-31	EWO 000145	Technical Specification Revision 10	
		EWO 000147	Fish Exclusion Mounting Plates	
		EWO 000146 R1	SW Hoist Tower Column Anchor Qty Change - Revision 1	
		EWO 000148	Waterstop Technical Specification 031513 Update	
		EWO 000149	Spillway Fueling Platform Precast	
		EWO 000150	Service Bay Box Drain Culvert	
		EWO 000152	Removal of Clearing Quantity for South Dyke	
		EWO 000153	Spillway Warning System	
		EWO 000154	Stage 2 Island CD Excavation	
	2017-01-31	EWO 000155	Material Substitutions for Wall Fittings	
		EWO 000159	June 2016 Directed Work	
		EWO 000147 R1	Fish Exclusion Mounting Plates - Revision 1	
		EWO 000148 R1	Waterstop Technical Specification 031513 Update - Revision 1	
		EWO 000161	Roof & Floor Deck Material Substitutions	
		EWO 000154 R1	Stage 2 Island CD Excavation - Revision 1	
	2017-02-21	EWO 000150 R1	Service Bay Box Drain Culvert - Revision 1	
		EWO 000149 R1	Spillway Fueling Platform Precast - Revision 1	
		EWO 000146 R2	SW Hoist Tower Column Anchor Qty Change - Revision 2	
		EWO 000156	Vertical Surface Prep Spillway	
		EWO 000157	Vertical Surface Prep and Additional Joints Service Bay	
		EWO 000158	Vertical Surface Prep Powerhouse Complex	
		EWO 000156 R1	Vertical Surface Prep Spillway - Revision 1	
		EWO 000164	SB Trap Primer	
		EWO 000162	CDCD Redesign and North Extension	
	2017-02-27	EWO 000166	Embedded Guide Scope Change	
	2017-02-28	EWO 000165	Embedded Plate MK7	
	2017-03-31	EWO 000168	Powerhouse Crane Rail Girder Splice at Gridline 27	
		EWO 000167	Alternate for Hex Lock Nuts	
		EWO 000169	SW Ancillary Building Additional Wall Construction Joints	
	2017-04-30	EWO 000170	Central Dam Revision	
		EWO 000171	NCRG Top-up	
	2017-05-31	EWO 000172	Rock Netting Quantity Reconciliation	
		EWO 000176	W21, W34 and W44 inlet fittings (included in AA#7)	
		EWO 000173	Class 2a, 2b Lift Thickness	
		EWO 000181	Class 1 Lift Thickness	
		EWO 000177	Spillway condensed water drainage system (included in AA#7)	

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Change Type	Entered on Date	Work Order #	Header Description	Amt Before PST
		EWO 000184	OWS Facility, Oil Storage, W21 & W34 Systems (included in AA#7)	[redacted]
		EWO 000174	W34, A72, HV & W44 Systems (included in AA#7)	
		EWO 000182	W21, W34, W44 and W45 Systems (included in AA#7)	
		EWO 000180	Diesel Generator Fuel System - Components & Fittings (<$100K)	
		EWO 000190	Domed Hatch Substitution	
		EWO 000183	Sanitary and Domestic Systems (included in AA#7)	
		EWO 000191	Water Treatment Plant (<$20K)	
		EWO 000189	Intake headblock lap location change below 151.400	
		EWO 000185	Class 2b Production (included in AA#7)	
		EWO 000186	North Dyke Modified Low Head Granular Dyke in place of Freeboard Dyke (~-$34K)	
		EWO 000195	Unit 2 Intake Walls North Pier	
		EWO 000187	Access Control and Video Surveillance design updates (~$100K)	
		EWO 000196	Intake LHB Couplers	
		EWO 000194	Technical Specification Revision 11	
	2017-06-30	EWO 000197	Spillway Complex Infill Concrete (included in AA#7)	
		EWO 000198	Embedded Guide Revisions (included in AA#7)	
		EWO 000188	Tower Spur Footing Installation	
		EWO 000200	Embedded Anchors Update (included in AA#7)	
		EWO 000199	Spillway Fencing (included in AA#7)	
		EWO 000192	Technical Specification Updates, Sections 260521, 261102, 262213 (included in AA#7)	
		EWO 000203	Intake headblock additional vertical laps at el. 151.400	
		EWO 000207	Draft Tube Access Hatch Deck Fastening	
		EWO 000206	Technical Specification 260529 Update	
		EWO 000204	Technical Specification 083619 Update	
		EWO 000212	Tailrace Cofferdam Wet Excavation (included in AA#7)	
		EWO 000213	Composite Sand for North Dyke (included in AA#7)	
		EWO 000214	Permanent Erosion Protection (included in AA#7)	
		EWO 000215	Foundation Grouting Plasticizer Substitution	
	2017-07-29	EWO 000202	Technical Specification 265000 Update	
		EWO 000205	Intake Unit 2 Pier 4, Unit 4 & 6 Pier 1 & 4 single lift rebar	
		EWO 000211	Technical Specification 283100 Update	
		EWO 000217	Dam Cross Section Modification	
		EWO 000220	Service Bay Quantity Reconciliation	
		EWO 000210	Updates to HVAC Systems 230700, 230900, 233000	
		EWO 000221	Cleanout Substitution	
		EWO 000202 R1	Technical Specification 265000 Update Rev 1	
		EWO 000223	Misc. Metal & Crane Rail	
		EWO 000210 R1	Updates to HVAC Systems 230700, 230900, 233000 Rev 1	

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Change Type	Entered on Date	Work Order #	Header Description	Amt Before PST
	2017-07-31	EWO 000171 R1	NCRG Top-up (Revision 1)	[redacted]
	2017-08-24	EWO 000193	Technical Specification Revision 12	
		EWO 000193 R1	Technical Specification Revision 12 Rev 1	
		EWO 000222	Spillway Fault Treatment	
		EWO 000224	HVAC Embedded Fitting Substitution	
		EWO 000226	Spillway Handrail Material	
		EWO 000209	Technical Specification Update 260528 Surface Grounding	
	2017-08-28	EWO 000211 R2	Technical Specification 283100 Update Rev 2	
	2017-08-31	EWO 000171 R2	NCRG Top-up (Revision 2)	
		EWO 000225	Technical Specification Update 270000	
		EWO 000227	Intake headblock lap location change in IN-X-J-09-05 & INX-J-10-05	
		EWO 000231	PH South Transition Infill Concrete	
		EWO 000219	Updates to PH Fire Protection Standpipe System 211200	
		EWO 000235	Vertical Embedded Piping Supports	
			Approved-GP Total	
Changes				
	2017-02-28	Amending Agreement 000007	Amending Agreement #7 - Revisions to Volume 1, 3 and 4	
			Changes Total	
Changes - Contingency				
	2017-03-31	CO 0001	Increase for General Civil contract delay	
			Changes - Contingency Total	
Changes - Escalation Allowance				
	2017-03-31	CO 0001	Escalation Allowance ETC	
			Changes - Escalation Allowance Total	
Changes - LOA 35 Allowance				
	2017-03-31	CO 0001	LOA 35 Allowance ETC	
			Changes - LOA 35 Allowance Total	
Changes - Profit				
	2017-03-31	CO 0001	Profit	
			Changes - Profit Total	
Forecasted - LOA 35				
	(blank)	EWO LOA 2016-1	BNA LOA #35 - 2016 Period 1 Payment (July, 2016)	
		EWO LOA 2016-2	BNA LOA #35 - 2016 Period 2 Payment (September, 2016)	
		EWO LOA 2016-3	BNA LOA #35 - 2016 Period 3 Payment (December, 2016)	
		EWO LOA 2016-4	BNA LOA #35 - 2016 Period 4 Payment (December, 2016)	
		EWO LOA 2016-5	BNA LOA #35 - 2016 Period 5 Payment (January, 2017)	
		EWO LOA 2017-1	BNA LOA #35 - 2017 Period 1 Payment (June, 2017)	
			Forecasted - LOA 35 Total	
Forfeited Bonus				
	2015-10-20	Forfeited Bonus 0001	Forfeited Bonus - December 2014	

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Change Type	Entered on Date	Work Order #	Header Description	Amt Before PST
		Forfeited Bonus 0002	Forfeited Bonus - January 2015	[redacted]
		Forfeited Bonus 0003	Forfeited Bonus - February 2015	
		Forfeited Bonus 0004	Forfeited Bonus - March 2015	
		Forfeited Bonus 0005	Forfeited Bonus - April 2015	
		Forfeited Bonus 0006	Forfeited Bonus - May 2015	
		Forfeited Bonus 0007	Forfeited Bonus - June 2015	
		Forfeited Bonus 0008	Forfeited Bonus - July 2015	
		Forfeited Bonus 0009	Forfeited Bonus - August 2015	
	2015-11-30	Forfeited Bonus 0010	Forfeited Bonus - September 2015	
	2016-03-31	Forfeited Bonus 0011	Forfeited Bonus - February 2016	
	2016-07-11	Forfeited Bonus 0012	Forfeited Bonus - December 2015	
		Amending Agreement 0013	Forfeited Bonus - As a result of Amending Agreement #7	
			Forfeited Bonus Total	
Proposed Future Work				
	(blank)	PEW MH-0065	[redacted]	
		PEW MH-0071		
		FQA 0001		
		FQA 0002		
		FQA 0003		
		PEW MH-0075		
		PEW MH-0076		
		FQA 0004		
		NIC 0077		
		PEW BBEHC-0091		
		PEW BBEHC-0093		
			Proposed Future Work Total	

1a

Table 7 MH Directed EWO's

MH Directed Work to BBE Hydro Construction	Value
February 15 MH Directed Work	[redacted]
January 2015 MH Directed Work	
December 2014 MH Directed Work	
April 2015 Directed Work	
May 2016 Directed Work	
June 2016 Directed Work	
March 2016 Directed Work	
April 2016 Directed Work	
May, June, July 2015 Directed Work	
February 2016 Directed Work	

1a

MH Directed Work to BBE Hydro Construction	Value
November 2014 Directed Work	[redacted]
August 2015 Directed Work	
September 2015 Directed Work	
August 14 MH Directed Work	
October 14 MH Directed Work	
September 14 MH Directed Work	
June/July 14 MH Directed Work	
January 2016 Directed Work	
Total	

1a

Review of Tables 6 and 7 shows the total additional for all the "Approved GP" EWO's, which is where the technically driven changes are recorded, adds up to [redacted] which includes [redacted] in MH directed work. The EWO values per year are:

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Year	EWO Value
2014	[redacted]
2015	
2016	
2017	
Total	

1a

Clearly the total project increase in price is not driven by the technical EWO's. In fact, the technical changes in 2017 have saved [redacted] according to the data provided.

Furthermore, the negative values for profit reductions add up to a savings of [redacted] so there is actually a net savings of approximately [redacted] between the profit reductions and the approved technical EWO's.

1a

The GCC price change to date is fundamentally all in the renegotiation of the contract AA#7 for [redacted]

1a

Normally the cost estimate for the majority of General Civil Contract components should be built up from the unit prices times the quantities. Given the dramatic change in the contract cost in AA#7 both the unit prices and the quantities deserve scrutiny.

As mentioned previously, the schedule changes to the GCC have impacted the other contracts, for example review of the [redacted] Voith contract for the supply of the units shows [redacted] in total revisions to the contingency of which [redacted] is associated with delays to the GCC. Similar impacts have occurred on the camp supply and operation.

1a

4.3 Quantities

The MH review of the cost increases to date lists changes in quantities as one of the factors in the price change. Most of the work to date has been related to earthworks and concrete. The mechanical and electrical costs associated with the balance of plant for the powerhouse and spillway are

proportionally small relative to the entire project and have generally not been started. Therefore, KCB concentrated our review on the earthworks and concrete quantities and their changes. Table 8 shows the values from the Original Contract (OC) dated Mar 10, 2014 compared with the Amending Agreement #7 (AA7) dated Feb 28 and also compared with some values from the original Hatch report titled the Stage IV Engineering Summary Report - GN-10.1 Rev 0.pdf.

Table 8 Civil Quantities changes

Work Class	Work Type	UoM	Stage IV Hatch Report	Original Budget (OC)	Current Budget (AA7)	%	Variance
				A	B	C	D=B-A
Concrete Works							
	Formwork	m^{-2}		*199,794.00*	*209,304.81*	*4.76%*	*9,510.81*
QTY	Spillway			18,395.00	24,656.16	34.04%	6,261.16
	Powerhouse (incl. Transitions)			63,814.00	65,747.76	3.03%	1,933.76
	Tailrace			51,841.00	52,298.97	0.88%	457.97
	Intake			50,231.00	50,249.66	0.04%	18.66
	Service Bay			15,513.00	16,352.26	5.41%	839.26
	Embedded Anchors	*kg*		*323,592.16*	*408,285.07*	*26.17%*	*84,692.91*
QTY	Spillway			40,604.00	125,296.91	208.58%	84,692.91
	Powerhouse (incl. Transitions)			282,988.16	282,988.16	0.00%	-
	Tailrace			-	-		-
	Intake			-	-		-
	Service Bay			-	-		-
	Reinforcing Steel	*kg*		*23,448,787.00*	*23,413,316.00*	*-0.15%*	*(35,471.00)*
QTY	Spillway			3,069,931.00	2,332,481.00	-24.02%	(737,450.00)
	Powerhouse (incl. Transitions)			8,431,035.00	8,431,035.00	0.00%	-
	Tailrace			4,892,100.00	4,892,100.00	0.00%	-
	Intake			5,811,260.00	5,811,260.00	0.00%	-
	Service Bay			1,244,461.00	1,946,440.00	56.41%	701,979.00
	Cast-In-Place Concrete	m^3	*356,800*	*329,713.00*	*322,194.07*	*-2.28%*	*(7,518.93)*
QTY	Spillway			57,290.00	58,438.25	2.00%	1,148.25
	Powerhouse (incl. Transitions)			118,348.00	118,303.50	-0.04%	(44.50)
	Tailrace			47,879.00	45,975.00	-3.98%	(1,904.00)
	Intake			71,760.00	71,530.72	-0.32%	(229.28)
	Service Bay			34,436.00	27,946.60	-18.84%	(6,489.40)
Structural Steel		**kg**		**1,684,784.00**	**2,081,500.00**	**23.55%**	**396,716.00**
QTY	Light Weight < 24.9 Kg/m			115,952.00	84,500.00	-27.13%	(31,452.00)
	Medium Weight > 25 kg/m and < 124.9 kg/m			388,306.00	1,052,000.00	170.92%	663,694.00
	Heavy Weight > 125 kg/m			377,076.00	80,000.00	-78.78%	(297,076.00)
	Shop Fabricated Beams and Columns (WWF)			803,450.00	865,000.00	7.66%	61,550.00

Work Class	Work Type	UoM	Stage IV Hatch Report	Original Budget (OC)	Current Budget (AA7)	%	Variance
				A	B	C	D=B-A
Earthwork							
	Unclassified Excavations	*m^3*	*3,078,700*	*3,226,490.00*	*3,937,244.49*	*22.03%*	*710,754.49*
QTY	for Central Dam			595,150.00	651,270.00	9.43%	56,120.00
	for North Dam			100,700.00	285,680.06	183.69%	184,980.06
	for South Dam			71,800.00	174,300.00	142.76%	102,500.00
	for North Dyke			567,340.00	600,000.00	5.76%	32,660.00
	for South Dyke			622,950.00	758,100.00	21.70%	135,150.00
	for North Access Road Ramp			32,750.00	32,750.00	0.00%	-
	for South Access Road Ramp			8,900.00	8,900.00	0.00%	-
	for all concrete structures in Powerhouse area			1,078,100.00	1,216,685.00	12.85%	138,585.00
	for all concrete structures in Spillway area			17,200.00	77,959.43	353.25%	60,759.43
	for Tailrace Channel Improvement			131,600.00	131,600.00	0.00%	-
	Rock Excavations	*m^3*	*1,976,400*	*1,937,975.00*	*2,079,870.40*	*7.32%*	*141,895.40*
QTY	Spillway			359,250.00	346,049.00	-3.67%	(13,201.00)
	Powerhouse (incl. Transitions)			433,500.00	317,904.00	-26.67%	(115,596.00)
	Tailrace			603,800.00	806,200.00	33.52%	202,400.00
	Intake			283,700.00	609,465.94	114.83%	325,765.94
	Service Bay			257,725.00	251.46	-99.90%	(257,473.54)
	Impervious Fill (Class 1)	*m^3*	*1,567,100*	*1,006,300.00*	*714,084.00*	*-29.04%*	*(292,216.00)*
QTY	for Central Dam			242,800.00	294,884.00	21.45%	52,084.00
	for North Dam			26,500.00	76,500.00	188.68%	50,000.00
	for South Dam			111,500.00	107,500.00	-3.59%	(4,000.00)
	for North Dyke			292,500.00	95,400.00	-67.38%	(197,100.00)
	for South Dyke			321,000.00	139,800.00	-56.45%	(181,200.00)
	for North Access Road Ramp			6,000.00	-	-100.00%	(6,000.00)
	for South Access Road Ramp			6,000.00	-	-100.00%	(6,000.00)
	Granular Fill	*m^3*	*1,437,550*	*3,800,135.00*	*2,248,242.00*	*-40.84%*	*(1,551,893.00)*
QTY	for Central Dam			773,100.00	633,842.00	-18.01%	(139,258.00)
	for North Dam			69,600.00	165,200.00	137.36%	95,600.00
	for South Dam			177,550.00	185,000.00	4.20%	7,450.00
	for North Dyke			1,295,990.00	508,600.00	-60.76%	(787,390.00)
	for South Dyke			1,467,895.00	734,400.00	-49.97%	(733,495.00)
	for North Access Road Ramp			10,000.00	15,200.00	52.00%	5,200.00
	for South Access Road Ramp			6,000.00	6,000.00	0.00%	-
	Rockfill	*m^3*		*1,567,750.00*	*2,917,677.00*	*86.11%*	*1,349,927.00*
QTY	for Central Dam			396,500.00	896,230.00	126.04%	499,730.00
	for North Dam			54,800.00	220,500.00	302.37%	165,700.00
	for South Dam			368,500.00	248,000.00	-32.70%	(120,500.00)
	for North Dyke			160,550.00	489,000.00	204.58%	328,450.00

Work Class	Work Type	UoM	Stage IV Hatch Report	Original Budget (OC)	Current Budget (AA7)	%	Variance
				A	B	C	D=B-A
	for South Dyke			158,900.00	623,003.00	292.07%	464,103.00
	for North Access Road Ramp			257,800.00	258,200.00	0.16%	400.00
	for South Access Road Ramp			56,300.00	56,300.00	0.00%	-
	Powerhouse (incl. Transitions)			114,400.00	126,443.00	10.53%	12,043.00
	Intake			-	1.00		1.00
	Riprap	*m^3*		*469,550.00*	*486,248.00*	*3.56%*	*16,698.00*
QTY	for Central Dam			111,400.00	110,300.00	-0.99%	(1,100.00)
	for North Dam			11,300.00	14,400.00	27.43%	3,100.00
	for South Dam			43,300.00	33,744.00	-22.07%	(9,556.00)
	for North Dyke			107,100.00	109,300.00	2.05%	2,200.00
	for South Dyke			175,650.00	179,400.00	2.13%	3,750.00
	for North Access Road Ramp			1,100.00	2,000.00	81.82%	900.00
	for South Access Road Ramp			500.00	500.00	0.00%	-
	Powerhouse (incl. Transitions)			19,200.00	36,604.00	90.65%	17,404.00
	Intake			-			

Examination of the table shows variances ranging from -41% for granular fill to +86% for rockfill, which suggests there may have been some volumes changed from one category to the other. The variance between the sum of the two is approximately 200,000 m3 or about 4%.

The concrete volumes starting with the Hatch project report are remarkably close for all the estimates.

In conclusion, the change in quantities in total do not justify the large increase in the contract value. If the basis for payment for the project was the original Unit Prices together with the actual quantities were the project would likely be within the contingency, i.e. on budget.

4.4 Unit Prices

The unit prices in the Bill of Quantities, Prices and Target Price Estimate- are very detailed, comparison with the unit prices of the original contract and later agreement amendments is difficult. For our review, and to enable comparisons, similar items in the Bill of Quantities have been grouped together and an equivalent unit price has been calculated by dividing the total cost of the grouped items by the total quantity.

KCB made a comparison of the consolidated unit prices thus calculated between the original contract, as provided in Amending Agreement 3 (March 2014) and the latest amendment with unit prices, as provided in Amending Agreement 7 (February 2017).

The following consolidated items are selected to provide an overview of the unit prices for the civil works:

- Cast-in-Place Concrete. The consolidated unit prices include the formwork costs. The ratio of formwork area to concrete volume differ for the various structures as follows:
  - Intake: formwork area to concrete volume = 0.7 m^2/m^3.
  - Powerhouse and service bay: formwork area to concrete volume = 0.52 m^2/m^3.
  - Tailrace: formwork area to concrete volume = 1.08 m^2/m^3.
  - Spillway: formwork area to concrete volume = 0.32 m^2/m^3.
- Reinforcing Steel.
- Structural Steel. The consolidated unit price included all main structural steelwork.
- Unclassified Excavation for concrete structures, for dams and dykes and for dykes in winter.
- Rock excavation.
- Impervious fill.
- Granular fill, all classes.
- Rockfill.

Table 9 presents the changes in the consolidated unit prices between the initial contract provided in Amending Agreement 3 and Amending Agreement 7.

Table 9 Consolidated Unit Prices Extract from Amending Agreement 3 and 7

Description	Unit	Amending Agreement 3		Amending Agreement 7		Consolidated Unit Price Increase
		Quantity	Consolidated Unit Price	Quantity	Consolidated Unit Price	
Cast-in-Place Concrete			[redacted]		[redacted]	[redacted]
Intake	m^3	72,210		71,530		
Powerhouse and service bay	m^3	151,334		146,248		
Tailrace	m^3	47,879		45,975		
Spillway	m^3	57,290		58,436		
Reinforcing Steel						
All structures	kg	23,448,787		23,218,582		
Structural Steel						
All structures	kg	1,684,784		2,081,500		
Unclassified Excavation						
For concrete structures	m^3	1,226700		1,426,044		
For dams and dykes	m^3	809,500		1,070,548		
For Dykes in winter	m^3	1,109,290		1.346,100		
Rock Excavation						
All rock excavations	m^3	1,937,975		2,079,869		

1a

Description	Unit	Amending Agreement 3		Amending Agreement 7		Consolidated Unit Price Increase
		Quantity	Consolidated Unit Price	Quantity	Consolidated Unit Price	
Compacted Fill			[redacted]		[redacted]	[redacted]
Impervious fill	m^3	1,006,050		714,084		
Granular fill	m^3	3,811,935		2,260,042		
Rockfill	m^3	1,567,750		2,319,923		

1a

The percentage increase in the consolidated unit prices from Amending Agreement 3 to Amending Agreement 7 in the samples provided in Table 9 vary between 67% to 366%. Reviewing the entire Bill of Quantities, Prices and Target Price Estimate in the two respective Amending Agreement, virtually all the unit prices show similar increases as demonstrated above. KCB believe that the substantial increases in the unit prices in Amending Agreement 7 is largely responsible for the substantial increase in the Target Price Estimate in Amending Agreement 7.

To be able to comment on the reasonableness of the unit prices in the Amending Agreements 3 and 7, KCB compared the unit prices with some historical information obtained for similar work for the construction of a large hydroelectric power project in northern Canada. Table 10 present the comparison between the consolidated unit prices for Amending Agreements 3 and 7 and the historical information.

Table 10 Comparison between Consolidated Unit Prices

Description	Unit	Consolidated Unit Price		
		Amending Agreement 3	Amending Agreement 7	Historical Information
Cast-in-Place Concrete		[redacted]		
Intake	m^3			$1,000
Powerhouse and service bay	m^3			$1,000
Tailrace	m^3			$1,200
Spillway	m^3			$600
Reinforcing Steel				
All structures	kg			$4.00
Structural Steel				
All structures	kg			$9.00
Unclassified Excavation				
For concrete structures	m^3			$10.00
For dams and dykes	m^3			$10.00
For Dykes in winter	m^3			$10.00
Rock Excavation				
All rock excavations	m^3			$20.00
Compacted Fill				
Impervious fill	m^3			$25.00
Granular fill	m^3			$10.00
Rockfill	m^3			$80.00

1a

The following comments are made regarding the comparison between the consolidated unit prices:

- Cast-in-Place Concrete. The consolidated unit prices in the initial contract appear to be low but those in the Amending Agreement 7 appear high compared to the KCB historical information.
- Reinforcing Steel. The consolidated unit prices in the initial contract appear to be low but those in the Amending Agreement 7 appear reasonable compared to the KCB historical information.
- Structural Steel. Both the consolidated unit prices in the initial contract and the Amending Agreement 7 appear to be low compared that in the KCB historical information. This difference could be the result of the difference locations for sourcing the structural steel.
- Unclassified Excavations. The consolidated rates for unclassified excavation appears to be reasonable but those in the Amending Agreement 7 appear high compared to the KCB historical information.
- Rock Excavation for both the initial contract and the Amending Agreement 7 appear to be higher than the KCB historical information. The higher rock excavation unit price could relate to the hardness of the rock being excavated.
- Impervious fill. The consolidated unit prices in the initial contract appear to be low but those in the Amending Agreement 7 appear very high compared to the KCB historical information.
- Granular fill. Both the consolidated unit prices in the initial contract and the Amending Agreement 7 appear to be low compared that in the KCB historical information.
- Rockfill. The consolidated unit price for both the initial contract and Amending Agreement 7 are significantly lower than the KCB historical information. The haul distance for the rockfill for the KCB historical information is very substantial as the quarry for this rockfill is located far away from the site, whereas the rockfill for the Keeyask GS is sourced locally.

In summary, the unit prices in the initial contract appear to be generally lower when compared with the corresponding KCB unit price data, whereas the unit prices in Amending Agreement 7 appear to be generally significantly high.

KCB was interested in the impact of the unit prices on the associated costs and therefore performed the following calculations using the consolidated unit prices from Table 9 and the associated quantities.

Initial Contract - The consolidated unit prices times the original estimated quantities = cost

Historical Information - The KCB historical unit prices times the original estimated quantities = cost

AA#7 – the AA#7 unit prices times the new estimated total quantities = cost. (Could be viewed as what the price should have been)

The results of our analysis are shown in Table 11.

Table 11 Unit Price and Cost Comparison

Description	Unit	Amending Agreement (AA) 3 Basis			Amending Agreement(AA) 7 Basis			KCB Historical Information Unit Prices		
		Total Quantity	Consolidated Unit Price	Total Cost ('000$)	Total Quantity	Consolidated Unit Price	Total Cost ('000$)	AA3 Total Quantity	Historical Unit Price	Total Cost (thousand $)
Cast-in-Place Concrete			[redacted]			[redacted]				
Intake	m^3	72,210			71,530			72,210	$1,000	$72,210
Powerhouse and service bay	m^3	151,334			146,248			151,334	$1,000	$151,334
Tailrace	m^3	47,879			45,975			47,879	$1,200	$57,454
Spillway	m^3	57,290			58,436			57,290	$600	$34,374
Reinforcing Steel										
All structures	kg	23,448,787			23,218,582			23,448,787	$4.00	$93,795
Structural Steel										
All structures	kg	1,684,784			2,081,500			1,684,784	$9.00	$15,163
Unclassified Excavation										
For concrete structures	m^3	1,226,700			1,426,044			1,226,700	$10.00	$12,267
For dams and dykes	m^3	809,500			1,070,548			809,500	$10.00	$8,095
For Dykes in winter	m^3	1,109,290			1.346,100			1,109,290	$10.00	$11,092
Rock Excavation										
All rock excavations	m^3	1,937,975			2,079,869			1,937,975	$20.00	$38,759
Compacted Fill										
Impervious fill	m^3	1,006,050			714,084			1,006,050	$25.00	$25,151
Granular fill	m^3	3,811,935			2,260,042			3,811,935	$10.00	$38,119
Rockfill	m^3	1,567,750			2,319,923			1,567,750	$80.00	$125,420
TOTAL										**$683,236**

1a

The table shows that, for the subset of quantities we examined, using the original unit rates the price would have been [redacted], and with the blended original and AA#7 rates the same work will be [redacted] or about [redacted] times the original target price. Using the AA#7 [redacted] multiplier the BBE original contract price might have been [redacted] 1a

Using KCB's assumed unit rates BBE's original Target Price was low by at least [redacted] or a factor of [redacted]. If the [redacted] were to have been included the BBE original contract price ([redacted]) would have been [redacted] 1a

There are other costs associated with the project that this simple analysis does not consider, for example mobilization, dewatering and coffer dam costs, which, if done in detail, will adjust these figures. But the conclusion is that the original BBE project target price was very optimistic and that a more realistic price might have been between $1.8B and $2.2B.

5 CONTRACTING METHODOLOGY

5.1 References

- Original Contract - 243994-0020-016203-CON-GCC Volume 1 20140310
- AA#7 - 243994-0020-016203-CON-GCC Volume 1 20170228.pdf

5.2 Discussion

The original 2014 contract was a cost reimbursable model with early contractor involvement. Early contractor involvement is currently one of the more favoured aspects of contracting. The advantages of working with a contractor to optimize the design, is intended to fairly apportion the risks and settle on fair profits and incentives for the contractor.

Based on our analysis of the design, the quantity estimates, the extra work orders and the unit prices, we could not initially understand how the project could be as far over budget as it is, because the variances in quantities are not that high and the initial unit prices were in fact low.

Then we read the 2014 contract terms, and in particular the Terms of Payment sections. Section 5 Price and Payment of the Work says:

> *"The general basis of payment for the Work will be on a cost reimbursable basis with provisions for an Initial Target Price and Final Target Price in accordance with and subject to the terms of the Contract."*
>
> *"For purposes of payment, the Work shall be measured as set out in the Contract documents."*

The Initial Target Price is defined, the Target Price Assumptions and calculation are defined and presented in sections 5 and 6. Most importantly the Adjustments to the target price are also defined and include:

- Escalation including;
- Extra Work Orders, *based on variations in quantities;*
- Additional scope items added to the contract;
- Extensions of time and delay payments; and
- Cash allowance overruns.

These adjustments are reasonable clauses and logical reasons for additional funds.

To that point the project risk seems to be clearly defined, and in fact Section 6.2.2 defines how the target price is to be adjusted for changes in quantities. Specifically, the unit prices are not to be changed unless the quantity variance is more than +/- 15%.

> *"….there shall be no changes to the Unit Prices originally submitted by the Contractor, unless the actual quantities vary from the estimated quantities by +/- 15% of the estimated quantities…."*

These are all reasonable and relatively typical contract clauses for a contract where the payment is based on unit prices and quantities for work actually performed.

Reading Section 9 Basis for Payment also seems generally reasonable for a cost reimbursable contract, with profit and GA&O defined as a percentage using formulas based on the Actual Costs and the Final Target Price.

However, the payment wording definition for Actual Costs does not seem to include any exclusions or amendment possibility and does **not seem to be related to quantities x unit prices**.

> *"Subject to these Terms and Conditions of Payment, the Purchaser shall pay the Contractor the Contractor's Actual Costs incurred in the performance of the Work."*

Thus, the definition of Actual Costs is critically important to the payment process. The Definition of Actual Costs from section 11 is:

> *""Actual Costs", for the purposes of the Contract, shall mean only the following:*
>
> *(a) **all actual, indirect and direct costs** incurred by the Contractor in performing the Work including, but not limited to (and specifically excluding GST and RST required to be collected from Purchaser by Contractor but including any RST required to be paid by Contractor to its suppliers or required to be self-assessed and paid by Contractor), all costs incurred for **all labour** (including the cost of workers' compensation assessments, vacation pay, employment insurance, pension plan payments, payroll taxes, and any other employee benefits paid by the Contractor), **equipment rentals, all supplies and materials, services, delivery and transportation, or any other direct, indirect and actual cost incurred by the Contractor in the performance of the Work** as is more fully set out in this Section 11;*
>
> *(b) all actual, indirect and direct costs incurred by the Contractor (in accordance with paragraph (a) above) resulting from an addition to, deletion from or modification of the Work as documented in an Extra Work Order or Change Order; and*
>
> *(c) all actual, indirect and direct costs incurred by the Contractor (in accordance with paragraph (a) above) resulting from a termination for convenience by the Purchaser of the Contract in accordance with Section 29.3 TERMINATION FOR CONVENIENCE of the General Specification…"*

As noted there is no connection between actual costs and the quantities and unit prices in the Bill of Quantities. This is a critical omission, because as has been demonstrated, the contractor may have little incentive to actually perform the work.

Another interesting clause relates to Progress and Cost Forecasts, whereby the contractor is paid two months in advance for planned work. We have never seen a contract with that clause, typically the way a contractor ensures his cashflow remains positive is through the mobilization payment and actually performing the work and earning revenue based on quantities times unit prices.

Interestingly even after the project schedule and budget went awry and was renegotiated, the 2017 contract AA#7 still has the same method of payment as the 2014 original contract using Actual Costs and still has little or no direct connection to measured work done or the approved unit prices except with respect to small changes dependent on the Target Price.

In summary, we have never seen a large contract where payment was not related to actual performance of the construction work as measured in some manner. Where we have seen cost reimbursable contracts is for small work directly controlled by the owner, for example drilling contracts where the owner tell the drillers where to drill, when to stop and then pays for actual equipment and crew time. MH is not a contractor and likely does not have the staff and experience to direct all aspects of a major project like Keeyask day to day, in sufficient detail, thus KCB believe the contract is very one sided benefiting the contractor.

6 SCHEDULE REVIEW

6.1 References

- BBE - High Level Schedule (current)
- BBE High Level Approved A7 Baseline
- BBE High Level Original Contract Schedule

6.2 Schedule

MGF has examined the schedule in detail however KCB also examined the overall schedule from a high level perspective, looking at the overall durations for the major structures.

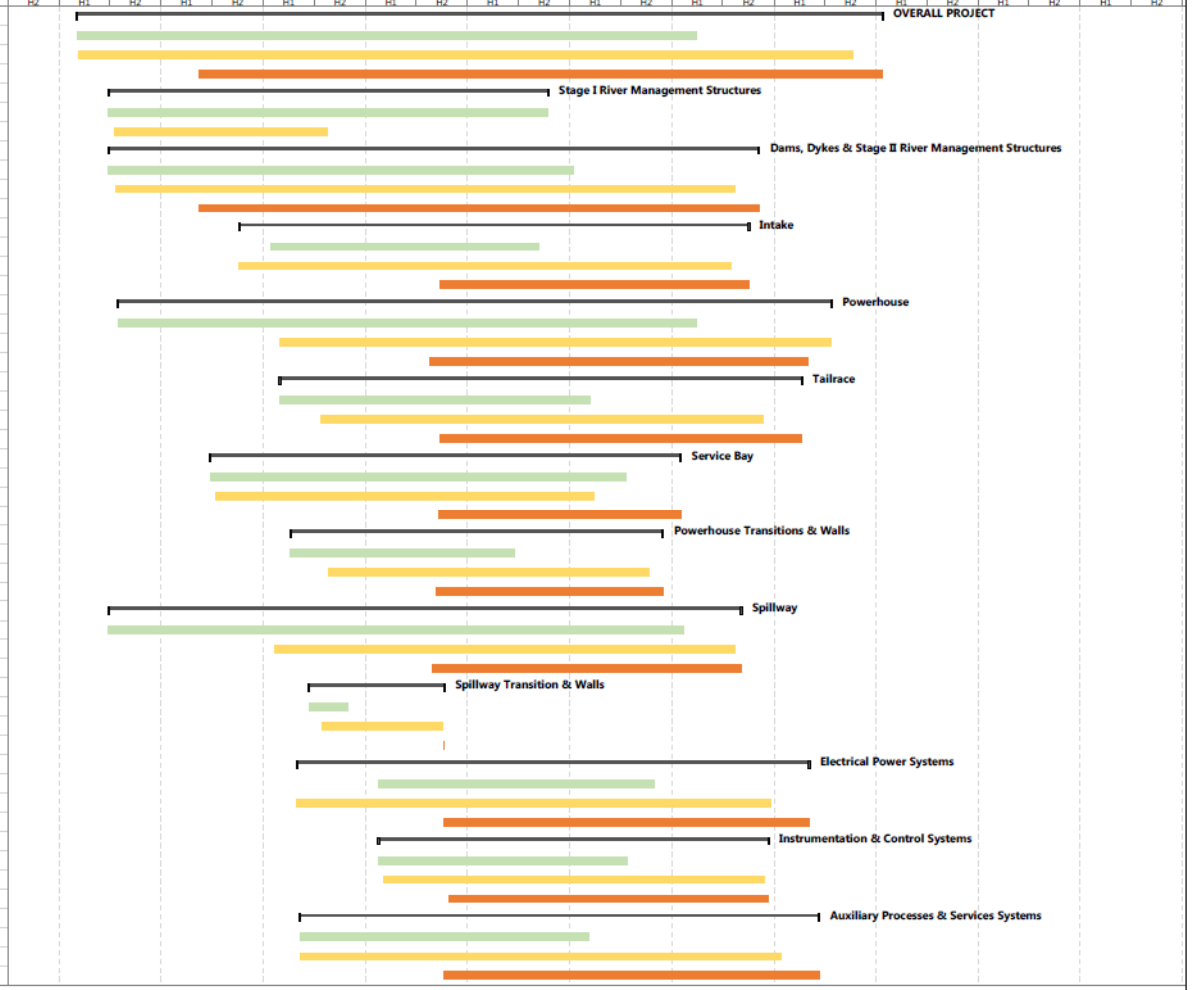
The original schedule, the AA#7 Baseline and a current schedule provided by MGF were all compared. The durations for the major activities are shown in the following table and schedule figure.

Table 12 Schedule Dates

Task Name	Original Schedule		Amendment #7 Schedule		Slippage	Current Schedule		Slippage
	Start	Finish	Start	Finish	Original vs #7 (Months)	Start	Finish	#7 vs Current (Months)
Stage I River Management Structures	27-Jun-2014	15-Oct-2018	16-Jul-2014	15-Aug-2016	-26.4	N/A	N/A	N/A
Dams, Dykes & Stage II River Management Structures	27-Jun-2014	11-Jan-2019	23-Jul-2014	13-Aug-2020	19.3	30-May-2016	08-Nov-2020	2.9
Intake	28-Jan-2016	10-Sep-2018	08-Oct-2015	30-Jul-2020	23.0	22-Sep-2017	02-Oct-2020	2.1
Powerhouse	31-Jul-2014	26-Mar-2020	01-Mar-2016	24-Jul-2021	16.2	18-Aug-2017	01-May-2021	-2.8
Tailrace	01-Mar-2016	12-Mar-2019	25-Jul-2016	23-Nov-2020	20.7	22-Sep-2017	09-Apr-2021	4.6
Service Bay	26-Jun-2015	19-Jul-2019	14-Jul-2015	27-Mar-2019	-3.8	20-Sep-2017	02-Feb-2020	10.4
Powerhouse Transitions & Walls	08-Apr-2016	15-Jun-2018	23-Aug-2016	08-Oct-2019	16.0	15-Sep-2017	30-Nov-2019	1.8
Spillway	27-Jun-2014	09-Feb-2020	10-Feb-2016	11-Aug-2020	6.1	25-Aug-2017	05-Sep-2020	0.8
Spillway Transition & Walls	13-Jun-2016	28-Oct-2016	29-Jul-2016	02-Oct-2017	11.3	06-Oct-2017	09-Oct-2017	0.2
Electrical Power Systems	17-Feb-2017	29-Oct-2019	01-May-2016	20-Dec-2020	13.9	06-Oct-2017	06-May-2021	4.6
Instrumentation & Control Systems	17-Feb-2017	26-Jul-2019	08-Mar-2017	27-Nov-2020	16.3	25-Oct-2017	11-Dec-2020	0.5
Auxiliary Processes & Services Systems	14-May-2016	07-Mar-2019	11-May-2016	24-Jan-2021	23.0	06-Oct-2017	10-Jun-2021	4.6

KGS High Level Schedule Comparison

ID	Task Name	Start	Finish
1	**OVERALL PROJECT**	**05 March 2014**	**23 January 2022**
2	Original Schedule	05 March 2014	26 March 2020
3	Amendment #7	10 March 2014	08 October 2021
4	Current Schedule	18 May 2015	23 January 2022
5	**Stage I River Management Structures**	**27 June 2014**	**15 October 2018**
6	Original Schedule	27 June 2014	15 October 2018
7	Amendment #7	16 July 2014	15 August 2016
8	**Dams, Dykes & Stage II River Management Structures**	**27 June 2014**	**08 November 2020**
9	Original Schedule	27 June 2014	11 January 2019
10	Amendment #7	23 July 2014	13 August 2020
11	Current Schedule	18 May 2015	08 November 2020
12	**Intake**	**08 October 2015**	**02 October 2020**
13	Original Schedule	28 January 2016	10 September 2018
14	Amendment #7	08 October 2015	30 July 2020
15	Current Schedule	22 September 2017	02 October 2020
16	**Powerhouse**	**31 July 2014**	**24 July 2021**
17	Original Schedule	31 July 2014	26 March 2020
18	Amendment #7	01 March 2016	24 July 2021
19	Current Schedule	18 August 2017	01 May 2021
20	**Tailrace**	**01 March 2016**	**09 April 2021**
21	Original Schedule	01 March 2016	12 March 2019
22	Amendment #7	25 July 2016	23 November 2020
23	Current Schedule	22 September 2017	09 April 2021
24	**Service Bay**	**26 June 2015**	**02 February 2020**
25	Original Schedule	26 June 2015	19 July 2019
26	Amendment #7	14 July 2015	27 March 2019
27	Current Schedule	20 September 2017	02 February 2020
28	**Powerhouse Transitions & Walls**	**08 April 2016**	**30 November 2019**
29	Original Schedule	08 April 2016	15 June 2018
30	Amendment #7	23 August 2016	08 October 2019
31	Current Schedule	11 September 2017	30 November 2019
32	**Spillway**	**27 June 2014**	**05 September 2020**
33	Original Schedule	27 June 2014	09 February 2020
34	Amendment #7	10 February 2016	11 August 2020
35	Current Schedule	25 August 2017	05 September 2020
36	**Spillway Transition & Walls**	**13 June 2016**	**09 October 2017**
37	Original Schedule	13 June 2016	28 October 2016
38	Amendment #7	29 July 2016	02 October 2017
39	Current Schedule	06 October 2017	09 October 2017
40	**Electrical Power Systems**	**01 May 2016**	**06 May 2021**
41	Original Schedule	17 February 2017	29 October 2019
42	Amendment #7	01 May 2016	20 December 2020
43	Current Schedule	06 October 2017	06 May 2021
44	**Instrumentation & Control Systems**	**17 February 2017**	**11 December 2020**
45	Original Schedule	17 February 2017	26 July 2019
46	Amendment #7	08 March 2017	27 November 2020
47	Current Schedule	25 October 2017	11 December 2020
48	**Auxiliary Processes & Services Systems**	**11 May 2016**	**10 June 2021**
49	Original Schedule	14 May 2016	07 March 2019
50	Amendment #7	11 May 2016	24 January 2021
51	Current Schedule	06 October 2017	10 June 2021



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Original Amendment #7 Current

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Some observations are:

- The earthworks, dams dykes and stage II river management structures are two years late, and that obviously impact other components.
- Compared with the original, the intake was started late on the AA7 schedule and based on work to date we do not understand how the long duration shown in AA7 can be compressed as shown on the current schedule.
- Similarly, the spillway work in the current schedule is a much shorter duration than either the original or the AA7 schedule, which may not be reasonable.
- The powerhouse duration in the current schedule is also dramatically shorter than the previous schedules.
- The Electrical Power system, Instrumentation and Control System and auxiliary Processes & Service Systems are all heavily dependent on the powerhouse schedule and in particular, require a weatherproof structure with all the walls and primary concrete installed to enable cable tray and pipe racks to be installed followed by the cables, pipes, cubicles and equipment and then all the terminations, connections, testing and commissioning. We do not understand how that work can start as close to the powerhouse start as shown on the current schedule and finish as close to the end of the powerhouse structure as shown.

In summary, the current schedule looks to be aggressive and unlikely to be met.

Note that the schedule evaluation considers the completion of all the units, and that some of the units may be complete and operational for the dates shown and that may be enough to handle the river flows at that time. Thus, there may be no hydrological reason to have all the units completed by 0ctober 2021 as shown, however there are likely strong commercial reasons to complete the project.

7 PROJECT EXECUTION AND CONSTRUCTION MANAGEMENT

7.1 References

- 243994-0020-016203-REC-Keeyask GCC Board Recommendation-2014 02 24
- KPMG Project Health Check_V10 - July 2016.
- Keeyask Recovery Plan Strategy for Implementation - 2016 10 26

7.2 Discussion

The execution of the work is behind schedule and over budget. As noted, the majority of the cost and schedule slippage can be traced back to the General Civil Contract and the lack of performance by the contractor.

KCB has not examined in any detail the manpower or the nominal productivity at site, however we understand from the changes in unit prices between the original and AA#7 Target Prices, and comments in reports related to the worker benefits, in particular booking time away from site, that productivity has not been as presented by BBE in their original bid.

Reading the Board Recommendations related to the contract price change, the KPMG project Health Check and the Recovery Plan strategy, we also understand there have been significant staff turnovers in the contractor's management and supervision, all of which will/have contributed towards delays on the project.

However, in our opinion the most significant issue for the project is the almost 100% decoupling of work performance from payment by paying Actual Costs instead of Quantities times Unit Prices for actual work done.

While we were not part of the process that selected the contracting model, we surmise that MH either had success with this model elsewhere, or there were significant reasons to push the project into construction quickly relying on the early contractor involvement, the expectations of a quality design from Hatch and an experienced contractor with a realistic target price to make the project a success. MH only assigned a contingency of [redacted] to the contract for MH held risks, which when added to the BBE target price is still lower than the costs of the project. While hindsight is 20:20 and we were not party to the bid evaluations, the contingency now looks to have been significantly too low. 4b

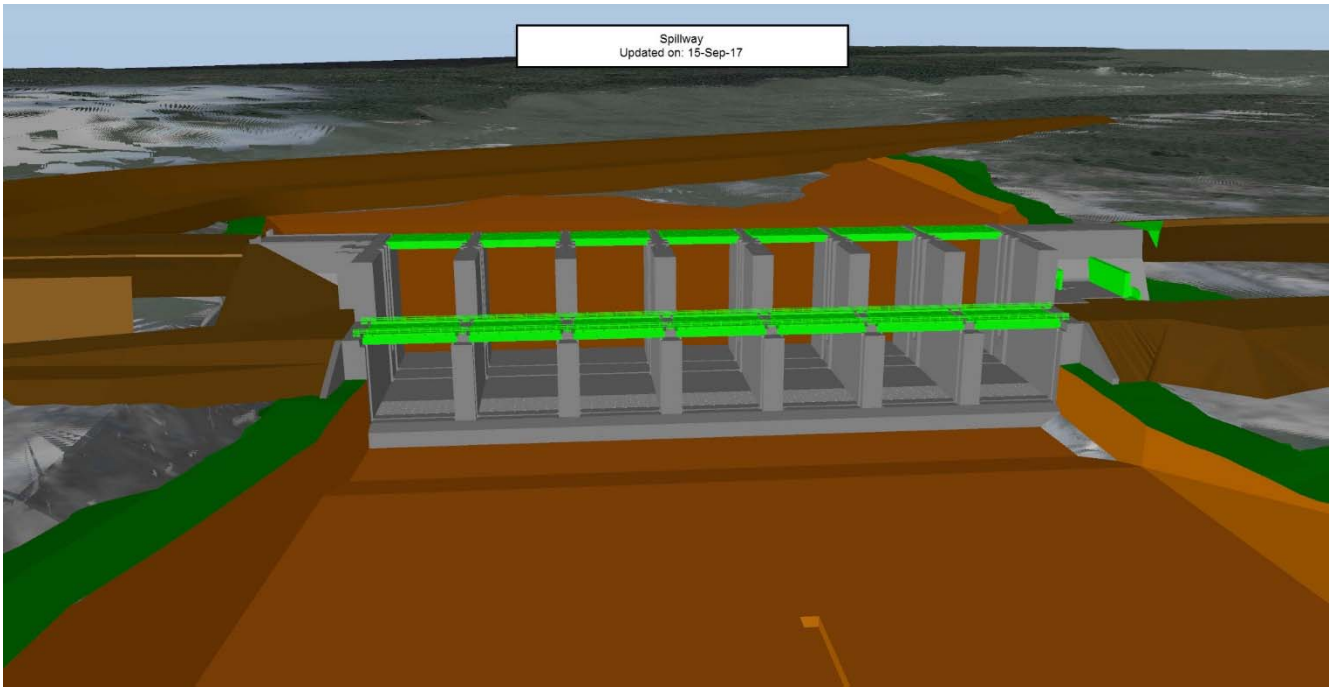
Interestingly during the discussions leading to AA#7 we understand there were serious considerations given to removing the contractor for all or part of the work.

Again, KCB was not part of the discussions and in all likelihood, would have also recommended continuing with the contractor as the likely least cost alternative. But we do not understand why the Actual Cost payment model remained almost unchanged without any modifications to connect payments to actual progress. We can only surmise there were legal issues preventing that much revision to the contract.

Review of the other major contracts for gates and the units found they are all more conventional, with payment tied to delivery and installation of various components.

KCB has observed that MH appears to have a robust and organized system for documenting changes, recording and filing information during construction which suggests the information needed for construction management is being collected and prepared. KCB has not been to site, and is unaware of the relationships between the MH and Hatch site staff and the BBE site staff, but we have read that getting staff for site for all parties has been somewhat of a problem. Changing staff at site makes building relationships harder and most certainly will affect speed of decision making at site and the level of trust which is always needed between owner and contractors staff.

After review of the referenced information, KCB is of the opinion that BBE will not be able to complete the project according to the AA#7 schedule and that the Actual Cost will therefore be higher than the current AA#7 value. The two figures below show the September 2017 work status on the spillway and powerhouse.



The spillway is relatively far advanced, however none of the ogee's are installed and none of the gates have been started. With reasonable progress next summer we would expect that the spillway will not be on the critical path.

The powerhouse is on the critical path and based on the current status KCB does not expect the powerhouse to be ready for any significant unit installation on schedule. Consequently, in addition to the additional costs for the civil work, there are likely to be additional claims for delay payment from Voith and almost all the other mechanical and electrical contractors and suppliers.

KCB has not examined the schedule in detail or the productivity rates, but MGF has, and after discussion with KCB, together our opinion is that we are forecasting a further delay.

APPENDIX B

Amplitude Consultants Report

Capital Expenditure Review

For the Bipole III Project

Converter Stations

Revision	Date	Prepared	Reviewed	Approved
0	28/11/17	L. Brand	K. Hua	L. Brand
1	1/12/17	L. Brand	K. Hua	L. Brand
2	2/12/17	L. Brand	K. Hua	L. Brand

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1 Introduction

Amplitude Consultants (Amplitude) were requested to undertake a review of the converter station component of the Bipole III HVDC project currently being built by Manitoba Hydro. Amplitude's scope of work was to, for the Keewatinohk and Riel high voltage direct current converter stations, and as directed by MGF, assist MGF with the assessment for reasonableness of the current forecast at completion capital costs, including whether appropriate contingencies and reserves have been provisioned.

Amplitude performed the required scope of work with the information made available through the Manitoba Hydro online document system and subsequent email responses to queries posed to Manitoba Hydro.

Amplitude experienced some difficulties related to the timing of PRA approvals for members of the team and in getting access to the Manitoba Hydro online document system, including:

1. Late advice of the PRA approval of the technical team members – the PRA process took longer than expected, with some team members not getting advised of the success of their PRA approval until a number of weeks after submission.
2. Difficulties getting access to and logging into the Manitoba Hydro online document system – despite being eventually provided user names and passwords, team members were unable to access the system due to a variety of IT and permission related issues. On the date of the submission of the first draft of the report to MGF, only one out of Amplitude's five team members was able to access the system using their credentials.

The issues above led to a late start on the review of the documentation, and some team members being unable to commence work and contribute as expected. The lead reviewer, who was the only person able to access the system, had to spend more time accessing documents and dealing with access and IT issues.

The outcomes of the review presented in this report are provided with the caveat that the issues described above reduced the effective amount of time that Amplitude had to review the vast amount of data and information provided.

Amplitude has addressed this scope item through two findings:

1. Our view on the reasonableness of the current (2016) forecast completion costs for the converter stations;
2. Our view on whether reasonable contingencies and reserves have been provisioned.

2 Reasonableness of the 2016 forecast completion costs for the converter stations

2.1 Observations & Findings

The most recent revision to the cost estimate and budget for the Keewatinohk and Riel converter stations was completed in 2016. This cost estimate applied the same structure as that used in the 2014 cost estimate, which is explained in detail in the Manitoba Hydro document "Bipole III Project, Basis of Estimate Document, September 2014 Cost Estimate Update" dated March 2015.

The 2014 cost estimate applied a Work Breakdown Structure level (WBS) and each WBS was broken down further into a number of networks. The cost estimate for the converter stations were grouped into nine WBS. The same WBS structure was applied to the 2016 estimate. Table 1 provides a summary of 2014 and 2016 cost estimates for the converter station WBSs.

Table 1 - Converter Station Cost Estimates - 2014 and 2016

WBS No.	Description	2014 Estimate (CAD)	2016 Estimate (CAD)
14363	Property – Riel Converter Station	[redacted]	[redacted]
14364	Riel Converter Station & 230kV AC Switchyard Site Development		
15533	Property – Keewatinohk Converter Station		
15540	Keewatinohk Converter Station		
15541	Riel Converter Station		
15544	Keewatinohk 230kV AC Switchyard		
21082	Keewatinohk Converter Station Distribution		
23788	Riel 230kV Expansion for Bipole III		
23837	Converter Stations Contingency		
	Totals	**2,675,082,692.80**	**2,779,633,110.33**

1a, 7a

The documents indicate that the values in Table 1 include Manitoba's Provincial Sales Tax. This was assumed to be 8% on "applicable items" in the 2014 estimate, and Amplitude has assumed that this same assumption was carried over to the 2016 estimate update.

Table 1 shows an increase in the estimate/budget between 2014 and 2016 for the converter stations of $104,550,417.53. Some WBS values were increased materially (15540, 15541 and 23837) while others were reduced. The most notable increase in budget is an increase in contingency by [redacted] 1a, 4b

Documents reviewed have identified a need to increase contingency during the April 2016 cost estimate revision, due to risks identified by the Boston Consulting Group. We understand that additional funds were requested as the confidence level of P50 was not considered "*appropriate to address the remaining risks on the work*"[1] and that the project management team requested additional funds to bring the confidence level to P75 "*in order to complete the project on budget and to address costs that had been drawn from contingency as a result of cost sharing with the now-shelved Conawapa Project*"[1]. A summary of the contingency adjustments is provided in the Manitoba Hydro document. These amounts add up to [redacted] The difference between the budget increase and this amount has been explained by Manitoba Hydro as due to a reduction in the target adjustment account that is held, from [redacted] 1a, 7a These are accounting elements and Amplitude is not qualified to comment on such transactions.

[1] Manitoba Document "CEF-16 Budget Update and CPJA Budget Increase Summary", August 29, 2017.

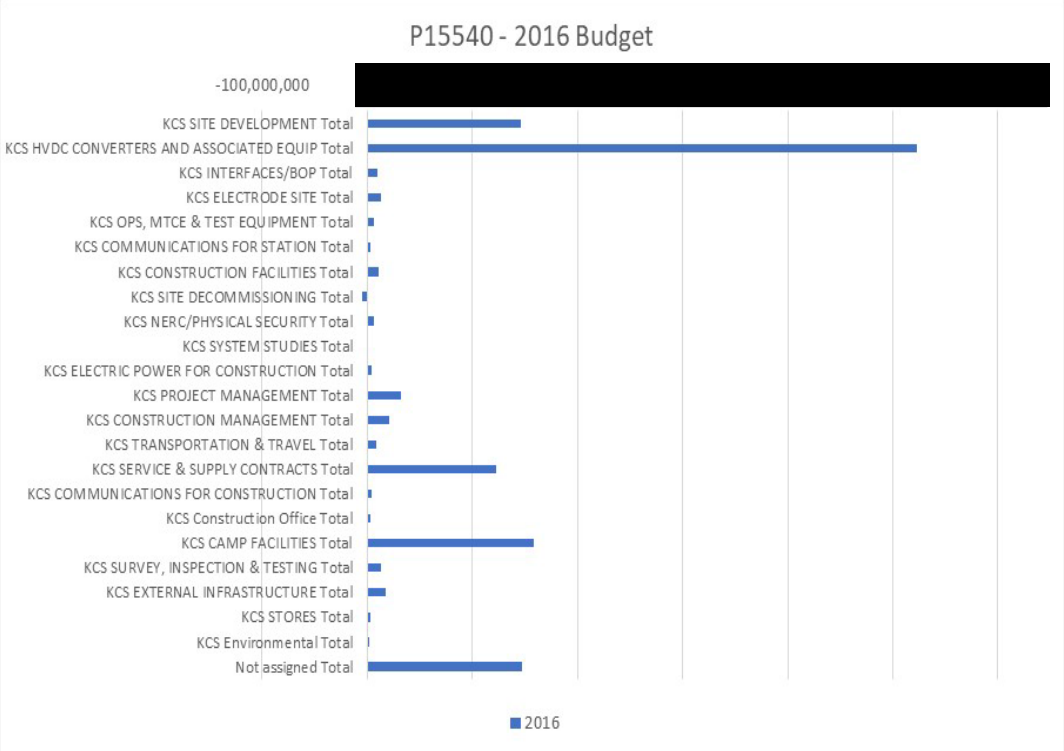
The only scope change identified in the documents provided is the additional funding for the access road for Conawapa, the cost of which was originally to be shared with the Conawapa Project, which was since shelved[2]. This resulted in an increase to the converter station contingency of [redacted] 7a

The WBS values in Table 1 show that the major cost items for the converter stations are (in descending order):

1. WBS 15540 - Keewatinohk Converter Station
2. WBS 15541 - Riel Converter Station
3. WBS 23837 - Converter Stations Contingency.
4. WBS 15544 - Keewatinohk 230kV AC Switchyard
5. WBS 14364 - Riel Converter Station & 230kV AC Switchyard Site Development

The first two WBS (15540 and 15541) make up close to 78% of the total budget for the overall converter station costs. These two WBS have a high number of cost networks, compared to the others, having each 22 networks. A breakdown of the 2016 budget allocations for each of the 22 networks for P15540 an P15541 is provided in Table 2 and Table 3 respectively.

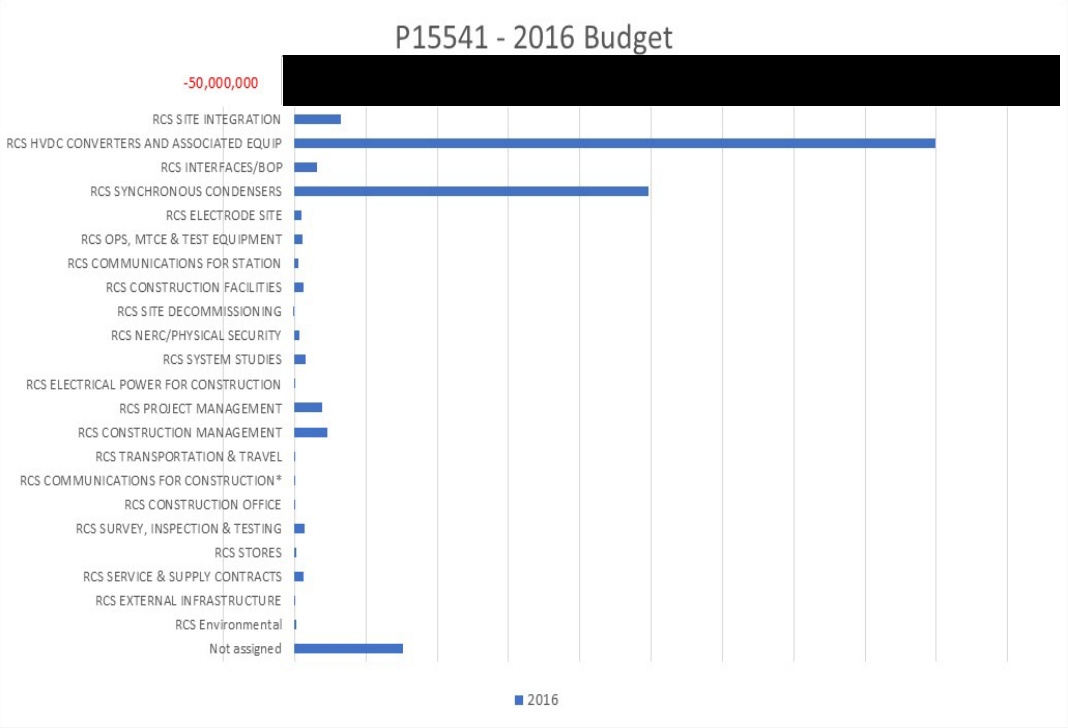
Table 2 - Breakdown of Cost Networks for P15540 - Keewatinohk Converter Station



1a, 7a

[2] Manitoba Hydro Document, "Basis for the Current Converter Stations Budget", page 1.

Table 3 - Breakdown of Cost Networks for P15541 - Riel Converter Station



1a, 7a

For Keewatinohk (P15540), it can be seen that the cost network for the HVDC converters and associated equipment (Network 244644) is the dominant cost, as would be expected. This is followed by the camp facilities (Network 244633), site development (Network 244643) and not assigned amounts.

For Riel (P15541), the dominant cost is again the HVDC converters and associated equipment (Network 244616) followed by the cost of the Synchronous Condensers (Network 244618) and unassigned amounts.

The sum of the HVDC converters and associated equipment networks (for both sites) and the synchronous condensers at Riel (i.e. the major EPC contracts) makes up over [redacted] or about [redacted] of the total estimate for the HVDC converters. In our experience, this proportion of "EPC costs" to "non-EPC costs" appears low, although we acknowledge that there are some unique major cost elements to this project, such as the extensive work on the AC switchyards and the provision of the camp at Keewatinohk that do not fall within the scope of the EPC contracts for the converter stations and synchronous condensers.

1a, 7a

For the large part, the overall cost of the converter stations is made up of three major contracts:

- HVDC Converter Stations and Associated Equipment – Siemens/Mortensen.
- Synchronous Condensers – Voith.
- Keewatinohk AC Switchyards – SNC Lavalin.

The information provided indicates there is also an EPC contract for the Riel Converter Station 230kV Switchyard Expansion and Switchyard, although no information on such a contract was provided.

2.1.1 Siemens/Mortensen Contract

The Siemens/Mortensen EPC Contract covers the engineering, procurement, construction and commissioning of both HVDC converter stations including all equipment associated with the converter

valves, converter transformers, civil and structural, AC and DC yards, auxiliary power, control and protection and mechanical plant.

The contract was awarded following a competitive tender process. Tender documentation provided shows that there were three bidders:

1. Siemens / Mortenson Construction (Siemens)
2. ABB/Kiewit (ABB)
3. Alstom / PCL Constructors Canada Inc. (Alstom)

All three companies are well known in the HVDC industry and have a long history of providing LCC HVDC transmission solutions globally. Copies of the individual tender submissions were provided to Amplitude, along with a spreadsheet summarising the outcomes of the tender analysis conducted by Manitoba Hydro[3].

The original bid price from Siemens/Mortensen for the main engineering, construction, installation testing, commissioning and project management component of the works (excluding spares, provisional sums, training and other optional components) was approximately [redacted] 1a, 7a, 8a

In our view, the technology partners of all three bidders (i.e. Siemens, ABB and Alstom Grid) are all in the "top three" in terms of experience with the development and delivery of LCC HVDC projects worldwide.

In our view, the comparison of three competitive bids from the three most experienced vendors of this technology provides some comfort that the EPC contract costs of the HVDC converter stations for Bipole III are within market for the scope of the project and location.

The tender evaluation sheet provided by Manitoba Hydro[3] identifies all three bidders as having passed the mandatory requirements. [redacted] 8a Amplitude did not explore these evaluations in detail, however the techno-economic evaluation of the bidders appears to have been thorough with consideration was given to technical capability, compliance with technical requirements, performance (including losses and expected replacement costs), technology proposed, schedule and overall value.

Siemens/Mortensen were the selected tenderer. The final contract price, assumed to be after post-tender clarification and negotiation (excluding spares, provisional sums, training and other optional components) was approximately [redacted][4]. 8a

The breakdown of the initial contract price for the Siemens/Mortensen contract is shown in Table 4.

Table 4 - Major Cost Components of Siemens/Mortensen Contract - Initial Contract Price

No.	Description	Cost
1	System Engineering and System Studies	[redacted]
2	Keewatinohk Converter Station – Design, Supply, construction, installation, testing, commissioning and mandatory spares for converter equipment and civil works.	
3	Riel Converter Station – Design, Supply, construction, installation, testing, commissioning and mandatory spares for converter equipment and civil works.	
4	Project Management Services and Performance Bond	
5	Optional Spares and Training	
	Total:	**$819,773,930.35**

1a, 7a, 8a

[3] 244616-244644-0020-033102-SHT-Final Proposal Evaluation-20140627.xlsx
[4] Converter Equipment Contract, Schedule III "Payment Milestones & Contract Price".

Note that item 4 in Table 4 (project management services and performance bond) makes up [redacted] of the whole contract price, with the "Performance Bond" component (we expect to be a requirement of the contract) called out as just under [redacted] of that amount (i.e. just under [redacted] of item 4). 1a, 8a

The initial contract price presented here is exclusive of PST. Manitoba Hydro has advised that the calculated PST amount for the base contract is [redacted][5], bringing the initial contract price to [redacted] including PST.

2.1.1.1 Contract Variations

The copies of the approved project variations that were provided have been reviewed by Amplitude. A total of 115 variations were reviewed. The status of the variations received is summarised below:

- The total value of approved variations reviewed was [redacted] This is close to the number determined from the combination of the variation amounts from the latest Siemens and Mortensen progress statements of [redacted] (to end of September 2017). Manitoba Hydro has since emailed an updated value of [redacted] for the combined Siemens/Mortensen variations. All these values are exclusive of PST. 1a, 8a
- There are some variations that still have no value, although most of these are expected to be not material. It is expected that the difference between the two values above are due to these "actual cost" variations.
- The variations are broken down by site as approximately 66% at Keewatinohk and 34% at Riel. In some cases, assumptions as to which site was affected or whether the costs would be roughly 50/50 between the sites have been made by Amplitude.
- Approximately 80% of the total value of approved variations are due to 14 variations (out of 115), all with a value greater than $1M.

Manitoba Hydro has advised a calculated PST amount on the variations of $1,086,687.74. Therefore, the sum of the Siemens/Mortensen original contract price and the value of approved variations (taking the latest advised by Manitoba Hydro), up to end of September 2017, comes to $904,604,618.48 including PST.

In the spreadsheet "2018 06 BPIII CS September 2017 Monthly Contracts Report 20171011.xlsx", the following information is provided:

- Current Contract Value - [redacted]
- Actuals including accruals - [redacted] 1a, 7a, 8a
- Dollars Remaining - [redacted]

There is a discrepancy between the original contract price plus variations determined by Amplitude ([redacted]) and the stated current contract value ([redacted]) of [redacted] which has been explained by Manitoba Hydro as the difference is due to escalations for steel, copper, on-site labour and concrete costs which are allowed under Schedule III of the contract[6]. 1a, 7a, 8a

For the purpose of determining adequacy of remaining budget and contingency, a post-PST contract value of [redacted] will be used.

2.1.1.2 Overall Cost Compared to Other Projects

The pricing of HVDC converter stations can be very complex, and dependent on many factors. In our view, the most accurate cost estimates and pricing is delivered by the vendors themselves, who can

[5] Email from Alastair Fogg of Manitoba Hydro dated 17 November 2017.
[6] Email from Alastair Fogg of Manitoba Hydro dated 17 November 2017.

take account of these factors and have access to detailed design and up to date pricing for components and materials. Our experience shows that accurate estimates should involve the submission of budgetary estimates from the HVDC vendors. Any attempts to build a check price from the bottom up with limited information is likely to result in large discrepancies that will be difficult or impossible to explain.

Some factors that influence pricing when comparing converter station EPC costs between projects include:

1. Cost of raw materials and metals – HVDC converter stations costs are dependent on the cost of certain raw materials and metals at the time – including concrete, steel, iron and copper. The cost of these materials will vary from year to year, either due to fluctuations in global markets or due to changes in local supply and demand.
2. Global demand for HVDC and vendor manufacturing capacity – there are only a relatively small number of HVDC vendors globally and their engineering resources and manufacturing capacities are finite. The global demand for HVDC projects can vary from year to year, although we are observing an overall increase in demand annually. If the vendors cannot increase resources and capacity in proportion to the increase in demand, this may push up costs and push back delivery schedules. In a situation where all vendors have many projects underway and have their manufacturing "slots" already filled, the submitted costs for the work, even in a competitive tender, could be higher across the board than previous projects.
3. Location – The location of the project can drive the project cost in a number of ways. The "top three" major HVDC vendors are all based in Europe (UK, Sweden and Germany). Projects that are a large distance from the HVDC vendors' facilities, especially those that require a long inland journey or require equipment to be flown to site, will incur higher transportation charges and longer lead times. Remote locations tend to require labour to be brought in from outside (leading to higher travel and accommodation costs) and the provision of higher wages or salaries to compensate for the remote location.

Most reported costs for HVDC projects are published exclusive of local taxes. Therefore, the estimated pre-PST current contract value of [redacted] will be used for comparison, less the performance bond component ([redacted][7]). The cost per kW for both terminals, based on 2,000MW continuous rating comes to approximately $422.6/kW. In the case of Bipole III, the entire converter station is specified to a 15% "continuous overload", which from an equipment and materials point of view is more or less a 2,300MW converter. Based on 2,300MW the cost per kW becomes approximately [redacted]. 1a, 8a

Amplitude presents here a selection of reported HVDC EPC costs for a variety of LCC projects, and has scaled these to 2016 levels for comparative purposes. These values represent actual announced costs and often represent the initial contract price (i.e. public announcement by the vendors on project award, without variations). Representative projects have been identified based on these being relatively recent (since 2006), utilising LCC HVDC technology, bipolar configuration and where a statement as to the converter station (only) contract has been issued from a reliable source. All of these projects except one (China) are based on one valve group per pole. These are the EPC contract costs only and does not include other non-EPC costs, such as owner's costs, environmental, permitting and land acquisitions. The selection is presented in Table 5.

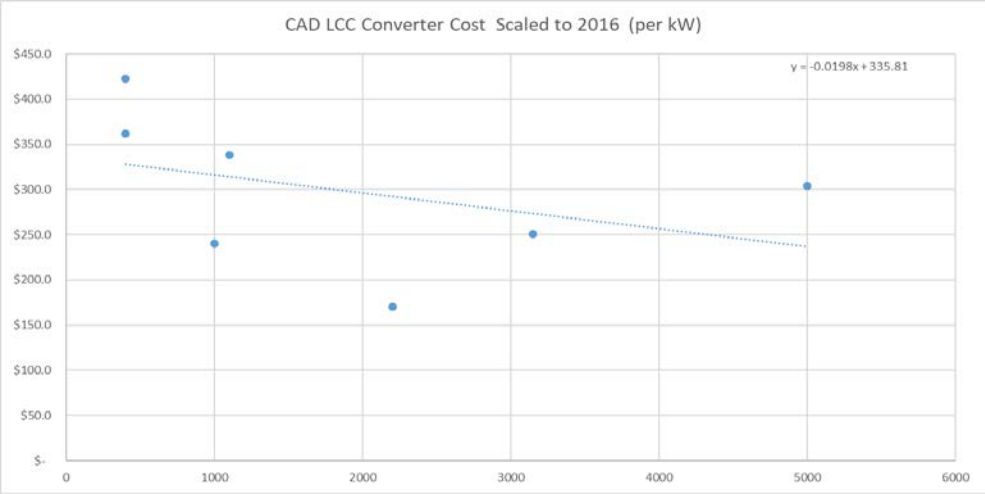
[7] Converter Equipment Contract, Schedule III "Payment Milestones & Contract Price"

Table 5 -Sample of HVDC LCC Projects - Reported Converter Station Contract Costs

Project	Year Published	Type	Converter Type and Rating	Converter EPC Costs (Original Currency, Published Date)	Converter EPC Costs (CAD/kW, Scaled to 2016)[8]	Source
COMETA (Romulus) Project, Spain	2007	Vendor Release	400MW Bipole	EUR 100m	CAD422.97/kW	https://www.energy.siemens.com/us/pool/hq/power-transmission/HVDC/HVDC-Classic/pm-pdf/pm-1-COMETA.pdf
Jeju-Jindo HVDC, South Korea	2009	News Release	400MW Bipole	USD 112.9m	CAD361.6/kW	http://asian-power.com/project/news/areva-gets-us1129m-contract-in-south-korea
SA.PE.I HVDC, Italy	2006	Vendor Release	1,000MW Bipole	EUR 143.4m	CAD240.5/kW	http://www.abb.com/cawp/seitp202/9e5c1f1a1cb0675ac12571800058456d.aspx
BritNed, UK-Netherlands	2007	Vendor Release	1,100MW Bipole	EUR 220m	CAD338.3/kW	http://www.ptd.siemens.de/artikel0906_high.pdf
Western HVDC Link, United Kingdom	2012	Vendor Release	2,200MW Bipole	GBP 223.8m	CAD170/kW	https://www.ofgem.gov.uk/ofgem-publications/52669/jul12whvdcdecisionfinal-pdf
Rio Madeira Bipole 2, Brazil	2009	Vendor Release	3,150MW Bipole	USD 480m	CAD251.2/kW	https://energy.gov/sites/prod/files/2013/05/f0/HVDC2013-Kirby_0.pdf
Yunnan-Guangdong HVDC, China	2007	News Release	5,000MW Bipole	USD 1,230m	CAD304.4/kW	http://www.tdworld.com/transmission/dc-answer

The converter station costs from Table 5, in CAD/kW, are shown graphically in Figure 1.

Figure 1 - Cost/kW for Two-Terminal Converter Stations



[8] For both converters, converted to CAD and scaled as follow: Scaling has been performed as follows: The value is converted to Canadian currency using annual average exchange rate for the year of publication and then scaled to 2016 amounts using published inflation rates for Canada.

Using the trend line, the sample produces a cost per kW for a 2,000MW of CAD296/kW and for a 2,300MW HVDC system, CAD290/kW. Multiplying these by their respective ratings results in an EPC contract cost between $592M and $667M.

It should be stressed again that these values are based on initial contract price (announcements made on award) and are not reflective of final converter station EPC contract costs at or toward the end of each project.

There also exists some Cigre documents that provide good benchmarks for pricing, although one of these uses quite old data. Two such references are:

- Technical Brochure 186 – "Economic Assessment of HVDC Links" published in June 2001. The document provides some costing information for LCC HVDC converters (Table 4.1). This document presents costing information that are stated as being "typical turnkey costs of the vendor's HVDC supply and installation" or in other words, the total expected vendor contract (EPC) cost. The values provided cover both terminals of a two-terminal scheme and they assume the DC bipole is made up of only one valve group per pole and no requirement for additional reactive power compensation due to connection to a weak AC system (i.e. synchronous condensers). The costs specifically do not include owner's costs, taxes, IDC or borrowing costs and are quoted to be at an accuracy of "no better than ±20%".
- Technical Brochure 492 – "Voltage Source Converter (VSC) HVDC for Power Transmission – Economic Aspects and Comparison with other AC and DC Technologies" published in April 2012. Although this document is a reference for VSC projects, some indicative pricing for a bipole LCC project (1,000MW) is provided. The values are stated as having an accuracy of ±30%.

By applying the same scaling assumptions as applied to the values in Table 5, the indicative cost per kW values become:

- TB186 – 2,000MW Bipole - $294.7 / kW; and
- TB492 – 1,000MW Bipole - $298.2 / kW.

In recent years, Canada has seen two new HVDC systems installed in Alberta. Both of these projects were built by Siemens, and both utilise the same LCC HVDC technology, albeit using one valve group per pole. While the ultimate design of these projects is for a bipole configuration, only one pole was built for each, with the individual pole being rated at 1,000MW. In both cases, we could not locate a vendor announcement for the overall contract price. However, there is information available publicly issued by the Alberta Utilities Commission (AUC) that provides the following information.

- Western Alberta Transmission Line (WATL) – Estimated cost of the converter station contract after deducting costs associated with significant works undertaken by the contractor for nearby AC substations, was $360M[9/10]. After scaling, and based on 1,000MW converters, we estimate this at $376.4/kW.
- Eastern Alberta Transmission Line (EATL) – Estimated forecast cost for the converter stations was $481.8M, but after removing AC interconnection facilities, reactive power compensation

[9] Alberta Utilites Commission, "Decision 2013-407: AltaLink Management Ltd. 2013-2014 Genreal Tariff Application," AUC, Nov. 2013.
[10] Transsmission Facilities Cost Monitoring Committee, "Review of the cost status of major transmission projects in Alberta," TFCMC, Dec. 2013.

and ATCO in-house labour, the estimate for the contractor works becomes $374.4M[11]. Further adjustments to the contract price (downwards) resulted in an estimated at the time (2012) of $349.8M[12]. After scaling, and based on 1,000MW converters, we estimate this at $369.1/kW.

These values are more in line with the cost per kW for Bipole III, and are likely more relevant given they are located in Canada and would have experienced similar circumstances as the Bipole III project, particularly in relation to proximity to the vendor facilities, construction and operation in harsh environmental conditions and the remoteness of at least one converter station site.

2.1.1.3 Price Differentiators

There are certain differentiators associated with the scope of the Bipole III project that are likely to impact the comparison of the cost of this HVDC scheme with others, particularly those outside of Canada. Some key differentiators that would lead to a higher cost compared to other HVDC LCC projects include:

- Each pole of the Bipole III project comprises two series valve groups. The majority of HVDC projects built up to now have only one valve group per pole. Poles can be split into series valve groups particularly where there are certain practical limitations with the project size – such as the manufacture and transportation to site of the converter transformers. Splitting the pole into valve groups results in double the number of valve halls and converter transformers, although these will have lower power ratings each, and one of these valve halls/transformers will have a much lower line to ground voltage (shorter clearances, smaller building, smaller transformer). The overall effect however would be that a two-valve group pole would be more expensive than a single valve group pole of the same rating and voltage. On page 24 of Cigre Technical Brochure 186, the following statement is made:

  "*It is estimated that there would be about a 20% total cost premium to the turnkey supply for a same-size bipole having two parallel valve groups per pole instead of one. If the two valve groups are in series, however, this extra cost applies only to the second (higher-voltage) valve groups*."[13]

  The statement is not helpful in determining an actual cost difference for multiple series valve groups, but does identify that there will be a cost premium associated with it when compared to the cost of projects with only one valve group per pole.
- Extreme temperature and environmental conditions to be experienced both during construction (at both sites) and during operations.
- The remoteness of the Keewatinohk Converter Station site, and the additional costs associated with performing work in these locations (personnel, travel, transportation etc.).
- Unique controls, including:
  - De-icing controls – the capability to operate with each pole in opposite directions to de-ice the transmission lines.
  - SPS interface, frequency controls, damping controls and reduction ("run-back") capability.
  - NERC cyber security requirements.

[11] Alberta Utilities Commission, "Decision 2013-358: ATCO Electric Ltd. 2013-2014 Transmission General Tariff Application," AUC, Sept. 2013.
[12] ATCO Electric Ltd., "Updated cost for Eastern Alberta Transmission Line project," AUC, Dec. 2013.
[13] Cigre Technical Brochure 186 "Economic Assessment of HVDC Links", June 2001, Page 24.

- External TFR systems in addition to those provided with the Vendor's C&P systems (typical).
- Control system replica for the RTDS lab at Riel and the control system simulators at each converter.
- Interface to the Manitoba Hydro supplied DC line fault locator.

These price differentiators are expected to result in a higher EPC contract price than other projects that do not have these characteristics. It is not possible to quantify by how much with the information available and the time provided.

2.1.1.4 Summary of Outcomes

The comparison of three competitive bids from the three most experienced vendors of this technology provides some comfort in the validity of the EPC contract costs of the HVDC converter stations for Bipole III. The Siemens-Mortensen price was selected as having a lower "Total Evaluation Price" than the other two bidders.

In terms of comparing the Bipole III Siemens-Mortensen current contract value of [redacted] (without PST) with comparative projects and cost references: 1a, 8a

1. The values drawn from Figure 1 will result in a vendor (EPC contract) price for 2,000MW-2,300MW bipole converter stations between $592M and $667M. These values will be based on initial contract prices, are based on projects that have one valve group per pole and will have some error associated with scaling assumptions and due to each comparative HVDC project having slight differences in scope that impact price.
2. The values drawn from the Cigre technical brochures will result in a vendor (EPC contract) price for 2,000MW-2,300MW bipole converter stations between $589.4M and $685.8M. These values are stated as having an accuracy no better than ±20%, widening the range to between $471.5M and $822.9M. These values are based on projects that have one valve group per pole.
3. The values drawn from information from recently completed HVDC LCC projects in Canada, the WATL and EATL projects in Alberta, will result in a vendor (EPC contract) price for 2,000MW-2,300MW bipole converter stations between $738M and $865.7M. These projects have only one valve group per pole.

Due to the expected cost premium for two valve groups per pole and for the challenges associated with the remoteness of the Keewatinohk Converter Station, it is expected that the Bipole III costs will be higher than representative single valve group per phase projects not located in remote areas, as would be the case for those identified in items 1 and 2 above.

2.1.2 Voith Contract

The synchronous condenser contract makes up over [redacted] of the estimate for WBS P15541 Network 244618. The contract covers the design, manufacture, supply, install, construct and commission four synchronous condensers, each rated at 250MVAr, at the Riel Converter Station. 1a, 8a

The contract was awarded following a competitive tender process. Tender documentation provided shows that there were three bidders – Siemens, Alstom and Voith.

The original bid price from Voith was [redacted] 1a, 8a

From the tender evaluation sheet provided, we observe that all three bidders passed the mandatory requirements[14]. [redacted]

1a, 8a

Voith was the selected tenderer. The final contract price (assumed to be after post-tender clarification and negotiation) was [redacted] not including PST.

The breakdown of the initial contract price for the Voith contract is shown in Table 6.

Table 6 - Major Cost Components of Voith Contract - Initial Contract Price

No.	Description	Cost
1	Engineering and Design	[redacted]
2	Manufacture and Supply of Equipment and Materials	
2a	Synchronous Condensers and Associated Equipment	
2b	Civil Works	
3	Installation and Construction	
3a	Synchronous Condensers and Associated Equipment	
3b	Civil Works	
4	Testing and Commissioning	
5	Spare Parts	
6	Project Management	
7	Training	
	Total:	**$213,896,689**

1a, 7a, 8a

In the cost breakdown, site installation and construction costs make up [redacted] of the total contract price, while project management makes up [redacted] of the total contract price. The actual supply of the synchronous condensers and associated equipment is only just above [redacted] of the total contract price. This shows the strong influence of local conditions and project/construction management on the pricing for this contract.

1a, 8a

2.1.2.1 Contract Variations

The copies of the approved project variations that were provided have been reviewed by Amplitude. A total of [redacted] variations were reviewed. The status of the variations received is summarised below:

- The total value of approved variations reviewed was [redacted] This is significantly lower than the number determined from the combination of the variation amounts from the latest Voith/Stuart Olsen progress statements of [redacted] (to end of September 2017)

1a, 8a

- There are some variations that still have no value. We anticipate that the difference between the amount of approved variation reported by Voith and Stuart Olsen and the numbers we have looked at is due to these types of variations, or we have not been provided with all variations for this contract.
- Of those provided to Amplitude, only one variation had a value greater than $1M and the value of this variation ([redacted]) makes up almost 50% of the total variations provided to Amplitude (over 26% of the total approved variations reported by Voith and Stuart Olsen). [redacted]

1a, 8a

[14] 244618-0020-033852-MAT-Riel Synchronous Condenser Final Evaluation Matrix-20150206.xlsx

The sum of the Voith original contract price and the value of approved variations (using the end of September value reported by Voith and Stuart Olsen) comes to [redacted] (not including PST). No calculated PST amount has been provided by Manitoba Hydro. 1a, 8a

In the spreadsheet "2018 06 BPIII CS September 2017 Monthly Contracts Report 20171011.xlsx", the following information is provided:

- Current Contract Value - [redacted]
- Actuals including accruals - [redacted]
- Dollars Remaining - [redacted]

1a, 8a

There is a discrepancy between the original contract price plus variations determined by Amplitude ([redacted]) and the stated current contract value ([redacted]). The latter values are post-PST amounts, and likely the difference is due to both PST and escalation for metal, material and labour prices as allowed under Schedule III of the contract [15]. 1a, 8a

2.1.2.2 Overall Cost Compared to Other Projects

Similar limitations and influencing factors to those identified for the cost of the converter stations would apply here. Table 7 provides a sample of publicly available information related to the cost of synchronous condensers globally.

Table 7 – Publicly Available Pricing Information on Synchronous Condenser Projects

Reference	Year Published	Source Type	Synchrnous Condenser Type and Rating	EPC Costs (Original Currency, Published Date)	EPC Costs (CAD/kVAr, Scaled to 2016)[16]	Source
Cigre TB186	2000	Estimate	250MVAr	€ 20,000,000	$159.92	Cigre TB186 "Economic Assessment of HVDC Links"
Codrongianos Substation on Sardinia island	2014	Actual	2 x 250MVAr	€ 40,100,000	$120.66	http://integrated.terna-reports.it/2014/sites/default/files/pdf-header/Terna_Annual_Report_2014.pdf
Favara and Partinico Substations near Sicily	2015	Actual	2 x 160MVAr	€ 30,800,000	$138.51	http://integrated.terna-reports.it/2015/sites/default/files/pdf-header/Terna_Integrated_Report_2015.pdf
Bjæverskov Substaion, Denmark	2012	Actual	1 x 250MVAr	€175,000,000	$127.47	https://energinet.dk/Om-nyheder/Nyheder/2017/04/25/Energinet-dk-sikrer-spandingen-pa-Sjalland
Fraugde and Herslev Substation, Denmark	2013	Actual	2 x 200MVAr	€340,000,000	$163.07	https://energinet.dk/Om-nyheder/Nyheder/2017/04/25/Energinet-dk-bygger-nye-anlag-pa-Fyn-og-Vestsjalland

[15] Email from Alastair Fogg of Manitoba Hydro dated 15 November 2017.
[16] Reported amount converted to CAD and scaled as follow: Scaling has been performed as follows: The value is converted to Canadian currency using annual average exchange rate for the year of publication and then scaled to 2016 amounts using published inflation rates for Canada.

Reference	Year Published	Source Type	Synchrnous Condenser Type and Rating	EPC Costs (Original Currency, Published Date)	EPC Costs (CAD/kVAr, Scaled to 2016)[16]	Source
Otahuhu, Auckland New Zealand	2005	Estimate	1 x 100MVAr	NZD22,686,000	$232.26	https://www.ea.govt.nz/dmsdocument/4715
Grid Upgrade Plan 2007, New Zealand	2008	Estimate	1 x 120MVAr	NZD34,000,000	$240.60	https://www.transpower.co.nz/sites/default/files/plain-page/attachments/hvdc-gup-vol-I-may-2008.pdf
Proposed Haywards, New Zealand	2005	Estimate	1 x 65MVAr	NZD12,900,000	$203.18	https://www.ea.govt.nz/dmsdocument/180

The values in Table 7 show costs per kVAr ranging from $120.66/kVAr to $240.60/kVAr. The estimated current contract value (pre-tax and escalation) of $220.2M for 1,000MVar equates to $220.2 per kVAr.

Based on these amounts, the Voith contract is within the range of other projects, although it is on the high side of this range. The costing factors and price differentiators unique to the Bipole III project as discussed for the converter station pricing are likely to apply when comparing the cost of Bipole III to the cost of projects elsewhere in the world – including the extreme temperature and environmental conditions to be experienced both during construction and during operations.

2.1.3 SNC-Lavalin Contract

The AC switchyard contract makes up over [redacted] of the estimate for WBS P15544. The work included in this contract consists of system studies, supervision, design, manufacture, factory testing, supply, delivery to site, installation, site testing, commissioning of the nine-bay Keewatinohk 230 kV air insulated AC switchyard located adjacent to the Keewatinohk converter building, with all associated buildings and equipment. 1a, 8a

The contract was awarded under a competitive tender process. Tender documentation provided shows that there were three bidders – Burns & McDonnell, Siemens Canada and SNC-Lavalin.

The original adjusted proposal price from SNC-Lavalin was [redacted] 1a, 8a [redacted]

SNC-Lavalin was the selected tenderer. The final contract price (assumed to be after post-tender clarification and negotiation) was [redacted] including spare parts and training, not including PST. 1a, 8a

The breakdown of the initial contract price for the SNC-Lavalin is shown in Table 8.

Table 8 - Major Cost Components of SNC-Lavalin Contract - Initial Contract Price

No.	Description	Cost (CAD)
1	Design, Supply, Installation, Testing & Pre-Commissioning of Switchyard and Equipment	[redacted]
2	Design, Supply, Construction, Testing and Commissioning of Civil Works, Structures, Foundations and Buildings	
3	Site and Interface Support	
4	Switchyard Commissioning Support	
5	Project Management Services	
6	Aboriginal Awareness Training and Ceremonies	
7	Performance and Payment Securities	

1a, 7a, 8a

No.	Description	Cost (CAD)
8	Spare Parts and Special Tools	[redacted]
9	On-the-Job Training Plan	
10	Training of the Purchaser's Personnel for the Operation and Maintenance of the Switchyard	
	Total:	**$123,838,715.43**

1a, 7a, 8a

In the cost breakdown, the equipment, site installation and construction make up [redacted] of the whole project, while project management makes up only [redacted] of the total contract price. 1a, 8a

2.1.3.1 Contract Variations

The copies of the approved project variations that were provided have been reviewed by Amplitude. A total of [redacted] variations were reviewed. The status of the variations received is summarised below: 1a, 8a

- The total value of approved variations reviewed was [redacted] This is slightly lower than the number determined from the reported variation amounts from the latest SNC-Lavalin progress statement of [redacted] (to end of August 2017).
- Of those provided to Amplitude, three variations had a value greater than $1M and the value of the largest variation ([redacted]) makes up almost [redacted] of the total variations provided to Amplitude. This variation was a request for SNC-Lavalin to implement the revised circuit breaker requirements for the design of the 230kV AC Switchyard. 1a, 8a

The sum of the original contract price and the value of approved variations (using higher number from the sum of the variations provided) comes to [redacted] (not including PST). No calculated PST amount has been provided by Manitoba Hydro. 1a, 8a

In the spreadsheet "2018 06 BPIII CS September 2017 Monthly Contracts Report 20171011.xlsx", the following information is provided:

- Current Contract Value - [redacted]
- Actuals including accruals - [redacted]
- Dollars Remaining - [redacted]

1a, 8a

There is a discrepancy between the original contract price plus variations determined by Amplitude ([redacted]) and the stated current contract value ([redacted]). The latter values are post-PST amounts, and likely the difference is due to both PST and the escalation for metal, material and labour prices as allowed under Schedule III of the contract [17]. 1a, 8a

2.2 Conclusions & Recommendations

- The comparison of three competitive bids from the three most experienced vendors of this technology, with at least two of these being very close in price – provides some comfort in the validity of the EPC contract costs of the HVDC converter stations for Bipole III.
- Comparing the Bipole III HVDC EPC contract cost with other comparative projects and cost references in the public domain, we conclude that the EPC costs are reasonable after taking into consideration the use of two valve groups per pole, the remoteness of the Keewatinohk Converter Station and the extreme temperature and environmental conditions to be experienced both during construction and during operations.

[17] Email from Alastair Fogg of Manitoba Hydro dated 15 November 2017.

- Similarly, we are on the view that the EPC costs for the synchronous condensers are reasonable, after comparison to publicly available cost references and consideration of the extreme temperature and environmental conditions to be experienced both during construction and during operations.

2.3 Source of Information & Reference materials

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3 Reasonableness of contingencies and reserves Observations & Findings

3.1 Observations & Findings

Information on actual costs incurred per WBS and per network, up to September 2017, has been provided and reviewed by Amplitude[18].

The actual costs incurred to September 2017 versus the 2016 budget is presented in Table 9 and graphically in Figure 2.

Table 9 - Bipole III - Actual Costs incurred to September 2017 versus the 2016 Budget

WBS	Description	2016 Budget	Sept 2017 Actual	Remaining Budget
P:15533	Property for Keewatinohk Converter Station	[redacted]		
P:15540	Keewatinohk Converter Station			
P:15544	Keewatinohk 230KV AC Switchyard			
P:21082	Keewatinohk Converter Station Distribution			

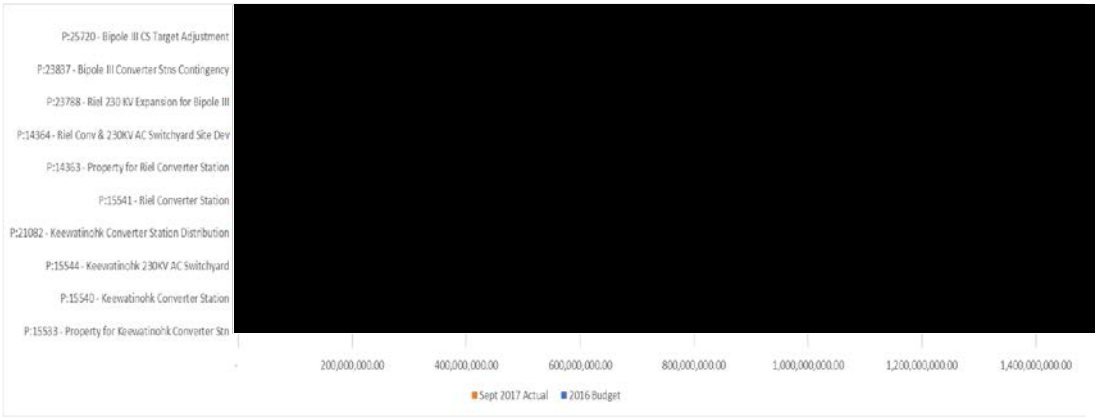
1a, 7a, 8a

[18] BPIII CS CPJ Comparison vC14 vs vC16 Actual spend to Sept 30, 2017.xlsx

WBS	Description	2016 Budget	Sept 2017 Actual	Remaining Budget
P:15541	Riel Converter Station	[redacted]		
P:14363	Property for Riel Converter Station			
P:14364	Riel Conv & 230KV AC Switchyard Site Dev			
P:23788	Riel 230 KV Expansion for Bipole III			
P:23837	Bipole III Converter Stns Contingency			
P:25720	Bipole III CS Target Adjustment			
	Totals	**2,780,556,950.46**	**2,136,788,968.93**	**644,691,821.66**

1a, 7a, 8a

Figure 2 - Bipole III Converter Station Costs - 2016 Budget vs Sept 2017 Actual - WBS Level



1a, 7a, 8a

Table 9 and Figure 2 both show that as at September 2017, all WBSs are running under budget with a substantial contingency remaining on the project.

As at the end of September 2017, the project has been progressed to the point that significant progress has been made on the construction and installation of the converter stations and AC switchyards at both sites and of the synchronous condensers at Riel.

An overall picture of the remaining activities of the converter station component of the project is shown in Table 10 which is based on our interpretation from the latest schedules provided in .XER format for the three major contracts (HVDC converters, synchronous condensers and AC switchyards).

Table 10 - Bipole III – Converter Station Works – Major Remaining Activities

Contract	Activity
HVDC	Loss Measurements and Losses Study
HVDC	Manufacture of Spare Transformers
HVDC	Manufacture of HVDC Line Coupling Capacitors
HVDC	Operator Training Simulator – Preparation for Shipment
Converter Stations	
HVDC	Completion of Civil Works, Structural Erection and Installation – Converter Building, AC Yard and DC Yard
HVDC	Civil works for spare transformer bays
HVDC	Completion of equipment installation and pre-commissioning - Filter Bays
HVDC	Completion of equipment installation and pre-commissioning - Valve and Valve Cooling

Contract	Activity
HVDC	Completion of equipment installation and pre-commissioning – Valve hall equipment
HVDC	Completion of pre-commissioning – Converter transformers
HVDC	Completion of pre-commissioning – AC and DC yards
HVDC	AC Yard - High voltage connections to filter banks and converter transformers
HVDC	DC Yard – High voltage connections to DC equipment and HVDC line
HVDC	Completion of installation and termination of control and fibre optic cable installations in converter building
HVDC	Completion of drywall and internal finishing in converter building
HVDC	Completion of HVAC, fire and auxiliary systems in converter building
HVDC	Completion of overhead wire installation – AC and DC yards
HVDC	Completion of yard fencing and grounding
HVDC	Sub-Systems Tests and Station Tests
Synchronous Condensers	
Synch Cond	Complete Manufacturing rotor and stator – SC5
Synch Cond	Complete Manufacturing of Unit Transformer – SC4 and SC5
Synch Cond	Complete installation works – electrical, cabling, auxiliary systems and mechanical systems – SC2, SC3, SC4 and SC5
Synch Cond	Mechanical Completion of SC2, SC3, SC4 and SC5
Keewatinohk 230kV Switchyard	
230kV Switchyard	Complete cable installation, interface to converter stations – controls and communications
230kV Switchyard	Complete 600V building feeder cable installations
230kV Switchyard	Complete switchgear building and control building
230kV Switchyard	Complete fire protection works
230kV Switchyard	Pre-commissioning of buswork, lighting and grounding
230kV Switchyard	Pre-commissioning of AC and DC station services
230kV Switchyard	Complete grounding works
230kV Switchyard	Pre-commissioning of CBF bays and switchgear buildings
230kV Switchyard	Sub-Systems Testing
Testing and Commissioning	
HVDC	System Tests – KCS and RCS
HVDC	Acceptance Tests – KCS and RCS
HVDC	Trial Operation
Synch Cond	Testing and commissioning of SC2, SC3, SC4 and SC5
230kV Switchyard	System Testing

The expected status of each WBS, based on the information provided, is summarised in the following sections.

3.1.1 P15533 - Property for Keewatinohk Converter Station

Manitoba have advised that typically property for transmission lines are acquired by easement and converter station sites by ownership[19]. The estimate for the property components for the converter stations (P15533 and P14363) includes internal and external labour to conduct property appraisals, property acquisitions and surveys.

Manitoba Hydro will own the land for the Keewatinohk Converter station at the end of the project. As this site is on Crown land, a flat rate annual fee is paid up front for permission for construction rights and access to the land[20].

This WBS has only one Network (243352). The breakdown of actual versus 2016 budgeted expenditure is shown in Table 11.

Table 11 - WBS15533 - Budget vs Actual

Description	2016 Budget	Sept 2017 Actual	Budget Remaining
LAND PURCHASES-NRTHRN CNVRTR STATION* Total	[redacted]	[redacted]	[redacted]
Conawapa Access Road* Total			
Keewatinohk Infrastructure Total			
Not assigned Total			
Totals	**486,556.41**	**463,957.75**	**22,598.66**

1a, 7a, 8a

The majority of costs associated with this project has been related to the land purchase. Given the project site works are close to completion, it is reasonable to expect that any further expenditure on this WBS, if any, would be non-material.

3.1.2 P15540 - Keewatinohk Converter Station and P15541 - Riel Converter Station

These WBS cover the largest component of the overall converter station costs. Each WBS contains 22 cost networks, covering various cost elements for the converter station. A summary of these networks, along with the 2016 budget and Sept 2017 actual costs (assumed to include PST) is provided in Table 12 and Table 13 for P15540 (Keewatinohk) and P15541 (Riel) respectively.

Table 12 - WBS15540 - Budget vs Actual

Network No.	Description	2016 Budget	Sept 2017 Actual	Budget Remaining
244643	KCS SITE DEVELOPMENT	[redacted]	[redacted]	[redacted]
244644	KCS HVDC CONVERTERS AND ASSOCIATED EQUIP			
244645	KCS INTERFACES/BOP			
244646	KCS ELECTRODE SITE			
244647	KCS OPS, MTCE & TEST EQUIPMENT			
244648	KCS COMMUNICATIONS FOR STATION			
244649	KCS CONSTRUCTION FACILITIES			
244650	KCS SITE DECOMMISSIONING			
244651	KCS NERC/PHYSICAL SECURITY			
244652	KCS SYSTEM STUDIES			
244653	KCS ELECTRIC POWER FOR CONSTRUCTION			
244654	KCS PROJECT MANAGEMENT			
244655	KCS CONSTRUCTION MANAGEMENT			

1a, 7a, 8a

[19] Manitoba Hydro, "Bipole III Project, Basis of Estimate Document, September 2014 Cost Estimate Update", Revision 0, March 2015, Page 85.
[20] Manitoba Hydro, "Bipole III Project, Basis of Estimate Document, September 2014 Cost Estimate Update", Revision 0, March 2015, Page 87.

Network No.	Description	2016 Budget	Sept 2017 Actual	Budget Remaining
244657	KCS TRANSPORTATION & TRAVEL	[redacted]		
244658	KCS SERVICE & SUPPLY CONTRACTS			
244660	KCS COMMUNICATIONS FOR CONSTRUCTION			
244662	KCS Construction Office			
244663	KCS CAMP FACILITIES			
244664	KCS SURVEY, INSPECTION & TESTING			
244674	KCS EXTERNAL INFRASTRUCTURE			
244676	KCS STORES			
250135	KCS Environmental			
#	Not assigned			
		1,247,788,230.87	**1,048,335,823.44**	**199,452,407.43**

1a, 7a, 8a

Table 13 - WBS15541 - Budget vs Actual

Network No.	Description	2016 Budget	Sept 2017 Actual	Budget Remaining
244615	RCS SITE INTEGRATION	[redacted]		
244616	RCS HVDC CONVERTERS AND ASSOCIATED EQUIP			
244617	RCS INTERFACES/BOP			
244618	RCS SYNCHRONOUS CONDENSERS			
244619	RCS ELECTRODE SITE			
244620	RCS OPS, MTCE & TEST EQUIPMENT			
244621	RCS COMMUNICATIONS FOR STATION			
244622	RCS CONSTRUCTION FACILITIES			
244623	RCS SITE DECOMMISSIONING			
244624	RCS NERC/PHYSICAL SECURITY			
244625	RCS SYSTEM STUDIES			
244626	RCS ELECTRICAL POWER FOR CONSTRUCTION			
244627	RCS PROJECT MANAGEMENT			
244628	RCS CONSTRUCTION MANAGEMENT			
244630	RCS TRANSPORTATION & TRAVEL			
244632	RCS COMMUNICATIONS FOR CONSTRUCTION*			
244633	RCS CONSTRUCTION OFFICE			
244634	RCS SURVEY, INSPECTION & TESTING			
244635	RCS STORES			
244636	RCS SERVICE & SUPPLY CONTRACTS			
244675	RCS EXTERNAL INFRASTRUCTURE			
250136	RCS Environmental			
	Not assigned			
		913,888,428.46	**701,884,398.56**	**212,004,029.90**

1a, 7a, 8a

The reported status of the payment milestones for the Siemens/Mortensen Contract is shown in Table 14. Note that while the table shows reporting from Siemens to end August, Amplitude was advised that this is because no payment milestones were claimed by Siemens during September 2017[21].

[21] Email from Kimberley Savage of Manitoba Hydro dated 18 November 2017.

Table 14 - Progress Payments Made for Siemens/Mortensen Contract – Up to End September 2017

Contract No. 033102	Siemens (end August-2017)			Mortenson (end September-2017)			Total Paid to Date (September 2017)	Total Remaining to Date (September 2017)
	Payment to Date	Remaining	%Spent	Payment to Date	Remaining	%Spent		
Item 1: System Engineering & System Studies	[redacted]							
Item 2: Design & Supply of HVDC Converters and Associated Equipment for Keewatinohk Station								
Item 3: Design & Supply of HVDC Converters and Associated Equipment for Riel Station								
Item 4: Design and Supply of Civil Works for Keewatinohk Station								
Item 5: Design and Supply of Civil Works for Riel Station								
Item 6: Construction and Installation of Keewatinohk Station								
Item 7: Construction and Installation of Riel Station								
Item 8: Testing and Commissioning of Keewatinohk Station								
Item 9: Testing and Commissioning of Riel Station								
Item 10: Mandatory and Recommended Spares for Keewatinohk								
Item 11: Mandatory and Recommended Spares for Riel								
Item 14: Project Management Services & Performance Guarantee								
Item 15: Aboriginal Awareness Training and Ceremonies - Keewatinohk								
Item 16: Optional Spares, Special Tools and Maintenance Equipment for Keewatinohk (Purchaser's Option)								
Item 17: Optional Spares, Special Tools and Maintenance Equipment for Riel (Purchaser's Option)								
Item 18: On-the-Job Training Plan for Keewatinohk Site (Purchaser's Option)								
Item 19: On-the-Job Training Plan for Riel Site (Purchaser's Option)								
Item 20: Training of Personnel for the Operation & Maintenance of Bipole III HVDC Converter Stations (Purchaser's Option)								
Variations								
Variations: LOA 35 Completion Bonus								

1a, 7a, 8a

Contract No. 033102	Siemens (end August-2017)			Mortenson (end September-2017)			Total Paid to Date (September 2017)	Total Remaining to Date (September 2017)
	Payment to Date	Remaining	%Spent	Payment to Date	Remaining	%Spent		
Totals	$329,034,656.24	$69,253,644.12		$418,788,573.31	$51,471,625.86		$747,823,229.55	$120,725,269.98

Table 14 shows that as of end of September 2017, there is a commitment to pay the Siemens/Mortensen contract $120.7M (not including PST). Using an assumed overall PST of 4%[22], this comes to approximately $125.5M including PST. All approved variations are included in Table 14. Amplitude are not aware of any pending variations that are pending and have not already been approved.

Table 9 shows approximately [redacted] of budget remaining between WBS P15540 and P15541 (including PST). In terms of the networks in each of these WBSs that contain the Siemens/Mortensen contract (244644 and 244616 respectively), the remaining budgets for these networks add up to about [redacted]. This means that assuming no variations, and no other activity under 244644 and 244616 not already costed under the Siemens/Mortensen contract, at least [redacted] will need to come out of the other budgets and/or contingency (P23837). Table 9 shows there to be [redacted] remaining in the contingency. 1a, 7a, 8a

The other significant contract element is the Voith contract for the Synchronous Condensers at Riel Converter Station. Table 13 shows that for the cost network associated with the synchronous condensers (244618), the actual expenditure to end September 2017 is approximately [redacted] compared to a budget of [redacted] (inclusive of PST), leaving a remaining budget for the network of approximately [redacted] This cost network includes the Voith contract, which makes up about [redacted] of the budget, with the remaining budget covering Manitoba Hydro staff and contractor works. 1a, 7a, 8a
The reported status of the payment milestones for the Voith Contract is shown in Table 15.

Table 15 - Progress Payments Made for Voith Contract – Up to End September 2017

Contract No. 033852	Voith Hydro (September-2017)			STUART OLSON (September-2017)			Total Paid to Date (September 2017)	Total Remaining to Date (September 2017)
	Payment to Date	Remaining	%Spent	Payment to Date	Remaining	%Spent		
Item 1: Design of Synchronous Condensers & Associated Equipment	[redacted]							
Item 2: Design of Civil Works								
Item 3: Manufacture & Supply								
Item 4: Installation & Construction								
Item 5: Testing & Commissioning								
Item 6: Mandatory & Recommended Spares								
Item 7: Project Management Services								
Item 8: Optional Spares, Special Tools & Maintenance Equipment								
Item 9: Training of Purchaser's Personnel for O&M of Synchronous Condensers								

1a, 7a, 8a

[22] Amplitude has not calculated the elements of these contracts that are subject to PST. However, the percentage of PST to contract values provided by Manitoba Hydro in an email dated 17 November 2017 shows this proportion to vary between 2% and 4%, depending on the proportion of labour and materials. We have used 4% as a conservative estimate, for comparative purposes.

Contract No. 033852	Voith Hydro (September-2017)			STUART OLSON (September-2017)			Total Paid to Date (September 2017)	Total Remaining to Date (September 2017)
	Payment to Date	Remaining	%Spent	Payment to Date	Remaining	%Spent		
(Purchaser's option - not exercised yet)	[redacted]							
Variations								
Totals	$113,891,199.99	$21,443,921.75		$57,106,532.23	$27,776,037.43		$170,997,732.22	$49,219,959.18

1a, 7a, 8a

Table 15 shows that as of end of September 2017, there is a commitment to pay the Voith contract a further $49.2M (not including PST) or, using the same PST assumptions previously, approximately $51.17M including PST. All approved variations are included in Table 15. Amplitude are not aware of any pending variations that are pending and have not already been approved.

Table 13 shows approximately [redacted] of budget remaining for WBS P15541/ cost network 244618 (including PST). This means that assuming no variations, and no other activity under cost network 244618 not already costed under the Voith contract, at least [redacted] will need to come out of the other budgets and/or contingency (P23837). 1a, 7a, 8a

The analysis above covers cost network 244644 in WBS 15540 (Keewatinohk Converter Station) and cost networks 244616 and 244618 in WBS 15541 (Riel Converter Station). Combined, it is expected that at least [redacted] will need to come out of contingency just to cover off outstanding committed values to the contracts – assuming no further Manitoba Hydro costs are to be charged to these networks (which is unlikely) and no further variations are received (also unlikely). There is not enough information or time for Amplitude to attempt to analyse these costs to project completion. 1a, 7a, 8a

However collectively, these three WBS account for only [redacted] of the 2016 budget and [redacted] of actual expenditure to date. These costs are mostly Manitoba Hydro staff and contractor costs and associated smaller contracts. There is not enough information or time for Amplitude to attempt to analyse these costs to project completion. However, Table 16 and Table 17 provide some commentary on these activities for Keewatinohk and Riel respectively, including whether there is expected to be substantial activity going forward (from end of September 2017) based on the estimated remaining activities provided in Table 10. 1a, 7a, 8a

Table 16 - P15540 - Keewatinohk Converter Station - Status of Other Networks

Network No.	Description	Scope Inclusions[23]	Budget Remaining	Anticipated Future Activity
244643	KCS SITE DEVELOPMENT	• Civil site development, ancillary and auxiliary buildings, insulation stone, concrete supply and aggregate, asphalt pavement, re-vegetation, landscaping and signage. • Includes draining and improvement to existing site prior to construction, plus clearing and winter excavation, and placement of materials. • Mostly internal labour, supply and installation contracts and expenses.	[redacted]	• The bulk of this work should be complete, covering site preparation, civil and earthworks. • There will still potentially be some insulation stone, asphalt, re-vegetation and landscaping to be done. • No information available on the status of these works. • Assume the remaining budget will be spent.
244644	KCS HVDC CONVERTERS AND ASSOCIATED EQUIP	• Elements not directly associated with the Siemens/Mortensen contract includes line fault locators and special protection schemes, grounding studies, construction work oversight and support services. • Also includes HVDC expertise for early phases of the project.		• Assume line fault locators and SPS schemes installed. • Grounding studies should be complete. • Early phase of project sunk cost. • Some outstanding activity for oversight completion of Siemens/Mortensen Contract.

1a, 7a, 8a

[23] Taken from Manitoba Hydro document "Bipole III Project, basis of Estimate Document, September 2014 Cost Estimate Update", Revision 0, March 2015.

Network No.	Description	Scope Inclusions[23]	Budget Remaining	Anticipated Future Activity
				• With an anticipated site completion date of 20 July 2018, there remains another 9 months of construction oversight for this contract. • No information available on ongoing costs for construction oversight. • Assume a portion of the remaining budget will be spent on these activities.
244645	KCS INTERFACES/BOP	• Includes supplementary electrical and mechanical works, transition structures, 230kV and 12kV connections, DC line connections, ground grid, electrode connections and lightning protection.		• Some of these activities are likely complete – electrical and mechanical interfaces, ground grid, lightning protection and some of the high voltage connections. • There may be remaining activities for the 230KV, DC line and electrode connections although no information available on the status of these works. • Assume the remaining budget will be spent.
244646	KCS ELECTRODE SITE	• Covers the design, installation and construction of the electrode and the access road to electrode site. • Includes internal costs for detailed design, construction management and oversight, support services.		• This component is already overbudget. • There should be no further work on site improvement and preliminary engineering. • Manitoba Hydro advised that "The Keewatinohk Electrode work is complete and no additional costs are anticipated."[24] • The overrun was due to significant construction issues and challenges encountered, including excessively wet conditions, extra de-watering and excavation and added costs for blasting larger rocks and boulders[24]. • Based on advice from Manitoba Hydro, assume no further expenditure on this item.
244647	KCS OPS, MTCE & TEST EQUIPMENT	• Includes furniture for all site buildings, test equipment and motor vehicles, plus internal labour to procure these.		• No information provided on the progress of these items. • These items tend to be procured towards the end of the project, so it is reasonable to expect that much of this had not been procured as of the end of September 2017. • Assume the remaining budget will be spent.
244648	KCS COMMUNICATIONS FOR STATION	• Includes OPGW to Long Spruce and Henday, internal comms installed with the distribution networks plus communications equipment for between KCS and RCS and from the site to SCC and BUCC.		• No information provided on the progress of these items. • Some of these items tend to be procured in the leadup to commissioning. • Assume the remaining budget will be spent.
244649	KCS CONSTRUCTION FACILITIES	• Includes procure of fire equipment, fire truck, modular and pre-engineered buildings, motor vehicles, forklifts, load, grader et. • Some site electrical panels and fuel tanks.		• Cost information shows the fire truck has been procured and significant expenditure of fire protection, vehicles and buildings already. • As these are all procured for the purpose of construction, and site construction is in its final stages (moving into commissioning), assume all expenditures are complete and no further activity.
244650	KCS SITE DECOMMISSIONING	• Includes salvage for main camp and construction facilities.		• The site has not yet been decommissioned (as of September 2017). • Keep in full anticipated salvage.
244651	KCS NERC/PHYSICAL SECURITY	• Includes physical security and NERC compliant cyber security, including all consulting and construction.		• Very little has been spent on this item as of September 2017. • Possibly this is an activity that will incur costs later in the project. • Assume the remaining budget will be spent.
244652	KCS SYSTEM STUDIES	• Includes system studies for both KCS and RCS, with the costs divided equally between both sites.		• These studies are usually performed before the project commences. • Assume no more activity on this item.
244653	KCS ELECTRIC POWER FOR CONSTRUCTION	• Includes site electrical distribution and the cost of taxes for consumption of electrical power.		• While the construction and installation components would have been completed prior to commencement of construction, there will be continued consumption of electrical power for the next 9 months+. • No information available on how much power consumption and the value of these taxes going forward. • Assume the remaining budget will be spent.
244654	KCS PROJECT MANAGEMENT	• Includes costs for Manitoba Hydro personnel to provide: - cost and scheduling services - project accounting services		• These activities would be expected to continue until the end of project works (July 2018). • No information available on forecast costs for these activities.

1a, 7a, 8a

[24] Email from Alastair Fogg of Manitoba Hydro on 14 November 2017.

Network No.	Description	Scope Inclusions[23]	Budget	Anticipated Future Activity
		- project and engineering management - health and safety management - project insurance - quality assurance (third party) - builder's risk insurance at KCS - wrap up liability, builder's risk, deductible expenses and policy extensions		• 75% has been spent. • Given the converter station contracts were signed in October 2014 (3 years ago) and there is approximately 9 months remaining after September 2017 (i.e. 20% of project duration remaining), it is reasonable to assume the remaining 25% will be spent.
244655	KCS CONSTRUCTION MANAGEMENT	• Includes both Manitoba Hydro and contracted personnel to undertake site management, construction management, contract administration, cost and scheduling services, site engineering and work package management.		• This item includes budgeted amounts close to $3.8M for commissioning activities. • Just over 60% of the site construction and safety management has been spent. • Converter station site construction commenced approximately 24 months ago with 9 months remaining, it is reasonable to expect that the remaining 40% will be spent (plus commissioning budget). • Assume the remaining budget will be spent.
244657	KCS TRANSPORTATION & TRAVEL	• Incudes travel and transportation costs for Manitoba Hydro personnel and contracted personnel. • Includes all costs directly to MH personnel (including contracted personnel) travelling to and from KCS		• Just over 55% has been spent to date. • Assume the remaining budget will be spent.
244658	KCS SERVICE & SUPPLY CONTRACTS	• Services required during KCS construction, including catering, janitorial, security, maintenance, emergency medical services. employee retention and support, Manitoba Advanced Education and Training Referral Services, satellite services, TV, internet and telephone, landfill and parking, sewage removal and portable toilets, propane gas, fuel and septic services and interim camp accommodations.		• With the exception of interim camp accommodations, these costs will be expected to continue to be incurred until the end of site activities. • Just over 65% of the original budget has been spent. • Converter station site construction commenced approximately 24 months ago with 9 months remaining, it is reasonable to expect that the remaining 35% will be spent. • Assume the remaining budget will be spent.
244660	KCS COMMUNICATIONS FOR CONSTRUCTION	• Includes communications in site trailers during construction - telephone, FAX and LAN and fibre optic messenger cables and internal labour, supply contracts.		• Those items associated with general infrastructure should be complete. • The remaining items are well under-budget – only 43% spent to date. • Assume the remaining budget will be spent.
244662	KCS CONSTRUCTION OFFICE	• Include miscellaneous purchase orders to procure materials and equipment as needed. • Purchase cost of office equipment, office furniture, printers and supplies.		• It is expected that the majority of the more expensive items required for the construction office would have already been procured with only office supplies (non-material) outstanding. • Assume no further activity on this item.
244663	KCS CAMP FACILITIES	• Site improvement, engineering, construction of a high quality 600 person residence including kitchen, lounge and common room facilities. • Furnishings, finishings and equipment 3 x pre-engineered buildings for recreation centre, emergency response and maintenance building. • Supply and setup of all furnishings and equipment, including gym, appliances and furniture. • All camp and camp lagoon construction, - potable water treatment plant, fire suppression storage tank and domestic water systems.		• All of these activities should have been completed early in the project. • Assume no further activity on this item.
244664	KCS SURVEY, INSPECTION & TESTING	• Includes supplies and services required for quality assurance. • Set up of new concrete testing lab, aggregate testing, new mobile soils testing lab, survey equipment and seismic and vibration monitoring equipment. • Site inspection services, concrete inspection and water testing, engineering survey services.		• It is expected that the various labs and civil testing facilities have already been procured with very little ongoing need for concrete inspection, water testing and engineering survey services. • Assume no further activity on this item.
244674	KCS EXTERNAL INFRASTRUCTURE	• Includes upgrades to the existing stores and staging area, repairs to existing buildings, regrading 160,000m2 of fenced area and general site improvements. • 1.4km of ballast and rail and remediation of existing rail.		• Many of these activities are expected to have occurred early in the project. • Includes provincial road upgrades. • No information available as to the status of these activities. • Assume no further activity on this item.

1a, 7a, 8a

Network No.	Description	Scope Inclusions[23]	Budget Remaining	Anticipated Future Activity
244676	KCS STORES	• Includes the cost of miscellaneous local purchases, the relocation of foldaway and existing "coverall" buildings and maintenance costs for yard and fabric storage buildings. • Yard fencing, wheeler storage trailer, shelving, tarps, slings, barriers and warehousing in Winnipeg.	[redacted]	• The vast majority of equipment now installed. • Expect that the cost of warehousing buildings and yards was incurred early in the project. • Assume no further activity on this item.
250135	KCS Environmental	• Includes the management and administration of Environmental Protection Program during construction. • The preparation of documents, correspondence, work permit preparation on crown land, familiarity with water rights act and related activities • Costs for consultants for monitoring work (vegetation, heritage, aquatic and mammals), including 2 years post-construction		• Budget included need for monitoring for 2 years post construction. • Assume the remaining budget will be spent.

1a, 7a, 8a

Table 17 - P15541 - Riel Converter Station - Status of Other Networks

Network No.	Description	Scope Inclusions[25]	Budget Remaining	Anticipated Future Activity
244615	RCS SITE INTEGRATION	• Civil site development, ancillary and auxiliary buildings, insulation stone, asphalt pavement, re-vegetation, landscaping and signage. • Includes underground infrastructure (drain extensions, fire water line, fire hydrants etc).	[redacted]	• The bulk of this work should be complete, covering site preparation, civil and underground works. • There will still potentially be some insulation stone, asphalt, re-vegetation and landscaping to be done. • No information available on the status of these works. • Assume the remaining budget will be spent.
244616	RCS HVDC CONVERTERS AND ASSOCIATED EQUIP	• Elements not directly associated with the Siemens/Mortensen contract includes line fault locators and special protection schemes, grounding studies, construction work oversight and support services. • Also includes HVDC expertise for early phases of the project.		• Assume line fault locators and SPS schemes installed. • Grounding studies should be complete. • Early phase of project sunk cost. • Some outstanding activity for oversight completion of Siemens/Mortensen Contract. • With an anticipated site completion date of 20 July 2018, there remains another 9 months of construction oversight for this contract. • No information available on ongoing costs for construction oversight. • Assume a portion of the remaining budget will be spent on these activities.
244617	RCS INTERFACES/BOP	• Includes supplementary electrical and mechanical works, transition structures, 230kV and 12kV connections, DC line connections, ground grid, electrode connections and lightning protection.		• Some of these activities are likely complete – electrical and mechanical interfaces, ground grid, lightning protection and some of the high voltage connections. • There may be remaining activities for the 230KV, DC line and electrode connections although no information available on the status of these works. • Assume the remaining budget will be spent.
244618	RCS SYNCHRONOUS CONDENSERS	• Elements not directly associated with the Voith contract includes construction work oversight and support services. • Also includes expertise for earlier contract phases.		• Early phase of project sunk cost. • Some outstanding activity for oversight completion of Voith Contract. • With an anticipated site completion date of August 2018 (SC5), there remains another12 months of construction oversight for this contract. • No information available on ongoing costs for construction oversight. • Assume a portion of the remaining budget will be spent on these activities.
244619	RCS ELECTRODE SITE	• Covers the design, installation and construction of the electrode and the access road to electrode site. • Includes internal costs for detailed design, construction		• Based on advice from Manitoba Hydro, assume no further expenditure on this item.

1a, 7a, 8a

[25] Taken from Manitoba Hydro document "Bipole III Project, basis of Estimate Document, September 2014 Cost Estimate Update", Revision 0, March 2015.

Network No.	Description	Scope Inclusions[25]	Budget	Anticipated Future Activity
		management and oversight, support services.		
244620	RCS OPS, MTCE & TEST EQUIPMENT	• Includes furniture for all site buildings, test equipment and motor vehicles, plus internal labour to procure these.		• No information provided on the progress of these items. • These items tend to be procured towards the end of the project, so it is reasonable to expect that much of this had not been procured as of the end of September 2017. • Assume the remaining budget will be spent.
244621	RCS COMMUNICATIONS FOR STATION	• Includes communications equipment for between KCS and RCS and from the site to SCC and BUCC. • Also communications to Dorsey.		• No information provided on the progress of these items. • Some of these items tend to be procured in the leadup to commissioning. • Assume the remaining budget will be spent.
244622	RCS CONSTRUCTION FACILITIES	• Includes procure of modular and pre-engineered buildings, motor vehicles, forklifts, loaders, etc. • Some site electrical panels, toilets, washcars and fuel tanks.		• Cost information shows the expenditure to date on vehicles and buildings are significantly below budget. • As these are all procured for the purpose of construction, and site construction is in its final stages (moving into commissioning), assume all expenditures are complete and no further activity.
244623	RCS SITE DECOMMISSIONING	• Includes salvage for main camp and construction facilities.		• The site has not yet been decommissioned (as of September 2017). • Keep in full anticipated salvage.
244624	RCS NERC/PHYSICAL SECURITY	• Includes physical security and NERC compliant cyber security, including all consulting and construction.		• Very little has been spent on this item as of September 2017. • Possibly this is an activity that will incur costs later in the project. • Assume the remaining budget will be spent.
244625	RCS SYSTEM STUDIES	• Includes system studies for both KCS and RCS, with the costs divided equally between both sites.		• These studies are usually performed before the project commences. • Assume no more activity on this item.
244626	RCS ELECTRICAL POWER FOR CONSTRUCTION	• Includes site electrical distribution and the cost of taxes for consumption of electrical power.		• While the construction and installation components would have been completed prior to commencement of construction, there will be continued consumption of electrical power for the next 9 months+. • No information available on how much power consumption and the value of these taxes going forward. • Assume the remaining budget will be spent.
244627	RCS PROJECT MANAGEMENT	• Includes costs for Manitoba Hydro personnel to provide: - cost and scheduling services - project accounting services - project and engineering management - health and safety management - project insurance - quality assurance (third party)		• These activities would be expected to continue until the end of project works (July 2018). • No information available on forecast costs for these activities. • 60% has been spent. • Given the converter station contracts were signed in October 2014 (3 years ago) and there is approximately 9 months remaining after September 2017 (i.e. 20% of project duration remaining), it is reasonable to assume at least 25% will be spent. • Reduce remaining budget by 15% of original budget (approx. $2.8M).
244628	RCS CONSTRUCTION MANAGEMENT	• Includes both Manitoba Hydro and contracted personnel to undertake site management, construction management, contract administration, cost and scheduling services, site engineering and work package management.		• This item includes budgeted amounts close to $4.0M for commissioning activities. • Only 37.5% of the site construction, safety management and HVDC construction support has been spent. • Converter station site construction commenced approximately 24 months ago with 9 months remaining, it is reasonable to expect that another 25% will be spent (plus commissioning budget). • Reduce remaining budget by 37.5% of original budget for these three activities (approx. $7M).
244630	RCS TRANSPORTATION & TRAVEL	• Incudes travel and transportation costs for Manitoba Hydro personnel and contracted personnel. • Includes all costs directly to MH personnel (including contracted personnel) travelling to and from RCS.		• Just over 30% has been spent to date. • Assume the remaining budget will be spent.
244632	RCS COMMUNICATIONS FOR CONSTRUCTION*	• Includes communications in site trailers during construction - telephone, FAX and LAN and fibre optic messenger cables and internal labour, supply contracts.		• Those items associated with general infrastructure should be complete. • Assume the remaining budget will be spent.
244633	RCS CONSTRUCTION OFFICE	• Include miscellaneous purchase orders to procure materials and equipment as needed. • Purchase cost of office equipment, office furniture, printers and supplies.		• It is expected that the majority of the more expensive items required for the construction office would have already been procured with only office supplies (non-material) outstanding. • Assume only the remaining consumables budget ($0.264M).

1a, 7a, 8a

Network No.	Description	Scope Inclusions[25]	Budget Remaining	Anticipated Future Activity
244634	RCS SURVEY, INSPECTION & TESTING	• Includes supplies and services required for quality assurance. • Set up of new concrete testing lab, seismic and vibration monitoring equipment. • Site inspection services, concrete inspection, engineering survey services.	[redacted]	• It is expected that the various labs and monitoring equipment have already been procured with very little ongoing need for concrete inspection and engineering survey services. • Assume no further activity on this item.
244635	RCS STORES	• Includes shelving for storages and warehousing in Winnipeg, along with maintenance costs for the stores building and internal labour for a storekeeper and utility worker. • .		• The vast majority of equipment now installed. • Expect that the cost of warehousing buildings and yards was incurred early in the project. • Assume no further activity on this item.
244636	RCS SERVICE & SUPPLY CONTRACTS	• Services required during RCS construction, including site engineering, cost and schedule services, janitorial, security, maintenance, emergency medical, telephone services, landfill charges, sewage removal, maintenance of portable toilets and supply of fuel.		• Many of these costs will be expected to continue to be incurred until the end of site activities. • Only 28% of the original budget has been spent. • Converter station site construction commenced approximately 24 months ago with 9 months remaining. • It is reasonable to expect that no more than 30% of the original estimate will be spent to end of the work. • Assume only $1.92M to remain in the budget.
244675	RCS EXTERNAL INFRASTRUCTURE	• Includes rail upgrades at the RCS site (2km) and turnout. • Also includes internal labour for procurement and legal services.		• These activities should have occurred early in the project. • Assume no further activity on this item.
250136	RCS Environmental	• Includes the management and administration of Environmental Protection Program during construction. • The preparation of documents, correspondence, work permit preparation on crown land, familiarity with water rights act and related activities • Costs for consultants for monitoring work (vegetation, heritage, aquatic and mammals), including 2 years post-construction		• Budget included need for monitoring for 2 years post construction. • Assume the remaining budget will be spent.

1a, 7a, 8a

For Keewatinohk, the assumptions summarised in Table 16 mean that of the remaining budget of [redacted] for this WBS, at least another [redacted] will be expected to be incurred, plus what assumptions can be made for ongoing activities for cost network 244644. If we assume 10% of remaining budget for continued oversight of the HVDC converter installation works (i.e. [redacted]) – that means approximately [redacted] remaining plus the outstanding commitment on the Siemens Mortensen contract.

1a, 8a

For Riel, the assumptions summarised in Table 17 mean that of the remaining budget of [redacted] for this WBS, at least another $58.1M will be expected to be incurred, plus what assumptions can be made for ongoing activities for cost networks 244616 and 244618. If we assume 10% of remaining budget for oversight of the HVDC converter installation works and the synchronous condenser installations works (i.e. [redacted]) – that means approximately [redacted] remaining plus the outstanding commitment on the Siemens Mortensen and Voith contracts.

1a, 8a

Combining these two amounts ([redacted] including PST) with the amounts owing on the Siemens/Mortensen contract (estimated at approximately [redacted] including PST) and the Voith contract (estimated at approximately [redacted] including PST), this comes to approximately [redacted] (including PST), well below the combined remaining budget of [redacted], without having to dip into contingency (P23837).

1a, 8a

3.1.3 P15544 - Keewatinohk 230KV AC Switchyard

According to the costing information provided, this WBS has a number of networks covering preliminary engineering, foundations, buildings linear infrastructure, circuit breakers, station services, control and protection, communications and AC switchgear for the new 230kV switchyard located adjacent to the

Keewatinohk Converter Station. This includes an EPC contract for the substation works. The breakdown of actual versus 2016 budgeted expenditure is shown in Table 18.

Table 18 - WBS15544 - Budget vs Actual

Network No	Description	2016 Budget	Sept 2017 Actual	Budget Remaining
244671	KCS 230kV AC Switchyard	[redacted]		
244673	Spare network – 230kV Switchyard			
	Not assigned			
		164,235,230.53	**160,823,007.09**	**3,412,223.44**

1a, 7a, 8a

Table 18 shows that majority of the budget has been spent as of September 2017.

In cost network 244671, the largest single cost will be the SNC Lavalin contract, which has a reported current contract value of [redacted] (including PST), making up close to [redacted] of the budgeted amount. The estimated amount outstanding on this is estimated to be $30M (not including PST) or, using the same PST assumptions previously, approximately [redacted] including PST. Assuming no further Manitoba Hydro activity (which is unlikely), the deficit will be about [redacted] Including another [redacted] for Manitoba Hydro costs, this will require at least [redacted] from contingency.

1a, 8a

3.1.4 P21082 - Keewatinohk Converter Station Distribution

The 2014 Basis of Estimate does not provide any detail as to what is and is not included within this WBS.

From the detailed cost estimate data, the scope covered by this WBS covers a number of smaller activities associated with providing power distribution to the site, and includes:

- Relocation of Keewatinohk LC9 Line
- Power to the Keewatinohk Start Up Camp
- Power to the Security Gate House
- EMPA Distribution
- Converter Station Distribution
- Converter Station Batch Plant

The reported amount incurred to September 2017 is [redacted] With a 2016 budget of [redacted] there is [redacted] remaining in the budget.

1a

While no details are provided, these activities appear related to the initial provision of power and a number of site construction and up-front works. It is reasonable to expect that any further expenditure on this WBS, if any, would be non-material.

3.1.5 P14363 - Property for Riel Converter Station

Manitoba Hydro owns the land for the Riel Converter station[26]. The land was privately owned and purchased prior to construction. The Manitoba Report published in 2014 advised that the costs included in the estimate are the sunk costs of purchasing the land[26].

This WBS has only one Network (243351). The breakdown of actual versus 2016 budgeted expenditure is shown in Table 19.

[26] Manitoba Hydro, "Bipole III Project, Basis of Estimate Document, September 2014 Cost Estimate Update", Revision 0, March 2015, Page 85.

Table 19 - WBS14363 - Budget vs Actual

Description	2016 Budget	Sept 2017 Actual	Budget Remaining
REQUIRED LAND PURCHASE* Total	[redacted]		
OPTIONAL LAND PURCHASES Total			
LAND - SALE OF SURPLUS ITEMS Total			
Not assigned Total			
-	**18,030,907.33**	**17,842,418.11**	**188,489.22**

1a, 7a

The majority of costs associated with this project has been related to the land purchase. Given the project site works are close to completion and advice that the Riel Converter Station land was purchased before 2014, it is reasonable to expect that any further expenditure on this WBS, if any, would be non-material.

3.1.6 P14364 - Riel Conv & 230KV AC Switchyard Site Dev

Amplitude has received no information on the major contract associated with this work.

According to the costing information provided, this WBS has a number of networks covering site development (including contract and protection management, provision of circuit breakers, grounding and technical studies, civil and electrical works and commissioning), an EPC contract for the work at Riel Converter Station, some old (assumed to be sunk) costs for the Bipole III 230kV expansion and some communication works. The breakdown of actual versus 2016 budgeted expenditure is shown in Table 20.

Table 20 - WBS14364 - Budget vs Actual

Network No	Description	2016 Budget	Sept 2017 Actual	Budget Remaining
243371	Riel Converter Site Development Total	[redacted]		
243400	Design/Construct for Riel Convert Total			
243443	Riel Station Eng. Procurement Contract Total			
244172	(OLD)Riel C.S. 230KV Expansion for BPIII Total			
246108	Riel Converter Site Dvlpmt-Const Pwr Total			
246242	Riel Communications Total			
4302550	Riel Station 230 kV Expansion Ph2 Total			
#	Not Assigned Total			
		132,721,211.72	**131,855,257.75**	**865,953.97**

1a, 7a, 8a

Table 20 shows that majority of the budget to be spent as of September 2017. As we have not received any updated schedules or contract reports for this work, Amplitude is unable to provide an opinion as to whether this budget is expected to be used or if this work will require anything from contingency.

3.1.7 P:23788 - Riel 230 KV Expansion for Bipole III

Amplitude has received no information on the major contract associated with this work.

The breakdown of actual versus 2016 budgeted expenditure is shown in Table 21.

Table 21 – WBS23788 - Budget vs Actual

Network No	Description	2016 Budget	Sept 2017 Actual	Budget Remaining
253035	Riel C.S. 230kV Expansion for BPIII	[redacted]		
253036	Riel HVDC Reduction for Riel Expansion			
#	Not Assigned Total			
		86,810,310.68	**72,245,731.04**	**14,564,579.64**

1a, 7a

Table 20 shows that majority of the budget to be spent as of September 2017. As we have not received any updated schedules or contract reports for this work, Amplitude is unable to provide an opinion as to whether this budget is expected to be used or if this work will require anything from contingency.

However, it is expected from observations of other parts of the project that the majority of this work should be complete, and therefore it is assumed that the remaining budget will be adequate to finalise any outstanding activity.

3.2 Conclusions & Recommendations

- In our view, the remaining budget for the Keewatinohk 230kV AC Switchyard (P15544) will not be enough to cover the outstanding contract amounts payable to SNC Lavalin and will require a draw from contingency of the order of at least [redacted] 1a, 7a, 8a
- For the remaining WBS numbers associated with the HVDC converter stations (i.e. P14363, P14364, P15533, P15540, P15541, P21082, and P23788), the information made available indicates that there should be satisfactory amounts remaining in the budgets for each WBS to complete the project without having to draw from contingency.
- The current contingency budget for the converter stations (P23837) is [redacted] Taking out the [redacted] from P15544 should leave approximately [redacted] remaining to cover the impact of any unexpected events or activities which cannot be ascertained from the information made available for this review. 1a, 7a, 8a
- No information has been provided on outstanding contracts associated with P14354 and P23788, covering the Riel 230kV AC switchyard site development and the Riel 230kV expansion. It has been assumed that given the current status of the site works, these activities are expected to be complete or close to completion and no further material costs are expected.

3.3 Source of Information & Reference materials

- Manitoba Hydro, “BPIII CS CPJ Comparison vC14 vs vC16 Actual spend to Sept 30, 2017.xlsx”.
- Manitoba Hydro, “Bipole III Project, Basis of Estimate Document, September 2014 Cost Estimate Update, Revision 0,” March 2015.
- K. Savage, “Email,” 18 Nov. 2017.
- A. Fogg, “Email,” 14 Nov. 2017.

APPENDIX C

Scheduling Best Practices

Scheduling Best Practices

Manitoba Hydro has developed procedures for the Keeyask and Converter Station projects which generally follow recommended best practices by the Project Management Institute and/or AACE International; however, there does not appear to be any mechanism for enforcement of these procedures.

Due to the size, complexity and dollar value of these projects, a Project Management Office (PMO) would provide governance to Manitoba Hydro's major projects. The role of the PMO could include defining and updating existing standards and processes, developing and delivering project management training, mentoring, and conducting periodic audits on projects to identify non-conformance to documented schedule, cost, and risk procedures. The establishment of a PMO should reduce bureaucracy and duplication of effort across the projects while ensuring consistency and transparency.

Areas Requiring Improvement

- Basis of Schedule: There is no Basis of Schedule for the Keeyask Integrated Master schedule (IMS), the MMTP, nor the GNTL schedules. There is a Basis of Schedule for the Bipole III Converter Station. The General Civil Contractor for Keeyask, BBE, appears to be the only major contractor who submitted a Basis of Schedule. The Amending Agreement #7 (AA7) Basis of Schedule submitted by BBE was rejected by Manitoba Hydro. The Basis of Schedule should be a live document with updates as the schedule changes.
- Schedule Development: Bid packages should clearly identify schedule expectations and schedules not meeting these expectations should be rejected. Manitoba Hydro scheduling procedures should outline acceptable logic types within a schedule (e.g., Finish to Start (FS) versus Start to Start (SS), Finish to Finish (FF), or Start to Finsh (SF), maximum duration for any activity, maximum amount of lag, number and type of constraints allowed, removal of negative float, and how to handle planning packages (latest timing on decomposing the activities). How change orders are reflected in the schedule should also be considered. For example, if an activity has already started, how is additional scope handled in the schedule?
- Schedule Quality:
    - Missing logic: only the start activity should not have a predecessor and only the finish activity should not have a successor.
    - High duration: if they are planning packages, they should be identified as such in the schedule. These planning packages should be broken down into more detail before the work commences.
    - Use of relations other than Finish to Start (FS). Activities using other types of relations should be reviewed and changed where possible.
    - Hard constraints should be removed. If a constraint is required, change the constraint to a soft constraint which does not violate critical path method logic this should also resolve much of the negative float.
    - Lags: Consider replacing lag with activities to add visibility to the schedule.
- Schedules should be fully resource loaded.

- The Work Breakdown Structure developed for the project should be the same Work Breakdown Structure used in the schedule.
- Ensure activity names use a verb/noun construct (e.g., Pour Concrete) and that each activity name clearly identifies the work being performed and is unique so when the schedule is grouped or filtered differently, the activity name will still make sense. Avoid the use of acronyms and abbreviations.
- Pick one system to track costs, quality and progress. For example, Ecosys is system which integrates a variety of tools such as P6, SAP, and estimating systems to facilitate the creation of a "single version of the truth".